UNITED STATES COMMISSION OF FISH AND FISHERIES.

PART VII.

REPORT

OF

THE COMMISSIONER

FOR

1879.

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

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LETTER

FROM THE

COMMISSIONER OF FISH AND FISHERIES,

TRANSMITTING

His report for the year 1879.

MARCH 15, 1880.—Ordered to lie on the table and be printed.

UNITED STATES COMMISSION, FISH AND FISHERIES,
Washington, February 24, 1880.

GENTLEMEN: In compliance with the order of Congress I have the honor to transmit herewith my report for the year 1879, as United States Commissioner of Fish and Fisheries, embracing, first, the result of inquiries into the condition of the fisheries of the sea-coast and lakes of the United States; and, second, the history of the measures taken for the introduction of useful food-fishes into its waters.

Very respectfully, your obedient servant,

SPENCER F. BAIRD,
Commissioner.

HON. WM. A. WHEELER,
President of the United States Senate, and
HON. S. J. RANDALL,
Speaker of the House of Representatives.

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REPORT OF THE COMMISSIONER.

A.—GENERAL CONSIDERATIONS.

1.—INTRODUCTORY REMARKS.

The present report is intended to furnish an account, in compliance with law, of the operations of the United States Fish Commission during the year 1879, and for some of the branches of the work during the early portion of 1880. This continuation applies especially to the propagation of the eastern salmon, the land-locked salmon, the whitefish, and the cod.

The continued increase in the extent of the field of labor, referred to in previous reports, manifested itself also in 1879, as new subjects of inquiry presented themselves and increased the demands for service in the propagation and distribution of food-fishes. The appreciation of the work by Congress is shown by the increase in the amount of the appropriations, all of which, it is hoped, have been expended with due economy and consideration.

The machinery of the Commission, and especially its personnel, continues to be very limited, so that as much of the appropriation as practicable is used for the direct objects of the Commission.

The most noted features in the history of the Commission for the year are: First, the commencement of the distribution of young carp to various points in the United States; and, secondly, the authorization by Congress of the construction of a special steam-vessel to serve as a floating station for the hatching of shad and other useful food-fishes. More particular allusion to this will be made under the appropriate heading.

A pleasant experience of the year was the visit of The President and Cabinet to the Havre de Grace shad-hatching station on the 7th of June.

It is with very great regret that I chronicle the death, on the 6th of January, 1880, of Mr. James W. Milner, who has been connected with the Fish Commission as its principal assistant almost since its first inception in 1871. In that year he was detailed to make an investigation of the fisheries of the lake region, the results of which were published in the annual reports of the Commission. From that time he had particular charge of the field work connected with the propagation of the shad, and their transfer, and that of other species, to various parts of the United States. An earnest, patient, and able investigator, he very soon made himself familiar with the history of fish culture in general and the application of the various forms of fish-hatching apparatus to the needs of the Commission. Some very important modifications of machinery were due to his ingenuity, and, had he lived, it is safe to assume that he would have made a very distinguished record in his favorite science.

Mr. Milner's illness, in his own opinion, was first caused by exposure while superintending the work of hatching shad at Avoca, N. C., in the spring of 1878, and afterwards on the Susquehanna. He returned to Washington, where he remained several months during the summer, and then went back for a time to his residence in Waukegan, Ill.

After it had been determined to commence the work of hatching codfish at Gloucester in the winter of 1878–1879, Mr. Milner came to that station just prior to the breaking up of the summer party, and superintended the beginning of the work. Continuing to grow worse, he was ordered by his physician to Washington; and after remaining there for a few months he went to Florida where he staid during the winter and the early spring. Here he was able to spend a good deal of time in the open air, and to make a number of collections for the National Museum. Returning to Waukegan somewhat too soon, he took fresh cold, and, after a time, was directed to spend the summer in the high mountain region of Colorado. Not much benefit resulted from this experiment, and in the autumn of 1879 he again returned to Waukegan, and lingered there for several months until his death on the date mentioned.

As explained in previous reports, the work of the Commission falls naturally under two distinct heads: First, the investigation into the condition of the fisheries of the United States; their statistics: manner of prosecution: and how the service can be improved further, in the methods of capture, preparation, and preservation, or the increase in abundance. Secondly, the actual increase of the supply by artificial propagation and transfer to new localities or their multiplication in those in which an original abundance had become greatly reduced.

The first division of the work, as heretofore, has been, for the most part, conducted by Mr. G. Brown Goode, assisted by Dr. T. H. Bean.

The collection and determination of the marine invertebrates has been in charge of Prof. A. E. Verrill, with assistants to be mentioned hereafter.

In the illness and necessary absence of Mr. Milner I was very fortunate in being able to secure the co-operation of Mr. T. B. Ferguson, the Maryland commissioner of fisheries, of whose services, both to the cause of fish culture in general and the United States Fish Commission in particular, I have repeatedly made mention.

Of the several permanent stations of the Commission, the carp ponds have been as before under the charge of Mr. R. Hessel; the California salmon hatchery, under that of Mr. Livingston Stone; and those of the

Penobscot salmon, and the land-locked salmon, under that of Mr. Charles G. Atkins.

Fuller details will be furnished hereafter in regard to the various branches of operation.

2.—SPECIAL OBJECTS OF THE UNITED STATES FISH COMMISSION.

In the report for 1878 I have given in considerable detail, not necessary to be repeated here, a sketch of the objects of the Commission. Of course as the old problems are solved new points of inquiry arise to take their places, and in the wide range of subjects covered by the field of the Commission a vast deal remains to be done before its objects can be considered as properly accomplished.

Before proceeding to give special details connected with the different operations of the Commission, it gives me pleasure to acknowledge the services that have been rendered both by the Government and by private parties. The law in the statute book requiring the executive departments of the government to render the Commission all necessary and practical aid has, as heretofore, been faithfully carried out by them, as follows:

3.—ASSISTANCE RENDERED TO THE COMMISSION.

As in previous years, the work of the United States Fish Commission has been very greatly facilitated by the co-operation of various bodies, public and private.

The Navy Department.—The most important aid was rendered by the Secretary of the Navy, in the detail of the United States steamer Speedwell, under Lieutenant Tanner, with a full crew, for a three months' service, as referred to under the head of deep-sea research. Also, by the loan of a steam launch for service on the Susquehanna River.

Treasury Department.—The Bureau of Revenue Marine, of the Treasury Department, instructed Captain Fengar, of the cutter Ewing, stationed at Baltimore, to transport three scows of the Commission from Havre de Grace to Crisfield, Md., and from Crisfield to Baltimore.

The Light-House Board has continued its co-operation in requiring the keepers of light-houses and light-ships to make and render monthly a record of the temperature of the water.

The United States Coast Survey, under Captain Patterson, supplied a large number of charts for the use of the Commission; and also lent a number of Casella-Miller thermometers, while awaiting a supply from London.

The War Department.—The Secretary of War authorized the expenditure by the Engineer Bureau of an available portion of the river and harbor appropriation for dredging a channel through the bar at Spesutie Island, below Havre de Grace, to allow the passage of launches at low water to the fish-hatching barges near the island.

General Warren, of the Engineer Bureau, allowed the use of the schooner belonging to his office, during a period of several months in the summer, when not required by him, the Commission, of course, paying the running expenses.

The Signal Office lent the wire and cable together with the instruments necessary to effect telegraphic communication between Havre de Grace and the barges of the Commission at the Head of Chesapeake Bay. General Meyer also directed his observers to take special note of water temperatures at all the stations along the Atlantic and Pacific coasts, supplying thermometers to the observers already referred to, on the light-ships and at the light-houses. The blank was furnished by the Commission.

A detail of a military guard at the salmon-hatching station on the McCloud River by General McDowell was of great importance in protecting the property of the government against a crowd of lawless Indians and whites. An illustration of the value of this service is shown in the accompanying letter from Mr. Stone, in charge of the station.*

The Railroads.—All the railroads of the country to which application was made for the favor furnished circulars to agents and baggage-masters, instructing them to facilitate in every possible way the operations of the Commission, especially by accepting government orders for transportation and authorizing the carrying in baggage cars, without any charge, the cans containing young fish.

A list of the routes referred to will be found in the appendix.

The Pennsylvania Railroad Company in addition furnished a car, free of charge, for the transportation of all the eggs of California salmon from Chicago to Washington. The Philadelphia, Wilmington and Baltimore Railroad also rendered a similar favor in connection with the movement of young shad to various parts of the country.

Ocean Steamers.—The offer of free transportation of messengers and fish was made by the North German Lloyds, between Bremen and New York, and by the Royal Mail Steamship Company, between New York and Boston and Liverpool.

Telegraph Companies.—The Western Union Telegraph Company granted permission to stretch a telephone wire on its poles between Havre de Grace and Aberdeen, beyond which to the hatching station barges it was sustained by the flying poles of the Signal Office.

[*Extract from a letter written by Mr. Livingston Stone, September 23, 1879, United States Fishery, Baird, Shasta County, California.]

The value of our military guard was well illustrated this week, as follows: Some ill-favored fellows had been hanging around here for some time, and one day they appeared with a horse and wagon. I felt sure that they meant to steal our salmon, and, indeed, the next morning, just at day-break, the soldiers caught them in the very act of taking the spawning-salmon out of the corral. They undoubtedly meant to take a wagon load. They met with pretty rough treatment from the soldiers, as they deserved, and the circumstance is worth a great deal to the fishery, from the effect that it will have in the community around us, upon both Indians and white men.

4.—SERVICES RENDERED BY THE UNITED STATES FISH COMMISSION.

The extent and character of the distribution of eggs and young fish by the Fish Commission during the year will be found detailed in special reports on that subject and in the accompanying tables.

It may be well to call attention to what has been done in supplying eggs and fish to other countries. This has been done partly as an experiment, partly as a return for favors the transportation received, and partly for the purpose of keeping up an international comity, such as should prevail between various governments. A handsome acknowledgement was made on the part of the French authorities, in the form of a gold medal issued to the Fish Commission for its services in introducing the California salmon into France. In reply to an application to that effect a full series of the reports of the Commission was presented and a large amount of special information furnished.

At the close of the International Exhibition of 1876 an organization, entitled "The Permanent Exhibition Company," took charge of the main building and secured a large portion of the contents for the purpose of maintaining, with new additions, an interesting exhibition of the resources and industries of the world in general. Their plan included illustrations of processes of various kinds, and among them those relating to fish culture. Application was made to the Fish Commission for its assistance in this connection. As, however, the immediate work of the Commission required all its material and machinery, it was thought inexpedient to incur any extra expense in having additional apparatus prepared for this purpose. The invitation was, therefore, respectfully declined.

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

5.—FIELD OPERATIONS DURING THE SUMMER OF 1879.

Reference has been made in previous reports, as well as in the commencement of the present one to the services rendered by the Navy Department to the Fish Commission in the prosecution of its inquiries into the condition of the fisheries of the Eastern coast of the United States, the detailing, first, of the small launch in 1871; then of the "Blue Light" in 1873, 1874, and 1875, and of the "Speedwell" in 1877 and 1878, having been duly acknowledged. The work of the year 1879 has shown a similar dependence upon the co-operation of that department in the renewal of the detail of the Speedwell. Commander L. A. Beardslee having been assigned to other duty, Lieut. Z. L. Tanner, an experienced officer of the Navy, was placed by the secretary in command, with Mate James A. Smith, as executive officer, William B. Boggs, as engineer, John Corwine, as paymaster, and Dr. J. H. Kidder, as surgeon. Dr. Kidder acted in a similar capacity to the Commission in 1875.

Provincetown having been selected as being the center of a region hitherto unexplored by the Commission, and as furnishing much opportunity for investigation the beginning of July was fixed upon for the commencement of the work of the summer.

With my usual corps of assistants, I left Washington on the 10th day of July, and arrived at Provincetown on the 16th, establishing headquarters at the hotel of Mr. James Gifford. The berth of the steamer, and the laboratory were at the end of the wharf of Messrs. Bowley & Bros., where all necessary conveniences were readily secured. The Speedwell made her first trip to Gloucester to bring over portions of the Fish Commission equipments, which were stored at that place.

As in the previous years of the Fish Commission work, Prof. A. E. Verrill was in charge of the department of marine invertebrates, assisted by Mr. Richard Rathbun and Mr. S. Smith. Mr. G. B. Goode, assisted by Mr. F. W. True and Mr. F. Gardener, jr., supervised the collecting of the fishes, and Capt. H. C. Chester was in charge of the actual work of the dredge and the trawl.

The improvised laboratory at the end of Bowley's wharf furnished a somewhat cramped opportunity for investigation. Much information was gained by the careful study of the various forms of animal life which were brought in by the steamer.

Prof. Henry E. Webster, of Union College, Schenectady, N. Y., who spent the summer in Provincetown with his assistant, Mr. N. W. Benedict, rendered very great service in accompanying and superintending the dredging parties during the temporary absence of Professor Verrill, his own special research being directed toward the Annelida, or worms.

The Speedwell was ready for sea and placed in commission at the navy-yard, Washington, about noon of July 1. When she had taken on board all necessary stores and supplies she left Washington July 9th, arriving at Provincetown July 12, and making the trip in a little over three days. On the 16th of July she proceeded to Gloucester for the purpose of obtaining articles of apparatus which had been left in store at that place, returning to Provincetown on July 20.

The first exploring trip was made on July 21, after which date work continued whenever the weather and the operations of the Commission would permit. The regular routine embraced a sounding and temperature observation both at the surface and at the bottom before lowering either the dredge or the trawl. The vessel experienced no casualties during her term of service beyond the unexpected parting of a new three and a quarter Italian hemp rope. This accident was followed on September 20, by the breaking of a second spare line, bringing the work of the season to a close.

All the most important points within 20 miles of Provincetown were thoroughly explored with the exception of the coast-line between Chatham and the Cape, which had been left for the last trip, and, for reasons already given, was necessarily omitted. This region will, however, be the subject of subsequent examination. After one or two trips had been made for the special purpose of determining certain points relative to ocean temperatures, the Speedwell left for Gloucester on October 1st, there stowing the apparatus and returning to Provincetown. On October 6th the vessel took on board the stores and supplies to be carried back to Washington, as also the collections of natural history, a portion of which were to be left at New Haven, under Professor Verrill's care, the rest being destined for the National Museum. October 12th the Speedwell reached the navy-yard, Washington, and closed finally its relationships with the Fish Commission.

The full details of the work of the Speedwell will be found in an accompanying report by Lieutenant Tanner. From this report it will be seen that the vessel was in commission 116 days; was detained in port, on account of bad weather, for 28 days, and was actually engaged in dredging and trawling 24 days. The total number of hauls made with dredge and trawl was 148, averaging 6 per day. One hundred and eighty soundings were also made. The total distance traveled during the summer trip by the steamer was 3,122 miles.

As usual the commission had a large number of visitors during the summer interested in the general operations, or in some special branch of its work. Among these may be mentioned Prof. Asa Gray, of Cambridge, Dr. Thomas Brewer, of Boston, Mr. Isaac Hinckley, of Philadelphia, Mr. John Foord, editor of the New York Times, Mr. Charles Aldrich, of Iowa, Mr. May, Fish Commissioner for Nebraska, and others.

A great many specimens were gathered in the course of the summer's work, embracing numerous duplicates desired for distribution among the various educational establishments and museums of the country.

Reference is made in another part of this report to the work connected with the investigation of the American fisheries, undertaken in behalf of the census of 1880.

Mr. G. B. Goode, who was in special charge of this department, also had his headquarters at Provincetown with a sufficient corps to carry on his work, and was there enabled to obtain much of the statistical and other information required for the completion of his plan. The general results of the sea-coast work of the summer of 1879, in connection with the statistics of the fisheries, will be embodied in the fishery reports of the census of 1880, and therefore, need not be repeated here.

After his return to Washington Lieutenant Tanner was transferred by the Secretary of the Navy to the supervision of the construction of the Fish Commission steamer Fish Hawk, of which mention is made elsewhere.

In the report for 1878 mention was made of the fact that at the suggestion of the Commission a display station of the Signal Office establishment was put into operation at Gloucester. Finding no such station at Provincetown, and being well satisfied of its importance, I made application to General Myer for a similar service, which was granted.

The station was established there during the summer, and has been continued in operation ever since.

In previous reports mention has been made of the discovery in great abundance off the eastern coast of New England of the pole-flounder, *Glyptocephalus cynoglossus*, a member of the flat-fish family, of large size. This fish, entirely unknown on the American coast until its discovery by the Commission in 1877, has proved to be one of the most abundant of its kind, and promises to be a very important addition to the food resources of the country whenever the beam-trawl shall become generally used by the fishermen. This fish was taken in great quantities during the summer of 1879, and a large extension of its supposed range was established.

A second species of fish, also promising to be of great value as a food-fish, was brought to light during the summer of 1879; specimens were first obtained about eighty miles south of Noman's Land by Captain Kirby, of Gloucester, to be known as the tile-fish or *Lopholatilus chamæleonticeps*, constituting a genus and species entirely new to science. It is believed that the taking of this fish indicates the existence in the region of capture of an important resort of food-fishes in general. This point it is proposed to investigate at some future time.

6.—THE STEAMER FISH-HAWK.

The experience of the Commission has for several years past shown the efficiency and economy of floating stations for the hatching of shad, by means of which, after the work at one locality is exhausted, another can be taken up with the least possible delay. Heretofore the work has been done on floating barges, which have been towed from their winter stations in Washington, Baltimore, or Havre de Grace, to Albemarle Sound, and thence back again, stopping at one or more stations in the course of the season to prosecute their work. Towing has, however, proved to be a matter of great expense, and, in most cases, of peril also, flat-bottomed boats being unfitted for the dangerous navigation of the Chesapeake Bay, where, by a curious fatality, violent storms have generally prevailed whenever such transfer was to be made. The towing has been done by vessels of the revenue marine, through the courtesy of the Secretary of the Treasury and the superintendent of the bureau; but on more than one occasion the barges have been in imminent danger of foundering with their crews and contents.

The advantage, therefore, of having a floating hatchery on a well-constructed steamer, as being more suitable for transfer from point to point, has been urged strongly before the Commission; and, after various plans were considered, the designs of Mr. Copeland, of the Light-House Board, were fixed upon, and the appropriation of Congress of $45,000 for a steamer was made use of. As the law directed, the steamer was to be built under the supervision of the Secretary of the Treasury, and that officer placed it in charge of the Light-House Board.

From among many bids for the building of the same, that of Messrs. Pusey & Jones, of Wilmington, for $44,000, was accepted and the vessel, to be known as the Fish-Hawk, put under contract.

After the close of the cruise of the Speedwell in the autumn of the year, Captain Tanner was detached and placed in charge of the Fish-Hawk, visiting it at short intervals to inspect the progress of the work. In the course of the year considerable advance in its construction was made, and it is hoped that the vessel will be available for use in the spring of 1880. A detailed account of this vessel will probably appear in the next report of the Commissioner.

7.—ABSTRACT OF RESEARCHES PROSECUTED UNDER DIRECTION OF THE COMMISSION.

Among the collateral subjects of attention by the Fish Commission has been an investigation into the chemical composition of fish under the varying circumstances of age, sex, and the condition of the reproductive apparatus. This has a very important bearing both upon the availability of fish for food and also as furnishing material for the making of oils and fertilizers. A large number of analyses have been made by Professor Atwater which already supply the means of important deductions, especially as to the comparative nutritive power of the same quantity of flesh in different species.

A fuller statement of the general results of this inquiry will be found in the next report of the United States Fish Commission.

Among the more important researches made at Provincetown during the summer was that by Dr. Kidder, U. S. N., surgeon of the party, in regard to the temperature of fishes. For a long time it had been supposed that the temperature of fishes was always the same as that of the water in which they happened to be placed, but the experiments of Dr. John Davy indicated that, in some cases at least, especially where mackerel and tunny were the species in question, the actual temperature of the fish was a few degrees higher than that of the water. Dr. Kidder utilized such opportunities as were presented to him in determining this question and obtained some exceedingly interesting results, which have been published by the Fish Commission.

Among the special problems connected with the interests of the fisheries are economical methods for the production of cold, to be used in the preservation of fish for a certain length of time, either directly by reducing the temperature of the storage space, or indirectly by making ice to be employed for a similar purpose. In ordinary seasons, after an abundant ice crop, the ruling prices of $1 to $3 a ton is by no means exorbitant; when, however, as is not infrequently the case, the cost is from $10 upwards, the tax becomes very serious.

Among those who have devoted themselves to the solution of this question is Professor Gamgee, and to his pen am I indebted for an able article published in the last United States Fish Commission report.

Professor Gamgee has kindly offered to continue his investigations on this subject, with a special view of determining the feasibility of constructing a compact machine, which may be of service in bringing fresh to land, the specimens taken on board the Fish-Hawk. His article on the subject I hope to publish in a future report.

One object to which the Fish Commission has devoted much attention has been the bringing together of as complete a series as possible of all the various marine animals of North America, including in this group the seals and cetaceans. Among the least known forms are the larger varieties of porpoise, grampus, and whales, the opportunities for examining the latter being exceedingly scanty. Little can be seen of a whale in the water, whether dead or alive, and when stranded the flaccidity of the body distorts its shape to such an extent as to cause the fish to lose its natural appearance; nearly all the sketches of whales have been made from several different presentations of the animal; and, therefore, although fairly accurate, are not absolutely precise. Some of these sketches have been used for a basis of reconstruction or models of small size for the National Museum. Information having been received by telegram on the 12th of April, from Provincetown, of the stranding of a whale in good condition in Provincetown Bay, I dispatched Mr. Joseph Palmer, the modeler of the National Museum, to see whether he could not obtain a mold in plaster of the animal from which a cast might be made. He accordingly proceeded to Cape Cod, obtaining in Boston a sufficient amount of plaster in barrels for his purpose. On arriving at Provincetown, by the help of Mr. Small and other citizens, he was enabled to take a mold of the animal (a hump-back, about 30 feet long) in sections, which he brought back with him to Washington, and which has been stored in the armory building, to be used in the construction of a papier maché reproduction at the proper time.

The preparation of a series of casts in plaster and papier maché of the larger fishes, begun several years ago, has been continued by Mr. Palmer and his assistant; the painting, as before, having been executed by Mr. A. Zeno Shindler and Mr. John H. Richard.

8.—STATISTICS OF THE FISHERIES, EXCLUSIVE OF THOSE TAKEN IN CONNECTION WITH THE CENSUS.

In the summer of 1878, when the Fish Commission had its headquarters at Gloucester, an arrangement was made with Mr. George J. Marsh, in behalf of Mrs. Rogers, for the rental of a wharf and the necessary buildings at Fort Point for the service of the Fish Commission. These served as its headquarters during the season of 1878, and as the station for the codfish hatching during the winter of 1878–'79. A satisfactory arrangement was made with Mr. Marsh for continuing the lease of the premises for 1879, the necessity for such a station being quite urgent both as the central point from which the statistics of the Gloucester trade could be collected, and as a place of storage for a large amount of Fish Commission property. The station was in charge of Dr. T. H. Bean during the summer of 1879, and of Mr. A. Howard Clark since September, 1879, and to these gentlemen the Commission is indebted for a large amount of valuable information. They have also utilized the opportunity of constant association with the fishing vessels by inducing their captains to preserve and present any curious specimens of marine animals taken on the fishing banks. It is well known that not only are strange fishes frequently taken on the trawls, but starfishes, corals, &c., attach themselves to, or become entangled in, the lines and are hauled on board. Inquiries on board of vessels, as they came in from a trip, have resulted in the obtaining of most important additions to the North American fauna, hundreds of species having thus been procured that would otherwise have been entirely unobtainable.

A special catalogue of the donations derived from this source will be found in the present report.

The actual supervision of the wharf and building has been exercised by Capt. S. J. Martin, of Gloucester, who has remained on duty day and night, and who has also rendered essential service in collecting specimens and information for the Commission.

For the better appreciation of the relationships of the different fishing grounds off the eastern coast of North America, Professor Hilgard kindly consented to superintend the preparation by Mr. Lindenkohl of a relief map of the region between Sandy Hook, N. Y., and the eastern edge of the Grand Bank of Newfoundland, and from the coast of Maine and of the Gulf of Saint Lawrence to south of Nantucket Shoals. Contour lines were traced for the different depths, and the outlines cut out in cards of different colors, superimposed the one upon the other. By using cards of different thicknesses the proportional gradations in depth at each point were indicated in twenty-five-fathom stages up to a hundred and fifty, and by those of fifty fathoms for greater depths. This map has proved to be an object of extreme interest as illustrating much more clearly than has heretofore been possible the localities where the different kinds of fish were obtained, and showing why certain places were especially favorable fishing grounds in certain seasons.

Reference has been made in previous reports to an arrangement with Mr. Linnell, of Boston, for obtaining the statistics of the shore fisheries of Massachusetts, having their center of operations in Boston. The dock of which he is the wharfinger is a place of resort for nearly all the cod, haddock, herring, and other fishermen who sell their cargoes in that city; and as the charge for wharfage is in proportion to the character and number of fish, it becomes an easy matter to estimate with great precision. The fish not included under this arrangement are but a small percentage, and their numbers can be easily averaged.

The arrangement with Mr. Linnell was continued during the year, and his figures have been used in compounding the statistics for the census report of 1880.

9.—LEGISLATION IN REGARD TO FISHERIES.

As might naturally be expected, the real or supposed encroachments of the different classes of fishermen upon each other or the community at large has invoked the effort to secure legislation, both on the part of the United States Government and of individual States, to put a stop to the same. A yet undecided question is as to the actual jurisdiction over the waters, so far as the fisheries are concerned. It would naturally be supposed that the United States would have control at least as far as the three-mile limit of the ocean, beyond which the fisheries are common to the world at large. If this point be conceded, then comes the inquiry, How far can jurisdiction be exercised over the fisheries in the bays and navigable rivers? This question has never been settled.

It is well known that for many years past the menhaden fishery has been conducted during the summer and autumn with the greatest vigor along the coast of Maine, a large number of steamers as well as sailing vessels being employed in the capture of the fish, which are then taken to factories for conversion into oil and material for fertilizers. The extent to which this has been done has, in the opinion of many, greatly tended to drive the fish from the estuaries of the bays and rivers, and thus prevent their utilization by the hand-line fishermen and the resident population generally. Most of the fish are now taken several miles out to sea by the vessels just referred to. In order, therefore, to remedy this evil, a law was passed by the State of Maine prohibiting the use of purse seines within three miles of her shore. This action very naturally excited the antagonism of the menhaden fishermen, and an appeal was made to me for counsel and advice in the matter. While not able at present to say whether the complaints of the people of Maine against the menhaden fishermen are well founded or not, I could only suggest that the opportunity was a favorable one for having the question decided by transferring it to the Supreme Court of the United States. It was accordingly arranged that this should be done by making up a special case and letting it take its legal course. By a most curious coincidence, however, very few menhaden visited the coast of Maine in 1879, the falling off being extremely abrupt and very marked. What occasioned this change of habit on the part of the fish it is impossible to say. It could not have been caused by the excessive pursuit of the fish, as the number on the coast in the fall of 1878 was very great, and should have furnished an ample supply for the season of 1879. It is possible that some variation of ocean temperature or currents affected the food of the fish, if not the menhaden themselves, thus causing them to seek new feeding grounds. It will be a matter of much interest to determine to what extent this abandonment of once favorite grounds will continue in the future.

The above case has its parallel in the departure from the coast of the United States of the bluefish, about 1763, their absence continuing well into the beginning of the next or present century.

C.—CO-OPERATION WITH THE SUPERINTENDENT OF THE CENSUS.

10.—PRELIMINARY ARRANGEMENTS.

In July, 1879, an arrangement was made with General Francis A. Walker, Superintendent of the Tenth Census, by which an investigation of the fisheries of the United States was undertaken as the joint enterprise of the United States Fish Commission and of the Census Bureau. It was decided that this investigation should be as exhaustive as possible, and that both the United States Fish Commission and the Census should participate in it. The preparation of a statistical and historical report upon the fisheries, to form one of the series to be presented by the Superintendent of the Census as the result of his investigations, in 1880, has been the main object of the work, but, in connection with this, extensive investigation into the methods of the fisheries, into the distribution of the fishing grounds, and the natural history of useful marine animals have been and are being carried on.

The direction of this investigation was placed in the hands of Mr. G. Brown Goode, who was appointed a special agent of the Census Office, and who has been carrying on this work in addition to the performance of his duties in connection with the National Museum and the Fish Commission. The work was begun on July 1, 1879, has been vigorously prosecuted since that time, and the final report will probably be presented as early as July, 1881.

11.—PLAN OF INVESTIGATION.

The plan of the investigation was drawn up before the beginning of the work, and has been published in an octavo pamphlet of fifty-four pages, entitled "Plan of Inquiry into the History and Present Condition of the Fisheries of the United States." Washington: Government Printing Office. 1879.

The scheme of investigation divided the work into the following departments:

I.—*Natural history of marine products.*

Under this head was to be carried on the study of the useful aquatic animals and plants of the country, as well as of seals, whales, turtles, fishes, lobsters, crabs, oysters, clams, &c., sponges and marine plants. and inorganic products of the sea, with reference to (A) Geographical distribution; (B) Size; (C) Abundance; (D) Migration and movements; (E) Food and rate of growth; (F) Mode of reproduction, and (G) Economic value and uses.

II.—*The fishing grounds.*

Under this head are studied the geographical distribution of all animals sought by fishermen and the location of the fishing-grounds, while with reference to the latter are considered: (A) Location; (B) Topography; (C) Depth of water; (D) Character of bottom; (E) Temperature of water; (F) Currents, and (G) Character of invertebrate life, &c.

III.—*The fishermen and fishing towns.*

Here are considered the coast districts engaged in the fisheries with reference to their relation to the fisheries, historically and statistically, and the social, vital, and other statistics relating to the fishermen.

IV.—*Apparatus and methods of capture.*

Here are considered all the forms of apparatus used by fishermen, boats, nets, traps, harpoons, &c., and the methods employed in the various branches of the fishery. Here each special kind of fishery, of which there are more than fifty in the United States, is considered separately with regard to its methods, its history, and its statistics.

V.—*Products of fisheries.*

Under this head are studied the statistics of the yield of American fisheries, past and present.

VI.—*Preparation, care of, and manufacture of fishery products.*

Here are considered the methods and the various devices for utilizing fish after they are caught, with statistics of capital and men employed, &c.: (A) Preservation of live fish; (B) Refrigeration; (C) Sun-drying; (D) Smoke-drying; (E) Pickling; (F) Hermetically canning; (G) Fur dressing; (H) Whalebone preparation; (I) Isinglass manufacture; (K) Ambergris manufacture; (L) Fish guano manufacture, and (M) Oil rendering, &c.

VII.—*Economy of the fisheries.*

Here are studied (A) Financial organization and methods; (B) Insurance; (C) Labor and capital; (D) Markets and market prices; (E) Lines of traffic, and (F) Exports, imports, and duties.

VIII.—*Protection and culture.*

This includes all kinds of supervision by the government, such as: (A) Legislation; (B) Bounties and licenses; (C) Fishery treaties, and (D) Public fish culture.

The various inquiries provided for in this scheme of investigation have been made in three ways:

(I.) By correspondence with persons in different parts of the country.

(II.) By a systematic overhauling and compilation of past records, not the least among which are the local newspapers.

(III.) By sending special agents to make personal inquiries in every part of the United States where the fisheries are of considerable importance.

The last-named method has, of course, been by far the most important and the most successful, and it is unfortunate that the length of time and the amount of money available have not permitted the employment of a larger number of assistants in this branch of the work, and have not allowed them to devote as much attention to working out specific questions as has in many cases seemed imperatively necessary.

12.—DETAILS OF PROGRESS DURING THE YEAR.

The fishery industry is of such great importance and is undergoing such constant changes that a visit of a few days to any locality, even by the most competent expert, has invariably proved unsatisfactory. They have been able to collect only the most important facts, leaving many subjects of interest untouched.

The field-work has been assigned to the following special agents:

I. Coast of Maine, east of Cape Elizabeth. R. E. Earll and Capt. J. W. Collins.

II. Cape Elizabeth to Plymouth (except Cape Ann) and eastern side of Buzzard's Bay. W. A. Wilcox.

III. Cape Ann. A. Howard Clark.

IV. Cape Cod. F. W. True.

V. Provincetown. Capt. N. E. Atwood.

VI. Rhode Island and Connecticut west to the Connecticut River. Ludwig Kumlien.

VII. Long Island and north shore of Long Island Sound and west to Sandy Hook. Fred Mather.

VIII. New York City. Barnet Phillips.

IX. Coast of New Jersey. R. E. Earll.

X. Philadelphia. C. W. Smiley and W. V. Cox.

XI. Coast of Delaware. Capt. J. W. Collins.

XII. Baltimore and the oyster industry of Maryland and Virginia. R. H. Edmonds.

XIII. Atlantic coast of Southern States. R. E. Earll.

XIV. Gulf coast. Silas Stearns.

XV. Coast of California, Oregon, and Washington. Prof. D. S. Jordan and Mr. C. H. Gilbert.

XVI. Puget Sound. James G. Swan.

XVII. Alaska seal fisheries. H. W. Elliott.

XVIII. Great Lakes fisheries. Ludwig Kumlein.

XIX. River fisheries of Maine. C. G. Atkins.

XX. The shad and alewife fisheries. Marshall McDonald.

XXI. Oyster fisheries. Ernest Ingersoll.

XXII. Lobster and crab fisheries. Richard Rathbun.

XXIII. Turtle and terrapin fisheries. F. W. True.

XXIV. The seal, sea-elephant, and whale fisheries. A. Howard Clark.

The different districts and departments of research in the preceding table are numbered serially.

The following table shows the intervals of time during which work has been carried on in each. (The numbers in the following table correspond with those in the preceding table.)

I. August 1 to October 30, 1879.

II. September 2, 1879, to January 1, 1880.

III. September, 1879, to January, 1880.

IV. July to October, 1879.

V. August, 1879, to January 1, 1880.

VI. August 16 to January 1, 1880.

VII. August 1, 1879, to January 1, 1880.

VIII. January, 1879, to January 1, 1880.

XIV. August, 1879, to January 1, 1880.

XVIII. August, 1879, to January 1, 1880.

XX. October, 1879, to January 1, 1880.

XXI. September, 1879, to January 1, 1880.

In addition to the field assistants already mentioned a staff from the beginning have been at work in the office of the division, carrying on correspondence, searching past records, and preparing the report for publication. Mr. C. W. Smiley, Mr. F. W. True, Mr. James Temple Brown, and Mr. George S. Hobbs have been connected with the work from its start, and from a later date Mr. J. E. Rockwell, Mr. C. W. Scudder, Mr. G. P. Merrill, and others have been thus employed. A number of clerks have also been detailed by the Superintendent of the Census, at one time as many as eight. A large part of the clerical force under the direction of Mr. Smiley, who has in special charge the correspondence and the work of compiling statistics from responses to circulars.

Some of the explorations carried on by the special agents of the Census Office, and engaged in this work, are deserving of more extended notice. The labors of Mr. Earll and Captain Collins on the coast of Maine were necessarily confined largely to the gathering of statistics, there being but little opportunity for zoological work, such as was carried on by several others of the party. The natural history of the fishes of New England, however, is well known, and the number of species of fish accessible from the shore is very limited.

A large amount of material for a very elaborate statistical, descriptive, and historical report was obtained, and also a very interesting series of sketches of fishery implements made by Captain Collins.

The same method was pursued on the coast of Massachusetts by Messrs. Clark, True, Atwood, and Wilcox. In this region considerable additions were made to the collection of fishery implements, and deposited by the Fish Commission in the National Museum.

The exploration of the Gulf of Mexico by Mr. Stearns brought about important results statistically, and also greatly increased our knowledge of the habits of the food-fishes and the methods of conducting the fisheries. A number of new species were added to the fauna of the United States by Mr. Stearns and his party. The circuit of the Gulf of Mexico from Key West to Galveston was made in a small sloop, chartered for the purpose.

The work of the other specialists, engaged in the census of the fisheries, has uniformly been productive of results important to the work of the Fish Commission.

In addition to the explorations already referred to, three special expeditions were organized for the purpose of studying the methods of the vessel fishermen upon the fishing grounds.

In the summer of 1879, Mr. Newton P. Scudder was sent to study the American halibut fisheries in Davis' Straits. He went as a passenger on the schooner Bunker Hill, of Gloucester, leaving that port on June 10, 1879, and returning on September 17 of the same year. His experiences are detailed in an important essay which will be printed in a subsequent number of the Fish Commission reports.

Mr. H. L. Osborn made a similar study of the Grand Bank codfishery. He sailed from Gloucester on the schooner Victor, July 10, and returned late in October. He made extensive natural history collections and prepared an important report which will also be printed.

Mr. John P. Gordy spent three weeks upon a Gloucester mackerel schooner for the special purpose of studying the mental and moral characteristics of the fishermen and the methods of the fishery, upon which he has submitted a report containing much interesting information.

C.—THE PROPAGATION OF FOOD FISHES.

WORK ACCOMPLISHED IN 1879.

The Quinnat or California Salmon (*Salmo quinnat*).

The McCloud River Station.—The experiences of previous seasons had indicated to Mr. Livingston Stone, who continued in charge of the McCloud River Station, the importance of detaining the salmon near the station by means of an impassable barrier across the river. By the construction of a rack across the river he prevented the further ascent of the fish, holding them at the fishery, where they could be readily captured by his seine when the spawning season commenced. The yield of spawning fish, and consequently of eggs, was much increased.

The obstruction on the river had also another good effect, for by the rack, which prevented their ascent (their instincts preventing their going down), they were kept in the pools and were not so emaciated by the extended journey which causes them to reach the upper rivers in a state of exhaustion. Although the salmon of the McCloud River, which had hitherto been penned, suffered much from confinement, the fish which were detained by means of the rack did not seem at all affected.

As the custom prevails of turning the fish back into the river after the eggs had been taken, this device of obstructing the river has no doubt been beneficial in preserving many of the adult fish which would otherwise have died from the exhaustion consequent upon any further ascent of the river.

Mr. Stone was much disheartened in the early part of the season by getting only young male fish (Grilse) until after the middle of August. The great number of these young males doubtless resulted from the artificially propagated fish which had been turned loose in previous years. Larger salmon, however, made their appearance in considerable numbers after the first of August, the fishing for the canneries having been stopped at that date by the limitation of the fishing season. The total production of eggs during the season of 1879 was about 9,500,000.

Mr. Stone reports that the Indians seemed much better disposed than in previous years. This change of attitude was possibly caused by the suppression of the revolts by the Army on the frontier. The presence of a detail of soldiers furnished by the commander of the department was most beneficial, not only on account of the moral effect which their presence had on the Indians, but as a restraint on the white marauders.

In Mr. Stone's report will be found the schedule of the distribution made of the 4,150,000 eggs which were taken to the East, the usual number of eggs and young fish having been reserved to keep up the stock in the McCloud River.

Besides the eggs distributed as shown in this table, 150,000 were sent to the Société d'Acclimatation, Paris, France; 100,000 to the Fischerei-Verein, Germany; 150,000 to the Zoological Society of Amsterdam, Holland; and 100,000 to the Dominion of Canada.

The eggs for distribution in the Eastern States and for shipment to Europe were sent from Redding in a refrigerator car, obtained from the Central Pacific Railroad. Mr. Fred Mather, one of the assistants of the Commission, having been instructed to meet the car on its arrival in Chicago, for the purpose of overhauling the eggs and re-icing and reshipping in accordance with the schedule of distribution given him, did so at 6.30 p. m. on the 11th of October.

The refrigerator was there opened and the eggs for Washington taken out, the chambers refilled with ice and placed in one end of an ordinary baggage car, and in the other end those for Europe, New York, Pennsylvania, and New Jersey. The eggs for Minnesota, Wisconsin, Iowa, Ohio, and Canada were left in the refrigerator car, and, after having been re-iced, were delivered to the United States and American Express Companies at three o'clock the following day.

The baggage car left Chicago at 5.15 on October 12, bound East. On the following day it arrived in Pittsburgh, where the eggs for Pennsylvania were delivered to the Adams Express Company, consigned to Mr. S. Weeks, at Corry, Pa. The weather was unusually warm, causing the ice to melt very freely and necessitating re-icing at this point.

On the arrival of the train at Harrisburg the three crates for Europe and the half crate for New York; the five crates for New Jersey and the two for Marietta, Pa., were transferred to an express car of the train for New York, where they arrived at 5.37 the next morning.

The crates were found on being unpacked to be in excellent condition, having sustained a loss of not more than 4 or 5 per cent.

The half crate, which was sent to Mr. Blackford, the commissioner for New York, not having been provided with an ice chamber, was found to be a total loss.

The United States Fish Commission for several years past has been sending eggs of the California salmon (*S. quinnat*) to Germany, Holland, and France. From some cause or other these attempts to plant our salmon in European waters have met with more or less failure, owing principally to the agents sent in charge being unable to secure the necessary accommodations for the eggs on shipboard; the parts of the vessel assigned to their use having been generally either too warm, the supply of ice limited, &c.

Accordingly when this year (1879) it was decided to make another essay at their transfer, it was proposed that the crates of eggs be placed in the hands of some officer of the ship taking them, and a bonus given him on showing a receipt from the consignees of the delivery of the eggs in good condition.

In pursuance of this plan, Mr. Fred Mather, the agent of the Commission in New York, was instructed to turn over to the purser of the North German Lloyd steamer Mosel, sailing on the 18th October, the quota of eggs intended for Germany. The purser accepted the trust, and delivered the eggs at Bremerhaven to the agent of the Deutsche Fischerei-Verein, Mr. R. Eckardt, who gave a receipt therefor as having been received by him in healthy condition. On presentation of this receipt to Mr. Mather, the purser received the stipulated honorarium.

On the 22d October the consignments intended for Holland and France were placed on board the steamers Schiedam and Labrador, respectively, and received by their pursers. Those intended for Holland were taken at Rotterdam by the superintendent of fisheries of Holland, Mr. C. J. Bottemanne, and those for France were handed at Havre to the agent of the Société d'Acclimatation, Mr. Grisard, both of whom gave receipts for the delivery of the eggs to them in perfect condition. The *douceurs* were accordingly paid.

By this mode of shipment the eggs received the attention they required—the emulation of the officers of the respective ships having been excited—and were transported at a trifling cost; the expense of a special messenger, which had previously been found necessary, being thus avoided.

These three consignments were, however, all carefully packed by Mr. Mather in the apparatus devised by him for the purpose in 1878, and which received the unqualified indorsement and approval of the French and German experts who had occasion to examine it.

A report by Mr. C. J. Bottemanne contains an interesting account of the introduction of these fish into the Netherlands. The shipment of eggs of this fish in 1877 was entirely unsuccessful, as only three fish were produced out of 100,000 eggs sent.

The transfer of the eggs the following year was more successful, as a loss of only some 26 per cent. was experienced, and we had become so much more expert in packing the eggs, that of the shipment made in 1879 the loss had been reduced to 21 per cent. When we take into consideration the fact that the eggs were transported by wagon over a rough country for about thirty miles before they could be placed in the cars; then by rail across the continent to be reshipped for a two weeks journey across the Atlantic, and after that compelled to take another railroad journey from Rotterdam to Amsterdam, the success was somewhat remarkable.

Monsieur Bottemanne reports that most of the fish were placed in the tributaries of the Meuse, a few only having been retained in the zoological gardens at Amsterdam.

The importance of maintaining a full supply of breeding fish in the Sacramento and McCloud Rivers, for the purpose of obtaining from year to year a stock of eggs sufficiently large to meet all demands, induced an arrangement with the California commissioners by which it was agreed that about one-fifth of the whole yield, hatched out at the fishery, should be returned to the water.

As the hatching out of these eggs necessarily takes place after the close of the regular work of the commission in securing them from the breeders, it was deemed expedient to accept the offer of the California State fish commissioners to defray the actual expense of hatching, which has accordingly been paid by them in 1879, as also heretofore.

The result of their work is seen in an extraordinary increase in the number of mature fish returning from the ocean, and in the great extension of the industry of salmon canning.

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

The Crooks Creek Station.—Mr. Stone having been instructed to enlarge the operations of the work on the McCloud River by the propagation of the California brook trout, he selected a point some miles above on a small tributary of the McCloud River called George Crooks Creek.

This creek flows into the McCloud River only four miles above the salmon-breeding establishment and was selected as being well supplied with clear cold water. Many difficulties were encountered in establishing this station, as only a rough Indian trail led to the site. This necessitated the "packing" of all the lumber and equipment necessary for this station.

During the season a dwelling and hatching house were built and the necessary furniture, &c., transported to the station.

The trout-hatching house was constructed on the same general plan as the salmon-hatching house, with a capacity of 6,000,000 eggs. Having prepared the ponds, which were supplied by a constant and ample flow of water, the breeding fish were captured by angling and kept in traps constructed of heavy timber poles. The traps were well secured against casualty in case of high water.

This fish is much esteemed and will no doubt be a valuable acquisition to the food fishes of the Atlantic States, especially to such waters as may be found too warm for the less hardy brook trout native to the Atlantic.

An interesting experiment in connection with the culture of the *Salmo iridea* was made in Japan by Mr. Sekizawa Akekio, a most accomplished Japanese gentleman, who manifested very great interest in all exhibits pertaining to fish culture at the Philadelphia exhibition of 1876. Shortly after his return to Japan he established several hatching stations at various points. On June 9, 1877, he received a supply of eggs from the United States fish ponds on the McCloud River. A large number of fish were hatched out, and, as may be seen from a commuication received from him on April 12, 1880, lived (for at any rate) nearly three years, at which period of their life they averaged nineteen inches in length. A drawing of one of these 3-year old fish accompanying his communication furnished a magnificent illustration of the species. At that age both males and females were ready to spawn and promised to furnish a large number of eggs.

These results show clearly the ability of this species to sustain itself in remote localities, and also illustrate the fact that in less than three years they are ready to spawn and may at that age have attained the weight of at least five pounds.

Atlantic Salmon (*Salmo salar*).

The Penobscot River Station.—The indications of the successful introduction of this fish into rivers even as far south as the Delaware and Susquehanna, and the great increase which has already been observed in its abundance in the Penobscot Bay, led to the determination that the work which had been intermitted at Bucksport should be again pushed forward.

Mr. Atkins was therefore instructed to arrange for a supply of breeding fish and to extend the operations at Bucksport as far as practicable. It having been clearly shown that the salmon could be readily confined in fresh-water ponds from June until November without interfering with the development of the ovaries, Mr. Atkins selected Dead Brook as a good site for the inclosure, and a convenient location for a hatching house.

He secured in good condition 264 salmon at an average cost of $2.16 each. A heavy rain-fall on the 17th and 18th of August caused a freshet in Dead Brook which resulted in a considerable loss of fish, reducing the number to 59. He commenced to take spawn on the 24th of October, and secured 211,692 eggs by the middle of November. These eggs were distributed to the State commissioners of New Hampshire, Massachusetts, Connecticut, New Jersey, and Maryland.

The reports from these States show that 180,000 were actually planted, principally in the tributaries of the Merrimac, Connecticut, Delaware, Susquehanna, Potomac, and Ohio Rivers.

The work at this station will be continued on a larger scale hereafter, as the increase of salmon in many of the eastern rivers has been very marked and the indications point to the successful establishment of this fish in the tributaries of the great lakes.

There is no more interesting fact in connection with the propagation of fishes than that of their return to the original spawning ground at the expiration of a given time. The young fish also hatched out at any point, will in their turn seek the same place for purposes of reproduction. Numerous instances of this fact are on record: thus, Mr. Wilmot, who, for several years past has been engaged in hatching out salmon at Newcastle, on the north shore of Lake Ontario, has presented to the United States Fish Commission the stuffed specimen of a female fish, from which he had taken eggs for three successive years, as indicated by his marks, which were apparent on the skin. At the United States salmon-hatching station on the Penobscot, Mr. Charles G. Atkins has been in the habit of tagging and numbering the fish which he captures for his purposes and which are released in Penobscot Bay when he has finished operations with them. Of these quite an appreciable number have been taken in subsequent years, identified by their labels. A still further instance of this is shown in regard to the California salmon. In previous reports I have referred to Mr. R. D. Hume, of Edinburg, Oregon, in connection with the artificial hatching of salmon by him in 1877 and 1878. In the former year he marked a hundred fish, letting them go, and the next year he is said to have retaken ten of the number.

Schoodic Salmon (*Salmo salar*, subs. *sebago*).

Grand Lake Stream Station.—Pains have been taken in previous reports to call attention to the value of this variety of the salmon family.

The facilities for procuring and caring for the eggs of this fish at Grand Lake Stream until ready for distribution, were much enlarged during this year, and although the number of spawning fish captured was not greater than in previous years, 1,113,000 eggs were procured, of which only $11\frac{3}{10}$ per cent. were lost.

During their development 249,000 eggs were reserved to keep up the supply of fish in Grand Lake Stream and 744,000 were distributed. The average length of the fish captured this year exceeds that of any of the four preceding years, the longest male fish being twenty-four inches and the longest female twenty-two inches.

Many interesting comparisons of the results obtained during the several years will be found in Mr. Atkins' very interesting report, which is appended.

The first spawn was taken on November 7, and the spawning was finished by the 22d of the same month. The eggs had sufficiently developed to be shipped by the 6th of January, and were distributed to the waters of many States, as shown in Mr. Atkins' report.

Instructions have been given for the enlargement of the facilities, and as the fish increase, in consequence of the large deposits of young fish, the spawn procured from them can be cared for and properly developed.

Should the operations of the Commission increase in the future as they have in the past, arrangement must necessarily be made for the establishment of several supplementary stations for hatching the eggs of the Salmonidæ. At present, the works on the McCloud River for the California salmon, those on the Penobscot River for the Eastern salmon, and those at Grand Lake Stream for the land-locked salmon are the only ones provided by the Commission. From these points the eggs are forwarded to the hatcheries of the various States, and the distribution and deposit of the fry is effected largely under the auspices of the State commissioners. As, however, there are large central districts available for the fish, where there are either no State commissioners, or such as are without the means for further treatment of the eggs, it has been thought advisable to look into the question of localities, especially in the Southern and Southwestern States. The difficulty, however, is to find an ample supply of water sufficiently cold for the various species. The spring water in the South, although palatable to the taste, is usually too warm for hatching and preserving the fry of the Eastern salmon and trout. As one advantage of the California species of salmon and trout over their allies in the East consists is their greater adaptability to warm water, it is possible that this project may after a time be carried out successfully. Among other points which have been especially urged as suitable for such establishments is that of Huntsville, Ala., where a large spring in the town has been offered for the purpose.

Shad (*Alosa sapidissima*).

The propagation and distribution of shad were continued in the same localities that had been occupied during the previous year, and although the season was somewhat unpropitious, the aggregate yield of young shad was increased from 15,500,000 the previous year to 16,062,000, and, the arrangements for the distribution having been much improved, a large proportion of these were transferred to outside waters.

Albemarle Sound Station.—Although anxious to continue the work, so successfully inaugurated in previous years in Albemarle Sound, it was not deemed advisable to transfer the full equipment of hatching apparatus to this station, as they proved to be somewhat too unwieldy to be moved with safety and certainty to such distant points. It was also anticipated that the large deposits of shad made in previous years in the Potomac and Susquehanna Rivers would furnish during the season of 1879 a larger supply of spawning fish. It was therefore deemed advisable to retain the hatching apparatus, which had been remodeled for operations in Maryland, where it had hitherto been so successful. It was determined to rely entirely upon the steamer Lookout, the services of which had been secured for the purpose, and accordingly she was sent to the mouth of the Chowan River, in charge of Mr. Jno. L. Saunders, where she arrived April 11. The season not being very far advanced at this time, the crew were employed in arranging the apparatus until the eleventh day of April, when active operations were commenced.

The equipment of the Lookout, as in previous years, consisted of six cones, placed on the deck forward of the pilot-house, which supported a distributing tank to supply them with water. These cones had been perfected under the direction of Mr. Ferguson, and proved thoroughly efficient.

The rest of the apparatus used were the plunging buckets, also an invention of Mr. Ferguson, the machinery for operating which had been much improved.

On account of the want of space on this small steamer, a hastily constructed pier was run out from the wharf at Avoca, and the use of a small steam-engine was secured from Dr. Wm. R. Capehart, proprietor of the fishery, which was furnished with steam from the boilers of the Lookout, and provided the motive power to operate the plunging buckets.

From the 11th of April to the 14th of May the Lookout was moored to this wharf, her small pump supplying the cones which were used simultaneously with the plunging cylinders, a neat arrangement of pulleys having been substituted for the levers which were first used to operate the buckets.

During the period referred to 5,295,000 young shad were produced in the apparatus described, operated by the limited force which could be accommodated on this small steamer. As this apparatus was somewhat hastily improvised and much altered in details from that hitherto used, the reports from the station were looked forward to with some anxiety.

After some time spent in experimenting, Mr. Saunders reported that the machinery did exceedingly well, and that the motion was better than ever before. The eggs were kept moving nicely, and the young fish came out strong and healthy. He estimated the number of eggs hatched to be at least 90 or 95 per cent. of the eggs placed in the cones.

Of the 5,295,000 first prodneed, 2,115,000 were turned over to Mr. S. G. Worth, the superintendent of fisheries of North Carolina, who has always co-operated cordially with the United States Commission, to be placed in the waters of the State. A distributing depot was established at Franklin, a station on the Seaboard and Roanoke Railroad, at the head of navigation of the Chowan River, and instructions were given to ship 200,000 fish nightly by the two alternating steamers, Chowan and Lota.

These shipments kept the messengers of the United States Commission constantly on the road transferring fish to the waters of the South and the Southwest, besides furnishing a large number to the North Carolina commission to be deposited in local waters.

The results of the operations at this station were most satisfactory when we consider the limited force employed, and hearty acknowledgments are due to Mr. Saunders and the faithful men under him.

At the close of the fishing season, on the 14th of May, the Lookout was transferred to the head of the Chesapeake Bay, where she was utilized in transferring fish to different points in Maryland.

Havre de Grace Station.—The two machinery barges having been remodeled, and the lever attachment to the Ferguson hatching apparatus having been replaced, under the inventor's direction, by a much neater and more compact arrangement of pulleys, the space made available by this change was utilized for the accommodation of a large number of cones. The barges were transferred early in April to Spesutie Narrows, a station which had been occupied during the previous years, and a portion of the hatching force placed on them with instructions to examine daily the fish taken by the large haul-seines and gill-nets operated in that locality.

The first ripe female shad was secured on the 3d of May.

The immediate charge of this station was assigned to Mr. F. N. Clark, of Northville, Mich., but it was not until the 19th of the month that the spawning fish were at all plentiful. From that time until the close of the season the operations were attended with great success, the number of fish produced at this station, under the charge of Mr. Clark, amounting to 9,500,000.

Mr. Saunders and a portion of the force with him in North Carolina were placed on the Machinery Barge No. 2, which was moored about three miles to the north of Spesutie Narrows, not far from the town of Havre de Grace; but operations were not fairly commenced until the 30th of May, from which time to the close of the season 1,252,000 shad were produced, making an aggregate of 16,062,000 at the three stations.

The disposition made of these fish will be found in the accompanying tables, which have been arranged, for easy reference, both geographically and chronologically.

The Potomac River Stations.—The force of the Commission being fully occupied in North Carolina and on the Susquehanna, operations on the Potomac were deferred until next year, when, it is hoped, a satisfactory report of results will be made.

Carp (*Cyprinis carpio*).

In the report of the Commission for 1878 will be found detailed the account of its labors connected with the culture of carp up to the end of that year, and especially of the transfer of a portion of the fish (brought over from Germany by Mr. Hessel and deposited first in the Druid Hill Park ponds) to the Monument lot, in the city of Washington.

The fish spawned in Druid Hill Park in 1878, but unfortunately they hybridized with some gold-fish that had accidentally got into the ponds, so that instead of having any carp of pure breed, there were about 2,000 crosses; these were destroyed, as being of no special value.

The work of 1879 was more satisfactory. Six thousand young of different breeds were secured, whereof 2,750 were planted in Maryland, the remainder being distributed in other States. The number of fish given to each applicant was from twelve to sixteen. The demand for the carp has been very great, and the calls have increased so rapidly as to render it doubtful whether, even with a much larger production, all the requirements can be met.

The Monument Station.—The station on the grounds of the Washington Monument for the cultivation of the carp has been maintained with great efficiency during the year, under the continued superintendence of Mr. Rudolph Hessel. Much labor has been expended in improving the walks, banks, and ponds, and in planting ornamental trees and shrubs, including the introduction of quite a variety of water plants, as pond-lilies, &c.

In April, a telephonic connection was established with the ponds, which proved of very great importance, giving to the superintendent and watchmen the means of instantaneous communication with the offices of the Commission and with the police headquarters, this latter advantage greatly adding to the safety of the property.

The larger pond, to the west of Executive avenue, which had originally been one, was divided into two by constructing causeways from the island to the east and west shores. This was done for the purpose of enabling the contractors for the White House lot sewer to prosecute their work along the northern half of the pond without being interfered with by the water; the southern half was accordingly kept filled while the northern half was empty. This has been to some extent a source of inconvenience to the Commission, but has greatly facilitated the work connected with the sewer.

During the severe winter the surface of the ponds was frozen, and the use of the north pond for skating purposes was permitted; the east pond, being filled with fish, was carefully kept undisturbed by means of placards forbidding the entrance of skaters upon it; no difficulty was experienced in maintaining this regulation. From time to time applications were made to have the north pond flooded for the improvement of the sport. Unfortunately the inlet pipes, being near the bottom of the pond, made it impossible to allow a discharge over the surface. It may be a question whether, when the supply of water for city purposes is greater, it may not be expedient to have at hand the means of surfacing the ice, when much cut up, with a fresh coat, for the benefit of the skating community.

The Arsenal Station.—The pond at the arsenal was, as before, in charge of Mr. Elliot Jones, chief clerk. The scale carp were planted in the pond, and the few young fish obtained were duly distributed.

It is proposed, with the consent of the military authorities, to extend these ponds another year, so as to render them more available for their purposes.

The Druid Hill Park Station.—The United States Commission continues to be under many obligations to the commissioners of Druid Hill Park for the important facilities afforded in the way of propagating carp from the parent fish, placed there on their arrival from Germany in 1877. New ponds were built for the accommodation of the fish, in part at the expense of the United States Fish Commission. They, however, were not ready until the latter part of the season. Had they been prepared earlier, the production would probably have been largely increased. Distribution of about 3,000 carp was made to the citizens of Maryland, that number constituting nearly all the fish found upon drawing off the single pond, which alone it was considered expedient to lay bare.

Transfer of German Carp by Dr. Finsch.—The importance of securing a fresh supply of the best varieties of German carp for distribution throughout the country, induced me to attempt a renewal of the stock which had been brought over by Mr. Hessel. I therefore gladly embraced an offer made by Dr. Otto Finsch, an eminent German naturalist, to bring with him, on an intended visit to the United States, an additional lot. He accordingly ordered from Mr. Eckhardt, of Lübbinchen, 100 Mirror carp, a year and a half old, and from six to eight inches long. These were received in four coal-oil barrels, each containing twenty-five fish. They came over on the "Lessing," of the Hamburg-American packet line, leaving Hamburg on April 23, and arriving at New York on May 6. The total loss of fish on the passage was 77, leaving only 23 to be sent to Washington, where they were delivered to Mr. Hessel, superintendent of the ponds.

A detailed account of the circumstances attendant upon this transfer of carp will be found in an article by Dr. Finsch in the appendix.

Codfish (*Gadus morrhua*).

In the report for 1878 a reference was made to the successful hatching of codfish at the Gloucester station. For the purpose of determining the possibility of transporting cod over long distances, a small number of the young fish were forwarded by express from Gloucester to Washington, arriving January 26 in excellent condition. These were placed on exhibition in the rooms of the Committee on Appropriations in both House and Senate, and were also exhibited to the President and Cabinet. On the 2d of August I went with Mr. Ferguson from Provincetown to Wood's Holl for the purpose of examining into the possibilities of hatching cod at that point. The indications were strongly in favor of the success of such an undertaking.

Striped Bass or Rock-fish (*Roccus lineatus*).

It has been a great desideratum with the Commission to find a locality where the striped bass, or rock-fish, can be obtained for purposes of propagation by artificial means. I regret to say that, so far, the success of the Commission in this respect has not been very great. During 1879, however, the opportunity was offered to make some experiments of this kind, which proved to be highly satisfactory. The fishery of Dr. W. R. Capehart, at Scotch Hall, Albemarle Sound, the seat of the shad-hatching work, furnished on May 6 three large females with ripe spawn, the eggs of which, when stripped, filled about twelve one-gallon cans. The eggs, when first spawned, were pale green, slightly larger than those of a herring, becoming after impregnation somewhat larger than the eggs of the shad. They were transparant and almost invisible, excepting for an oily globule whereby the presence of the egg could be detected. These eggs were placed in vessels used for hatching shad, some in cones and others in floating boxes, the period of introduction being midnight of May 6. On the morning of May 9 almost all the eggs were hatched, showing a much more rapid development than that of the shad eggs under similar circumstances. While the eggs were thought to be somewhat larger than those of the shad, the embryo was considerably smaller; although with a disproportionally large sized umbilical sac, they escaped readily through the wire-cloth used in the propagation of the shad.

A number of the fish were sent to Washington, and some to Baltimore, where the fish were deposited in the hatching-house of Druid Hill Park. They proved to be much more hardy than shad, as shown by the fact that some of the young were kept in a tin pail for ten days without change of water and evinced no signs of suffering.

Transfer of fish.

Marine and fresh-water species to California.—Upon application by the fish commissioner of California. Mr. Livingston Stone was authorized to undertake the transfer, in a car specially arranged for the purpose, of a series of fishes and invertebrates, especially of striped bass, eels, black bass, and lobsters. The principal difficulty was in regard to the salt-water species, for whose benefit it became necessary to carry a large quantity of salt water, with which the supply in the reservoirs was from time to time renewed. For some weeks before starting Mr. Stone had kept about a thousand gallons of water, by the end of which time it had become perfectly clear, the dead matter having settled to the bottom. It was a matter of some difficulty to procure striped bass of sufficient size for the transfer. They were, however, by permission of the New Jersey State commissioners, obtained in the Navesink River. The lobsters were secured from Messrs. Johnson and Young, of Boston; the eels were furnished from Albany by Mr. Seth Green, while the black bass were sent from Charleston, N. H.

Mr. Stone started for the West on June 12, and after various experiences arrived with comparatively little loss of fish at Sacramento, where some of the fresh water fish were planted. The striped bass were placed in the Sacramento River near Martinez, and the lobsters were introduced in the water at Oakland wharf.

The details of this trip will be found in the appendix.

Transfer of carp from Europe.—The result of this experiment, made under direction of Dr. Finsch, will be found under the heading of carp.

Tables of the distribution of fish.

In the following tables will be found the record of the distribution of shad, arranged, first, by the successive dates of shipment, and, secondly, geographically by States. In the report of Mr. Stone is detailed the distribution of the California salmon, while in that of Mr. Atkins are given the particulars referring to the distribution of the Penobscot and Schoodic salmon. The shipments of carp have been so small, comparatively, as scarcely to be entitled to a distinct tabulation. In the next annual report I hope to present a minute statement of the entire history of the introduction of young fishes into the waters of the United States, so far as the agency of the United States Commission is concerned, and that from the earliest dates. To these I refer for any deficiences in the present account.

1.—*Chronological record of distribution of young shad made from April 18, 1879, to June 14, 1879, from Avoca, N. C., and Havre de Grace, Md., under direction of the United States Commissioner of Fish and Fisheries.*

Date.	Place whence taken.	Number of fish— Originally taken.	Number of fish— Actually planted.	State.	Introduction of fish. Town or place.	Introduction of fish. Stream.	Introduction of fish. Tributary of—	Transfer in charge of—	Remarks.
Apr. 18	Scotch Hall Fishery, Avoca.	100,000	100,000	North Carolina	Weldon	Roanoke River	Albemarle Sound	C. J. Huske	Earliest fish out of egg.
18 to 24	Scotch Hall	50,000	50,000	do	Avoca	Albemarle Sound	Atlantic Ocean	S. G. Worth	
21	do	30,000	30,000	do	Near Warsaw	Six Runs	Cape Fear River	Tom Taylor	
21	Avoca	70,000	70,000	do	do	do	do	do	
21	Scotch Hall Fishery.	30,000	30,000	do	Rocky Mount	Tar River	Pamlico Sound	J. A. Woodward	
21	Avoca	70,000	70,000	do	do	do	do	do	
24	Scotch Hall Fishery.	100,000	100,000	do	Near Warsaw	Six Runs	Cape Fear River	C. J. Huske	
24	do	50,000	} 50,000	do	Scotch Hall Fishery.	Albemarle Sound	Atlantic Ocean	Tom Taylor	
24	do	25,000	}	do	Pollocksville	Trent River	Neuse River	do	The 25,000 were 4 days old when taken up and were 40 hours en route.
24	Avoca	100,000	95,000	do	do	do	do	do	
24	do	100,000	} 115,000	} do	Near Milburnie	Neuse River	Pamlico Sound	W. M. Russ	
24	Scotch Hall Fishery.	25,000	}	} do	do	do	do	do	The 25,000 were 4 days old when taken up and were 28 hours en route.
24	do	60,000	60,000	do	Scotch Hall Fishery.	Albemarle Sound	Atlantic Ocean	J. P. Heywood	
24	do	100,000	100,000	do	Near Kirby's Bridge (Warsaw)	Six Runs	Cape Fear River	C. J. Huske	
25	Avoca	100,000	100,000	do	Mount Olive	Goshen Creek	do	J. A. Woodward	
25	do	100,000	100,000	do	Rocky Mount.*	Tar River	Pamlico Sound	W. M. Russ	
26	do	150,000	150,000	Mississippi	Jackson	Pearl River	Gulf of Mexico	J. F. Ellis	
28	do	75,000	75,000	Georgia	Columbus	Chattahoochee River.	Appalachicola River.	L. Kumlein	
29	do	75,000	75,000	North Carolina	Avoca	Salmon Creek	Chowan River	J. A. Woodward	
29	do	150,000	150,000	do	Weldon	Roanoke River	Albemarle Sound	do	
30	do	325,000		South Carolina					Turned over to South Carolina; nearly a total loss.
May 2	do	200,000	40,000	Alabama	Railroad crossing	Allapahaw River	Suwanee River	C. W. Schuermann	

2			40,000	....do	....do	Little River	....do	....do	
2			60,000	Florida	....do	Ocilla River	Gulf of Mexico	....do	
2			60,000	....do	....do	Ockolockonee River.	....do	....do	
2	Avoca	120,000	120,000	Virginia	Near Franklin	Blackwater River	Chowan River	Tom Taylor	
2	....do	100,000	100,000	North Carolina	Weldon	Roanoke River	Albemarle Sound	J. A. Woodward	
2	....do	100,000	90,000	....do	Milburnie	Neuse River	Pamlico Sound	C. J. Huske	
3	....do	100,000	100,000	Georgia	Macon	Ocmulgee River	Altamaha River	J. F. Ellis	
3	....do	25,000	25,000	Virginia	Franklin	Blackwater River	Chowan River	S. G. Worth	
3	....do	75,000	75,000	South Carolina	Biggin Church	Cooper River	Charleston Harbor	J. A. Woodward	
3	....do	150,000	150,000	North Carolina	Avoca	Salmon Creek	Chowan River	....do	
5	....do	160,000						L. Kumlein	3 cans of fish dead before leaving Franklin, 2 more dead before reaching Weldon, balance died after leaving Wilmington, N. C.
6	....do	100,000	100,000	Virginia	Nottoway Station	Nottoway River	Chowan River	J. A. Woodward & G. H. Williams.	
6	....do	240,000	100,000	North Carolina	Near Salisbury	Yadkin River	Pedee River	C. J. Huske & Tom Taylor.	
7	....do	120,000	60,000	Georgia	Covington	Ulcofanhanchee River.	Ocmulgee River	C. W. Schuermann	
7			60,000	....do	Conyers	Yellow River	....do	....do	
7	Avoca	150,000	150,000	Virginia	Franklin	Meherrin River	Chowan River	J. A. Woodward	
7	....do	75,000	75,000	....do	....do	Blackwater River	....do	W. M. Russ	
7	....do	75,000	75,000	....do	Nottaway Station	Nottoway River	....do	G. H. Williams	
7	....do	95,000	95,000	....do	Franklin	Blackwater River	....do	W. M. Russ	
8	....do	225,000							Shipped by steamer from Norfolk for Crisfied. Heavy storm caused a delay and fish all died.
8	....do	15,000	15,000	North Carolina	Avoca	Salmon Creek	Chowan River		
8	Salmon Creek	200,000	30,000	Louisiana	Railroad crossing	Roundaway Creek	Mississippi River	H. E. Quinn	
8			35,000	....do	....do	Tensas River	....do	....do	
8			30,000	....do	....do	Bayou Macon	Tensas River	....do	
8			35,000	....do	....do	Bœuf River	Washita River	....do	
8			35,000	....do	....do	Crew Lake		....do	
8			35,000	....do	Monroe	Washita River	Black River	....do	
9	Salmon Creek	215,000	215,000	North Carolina	Avoca	Salmon Creek	Chowan River		
9	....do	210,000	210,000	....do	....do	....do	....do	Wm. M. Russ	
12	....do	250,000	250,000	....do	....do	....do	....do		
13	....do	175,000	90,000	Alabama	Near Union Springs	Pea River	Choctawhatchee River.	L. Kumlein	
13			85,000	....do	....do	Conecuh River	Escambia River	....do	
13	Avoca	140,000	25,000	Mississippi	Meridian	Chunky River	Chickasawhee River.	C. W. Schuermann	
13			75,000	Alabama	Columbus	Tombigbee River	Mobile Bay	....do	

1.—*Chronological record of distribution of young shad made from April* 18, 1879, *to June* 14, 1879, *&c.*—Continued.

Date.	Place whence taken.	Number of fish— Originally taken.	Number of fish— Actually planted.	State.	Introduction of fish. Town or place.	Introduction of fish. Stream.	Introduction of fish. Tributary of—	Transfer in charge of—	Remarks.
Apr. 13	Avoca	100,000	100,000	Virginia	Nottaway	Nottoway River	Chowan River	Taylor & Woodward.	
13	do	500,000	500,000	North Carolina	Deep Bend	North River	Albemarle Sound		
14	Norfolk, Va	250,000	80,000	Virginia	Franklin	Blackwater River	Chowan River	J. F. Ellis	Fish in bad condition, all but 80,000 died before leaving Norfolk, Va.
16	Spesutie Narrows	300,000	300,000	Maryland	Spesutie Naorrws	Susquehanna River	Chesapeake Bay	United States and Maryland.	
17	do	140,000	60,000	do	Cordova Station	Miles Creek	do	Thos. Hughlett, jr.	
17			80,000	do	do	Wye Mills Creek	Miles Creek	do	
18	Spesutie Narrows	150,000	150,000	do	Salisbury	Wicomico River	Chesapeake Bay	Levin Campbell	
19	do	225,000	115,000	do	Savage	Patuxent River	do	J. F. Ellis	
19			110,000	do	Laurel	do	do	do	
19	Spesutie Narrows	100,000	100,000	do	Spesutie Narrows	Susquehanna River	do	United States and Maryland.	
19	do	200,000	100,000	Texas	Minneola	Sabine River	Gulf of Mexico	H. E. Quinn	
19			100,000	do	Dallas	Trinity River	do	do	
20	Spesutie Narrows	200,000	50,000	Mississippi	Ripley	Tippah River		J. F. Ellis	
20			50,000	do	Railroad crossing	Tallahatchie River	Yazoo River	do	
20			50,000	do	do	Yocana River	do	do	
20			50,000	do	do	Yallabusha River	do	do	
21	Spesutie Narrows	25,000	25,000	Maryland	Havre de Grace	Susquehanna River	Chesapeake Bay	United States and Maryland.	
21	do	175,000	90,000	Texas	Hearne	Brazos River	Gulf of Mexico	L. Kumlein	
21			85,000	do	Austin	Colorado River	do	do	
21	Spesutie Narrrws	100,000	100,000	Maryland	Spesutie Narrows	Susquehanna River	Chesapeake Bay	United States and Maryland.	
22	do	200,000	50,000	Texas	Near Columbus	Colorado River	Gulf of Mexico	C. W. Schuermann	
22			50,000	do	Near Luling	San Marcus River	Guadalupe	do	
22			50,000	do	Near Seguin	Guadalupe River	Gulf of Mexico	do	
22			50,000	do	San Antonio	San Antonio River	do	do	
24	Spesutie Narrows	20,000	20,000	Delaware	Seaford	Nanticoke River	Chesapeake Bay	Thos. Hughlett, jr.	
24			80,000	Maryland	Federalsburg	do	do	do	
24	Spesutie Narrows	150,000	150,000	do	Spesutie Narrows	Susquehanna River	do	United States and Maryland.	
26	do	150,000	100,000	do	Whaleysville	Pocomoke River	do	Levin Campbell	
26			50,000	do	Near Berlin	St. Michael's River	do	do	
26	Spesutie Narrows	150,000	150,000	do	Spesutie Narrows	Susquehanna River	do	United States and Maryland.	
27	do	100,000	100,000	do	do	do	do	do	

28	....do	125, 000	125, 000	....do	... do	....do	....do	... do	
28	....do	200, 000	200, 000	Kentucky	Shepherdsville	Salt River	Ohio River	J. F. Ellis	
29	....do	100, 000	100, 000	Maryland	Henderson	Choptank River	Chesapeake Bay	Thos. Hughlett, jr.	
29	....do	50, 000	50, 000	....do	Spesutie Narrows	Susquehanna River	....do	United States and Maryland.	
29	....do	200, 000	50, 000	Georgia	Railroad crossing	Tugaloo River	Savannah River	H. E. Quinn	
29			37, 500	....do	Gainesville	Chattahoochee River.	Appalachicola River.	....do	Half of one can of fish died while taking it from Gainesville to the river.
29			100, 000	....do	Resaca	Coosa River	Alabama River	....do	
30	Spesutie Narrows	200, 000	140, 000	Maryland	Millington	Chester River	Chesapeake Bay	Levin Campbell	
30			60, 000	....do	Centreville	Corsica Creek	Chester River	....do	
30	Spesutie Narrows	200, 000	200, 000	....do	Spesutie Narrows	Susquehanna River	Chesapeake Bay	United States and Maryland.	
30	....do	150, 000	150, 000	....do	....do	... do	....do	....do	
31	....do	200, 000	100, 000	....do	Middletown	Sassafras River	....do	Thos. Hughlett, jr.	
31			100, 000	....do	... do	Bohemia River	....do	....do	
31	Spesutie Narrows	400, 000	400, 000	....do	Battery Light	Susquehanna River	....do	United States and Maryland.	
31	....do	200, 000	50, 000	Missouri	Franklin	Meramec River	Mississippi River	L. Kumlein	
31			75, 000	....do	Piedmont	Black River	White River	....do	
31			75, 000	....do	Poplar Bluffs	....do	....do	....do	
June 1	Spesutie Narrows	40, 000	40, 000	Maryland	Havre de Grace	Susquehanna River	Chesapeake Bay	United States and Maryland.	
1	....do	160, 000	20, 000	Kansas	La Cygne	Meris de Cygnes River.	Osage River	J. F. Ellis	
1	....do		15, 000	....do	Manhattan	Blue River	Kansas River	....do	
1			15, 000	....do	Railroad crossing	Republican River	....do	....do	
1			15, 000	....do	....do	Solomon River	....do	....do	
1			15, 000	....do	Ellsworth	Smoky River	... do	....do	
1			5, 000	....do	Redding	Meris de Cygnes River.	Osage River	....do	
1			10, 000	....do	Emporia	Neosho River	Arkansas River	....do	
1			2, 000	....do	Cottonwood Falls	Cottonwood River	Neosho River	....do	
1			3, 000	....do	Florence	....do	....do	....do	
1			3, 000	....do	....do	Doyle Creek	....do	....do	
1			5, 000	... do	Halstead	Little Creek	Arkansas River	....do	
1			5, 000	... do	Hutchinson	Cow Creek	....do	....do	
1			10, 000	... do	El Dorado	Walnut River	....do	....do	
1			10, 000	....do	Great Bend	.. do	... do	....do	
1			27, 000	... do	Leonard	Pawnee River	... do	... do	
1	Spesutie Narrows	200, 000	200, 000	Maryland	Elkton	Elk River	Chesapeake Bay	Thos. Hughlett, jr.	
1	....do	300, 000	300, 000	... do	Spesutie Narrows	Susquehanna River	.. do	United States and Maryland.	
1	....do	400, 000	400, 000	....do	Battery Light	....do	....do	....do	
2	....do	300, 000	300, 000	....do	Port Deposit	....do	....do	... do	
2	....do	250, 000	100, 000	Tennessee	Nashville	Cumberland River	Ohio River	C. W. Scheurmann	
2			75, 000	....do	Johnsonville	Tennessee River	do	....do	
2			25, 000	....do	Dresden	East Obion	Mississippi River	... do	
2			50, 000	....do	Paducah	West Obion	... do	....do	

I.—Chronological record of distribution of young shad made from April 18, 1879, *to June* 14, 1879, *&c.*—Continued.

Date.	Place whence taken.	Number of fish— Originally taken.	Actually planted.	State.	Introduction of fish. Town or place.	Stream.	Tributary of—	Transfer in charge of—	Remarks.
June 2	Spesutie Narrows.	200,000	200,000	Maryland	Spesutie Narrows.	Susquehanna River	Chesapeake Bay	United States and Maryland.	
2	Old Bay Fishery	120,000	120,000	....do	Old Bay Fishery	....do	....do	....do	
3	Spesutie Narrows.	225,000	200,000	West Virginia	Piedmont	Potomac River	....do	H. E. Quinn	Lost all the fish in one can.
3	....do	300,000	150,000	Maryland	Princess Anne	Monokin River	....do	Thos. Hughlett, jr.	
3			125,000	....do	Newtown	Pocomoke River	....do	....do	Lost all fish in one can.
3	Spesutie Narrows.	150,000	150,000	....do	Spesutie Narrows.	Susquehanna River	....do	United States and Maryland.	
4	....do	175,000	175,000	....do	Cockeysville	Gunpowder River	....do	Thos. Hughlett, jr.	
4	....do	150,000	150,000	....do	Battery Light	Susquehanna River	....do	United States and Maryland.	
6	....do	100,000	100,000	....do	Spesutie Narrows.	....do	....do	....do	
7	....do	85,000	85,000	....do	Old Bay Fishery	....do	....do	....do	Station No. 2.
7	....do	200,000	100,000	Ohio	Fremont	Sandusky River	Lake Erie	H. E. Quinn	
7			100,000	Indiana	Terre Haute	Wabash River	Ohio River	....do	
8	Spesutie Narrows	175,000	175,000	Maryland	Relay Station	Patapsco River	Chesapeake Bay	Wm. Hamlen	50,000 from Station No. 2.
8	....do	100,000	100,000	....do	Spesutie Narrows.	Susquehanna River	....do	United States and Maryland.	
9	....do	137,000	137,000	....do	Old Bay Fishery	....do	....do	....do	
9	....do	200,000	65,000	West Virginia	Rowlesburg	Cheat River	Ohio River	L. Kumlein	
9			65,000	....do	Grafton	Tygart's Valley	....do	....do	
9			70,000	....do	Clarksburg	West Fork River	....do	....do	
10	Spesutie Narrows.	200,000	200,000	Maryland	Point of Rocks	Potomac River	Chesapeake Bay	J. F. Ellis	
10	....do	125,000	125,000	....do	Patuxent	Patuxent River	....do	W. M. Russ	50,000 from Station No. 2.
10	....do	200,000	50,000	....do	Federalsburg	Nanticoke River	....do	Thos. Hughlett, jr.	
10			25,000	....do	Airey's Station	Transquaking Riv'r	....do	....do	
10			25,000	....do	Cambridge	Blackwater River	....do	....do	
10			50,000	....do	Hillsborough	Tuckahoe River	....do	....do	
10			50,000	....do	Henderson	Choptank River	....do	....do	
10	Spesutie Narrows	150,000	150,000	....do	Battery Light	Susquehanna River	....do	United States and Maryland.	
11	....do	125,000	105,000	....do	Railroad crossing	Gunpowder River	....do	Newton Simmons	Nearly all fish in one can died.
11	....do	200,000	140,000	....do					60,000 fish lost before leaving Havre de Grace, balance in good condition

									turned over to Mr. Creveling, of Pennsylvania.
11	....do	160,000	160,000	....do	Little Falls	Potomac River	....do	J. F. Ellis	
11	....do	125,000	20,000	Arkansas	Railroad crossing	Little Red River	Black River	W. M. Russ	
11			25,000	....do	....do	Saline River	Ouachita River	... do	
11			40,000	....do	....do	Ouachita River	Black River	....do	
11			40,000	... do	Fulton	Red River	Mississippi River	....do	
12	Spesutie Narrows	200,000	150,000	Kentucky	Shepherdsville	Salt River	Ohio River	Newton Simmons	
12			50,000	Indiana	Indianapolis	White River	Wabash River	....do	
13	Old Bay Fishery	125,000	20,000	Tennessee	Knoxville	Holston River	Tennessee River	J. F. Ellis	Station No. 2.
13			15,000	....do	Chattanooga	Tennessee River	Ohio River	... do	
13			45,000	Alabama	Lebanon	Big Wills Creek	Coosa River	....do	
13			45,000	....do	Tuscaloosa	Black Warrior River.	Tombigbee River	....do	
13	Old Bay Fishery	175,000	50,000	Delaware	Black Bird Station	Appoquinimink Creek.	Delaware Bay	Thos. Hughlett, jr.	
13			25,000	... do	Clayton	Duck Creek	....do	....do	
13			100,000	... do	Milford	Mispillion Creek	... do	....do	
13	Spesutie Narrows.	125,000	65,000	West Virginia	Hinton	New River	Great Kanawha River.	H. E. Quinn	25,000 from Station No. 2.
13			60,000	....do	Railroad crossing	Greenbrier River	New River	....do	
14	Old Bay Fishery & Spesutie Narrows.	150,000	75,000	Missouri	Gates Springs	James River	White River	L. Kumlein	100,000 from Station No. 2.
14			75,000	....do	15 miles from Arcadia.	San François River.	Mississippi River	....do	
14	Old Bay Fishery & Spesutie Narrows.	75,000	75,000	Maryland	Port Deposit	Susquehanna River	Chesapeake Bay	United States and Maryland.	
14	....do	200,000	200,000	....do	Havre de Grace	....do	....do	....do	
		16,842,000	15,589,500						

II.—*Geographical record of distribution of shad from April* 18,

Date.	Place whence taken.	Number of fish— Originally taken.	Actually planted.	State.	Introduction of fish. Town or place.
May 13	Salmon Creek	90,000	90,000	Alabama	Near Union Springs
13	do	85,000	85,000	do	do
13	Avoca	75,000	75,000	do	Columbus
June 13	Old Bay Fishery	45,000	45,000	do	Lebanon
13	do	45,000	45,000	do	Tuscaloosa
11	do	125,000	20,000	Arkansas	Railroad crossing
11	do		25,000	do	do
11	do		40,000	do	do
11	do		40,000	do	Fulton
May 24	Spesutie Narrows	20,000	20,000	Delaware	Seaford
June 13	Old Bay Fishery	50,000	50,000	do	Blackbird Station
13	do	25,000	25,000	do	Clayton
13	do	100,000	100,000	do	Milford
May 2	Avoca	60,000	60,000	Florida	Railroad crossing
2	do	60,000	60,000	do	do
Apr. 28	do	75,000	75,000	Georgia	Columbus
May 2	do	40,000	40,000	do	Railroad crossing
2	do	40,000	40,000	do	do
3	do	100,000	100,000	do	Macon
7	do	60,000	60,000	do	Covington
7	do	60,000	60,000	do	Conyers
29	Spesutie Narrows	200,000	50,000	do	Railroad crossing
30	do		37,500	do	Gainesville
27	do		100,000	do	Resaca
June 7	do	100,000	100,000	Indiana	Terre Haute
12	do	50,000	50,000	do	Indianapolis
1	do	160,000	20,000	Kansas	La Cygne
1	do		15,000	do	Manhattan
1	do		15,000	do	Railroad crossing
1	do		15,000	do	do
1	do		15,000	do	Ellsworth
1	do		5,000	do	Reading
1	do		10,000	do	Emporia
1	do		2,000	do	Cottonwood Falls
1	do		3,000	do	Florence
1	do		3,000	do	do
1	do		5,000	do	Halstead
1	do		5,000	do	Hutchinson
1	do		10,000	do	El Dorado
1	do		10,000	do	Great Bend
1	do		27,000	do	Larned
May 28	do	200,000	200,000	Kentucky	Shepherdsville
June 12	do	150,000	150,000	do	do
May 8	Salmon Creek	200,000	30,000	Louisiana	Railroad crossing
8	do		35,000	do	do
8	do		30,000	do	do
8	do		35,000	do	do
8	do		35,000	do	do
8	do		35,000	do	Monroe
16	Spesutie Narrows	300,000	300,000	Maryland	Spesutie Narrows
17	do	140,000	60,000	do	Cordova Station
17	do		80,000	do	do
18	do	150,000	150,000	do	Salisbury
19	do	225,000	115,000	do	Savage
19	do		110,000	do	Laurel
19	do	100,000	100,000	do	Spesutie Narrows
21	do	25,000	25,000	do	Havre de Grace
21	do	100,000	100,000	do	Spesutie Narrows
24	do	80,000	80,000	do	Federalsburg
24	do	150,000	150,000	do	Spesutie Narrows
26	do	150,000	100,000	do	Whaleysville
26	do		50,000	do	Near Berlin
26	do	150,000	150,000	do	Spesutie Narrows
27	do	100,000	100,000	do	do
28	do	125,000	125,000	do	do
29	do	100,000	100,000	do	Henderson
29	do	50,000	50,000	do	Spesutie Narrows
30	do	200,000	140,000	do	Millington
30	do		60,000	do	Centreville
30	do	200,000	200,000	do	Spesutie Narrows

1879, *to June* 14, 1879, *by United States Fish Commission.*

Introduction of fish.		Transfer in charge of—	Remarks.
Stream.	Tributary of—		
Pea River	Choctawhatchee River	L. Kumlien	
Conecuh River	Escambia River	do	
Tombigbee River	Mobile Bay	C. W. Schuerman	
Big Wills Creek	Coosa River	J. F. Ellis	
Black Warrior River	Tombigbee River	do	
Little Red River	Black River	W. M. Russ	
Saline River	Ouachita River	do	
Ouachita River	Black River	do	
Red River	Mississippi River	do	
Nanticoke River	Chesapeake Bay	Thos. Hughlett, jr.	
Appoquinimink Creek	Delaware Bay	do	
Duck Creek	do	do	
Mispillion Creek	do	do	
Ocilla River	Gulf of Mexico	C. W. Schuermann	
Ockolockonee River	do	do	
Chattahoochee River	Appalachicola River	L. Kumlien	
Allapahaw River	Suwanee River	C. W. Schuermann	
Little River	do	do	
Ocmulgee River	Altamaha River	J. F. Ellis	
Ulcofanhanchee River	Ocmulgee River	C. W. Schuermann	
Yellow River	do	do	
Tugaloo River	Savannah River	H. E. Quinn	
Chattahoochee River	Appalachicola River	do	One-half of one can of fish died while taking it from Gainesville to the river.
Coosa River	Alabama River	do	
Wabash River	Ohio River	do	
White River	Wabash River	Newton Simmons	
Marais des Cygnes River	Osage River	J. F. Ellis	
Blue River	Kansas River	do	
Republican River	do	do	
Solomon River	do	do	
Smoky River	do	do	
Marais des Cygnes River	Osage River	do	
Neosho River	Arkansas River	do	
Cottonwood River	Neosho River	do	
do	do	do	
Doyle Creek	do	do	
Little River	Arkansas River	do	
Cow River	do	do	
Walnut River	do	do	
do	do	do	
Pawnee River	do	do	
Salt River	Ohio River	do	
do	do	Newton Simmons.	
Roundaway Creek	Mississippi River	H. E. Quinn	
Tensas	do	do	
Bayou Macon	Tensas River	do	
Bœuf	Ouachita River	do	
Clear Lake		do	
Ouachita River	Black River	do	
Susquehanna River	Chesapeake Bay	United States and Maryland.	
Miles Creek	do	Thos. Hughlett, jr.	
Wye Mills Creek	Miles Creek	do	
Wicomico River	Chesapeake Bay	Levin Campbell	
Patuxent River	do	J. F. Ellis	
do	do	do	
Susquehanna River	do	United States and Maryland.	
do	do	do	
do	do	do	
Nanticoke River	do	Thos. Hughlett, jr.	
Susquehanna River	do	United States and Maryland.	
Pocomoke River	do	Levin Campbell	
Saint Michael's River	do	do	
Susquehanna River	do	United States and Maryland.	
do	do	do	
do	do	do	
Choptank River	do	Thos. Hughlett, jr.	
Susquehanna River	do	United States and Maryland.	
Chester River	do	Levin Campbell	
Corsica Creek	do	do	
Susquehanna River	do	United States and Maryland.	

II.—*Geographical record of distribution of shad from April* 18, 1879, *to*

Date.	Place whence taken.	Number of fish— Originally taken.	Actually planted.	State.	Introduction of fish. Town or place.
May 30	Spesutie Narrows.	150,000	150,000	Maryland	Speustie Narrows
31	....do	200,000	100,000	....do	Middletown
31	....do		100,000	....do	......do
31	....do	400,000	400,000	....do	Battery Light
June 1	....do	40,000	40,000	....do	Havre de Grace
1	....do	200,000	200,000	....do	Elkton
1	....do	300,000	300,000	....do	Spesutie Narrows
1	....do	400,000	400,000	....do	Battery Light
2	....do	300,000	300,000	....do	Port Deposit
2	....do	200,000	200,000	....do	Spesutie Narrows
2	Old Bay Fishery	120,000	120,000	....do	Old Bay Fishery
3	Spesutie Narrows.	300,000	150,000	....do	Princess Anne
3	....do		125,000	....do	Newtown
3	....do	150,000	150,000	....do	Spesutie Narrows
4	....do	175,000	175,000	....do	Cockeysville
4	....do	150,000	150,000	....do	Battery Light
6	....do	100,000	100,000	....do	Spesutie Narrows
7	....do	85,000	85,000	....do	Old Bay Fishery
8	....do	175,000	175,000	....do	Relay Station
8	....do	100,000	100,000	....do	Spesutie Narrows
9	....do	137,000	137,000	....do	Old Bay Fishery
10	....do	200,000	200,000	....do	Point of Rocks
10	....do	125,000	125,000	....do	Patuxent
10	....do	200,000	50,000	....do	Federalsburg
10	....do		25,000	....do	Airey's Station
10	....do		25,000	....do	Cambridge
10	....do		50,000	....do	Hillsborough
10	....do		50,000	....do	Henderson
10	....do	150,000	150,000	....do	Battery Light
11	....do	125,000	105,000	....do	Railroad crossing
11	....do	200,000	140,000	....do	
11	....do	160,000	160,000	....do	Little Falls
14	....do	75,000	75,000	....do	Port Deposit
14	....do	200,000	200,000	....do	Havre de Grace
Apr. 26	Avoca	150,000	150,000	Mississippi	Jackson
May 13	....do	65,000	25,000	....do	Meridian
20	Spesutie Narrows.	200,000	50,000	....do	Ripley
20	....do		50,000	....do	Railroad crossing
20	....do		50,000	....do	......do
20	....do		50,000	....do	......do
31	....do	200,000	50,000	Missouri	Franklin
31	....do		75,000	....do	Piedmont
31	....do		75,000	....do	Poplar Bluffs
June 14	....do	150,000	75,000	....do	Gates Springs
14	....do		75,000	....do	15 miles from Arcadia
Apr. 18	Scotch Hall Fishery, Avoca.	100,000	100,000	North Carolina	Weldon
18 to 24	Scotch Hall	50,000	50,000	....do	Avoca
21	....do	30,000	30,000	....do	Near Warsaw
21	Avoca	70,000	70,000	....do	......do
21	Scotch Hall	30,000	30,000	....do	Rocky Mount
21	Avoca	70,000	70,000	....do	......do
24	Scotch Hall	100,000	100,000	....do	Near Warsaw
24	....do	50,000	50,000	....do	Scotch Hall Fishery
24	....do	25,000		....do	Pollocksville
24	Avoca	100,000	95,000	....do	......do
24	....do	100,000	115,000	....do	Near Milburnie
24	Scotch Hall	25,000		....do	......do
24	....do	60,000	60,000	....do	Scotch Hall Fishery
24	....do	100,000	100,000	....do	Near Kirby's Bridge (Warsaw).
25	Avoca	100,000	100,000	....do	Mount Olive

June 14, 1879, *by United States Fish Commission*—Continued.

Introduction of fish.		Transfer in charge of—	Remarks.
Stream.	Tributary of—		
Susquehanna River	Chesapeake Bay	United States and Maryland.	
Sassafras River	do	Thos. Hughlett, jr.	
Bohemia River	do	do	
Susquehanna River	do	United States and Maryland.	
do	do	do	
Elk River	do	Thos. Hughlett, jr.	
Susquehanna River	do	United States and Maryland.	
do	do	do	
do	do	do	
do	do	do	
do	do	do	
Monokin River	do	Thos. Hughlett, jr.	
Pocomoke River	do	do	Lost all the fish in one can.
Susquehanna River	do	United States and Maryland.	
Gunpowder River	do	Thos. Hughlett, jr.	
Susquehanna River	do	United States and Maryland.	
do	do	do	
do	do	do	Station No. 2.
Patapsco River	do	William Hamlin	50,000 from Station No. 2.
Susquehanna River	do	United States and Maryland.	
do	do	do	
Potomac River	do	J. F. Ellis	
Patuxent River	do	W. M. Russ	50,000 from Station No. 2.
Nanticoke River	do	Thos. Hughlett, jr.	
Transquaking River	do	do	
Blackwater River	do	do	
Tuckahoe River	do	do	
Choptank River	do	do	
Susquehanna River	do	United States and Maryland.	
Gunpowder River	do	N. Simmons	Nearly all in one can died.
			60,000 fish lost before leaving Havre de Grace; balance in good condition, turned over to Mr. Creveling, of Pa.
Potomac River	Chesapeake Bay	J. F. Ellis	
Susquehanna River	do	United States and Maryland.	
do	do		
Pearl River	Gulf of Mexico	J. F. Ellis	
Chunky River	Chickasawhee River	C. W. Schuermann	
Tippah River		J. F. Ellis	
Tallahatchie River	Yazoo River	do	
Yocana River	do	do	
Yalabusha River	do	do	
Meramec River	Mississippi River	L. Kumlien	
Big Black River	White River	do	
do	do	do	
James River		do	100,000 from Station No. 2.
San Francois River		do	
Roanoke River	Albemarle Sound	C. J. Huske	Earliest fish out of egg.
Albemarle Sound	Atlantic Ocean	S. G. Worth	
Six Runs	Cape Fear River	Tom Taylor	
do	do	do	
Tar River	Pamlico Sound	J. A. Woodward	
do	do	do	
Six Runs	Cape Fear River	C. J. Huske	
Albemarle Sound	Atlantic Ocean	Tom Taylor	The 25,000 were 4 days old when taken up, and were 40 hours en route.
Trent River	Neuse River	do	
do	do	do	
Neuse River	Pamlico Sound	W. M. Russ	The 25,000 were 4 days old when taken up, and were 28 hours en route.
do	do	do	
Albemarle Sound	Atlantic Ocean	J. P. Heywood	
Six Runs	Cape Fear River	C. J. Huske	
Goshen Creek	do	J. A. Woodward	

II.—*Geographical record of distribution of shad from April* 18, 1879, *to*

Date.	Place whence taken.	Number of fish— Originally taken.	Number of fish— Actually planted.	State.	Introduction of fish. Town or place.
Apr. 25	Avoca	100, 000	100, 000	North Carolina	Rocky Mount
29	....do	75, 000	75, 000	....do	Avoca
29	....do	150, 000	150, 000	....do	Weldon
May 2	....do	100, 000	100, 000	....do	....do
2	....do	100, 000	90, 000	....do	Milburnie
3	....do	150, 000	150, 000	....do	Avoca
6	....do	240, 000	100, 000	North Carolina	Near Salisbury
8	....do	15, 000	15, 000	North Carolina	Avoca
9	Salmon Creek	215, 000	215, 000	... do	......do
9	....do	210, 000	210, 000	....do	......do
12	....do	250, 000	250, 000	....do	......do
13	....do	500, 000	500, 000	North Carolina	Deep Bend
June 7	Spesutie Narrows.	100, 000	100, 000	Ohio	Fremont
Apr. 30	Avoca	325, 000	....	South Carolina	
May 3	....do	75, 000	75, 000	....do	Begin Church
5	....do	160, 000	....	....do	
June 2	Spesutie Narrows.	250, 000	100, 000	Tennessee	Nashville
2	....do	....	75, 000	....do	Johnsonville
2	....do	....	25, 000	....do	Dresden
2	....do	....	50, 000	....do	Paducah
13	Old Bay Fishery	20, 000	20, 000	....do	Knoxville
13	....do	15, 000	15, 000	....do	Chattanooga
May 19	Spesutie Narrows	200, 000	100, 000	Texas	Minneola
19	....do	....	100, 000	....do	Dallas
21	....do	175, 000	90, 000	....do	Hearne
21	....do	....	85, 000	....do	Austin
22	....do	200, 000	50, 000	....do	Near Columbus
22	....do	....	50, 000	....do	Near Luling
22	....do	....	50, 000	....do	Near Sequin
22	....do	....	50, 000	....do	San Antonio
2	Avoca	120, 000	120, 000	Virginia	Near Franklin
3	....do	25, 000	25, 000	....do	Franklin
6	....do	100, 000	100, 000	....do	Nottoway Station
7	....do	75, 000	75, 000	....do	......do
7	....do	150, 000	150, 000	....do	......do
7	....do	75, 000	75, 000	....do	......do
7	....do	95, 000	95, 000	....do	......do
8	....do	225, 000	....	....do	
13	....do	100, 000	100, 000	....do	Nottoway
14	....do	250, 000	80, 000	....do	Franklin
June 3	Spesutie Narrows.	225, 000	200, 000	West Virginia	Piedmont
9	....do	200, 000	65, 000	....do	Rowlesburg
9	....do	....	65, 000	....do	Grafton
9	....do	....	70, 000	....do	Clarksburg
13	....do	125, 000	65, 000	....do	Hinton
13	....do	....	60, 000	....do	Railroad crossing
		16, 842, 000	15, 589, 500		

June 14, 1879, *by United States Fish Commission*—Continued.

Introduction of fish.		Transfer in charge of—	Remarks.
Stream.	Tributary of—		
Tar River	Pamlico Sound	W. M. Russ	
Salmon Creek	Chowan River	J. A. Woodward	
Roanoke River	Albemarle Sound	do	
do	do	do	
Neuse River	Pamlico Sound	C. J. Huske	
Salmon Creek	Chowan River	J. A. Woodward	
Yadkin River	Peedee River	C. J. Huske and Tom Taylor.	
Salmon Creek	do		
do	do		
do	do	W. M. Russ	
do	do		
North River	Albemarle Sound		
Sandusky River	Lake Erie	H. E. Quinn	
			Turned over to South Carolina nearly a total loss.
Cooper River	Charleston Harbor	J. A. Woodward	
			3 cans of fish dead before leaving Franklin, 2 more died before reaching Weldon, balance died after leaving Wilmington, N. C.
Cumberland River	Ohio River	C. W. Schuermann	
Tennessee River	do	do	
East Obion River	Mississippi River	do	
West Obion River	do	do	
Holston River	Tennessee River	J. F. Ellis	Station No. 2.
Tennessee River	Ohio River	do	
Sabine River	Gulf of Mexico	H. E. Quinn	
Trinity River	do	do	
Brazos River	do	L. Kumlien	
Colorado River	do	do	
do	do	C. W. Schuermann	
San Marcus River	Guadalupe River	do	
Guadalupe River	Gulf of Mexico	do	
San Antonio River	do	do	
Blackwater River	Chowan River	Tom Taylor	
do	do	S. G. Worth	
Nottoway River	Chowan River	J. A. Woodward & G. H. Williams.	
do	do	G. H. Williams	
do	do	J. A. Woodward	
do	do	W. M. Russ	
do	do	do	
			Shipped by steamer from Norfolk for Crisfield. Heavy storm caused a delay and all fish died.
do	do	Taylor and Woodward.	
Blackwater River	Chowan River	J. F. Ellis	Fish in bad condition; all but 80,000 died before leaving Norfolk, Va.
Potomac River	Chesapeake Bay	H. E. Quinn	Lost all fish in 1 can.
Cheat River	Ohio River	L. Kumlien	
Tygart's Valley	do	do	
West Fork River	do	do	
New River		H. E. Quinn	25,000 from Station No. 2.
Greenbrier River		do	

APPENDIX A.

NATURAL HISTORY.

I.—THE MARINE ALGÆ OF NEW ENGLAND.

By Prof. W. G. Farlow.

INTRODUCTION.

This report is intended, with the exception of the Diatomes, to include all the marine species at present known to occur on the coast of the United States from New Jersey to Eastport, Me., and a few species are mentioned which, although they have not yet been found within our limits, are nevertheless to be expected from the fact that they occur on the neighboring coast of the British provinces. In preparing the report I have attempted to present, in a compact and more or less popular form, a description of the different orders and species of sea-weeds, so that persons who frequent the coast of New England, and especially those in the service of the Fish Commission, may have at hand the means of determining the forms found in our waters. The descriptive portion of the report is preceded by a short account of the general structure and classification of sea-weeds, which is necessary in the present case, because there is no generally accessible book in the English language which gives a good account of the modern views of the classification and structure of algæ.

The list of papers relating directly to New England algæ is very meager. In January, 1847, Prof. J. W. Bailey published in the American Journal of Arts and Sciences a paper entitled *Notes on the Algæ of the United States.* He enumerates 50 species found in New England, but some of the number are apparently erroneously credited to our coast. Two continuations of the article appeared in May, 1847, and July, 1848, in the former of which 19, and in the latter 17, species new to New England are enumerated. In 1847 Mr. S. T. Olney, in the Proceedings of the Providence Franklin Society, published a paper on *Rhode Island Plants*, in which he mentions 45 species of algæ. Most of the species in the papers above mentioned had been submitted to Prof. W. H. Harvey, of Dublin. The classic work of Harvey, the *Nereis Boreali-Americana*, of which the first two parts were published in the Smithsonian Contributions to Knowledge in 1852, and the third part in 1857, is the only elaborate account ever published with regard to the sea-weeds of the United States, and it has always been the standard authority on the subject. Since the appearance of Harvey's great work comparatively little has been added to our knowledge of the sea-weeds of New England. In the Report of the United States Fish

Commission for 1870–'72 is a *List of the Marine Algæ of the South Coast of New England*, in which 103 species are enumerated; and in the report for 1875 is a *List of the Marine Algæ of the United States*, intended as a catalogue of the sea-weeds exhibited by the Commission at the Centennial Exposition, in which additions were made to the New England flora. Besides the papers referred to, I would mention *Algæ Rhodiaceæ*, by S. T. Olney, published in 1871; *List of Marine Algæ Collected near Eastport, Me.*, by Prof. D. C. Eaton*; two papers by the writer in the Proceedings of the American Academy of Boston†; and *List of the Marine Algæ growing in Long Island Sound within 20 miles of New Haven*, by F. W. Hall‡. A series of dried specimens has been published conjointly by Dr. C. L. Anderson, Prof. D. C. Eaton, and myself, under the title of *Algæ Am.-Borealis.* The 130 species already published, in three fasciculi of 30 sets each, contain a number of the more interesting New England forms. A set has been presented to the Fish Commission, and that, together with the large set prepared for the Centennial Exhibition, to be deposited hereafter in the National Museum, will place in the hands of the members of the Commission sufficient material to render the task of determining our species comparatively easy.

It will be seen that we rely almost wholly on Harvey's *Nereis* for our knowledge of New England algæ, and it is surprising that so few species have been added to the flora in recent years. Of the species recently added, by far the larger number are insignificant in size, the rare *Nemastoma Bairdii* being almost the only species which would attract the eye by its beauty. Professor Harvey himself spent but a few weeks on the New England coast, and we must either suppose that the collectors of Harvey's time were more acute than those of the last few years, or else that the New England flora is very poor. That the flora is not very rich in species, even for a temperate region, is probably true, but it is too soon to assume that it is exceptionally poor.

The number of species which are so large and striking as to attract the amateur collector is nowhere large in temperate regions, and the so-called richness of a flora is generally dependent upon the number of small and insignificant species, which are recognized only by those who make a careful microscopic study. One reason for the apparent poverty of our marine flora is that our collectors have generally been amateurs, who pass a few weeks upon the shore and gather only the more beautiful and striking species. The number of persons who make microscopic examinations of our algæ is, however, increasing, and, as a result, numbers of small, but interesting, species have within a short space of time been brought to light, and it now seems likely that the New England flora is by no means so poor as was formerly supposed. The sever-

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* Trans. Conn. Acad., vol. ii, part 2, 1873.

† List of the Marine Algæ of the United States, Proc. Am. Acad. Art. and Sci., vol. x (n. s. ii), p. 351. On some Algæ new to the United States, l. c., vol. xii (n. s. iv), p. 235.

‡ Bulletin of the Torrey Botanical Club, vol. vi, No. 21, Sept., 1876.

ity of the climate, too, renders it difficult to collect during the winter and early spring months, when the species to be found are to a great extent different from those which flourish in summer. A rich harvest might be expected by an algologist who should pass the winter and spring at some exposed point upon the coast. The summer species may be said to be tolerably well known, but our knowledge of the winter forms is very deficient.

For the purpose of examining the algæ of the coast, I have visited Eastport, Portland, Cape Ann, Wood's Holl, Mass., where I passed two summers with the Commission, Newport, Noank, Conn., and Greenport, L. I. Unfortunately, I have not been able to make any excursions during the winter months, except to the coast near Boston, at Nahant and Marblehead, and my knowledge of the winter species is derived from specimens sent by correspondents.

In this connection I would express my sincere thanks to correspondents who have aided me by specimens and information, and I would acknowledge especially my obligations to Prof. D. C. Eaton, of New Haven; Mr. Horace Averill and Mr. A. R. Young, of Brooklyn; Mr. C. B. Fuller, of Portland; Mrs. A. L. Davis and Mrs. M. H. Bray, of Gloucester; Miss M. A. Booth, Mrs. Corcoran, Mrs. J. T. Lusk, Mrs. Beebe, Mr. F. S. Collins, and others, whose names are appended to the different species described. I am particularly indebted to the Fish Commission for their valuable aid in enabling me to dredge and collect in various interesting localities in Southern Massachusetts, at Noank, and at Gloucester, and to Mr. Alexander Agassiz for facilities for examining the coast at Newport. With the materials at hand I have attempted to review critically the species of our coast, and for this purpose it was necessary to compare them with the algæ not only of Great Britain, but of the other shores of Europe. I am, above all, indebted to Dr. Edouard Bornet, of Paris, who has constantly furnished information, both with regard to structure and nomenclature, without which it would have been impossible for me to form an accurate judgment concerning American species. I would also return my thanks to Prof. J. G. Agardh, of Lund; to Prof. J. E. Areschoug, Dr. W. B. Wittrock, and Dr. F. J. Kjellman, of Upsala, through whose kindness I have been able to examine very complete sets of Scandinavian and Arctic algæ, which have a special bearing on the New England flora; to Prof. E. Perceval Wright, of Dublin, who has obligingly allowed me to examine specimens in the Harveyan Herbarium at Trinity College; to M. A. Le Jolis, of Cherbourg, and Prof. J. T. Rostafinski, of Cracow, for valuable notes on *Laminariæ;* and to Mr. F. Hauck, of Trieste, for sets of Adriatic algæ.

If we regard the marine vegetation of the northeastern coast of the United States as a whole, we see that, beginning at Eastport, we have a strongly marked arctic flora, which is a direct continuation of that of Greenland and Newfoundland. As we proceed southward towards Boston, although the luxuriance of growth is less, the general appearance of the flora is still unmistakably arctic, if we except a few sheltered localities. The northern shore of Cape Cod, from its sandy character, is practically destitute of all species of algæ, except a few forms which are here and there found growing on the eel-grass. As soon as we pass to the south of Cape Cod, however, the flora assumes an entirely different aspect. The arctic and Northern European forms have disappeared, except at a few exposed points like Gay Head and Montauk, and, in their place, we find a number of species, as *Dasya elegans*, *Rhabdonia tenera*, *Chondria tenuissima*, *Sargassum vulgare*, characteristic of warmer seas.

The Long Island flora, which may be said to extend from Cape Cod to New Jersey, has a good deal in common with the northern part of the Adriatic. Among the more abundant species are *Dasya elegans*, *Polysiphonia variegata*, and, if we accept Zanardini's view, our common *Chondria Baileyana* and *Lomentaria Baileyana* are identical with *C. striolata* and *L. uncinata*, all species common near Venice. From New Jersey to Charleston, if we except Norfolk and one or two points on the North Carolina coast, almost no sea-weeds are known, presumably on account of the unfavorable nature of the shore, although, it must be confessed, the coast has never been carefully explored. Even with regard to the coast of New Jersey we have but little information. A number of *Florideæ*, usually growing attached to eel-grass, has been reported from Beesley's Point by Samuel Ashmead,* but it is almost certain that southward from that point, very little is to be expected.

It will be seen that Cape Cod is the dividing line between a marked northern and a southern flora. In fact, the difference between the floræ of Massachusetts Bay and Buzzards Bay, which are only a few miles apart, is greater than the difference between those of Massachusetts Bay and the Bay of Fundy, or between those of Nantucket and Norfolk. This difference in the flora corresponds precisely with what is known of the fauna. That Cape Cod formed a dividing line was known to Harvey, and subsequent observation has only shown, on the one hand, that the flora north of Cape Cod is more decidedly arctic than he supposed, and that, on the other hand, south of the cape it is more decidedly that of warm seas. The general fact of the distinctness of the two floræ is not weakened by the knowledge that we now possess, owing to the investigations of the Fish Commission, of the existence in a few sheltered localities north of Cape Cod of some of the characteristic species of Long Island Sound, and in a few exposed spots south of the cape of northern species. Of the more common species found along the whole coast of New England, by far the greater part are also common in Europe, as *Delesseria sinuosa*, *Corallina officinalis*, *Hildenbrandtia rosea*, *Polysiphonia violacea*, *P. fastigiata*, *P. nigrescens*, *P. urceolata*, *Rhodymenia palmata*, *Chondrus crispus*, *Cystoclonium purpurascens*, *Ahnfeltia plicata*, *Phyllophora Brodiæi*, *P. membranifolia*, *Polyides rotundus*, *Ceramium rubrum*, *Ptilota elegans*, *Leathesia tuberiformis*, *Chordaria fla-*

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* *Vid.* Proceed. Acad. Nat. Sci., Philadelphia, vol vi, p. 147, vol. x, p. 8.

gelliformis, *C. divaricata*. *Desmarestia aculeata*, *D. viridis*, *Phyllitis fascia*, *Scytosiphon lomentarius*, the common *Fuci* and *Laminariæ*, not to mention a large number of *Chlorosporeæ* and *Cryptophyceæ*. But a very few exclusively American species are found throughout our limits. Most of the purely American species are either confined to the shore south of Cape Cod or else to the shore from Boston northward. In fact, a good share of our common sea-weeds could be recognized from the figures in the Phycologia Brittanica.

Let us consider next the characteristic species between Boston and Eastport. In studying these we must turn not to works on the algæ of France, or Great Britain, but rather to those on Scandinavian algæ. It is especially instructive to examine the Algæ Scandinavicæ of Professor Areschoug in connection with our own forms. The resemblance is at once striking. At Eastport we have a magnificent growth of *Laminariæ* and *Fuci*, which predominate over all other forms. The larger species are even found high up on the shore, and we find growing in pools *Saccorhiza dermatodea*, *Laminaria longicruris*, *Agarum Turneri*, *Dictyosiphon hippuroides*, *Halosaccion ramentaceum*, and *Monostroma Blytii*; at low-water mark *Lithothamnion fasciculatum* abounds; and *Euthora cristata*, *Delesseria sinuosa*, *D. alata*, and *Callithamnion Pylaisæi* can easily be collected without wading. The rocks are covered with crusts of *Petrocelis cruenta*, and *Ralfsia verrucosa*, and the luxuriant *Fucus evanescens*. With the exception of *Agarum Turneri*, which is not found in Europe, but which occurs in the North Pacific, and *C. Pylaisæi*, which is peculiar to America, all the species named are found in the north of Norway. *Euthora cristata* does not appear south of Scotland, where it is rare, and *Laminaria longicruris* is scarcely known south of the northern part of Scotland. As we proceed southwards from Eastport to Nahant, near Boston, we find that the species named disappear into deeper water, and, with the exception of *Monostroma Blyttii*, are not generally seen except when washed ashore. *Dictyosiphon hippuroides* has not yet been seen south of Eastport, but *Saccorhiza dermatodea*, known to Harvey only from Newfoundland, is now known to occur at Marblehead, near Nahant, and *Halosaccion* is not rare in deep pools at Gloucester, while *Monostroma Blyttii*, in rather a small form, is found on exposed rocks at Little Nahant. *Fucus evanescens*, which is as abundant as *F. vesiculosus* at Eastport, seems to be replaced on the Massachusetts coast by *F. furcatus*. *Calliblepharis ciliata* of Harvey's Nereis, found from Cape Ann northwards is now known to be the same as *Rhodophyllis veprecula*, a common species on northern coasts. As yet none of the Scandinavian species of *Phlœospora* have been found with us, but it is not unlikely that they might be found by a botanist who should collect at Eastport in the spring. It is hardly likely that *Phlœospora tortilis* does not occur with us, for it is not uncommon on the Norwegian coast, and was collected in Greenland by Dr. Kümlien, of the Howgate expedition. *Polysiphonia arctica* may perhaps also be expected, as well as *Chætopteris plumosa*, a common species of Greenland and Northern Europe. *Odonthalia dentata*, a common species of Northern Europe, has not yet been found within our limits, although it is common at Halifax.

If north of Boston the principal feature of the marine vegetation is the enormous mass of large *Fuci* and *Phæosporeæ*, the *Florideæ* forming an insignificant part of the flora, the chief feature of the flora south of Cape Cod is the preponderance of *Florideæ* and the comparative insignificance of the *Fuci* and *Phæosporeæ*. In the case of the sea-weeds of Long Island Sound we cannot so directly refer them to species of any part of Europe as was possible in the case of the northern flora. Several of the more common and striking species, as I have already said, are identical with or closely related to Adriatic forms. We are not, however to push the comparison too far. The development of *Fuci* and *Laminariæ* in Long Island Sound, although meager compared with what we find north of Boston, is far beyond anything we find in the Adriatic, and, on the other hand, we do not have in Long Island Sound the numerous *Corallineæ* and siphonaceous *Chlorosporeæ*, which are common in the Adriatic, and which unmistakably indicate a subtropical flora. *Grinnellia americana*, *Dasya elegans*, *Rhabdonia tenera*, *Lomentaria Baileyana*, *Sargassum vulgare*, and most of the common species of Long Island Sound, are found as far south as the West Indies.

A consideration of the apparent exceptions to the law of the distribution of sea-weeds on our coast is not without interest. In the cold waters off Gay Head and Block Island, *Euthora cristata*, in a depauperate form, is sometimes found, and at exposed points we find a decided growth of *Laminariæ*, especially the digitate forms. *Ptilota serrata*, a typical northern species, has also been found in a much reduced form at the Thimble Islands, near New Haven.

In the town of Gloucester, near the village of Squam, is a small sheet of water called Goose Cove. The narrow entrance to the cove has been dammed up, and the water from the ocean enters only for a short time at the high tide. In this cove, to my surprise, I found *Rhabdonia tenera*, *Gracilaria multipartita*, *Chondria Baileyana*, and a large mass of *Polysiphonia Harveyi* and *P. Olneyi*. In short, the flora was entirely different from anything I had ever seen before north of Cape Cod, and entirely different from that of the adjacent shore, where the flora is entirely arctic. Furthermore, Squam is on the northern and inner side of Cape Ann, and as there is no connection of Goose Cove with the southern side of Cape Ann, and inasmuch as no vessels ever enter the cove, it is very difficult to account for the presence of the sea-weeds which grow there. The water which is confined by the dam is much warmer than that of the surrounding ocean, which would enable the species of warm waters to live if they were once introduced, but how are we to suppose that the spores were brought into the cove? It is hard to believe that they could have been brought by currents, for, as a matter of fact, the currents move in the wrong direction to produce such an effect. Certainly, *Rhabdonia tenera* is quite unknown in any other spot north of Cape Cod, the nearest locality being the coast near Nantucket, and it is very difficult to conceive that spores of that delicate species would survive in a very cold current, which not only must carry them outside of Cape Cod and across Massachusetts Bay, but also around to the sheltered cove at the point where Cape Ann joins the mainland at the north. If we compare the exceptional case of Goose Cove in the north with Gay Head and Montauk in the south, it seems to be the rule that wherever the water is cold enough, we meet arctic species, and wherever it is warm enough we have Long Island species, regardless of the remoteness of localities where the species naturally abound, and, as far as we know, of the absence of currents to transport the spores.

Our marine flora is marked by the complete absence of any members of the order *Dictyotaceæ*. *Haliseris polypodioides* has been found on the coast of North Carolina and, at Charleston, *Padina pavonia* begins to become common, but north of Norfolk not a single species of the order is known, the northern species referred by Harvey in the Nereis to the *Dictyotaceæ* being now known to belong to another order. Nor does any species of *Tilopteris* or *Cutleria* occur in New England. The absence of some of the common European genera of *Florideæ* is also worthy of notice. The genus *Nitophyllum* is entirely wanting north of North Carolina, and, although a species is said to have been collected off Cape Fear, and although *N. ocellatum* is occasionally found at Key West, this genus, which forms one of the more striking features of the European flora, may be said to be practically almost unknown anywhere on our Atlantic coast. *Bonnemaisonia asparagoides*, which occurs as far north as Norway, although rare, may perhaps be found with us. No species of *Schizymenia* or the related genera is found with us although the western coast is perhaps too rich in species of this perplexing group. *Plocamium coccineum*, one of the commonest red sea-weeds not only of Europe but of our west coast, is known with us in only one doubtful case. *Gelidium corneum*, which is abundant in almost all parts of the world, is only occasionally found in New England, and then only in the reduced form, separated by some as a distinct species, under the name of *G. crinale*. It may here be remarked that it is often a difficult matter to determine whether some of the more beautiful sea-weeds of Europe really occur with us or not. Our amateur collectors have frequently exchanged with European collectors, and one not unfrequently sees specimens of *Plocamium coccineum*, *Callophyllis laciniata* and other European species prized for their beauty, which are said to have been collected on our own coast. But inasmuch as no careful collector has found the species in question, I have considered it too unsafe to accept the statements of amateurs who, to my knowledge, have received specimens from Europe, and who, in general, are not accurate as to dates and localities. The preceding remark will not, however, apply to the species of *Fucus* and the coarser sea-weeds. *Fucus serratus*, very common in Europe, is very rare with us, having been found in but one locality in the United States and one in Nova Scotia. *Fucus canaliculatus*, *Himanthalia lorea*, and the common European *Cystoseiræ* are quite wanting. The nearly ubiquitous *Codium tomentosum* is a species which has not yet been found on our northern coast. On the other hand some species, as *Spyridia filamentosa* and *Chordaria divaricata*, are more abundant in New England than in Europe, and the same is probably true of *Euthora cristata* and *Ptilota serrata*, if we except perhaps the arctic zone.

It is evident that a great deal remains to be done before we can say that we have as accurate a knowledge of our marine flora as we have of that of most European countries. Hereafter any advance in the knowledge of our marine algæ must be made by a careful microscopic study on the shore. Probably all the large and striking species are now known, or if any remain to be discovered their discovery will be by mere chance, and not by any systematic search. What is especially needed is information about our winter and spring forms, and this can be best obtained by persons who either live on the shore or spend several months there, so as to be able to take advantage of the comparatively few days for collecting, which occur in our severe winters. The habits and structure of our *Laminariæ* need careful examination, microscopic as well as in the gross. The whole order of the *Phæosporeæ*, in fact, which abound in spring, should be studied, especially the genus *Ectocarpus* and its allies. Our *Cladophoræ* are in great confusion, and in the present paper I have been able to contribute but little towards their proper arrangement. Several years of study are necessary for the purpose, and, in fact, the task cannot well be accomplished until the European species are better known. Our *Ulveæ* are not in much better condition. The *Ulvæ* proper, thanks to the elaborate account of the genus given in Le Jolis's Liste des Algues Marines de Cherbourg, can be tolerably well made out; but the determination of some of the species of *Monostroma* is merely approximate. The *Cryptophyceæ*, which inhabit the shores and brackish localities, are very numerous, and a large number of forms probably remain to be discovered. A study of the last-named order is, moreover, not without a practical bearing, as is shown in another part of the report, by the fact that the cause of the so-called red fish is due to the growth of an alga of this order. It is probable that we have with us nearly all the European species of this order, and an excellent guide for our students, is the admirable paper by Warming on the Bacteria of the Danish Coast.*

Another group requiring study is the *Squamarieæ*, a small order consisting of species, which form crusts on stones and shells, often in deep water. As a rule comparatively little in the way of sea-weeds is found by dredging; but an examination of shelly and gravelly bottoms for *Squamariæ* is to be desired. Dredging is most successful between 10

* Om nogle ved Danmarks Kyster levende Bakterier, in Videns. Med. Natur. Foren., Copenhagen, 1875.

and 30 fathoms, and at a greater depth than 50 fathoms almost nothing is found. The oyster-beds of the coast should be carefully searched for *Cutleriece* and other sea-weeds found in similar localities in Europe. Finally, a thorough exploration of the tidal rivers and sheltered coves of the eastern coast of New England is much to be desired, in order that we may know to what extent the southern forms extend northward when they find sufficiently warm water and a suitable place of growth.

From an economical point of view, but little need be said with regard to our sea-weeds as an article of food. *Chondrus crispus*, the Irish moss, as it is called in this country, is the only species of any commercial value. It is collected in considerable quantities at several localities, but especially at Hingham, Mass. It is used for making sea-moss farine, and is also employed to some extent by brewers for clarifying beer. As yet the use of *Porphyra vulgaris*, the laver, one of the common species for making soups, has not been introduced. The Chinese employed in the shoe factories at North Adams, Mass., import the same species from China, not apparently knowing that they could obtain an abundance of it in Massachusetts. The dulse, *Rhodymenia palmata*, is sold to some extent in the seaport towns, especially in Boston, where it is eaten principally by sailors and the Irish population. It is generally imported from the British provinces, but it could be obtained in abundance anywhere north of Boston, or even in some places in Long Island Sound. The great use of our sea-weeds is for the purpose of making fertilizers, and immense quantities are carted from the beaches and spread over the land near the shore. Usage, however, varies at different localities, for at Eastport the larger sea-weeds, which are practically the same species that are highly esteemed in New Hampshire and Massachusetts, are considered of little value in comparison with animal manure. As far as I know, there are no manufactories of iodine or soda salts on our coast, although our species greatly resemble those used in Scotland for the purpose. The stem of the devil's aprons, *Laminariæ*, are used by surgical-instrument makers in the manufacture of sponge-tents.

Respectfully submitted.

W. G. FARLOW.

CAMBRIDGE, *January* 1, 1880.

STRUCTURE AND CLASSIFICATION OF SEA-WEEDS.

With a very few exceptions, all the plants of our coast which may be said really to grow in the water belong to the division of the vegetable kingdom known as the *Cryptogams*, or plants having no true flowers or seeds. Only two species of flowering plants are commonly found submerged in salt water, viz, *Zostera marina*, the salt-water eel-grass, and *Ruppia maritima*. The former is familiar to every one who has ever been to the shore, and is sometimes washed ashore in immense quantities. The latter is a common species of brackish bays and coves. If we add *Zannichellia palustris*, a species closely related to *Ruppia*, and a few species of *Potamogeton*, which occasionally make their way into brackish-water ditches and streams, we have completed the list of flowering plants which the student of marine vegetation is likely to meet on our coast. Excepting the few flowering plants just named, and a few *Characeæ*, an order whose place is doubtful but which is now generally placed near the mosses, which probably inhabit our brackish waters, our marine flora consists wholly of *Thallophytes*, the lowest division of the *Cryptogams*, the species of which are supposed to be destitute of any true axis and leaves such as are found in the higher plants. The *Thallophytes* have been divided into three classes, *Algæ*, *Fungi*, and *Lichens*. This classification, as we shall see, is based on physiological rather than on morphological grounds, and is very far from being satisfactory; but, although new classifications have been proposed, which, in time, will almost certainly supersede the old, at present it is impossible to ignore the old divisions, which may be said rather to be convenient than to be based on accurate knowledge of structure and development.

Of the three old groups, the *Algæ* may be described as *Thallophytes* which grow submerged in water or in wet places, which contain chlorophyl, or leaf-green, and which are able to transform inorganic into organic material, or, in other words, to support themselves from the inorganic matter about them. The *Fungi* do not grow submerged, do not contain chlorophyl, and are unable to change inorganic into organic matter, and hence must live as parasites upon bodies which contain organized matter. The *Lichens* were supposed by the older writers to be distinct from algæ and fungi, and characterized by having in their interior certain green bodies known as gonidia. It is to the first of the three divisions named, the algæ, that, with very few exceptions, all the strictly marine plants belong. How unscientific the division into algæ, fungi, and lichens is may be seen by the fact that on our coast there is one species of fungus which grows submerged in salt water, an undescribed species of *Sphæria*, which is parasitic on the stems of the large devil's apron, *Laminaria longicruris*. A few species of lichens grow between tide-marks, and several in places exposed to the spray. *Verrucaria mucosa* T. Fr. is abundant on our northern coast, and might be mistaken by a collector for *Isactis plana*. *Verrucaria maura* T. Fr., and one or two other *Verrucariæ*, are rather common near high-tide mark, but are not generally submerged. Practically speaking, then, when we speak of our sea-weeds we refer merely to the algæ, which constitute ninety-nine one-hundredths of the flora.

Harvey, in his Nereis, divided algæ into three classes, *Melanospermeæ*, *Rhodospermeæ*, and *Chlorospermeæ*. These three classes are distinguished by their color, the first being olive-brown, the second red or purple, the third green. This classification, which answered tolerably well for distinguishing the species at sight rests, upon what modern researches have shown to be erroneous views with regard to the structure and development of the different species, and Harvey's three classes no longer serve as a basis for classification. The *Melanospermeæ* and *Chlorospermeæ* are entirely rearranged, and although the *Rhodospermeæ* are still considered to form a natural group, the older name, *Florideæ*, employed by Agardh, is used to designate them. The basis of classification is the structure of the fruit and the organs of fructification, in the knowledge of which a great advance has been made during the last twenty years.

CRYPTOPHYCEÆ.—The lowest of all the algæ are those which belong to the order *Cryptophyceæ*, in which, as yet, the only reproduction known is by means of non-sexual spores and hormogonia. Most of the species of the order are bluish green, but some are purplish, brown, or even pink. The bluish-green coloring matter is due to the presence of phycochrome, which is a mixture of chlorophyl and phycocyanin. The last is extracted by water when the algæ containing it are bruised, the chlorophyl being soluble in alcohol. The species of *Cryptophyceæ* consist of cells which are usually roundish, or disk-shaped, and which are generally held together by a mass of gelatinous substance which surrounds them. The order is divided into two suborders, according to the arrangement of the cells in relation to the jelly. The first suborder, the *Chroococcaceæ*, includes all the species in which the cells are either isolated or arranged in amorphous or more or less spherical masses. Some of the species of this suborder are very small, and in some of the modern classifications are placed with the *Bacteria*, in the order *Protophytes*. The mode of growth of the *Chroococcaceæ* is by division of the cells, first into two, then into four, and so on. The masses which they form may be called colonies, each cell forming a distinct individual, which is usually capable of living apart from its fellows. Spores, which are known in only one species, are formed by some of the cells enlarging and taking on a thick cell-wall. Nothing like sexual reproduction is seen either in this or the next suborder.

NOSTOCHINEÆ.—In the second suborder of the *Cryptophyceæ*, the *Nostochineæ*, the cells are always attached to one another in the form of filaments, to which the name of *trichomata* is given. The trichomata may either be free, as in *Oscillaria* (Pl. I, fig. 5), inclosed in a sheath, as in *Lyngbya* (Pl. I, fig. 4), or packed in a dense mass of jelly, as in *Rivularia* (Pl. II, fig. 2). The cells composing the trichomata are usually disk-shaped or cylindrical, but are sometimes nearly spherical.

Besides the ordinary cells, we find in many species a second kind of cell, distinguished from the others by its glassy appearance and its yellowish or brownish rather than bluish-green color. (Pl. I, fig. 3, *a*; fig. 6, *b*; Pl. II, figs. 1 and 2, *a*.) They are called *heterocysts*, and are found sometimes scattered amongst the other cells, and sometimes at the end of the trichomata, their position often serving as a generic character. The reproduction of the *Nostochineæ* takes place in two ways, by *hormo-*

gonia and by spores. Both modes, however, are entirely of a non-sexual character. In the genera with numerous heterocysts, as *Nostoc*, the hormogonia are formed as follows: The cells intermediate between two heterocysts escape in the form of a small chain, called a *hormogonium*, and swim about with a spiral motion through the water. They at length become quiescent and begin to divide both transversely and longitudinally. Of the cells thus formed some become heterocysts, and in process of time a new *Nostoc* is formed. In the species destitute of heterocysts, or in which the heterocysts are few in number, the hormogonia are formed in a different manner. At certain points in the sheath of the trichoma constrictions are formed, and the cells between the constriction adhere to one another to form a hormogonium. We thus have formed a necklace of hormogonia, which are capable of moving upwards and downwards in the sheath until finally it is ruptured and the hormogonia make their escape. When free they are capable of moving about to a slight degree in the water, and eventually come to rest, and new heterocysts and trichomata are then formed by cell division.

The so-called spores of the *Nostochineæ* are formed by the enlargement of some of the ordinary cells to several times their original length until they become ovoid or cylindrical (Pl. I, fig. 3, *b*). They are found in a number of genera but in a number of others they have not yet been observed. They usually occupy a fixed position with regard to the heterocyst, so that they are used as a generic mark. When ripe they have a dense outer covering and become at times quite dark colored. They are more resistant than the ordinary cells and do not usually germinate until after a period of rest. In germination, which has only been observed in a few instances, the outer wall of the spore bursts open and the contents grow out in the form of a filament, in which by transverse division the ordinary cells are formed.

The *Cryptophyceæ* are algæ which flourish only in summer, but which can be found to some extent at all seasons. Most of them form slimy expansions on mud, wharves, stones, and on dead algæ. They are not often found submerged at any depth, but are most abundant near high-water mark. A few filamentous species attain a length of some inches but only one, *Lyngbya majuscula*, is sufficiently striking to have gained a popular name—*mermaid's hair*. The species of *Oscillaria*, *Spirulina*, and *Beggiatoa*, are capable of oscillating rapidly, but in this respect the marine species are not so well marked as the species of fresh water. The *Beggiatoæ* which are found on putrefying algæ give off the disagreeable odor of sulphuretted hydrogen often noticed at the sea-shore in hot weather. The species of *Cryptophyceæ* are very widely diffused, and, with two exceptions, our forms are all common in Europe.

ZOOSPOREÆ.—This order includes not only the greater part of the *Chlorospermeæ* of Harvey's Nereis, with the exception of the *Oscillatoriaceæ*, which belong to the *Cryptophyceæ*, but also the *Laminariaceæ* and all the *Dictyotaceæ* which Harvey attributes to the New England coast. Although the species included in this large order differ from one another in size and habit to an extent that would certainly forbid their being placed together, if we considered merely the character of the frond, yet they resemble one another very closely in their mode of reproduction, which is accomplished by means of zoospores. The *Zoosporeæ* are divided into four suborders, the *Chlorosporeæ*, or *Chlorozoosporeæ*, as the name is sometimes written, the *Phæosporeæ*, or *Phæozoosporeæ*, the *Bryopsideæ*, and the *Botrydieæ*. The former are abundant in both fresh and salt water, They especially frequent brackish waters and high tide-pools. The mass of the vegetation in brackish rivers is formed of species of this order. The species are either filamentous or else in the form of green membranes, as in the sea-lettuces, *Ulvæ*, which abound in muddy places between tide-marks. The contents of any of the cells may be transformed into zoospores, which escape from the mother cell usually at daybreak. The zoospores are of two kinds, microzoospores and macrozoospores. The latter are produced few in number in the mother cell, and when they have escaped into the water they are seen to be furnished with four cilia placed at one end, and with a dark red spot on one side. After swimming about for a short time they come to rest, the cilia disappear, a wall of cellulose is formed around the zoospore, which then begins to divide and produce a plant like that from which it came. The microzoospores are borne in considerable numbers in the mother cell, and when they escape they are seen to have only two cilia at one end, and a dark red spot on the side. The microzoospores, after swimming about a short time, approach one another in pairs, occasionally in threes, which in a short time coalesce so as to form a body known as the zygospore, or, to use a term first applied by Rostafinski, the isospore, which has four cilia and two dark red spots. The zygospore swims about for a short time, then comes to rest, takes on a cellulose wall, and begins to divide in the same manner as a macrospore. This process of union is called conjugation, and represents sexuality in its lowest form, it being impossible to say which of the conjugating bodies is male and which is female. It is only the microzoospores which come from different mother-cells which conjugate, but it is not quite certain whether the cells must belong to different individuals. The microzoospores, however, do not always conjugate. More frequently they do not, but, after swimming about separately for a short time, lose their cilia and begin to grow just like the macrozoospores. If one wishes to examine the zoospores, he has only at evening to put a piece of sea-lettuce into a vessel of salt water, and at daybreak the zoospores will have formed a green cloud in the water. If the cloud consists of microzoospores, it will collect in the vessel on the side nearest the light; if composed of macrozoospores, on the side away from the light. Conjugation was first observed in a marine species (*Ulva*) by Areschoug, but had previously been observed by Pringsheim in a fresh-water species (*Pandorina*). Since then conjugation of zoospores has been studied by several observers.

BRYOPSIDEÆ.—In the present paper this suborder includes a single species of our coast, *Bryopsis plumosa*, which consist of a single cell of very large size, which branches in a pinnate fashion. When about to reproduce, some of the branches are shut off from the rest of the frond by a cell-wall, and the contents are then transformed into zoospores. A conjugation has not yet been seen in this species. From its unicellular structure one might suppose that *Bryopsis* should be placed near *Vaucheria*, but no oospores have yet been observed like those in the last-named genus. In the absence of a knowledge of the development of the genus, it is retained as a divsion of the *Zoosporeæ*, differing from the *Chlorosporeæ* in the unicellular character of the frond.

BOTRYDIEÆ.—The development of *Botrydium granulatum*, which was fully studied by Rostafinski and Woronin, differs from that of the *Chlorosporeæ* which we have already described in the fact that there is first produced in the small unicellular frond of which this species is composed a number of round spores, or more properly zoosporangia, which are discharged from the mother cell. There is then formed in each zoosporangium a number of zoospores, which escape and conjugate with one another. De Bary and Strasburger have described a similar process in *Acetabularia mediterranea*, and have applied the name *gameten* to the zoospores which conjugate, and *zygote* to the body formed by conjugation. Secondary modes of reproduction by means of zoospores with a single cilium and so-called root-cells occur in *Botrydium granulatum*. *Botrydium* (*Codiolum*) *gregarium*, our only marine species, resembles *B. granulatum*, but its development has never been fully studied.

PHÆOSPOREÆ.—The *Phæosporeæ* are all marine, with one possible exception, and are, when growing, of an olive-brown color. They possess only one form of zoospore, which is more or less oval and pointed at one end and olive-brown in color, and are furnished with two cilia attached at one side and a red spot. The zoospores are not born indefinitely in any cell, but are produced only in certain cells or sporangia. Each species is supposed to have two kinds of sporangia: one called the unilocular sporangium, which contains a large number of zoospores, and another, called the plurilocular sporangium, which consist of an aggregation of small cells, each of which contains a single zoospore. The name of oosporangia was originally given by Thuret to the unilocular sporangia because they are usually more or less oval in shape, but he afterwards abandoned the name because it is more appropriately applied to the spores of the *Oosporeæ*. The older name of trichosporangia, which was at first applied to the plurilocular sporangia, has also been abandoned. Although, as has been said, each species is supposed to have both kinds of sporangia, in a large number of species only one kind has as yet been observed. Both may occur on the same individual and at the same time, but more frequently they are found at different seasons of the year. Although found all over the world, the *Phæosporeæ* particularly affect the temperate and arctic regions, and they fruit more abundantly, as a rule, in winter and spring than at other seasons, if we except a few genera, like *Ectocarpus*. The conjugation in this suborder was first seen by Areschoug in *Dictyosiphon*, and afterwards by Goebel in *Ectocarpus pusillus*. The zoospores unite in nearly the same way as in the *Chlorosporeæ*. According to Goebel, who studied the zoospores coming from plurilocular sporangia, the conjugation occurs between zoospores coming from different sporangia. The development of the zygospore and the action of the zoospores borne in the unilocular sporangia, except in the genus *Dictyosiphon*, are not yet satisfactorily known. Thuret and Bornet have seen bodies which they consider to be antheridia in several species of *Ectocarpus*, and Pringsheim at one time considered that he had found antheridia in a species of *Sphacelaria*. It is now admitted that the bodies found by Pringsheim belonged to a parasitic species of *Chytridium*, and Thuret and Bornet were unable to ascertain the development of the antheridia in *Ectocarpus*. At any rate, nothing like an oogonium or any female organ to be fertilized by the antherozoids has been found in the *Phæosporeæ*.

As has already been hinted, the genera of *Phæosporeæ* differ from one another very widely in the structure of the frond. From low forms, consisting of short filaments, we pass upwards, through various cylindrical, crustaceous, and globose forms, to the highly developed devil's aprons, *Laminareæ*, the largest of our sea-weeds; and, finally, on the coast of California and in the Antarctic Ocean, we find the perfection of the order in the enormous *Macrocystis pyrifera*, which is several hundred feet long; the *Nereocystis* or bladder-kelp of California; and *Egregia*, in which we have what appears to be a separate stem, leaves, bladders, and fruit-bearing leaves. Janczewski distinguishes three principal modes of growth of the thallus in *Phæosporeæ*. The first consist in growth from a single terminal cell, as in *Sphacelaria*, *Cladostephus*, and *Dictyosiphon*, resulting in the formation of a filamentous solid plant. The second mode consists in the simultaneous growth of several contiguous filaments at their tips, so as to form either a flat expansion, as in *Myrionema* and *Ralfsia*, or a more or less globular body, as in *Leathesia*. The third mode is illustrated by the genus *Laminaria*, in which there is a stalk, a blade, and root-like growths. The place of growth is at the point of union of stem and blade, and the new blade, which begins to form at the tip of the stem, grows upwards from the base and gradually pushes off the old blade. In *Scytosiphon* a similar mode of growth is found only here, there being no stalk, the growth is at the base of the plant. During a certain part of the year, especially in the spring, most of the *Phæosporeæ* are covered with delicate hairs, which disappear as the plant becomes old.

The suborder contains a large number of species, which are divided into several families. Those found on our coast are the following:

Scytosiphoneæ.—This family includes the two genera *Scytosiphon* and *Phyllitis*, which comprise the old *Chorda lomentaria* and *Laminaria* *fascia*, which were placed among the *Laminariæ* in the Nereis Am.-Bor. In *Phyllitis* the frond is membranous, and its whole surface is covered by the plurilocular sporangia which are formed from the superficial cells, which divide so as to form club-shaped filaments consisting of five or six cells, each one of which contains a zoospore. *Scytosiphon* resembles *Phyllitis* except that the frond, instead of being a flat membrane, is a hollow tube. There are no paraphyses in *Phyllitis*, but in *Scytosiphon* there are ovoidal cells interspersed among the plurilocular sporangia, which seem to be of the nature of paraphyses. No true unilocular sporangia are known in this family.

PUNCTARIEÆ.—In this family we find both unilocular and plurilocular sporangia, which are formed in spots on the frond, and arise from the superficial cells. The former are spherical and the latter ellipsoid in outline, and divided into a number of small cells.

DESMARESTIEÆ.—In the two preceding families the fronds were either flat membranes or hollow tubes. In the present there is a solid axis and numerous branches. The cells of the cortical layer are changed into unilocular sporangia. The plurilocular sporangia are unknown.

DICTYOSIPHONEÆ.—In this family the fronds are solid and branching as in the last, and only the unilocular sporangia are known. They are in the form of large spherical cells, imbedded in the cortical layer and opening at the surface. Except that in *Desmarestia* the sporangia are formed directly from the superficial cells, while in *Dictyosiphon* they originate below the surface, this tribe scarcely differs from the last.

ECTOCARPEÆ.—This family comprises a large number of filamentous algæ, upon whose branches are borne the sporangia. The plurilocular sporangia are usually in the form of pod-like branches, composed of a large number of small muriform cells, in each one of which is produced a zoospore. The unilocular sporangia are either globose bodies, borne on a short stalk, or else are formed by the direct enlargement of several contiguous cells of the branches.

SPHACELARIEÆ.—This family is kept distinct from the last by Thuret. Both unilocular and plurilocular sporangia are known, and are similar to those of the *Ectocarpeæ*. If the two families are to be kept distinct, the reason must be that the fronds of the present order are solid, and the growth is by the means of a single terminal cell, which is not the case in the *Ectocarpeæ*.

LEATHESIEÆ.—In the *Leathesieæ* and *Chordarieæ* the sporangia are distributed indefinitely over the frond, but in the succeeding families they are found in separate spots or bands. The *Leathesieæ*, in which we do not include *Myrionema*, are either in the form of small tufts, as in *Elachistea*, in gelatinous expansions of indefinite shape, as in *Petrospongium*, or in vesicular masses, as in *Leathesia*. The greater part of the frond consists of a cellular filamentous mass, upon the surface of which is borne a layer of short filaments composed of smaller cells. The unilocular and plurilocular sporangia are borne at the base of the peripheral filaments. In *Elachistea* there are also paraphyses.

CHORDARIEÆ.—In this family the branching frond is filamentous, and consists of an axis of longitudinal filaments and a peripheral series of short filaments, which are given off at right angles to the axis. The sporangia are found amongst the peripheral filaments, the unilocular are ovoidal, and the plurilocular arise from the metamorphosis of the cells at the outer extremity of the peripheral filaments.

ASPEROCOCCEÆ.—The fronds of this family are the counterparts of those in the *Scytosiphoneæ*, but the sporangia, instead of being superficial, are external and do not cover the whole surface, but are found in spots. The spots contain paraphyses and spherical unilocular sporangia.

RALFSIEÆ.—In this family, composed of very few species, the frond is in the form of a crust, resembling a lichen. The fruit is found on the surface in spots, composed of paraphyses and unicellular sporangia.

SPOROCHNEÆ.—Here the frond is a solid branching filament and the fruit is found in spots on the surface. Each spot consists of a number of paraphyses, at the base of which are either oval unilocular sporangia or plurilocular sporangia in the form of short filaments, resembling the sporangia of *Phyllitis*.

LAMINARIEÆ.—The family which includes the devil's aprons and sea-colander of our coast. The fruit either forms long patches or more or less irregular spots along the center of the frond. Unicellular sporangia only are known. The sporangia are separated from one another by peculiar-shaped unicellular paraphyses, which are expanded at the top so as to cover the sporangia.

OOSPOREÆ.—In the order *Zoosporeæ* the sexual reproduction consists in the direct union of two zoospores, which form a zygospore. The two conjugating zoospores, or gameten if we adopt De Bary's nomenclature, are alike in structure, and it is impossible to say which is male and which is female. In the *Cutlerieæ*, of which no representative has as yet been found on our coast, we have algæ resembling the *Phæosporeæ* in habit, but differing from them in that their reproduction is of a higher grade. The *Cutleriæ* have both zoospores and antherozoids, or proper male organs. The zoospores are large, and are born singly in cells, which are united in eights into an oblong body. The antheridia borne on distinct individuals are also oblong in shape, but, instead of being divided into eight cells, they are formed of a much larger number of small cells, in each one of which an antherozoid is produced. The antherozoids are small oval bodies, almost colorless, and provided with two lateral cilia. In *Cutleria collaris* Reinke found that the zoospores after swimming about for some time, lost their cilia and came to rest. While at rest the antherozoids approached them, and he considered that the sexual union then took place. Here, then, we find a clear distinction of the sexes such as is nowhere found in the *Zoosporeæ*, and it is but a step higher to the *Oosporeæ*, in which we have a distinct male organ, the antherozoid, borne in an antheridium, and a female, called in this order the oogonuim. The order is divided into two suborders, in which, although the general plan of reproduction is the same, the details vary.

VAUCHERIEÆ.—This suborder includes a number of species of green algæ which form dense turfs upon the mud in brackish ditches and rivers, or else loosely floating masses of green filaments. They may generally be recognized at sight by their deep-green shining color and velvety appearance. They consist entirely of long green threads, which occasionally branch, but which are destitute of any cross-partitions except at the time of reproduction. The non-sexual reproduction is by means of zoospores. A cross-partition is formed near the end of a filament, and in the cell thus cut off from the rest of the plant a single very large zoospore is formed. In some species the zoospore escapes through an opening in the apex of the cell, and when free its whole surface is seen to be covered by a large number of vibratile cilia. In other species the cell containing the zoospore breaks off from the rest of the plant and the zoospore remains in a more or less passive condition. The antheridia grow from the sides of the filaments, and are either in the form of oblong, at times nearly sessile, cells, or else a lateral shoot is formed which ends in one or more convolute processes, at the tips of which a cell is cut off from the rest. The antherozoids are very small bodies with two cilia. The *oogonia*, or female organs, are generally situated near the antheridia, and are irregularly ovoid, with a blunt tip. The cell contents collect in a roundish mass at the center, called the *oosphere*, while at the tip of the oogonium is a mass of slimy substance. At the time of fertilization the antheridium opens and discharges the antherozoids and the tip of the oogonium opens to admit the antherozoids, which remain for a short time in the interior of the oogonium and then withdraw. The oogonium is then closed and, the oosphere, which before fertilization was merely a mass of protoplasm, has now formed around it a wall of cellulose, and ripens, forming an *oospore*. The oospore finally escapes from the oogonium and germinates.

FUCACEÆ.—This suborder includes the rock-weeds, *Fuci* and *Sargassum*, of our coast, which constitute the bulk of the olive-brown sea-weeds found between tide-marks. The admirable paper of Thuret on the fertilization of *Fucus* leaves nothing to be desired on that subject, and his observations are now so widely known in this country that little need be said in this connection. In the two common rock-weeds of our coast, *Fucus vesiculosus* and *F. nodosus*, the two sexes are on distinct individuals. In *F. evanescens* and *F. furcatus* they are on the same individual. The *Fuci* fruit principally in winter and spring, but *F. vesiculosus* may be found in fruit throughout the year. In the last-named species, if we examine the swollen tips of the frond, we find certain granular bodies, which on section are seen to be sacks opening outwards. The sacks are called conceptacles. The male plant can generally be distinguished from the female by the brighter color of the tips which bear the conceptacles. A section through the conceptacles of the male plant, as in Pl. IX, Fig. 2, shows a number of branching filaments which line the interior of the conceptacle. Attached to the filaments are oval bodies, the antheridia. The antheridia contain the antherozoids, which are ovate and provided with two cilia attached at the side. Usually about day-break the antheridia discharge their antherozoids, which then swim about in the water until they reach the female plant. A section through the tip of a female plant shows a number of conceptacles similar in shape to those of the male plant. On the walls of the conceptacle there are paraphyses, and scattered among them are the oogonia, as shown in Pl. IX, Fig. 1. The oogonia are oval and seated on broad short pedicels. In *Fucus vesiculosus* the contents of the oogonia divide into eight oospheres, which are at first angular, but afterwards become spherical. The oogonia become free from their attachments, and the wall, which is really double, ruptures, and the oospheres escape into the water. In this condition they are merely spheres of protoplasm. The antheridia then collect around the oospheres in large numbers, and the mass begins to rotate. The rotation continues for a short time, and when it ceases the antherozoids withdraw and soon perish. It is not yet certain whether one or more of the antherozoids really penetrates into the substance of the oosphere during the revolutions. As soon as it comes to rest the oosphere takes on a cell-wall of cellulose and becomes an oospore, which after an interval of rest begins to divide so as to form eventually a new frond.

DICTYOTEÆ.—Although no members of this order are known on our coast north of North Carolina, the order cannot pass unnoticed in the present article, because it forms a connecting link between the *Fucaceæ* and *Phæosporeæ* on one hand and the *Florideæ* on the other. The species are olive-brown and form expanded membranous fronds. Three kinds of reproductive organs are known, antheridia, spores, and tetraspores. All are formed by outgrowths from the superficial cells. The tetraspores are formed, as the name implies, in fours in a mother cell, from which they escape and then readily germinate. The spores are borne singly in a mother cell. The antheridia are composed of a number of oblong cells, which become divided by numerous longitudinal and transverse divisions into small cells, each of which contains an antherozoid. The *Dictyotaceæ* resemble the *Florideæ* in having tetraspores and spores which germinate without first passing through a zoosporic condition. The action of the antherozoids is at present unknown, and the spores of this order cannot be the product of a fertilization such as we find in the *Florideæ*.

FLORIDEÆ.—This order is the same as the *Rhodospermeæ* of Harvey's Nereis. The species composing it form a very natural group, and are, with the exception of a few genera, entirely marine. Their color is always some shade of red or purple when they are growing in their normal condition. When, however, they grow in positions where they are much exposed to the light they become green, and in decaying they pass through various shades of orange and yellow to green. Their favorite place of growth is below low-water mark and in deeper water, but some species grow in tide-pools. The fronds vary in structure in the different genera, but as a rule they are less complicated than the fronds of the *Fuci* and *Laminarieæ*. The non-sexual mode of growth is by means of bodies called tetraspores, formed by the division of a single cell into four parts. The divisions may be at right angles to one another, when the tetraspore is said to be *cruciate;* they may be parallel to each other, in which case the tetraspore is said to be *zonate;* or they may be arranged as in Pl. XI, Fig. 1 *a*, when it is said to be *tripartite*. The tetraspores may either be isolated or collected in wart-like masses, called *nemathecia*. The individuals which bear the tetraspores are, with rare exceptions, distinct from those which bear the sexual fruit or cystocarps. Occasionally both kinds are found on the same individual, as sometimes happens in *Callithamnion Baileyi* and *Spyridia filamentosa*. The tetrasporic plants, taking the order as a whole, are decidedly more abundant than those which bear the cystocarps. The sexual fruit, called the cystocarp, is formed by the action of antherozoids upon a structure called the trichogyne, which forms a part of the procarpe. The antherozoids are small colorless spheres, destitute of cilia. They are borne singly in cells, which are agglomerated in various forms, which differ in the different genera, but are usually either in the shape of short, dense tufts, or else are siliculose in outline. In *Chondria* the antheridia cover the surface of irregular disk-like branches, and in membranous genera they form spots on the surface.

The name of *procarpe* was given by Bornet and Thuret to the collection of different cells, of which the female organ is composed before fertilization. The procarpes are borne on the younger parts of the frond generally near the surface. The cells of which they are composed may be divided into two sets—those which take part in the act of fertilization and those from which the spores are formed. The former consists of the *trichogyne*, a long, slender, hyaline hair, at whose base is the *trichophore*. The latter set, called by Thuret and Bornet the *carpogenic cell* or *system*, varies in the different genera, and is in most cases too complicated to be explained in the present article. In the simplest genera, as in *Nemalion* and *Batrachospermum*, the antherozoids come in contact with the extremity of the trichogyne, where they remain fixed for a considerable time. The contents of the antherozoid, or antherozoids—for more than one may be attached to the trichogyne—pass into the trichogyne, and, in consequence of this action, a change takes place in the trichophore, which divides, the divisions growing into short filaments, which are formed into chains of spores by transverse divisions. In this case the trichophore represents the carpogenic cell. In *Nemalion* the cystocarpic fruit is a globular mass of spores, arranged in filaments and destitute of any general envelope. In by far the greater number of genera the spores are not formed by direct outgrowths from the trichophore. In *Callithamnion*, for instance, the fertilizing influence is propagated from the trichogyne, through the trichophore and the cells below it which constitute the trichophoric apparatus, to certain lateral cells, from which by repeated cell-division the spores are formed. In *Dudresnaya* the cells of the trichophoric apparatus send out a number of lateral tubes, which, in turn, convey the fertilizing impulse to certain modified branches in other parts of the frond, so that, in reality, the cystocarp is formed at some distance from the trichogyne by means of which it has been indirectly fertilized. A similar mode of fertilization is known in *Polyides* and, according to Professor Schmitz, in the *Squamarieæ*. The cystocarps are sometimes naked, that is, without a special membranous envelope, as in *Nemalion*, but they not unfrequently are contained in a conceptacle or pericarp. In the latter case, the development can only be studied with difficulty, because the conceptacle, which originates from some of the cells below the trichophore, develops more rapidly than the rest of the cystocarp, and so shuts out from view the process of the formation of the spores. It is impossible in the present article to enter into the details of the development of the cystocarp in this complicated order, but the reader interested in the subject is referred to the superb work of Thuret and Bornet, *Études Phycologiques*, and the hardly less admirable *Notes Algologiques*, of the same authors, for a masterly exposition of the subject.

MODE OF COLLECTING AND PREPARING SEA-WEEDS.

The collector of sea-weeds should be provided with a pail of tin or wood, or, better still, with one of papier maché if it can be procured, in which he should place a number of large wide-mouthed bottles and several small bottles, and one or two vials filled with alcohol should not be forgotten. A knife is needed for scraping crustaceous algæ from stones, and a geologist's hammer and chisel are often useful. A hand-net, with a long, stout, jointless pole and net with small meshes is a necessity. Clothes for wading are also indispensable, since the best collecting grounds are below low-water mark. If the collector is not already sufficiently encumbered, he may throw a common botanical collecting-box over his shoulder, as it will serve to carry the coarser species. Collecting on sandy or gravelly beaches is very simple. One finds there only the *Florideæ* and larger brown sea-weeds which are washed ashore after a storm. It is only necessary to pull over the heaps of refuse at high-water mark, or to dip up with a net the specimens which are floating at low-water. Collecting on beaches is uncertain, because it is only at certain times that specimens are washed ashore. On rocky shores, on wharves, and on the eel-grass we are always sure to find something. One should examine the surface of rocks wet with the spray, the bases of the stalks of the marsh-grasses, and even the surface of mud which is overflowed at high tide. Here one will find an abundance of *Cryptophyceæ* and some *Chlorosporeæ.* Pools, more especially rocky pools, are rich in *Chlorosporeæ* and the filamentous *Phæosporeæ.* The richest locality is just beyond low-water mark, especially at the spring tides. One should carefully scrape old wharves and piers. This is best done at low tide from a boat. A long-handled net with a scraper on one side is the best thing, but any stout net will do. By scraping old woodwork which looks very unpromising one sometimes gets the rarer *Callithamnia* and other delicate algæ. A number of interesting species are also to be found growing on eel-grass, which may be reached at low tide by wading, or, better still, by boat.

For botanical purposes the dredge is not of very great service. One sometimes secures by its means rare species, but, as a rule, a day of dredging is a day wasted. Most algæ grow on rocky bottoms where the dredge does not work well, in fact not so well as grappling hooks. The best opportunity for dredging is on a shelly bottom, where several rare species are found. Good specimens are not unfrequently brought up by fishermen on their nets. The different species when collected should be cleaned of sand and small animals and placed in bottles, each species in a separate bottle. This is absolutely necessary in case of genera like *Cladophora* and *Ectocarpus,* which would otherwise be hopelessly entangled. The small specimens and those to be kept for microscopic study should be put into alchohol. The coarse species which are merely to be mounted and are not to be studied should be put dry into the pail. Anything to be studied should be kept in plenty of water, or, if not to be studied in a short time, be put immediately into alcohol. It is, however, useless to put into alcohol large quantities of sterile specimens of genera, like *Cladophora*, the species of which are characterized by their branching and not by microscopic structure. Sea-weeds are best mounted in salt water, that is, in this way they are in a more natural condition for after-study, and if one is able to procure plenty of salt water it is best always to mount in it. However, one may be stopping at a distance from the shore, in which case it is possible to make use of fresh water. Besides, if salt water is used continually the driers become saturated with salt, and it is then impossible to prepare specimens in the damp weather so frequent at the sea-shore. As a matter of economy, one had better mount only the finer and most important specimens in salt water and the rest in fresh water.

The larger sea-weeds, as the rock-weeds and devil's aprons, should be allowed to soak several hours in fresh water before being mounted. They can then be pressed in the same way as flowering plants, and, when dried, mounted on the ordinary herbarium sheets. If a number of large specimens are to be prepared, it is best to hang the plants up as soon as they are gathered and allow them to dry, and they can afterwards be soaked out at leisure in fresh water. The collector should know that there are probably no plants which so quickly spoil driers as the species of rock-weed. For mounting the smaller species one should have two or three shallow dishes of salt water, in which the plants are to be washed and floated out, and a deep basin of either salt or fresh water, as the case may be, for mounting. A zinc tank, one of whose sides is slanting, is convenient for mounting, but is rather an awkward thing to carry about in travelling. The specimens to be mounted are put into the basin and floated out; a piece of paper is slipped under them and they are lifted out of the water. A moderately thick unglazed paper is best for mounting, although almost any kind will do, provided it is not very thin. Many ladies make use of photographer's cards.

With a little practice it is perfectly easy to remove sea-weeds from the water, but to prevent the specimen slipping off the paper or to one side of the paper it is best to put the middle finger under the center of the paper and raise it so that the water drains off equally on all sides. Some slip a pane of glass under the paper, and lift it out of the water in that way. The papers should then be left in an inclined position for a short time, so that the superfluous water may run off. They are then to be put on the driers and covered with a piece of muslin or other thin white cloth, from which the glazing has been removed by washing. Very gelatinous specimens should be exposed for some time to the air before pressing. The driers should be of bibulous paper and the best material, but unfortunately the most expensive, is thick white blotting-paper. The specimens are to be laid on the paper and covered with a cloth, and then another layer of paper is placed above, and so on. The best form of press is a board with a number of stones for weights. The driers should be changed morning and night until the specimens are dry. Some of the smaller species dry in a few hours; others require two or three days. Great pressure is to be avoided, and the specimens, if prepared in fresh water, should not be allowed to remain long in the water. Most small species adhere to the papers naturally; others require to be fastened with gum. Besides mounting specimens on paper, it is a very good plan to prepare specimens of fruit or any small filamentous species on pieces of mica or glass. Fragments of mica good enough for the purpose can be obtained for a very small sum of those who manufacture air-tight stoves. Specimens prepared on mica can be moistened and at once used for microscopic study. All really microscopic forms, such as *Glœocapsa*, *Clathrocystis*, &c., had better be mounted on mica or glass than on paper. A difficulty is experienced in preparing corallines and other calcareous forms. If prepared in the same way as other sea-weeds, they become very brittle, and are often ruined by transportation. Various means have been devised for making them less brittle—such as painting them with a thin solution of gum. A better method is to paint them with a hot solution of isinglass which has been boiled for a few moments in alcohol. The habit may be preserved, although the structure is somewhat injured, by immersing corallines for a short time in some dilute acid, which, by removing the calcareous matter, renders the specimens more flexible.

As we have said, selected material for future study should be put into alcohol. Several other preserving fluids have been recommended, but none in the long run do as well as alcohol. Some species do well in glycerine, especially parasites like *Streblonema* and *Bulbocoleon*, which grow in the fronds of other species. A one per cent. solution of osmic acid is a favorite preserving fluid of some botanists. Certain sea-weeds, as the *Phæosporeæ*, can be mounted for the microscope in almost any of the ordinary mounting fluids, and keep very well. The *Florideæ*, on the other hand, do not keep at all well, and after a few months the preparations begin to spoil. A saturated solution of calcic chloride, a mixture of glycerine and acetic acid, half and half, boiled and filtered, weak solutions of carbolic acid, or a one per cent. solution of osmic acid are all about equally good for mounting algæ. As we have said, *Phæosporeæ* generally do well and *Florideæ* badly, but one sometimes has success even with the latter.

ORDERS AND SUBORDERS*

OF

MARINE ALGÆ OF NEW ENGLAND.

ORDER I. CRYPTOPHYCEÆ.

Suborder CHROOCOCCACEÆ.
NOSTOCHINEÆ.

ORDER II. ZOOSPOREÆ.

Suborder CHLOROSPOREÆ.
BRYOPSIDEÆ.
BOTRYDIEÆ.
PHÆOSPOREÆ.

ORDER III. OOSPOREÆ.

Suborder VAUCHERIEÆ.
FUCACEÆ.

ORDER IV. FLORIDEÆ.

Suborder PORPHYREÆ.
SQUAMARIEÆ.
NEMALIEÆ.
SPERMOTHAMNIEÆ.
CERAMIEÆ.
SPYRIDIEÆ.
CRYPTONEMIEÆ.
DUMONTIEÆ.
GIGARTINEÆ.
RHODYMENIEÆ.
SPONGIOCARPEÆ.
GELIDIEÆ.
HYPNEÆ.
SOLIERIEÆ.
SPHÆROCOCCOIDEÆ.
RHODOMELEÆ.
CORALLINEÆ.

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*An artificial key to the genera of New England algæ will be found at the end of this paper.

ORDER I. CRYPTOPHYCEÆ, Thuret.

Algæ composed of cells which are either isolated or imbedded in mucus, so as to form colonies, or united in the form of filaments. Color usually bluish green, sometimes brown, purple, or pink. Reproduction by hormogonia or non-sexual spores. Sexual reproduction unknown.

We have retained the name given by Thuret, in Le Jolis's Liste des Algues Marines de Cherbourg, to the group of low algæ in which sexual reproduction is unknown. Our species belong to the *Schizophytæ* of Cohn (Beiträge zur Biologie der Pflanzen, Vol. I, p. 202), which also includes the minute forms commonly known as *Bacteria.* Most of the species here enumerated are bluish green, owing to the presence of phycochrome, and would be placed by some writers in the order *Phycochromaceæ.* Some are destitute of phycochrome and have been placed by different writers in the *Chroococcaceæ* and *Palmellaceæ.* Nægeli, in Die Niederen Pilze, is of the opinion that the *Bacteria* should not be classed with the *Phycochromaceæ,* as in the *Schizophytæ* of Cohn, but one cannot expect to make a satisfactory classification of forms in which no sexual reproduction has, as yet, been discovered. The *Protophytes* of Sachs's Text-Book include all the *Schizophytæ* of Cohn, together with the *Palmellaceæ* and *Saccharomycetes.* From the nature of the plants themselves, none of the above classifications can be considered of decided scientific value, and, regarding the question of convenience alone, we have adopted the name *Cryptophyceæ* as expressing sufficiently well all the marine *Protophytes* of our coast, whether they contain phycochrome or not. The order is divided into two suborders, as follows:

a. Cells free, or united by a gelatinous intercellular substance into families which never form true filaments .... CHROOCOCCACEÆ.
b. Cells arranged in filaments .... NOSTOCHINEÆ.

SUBORDER CHROOCOCCACEÆ.

(*Glœogenæ,* Cohn in part.)

1. Cells free or united in twos or fours .... *Chroococcus.*
2. Cells united by a mucous intercellular substance into amorphous

[NOTE.—In the following descriptive part of the present paper the synonymy of the species is carried only so far as to enable the reader, in the first place, to recognize the more common synonyms and also the works in which the synonymy is given in full, and, in the second place, to give a reference to the more accessible works in which the different species are figured. Of the latter frequent reference is made to the *Nereis Boreali-Americana* and *Phycologia Brittanica* of Harvey, to the *Études Phycologiques* and *Notes Algologiques* of Bornet and Thuret, and the *Tabulæ Phycologicæ* of Kützing. For a list of descriptive works consulted the reader is referred to the end of this paper.

All microscopic measurements are given in fractions of a millimeter, but gross measurements of objects more than half an inch in diameter are given in feet and inches, as the divisions of the meter are not, in this country, readily applied to objects which can be seen by the naked eye.

Unless otherwise stated, the localities given are those in which the writer himself has collected the species, but in the case of common species it has been considered unnecessary to give special localities.]

colonies. Intercellular substance generally forming concentric layers around the cells .... *Glœocapsa.*

3. Cells united in colonies of definite shape.
   a. Cells arranged in the form of an irregular sphere, which becomes finally hollow and net-shaped .... *Clathrocystis.*
   b. Cells arranged in several layers forming a solid spheroidal body. *Polycystis.*
   c. Cells united in branching dendritic masses .... *Entophysalis.*

CHROOCOCCUS, Næg.

((From χροος, the color of the body, and κοκκος, a berry.)

Cell division taking place in all directions, cells spherical, solitary, or united in twos or some multiple of two, free, *i. e.*, not united into families by means of an intercellular substance.

According to Nægeli, the principal distinction between *Chroococcus* and *Glœocapsa* lies in the fact that in the former genus the cell-wall is thin, while in the latter it is thick and formed of concentric layers. This difference, however, is not constant, as in *Chroococcus turgidus* the cell-wall is comparatively thick, whereas in *Glœocapsa crepidinum* the cell-wall is reduced to a minimum. A more characteristic distinction seems rather to be the existence of an intercellular substance in *Glœocapsa* which binds the cells together, but which is wanting in *Chroococcus*.

C. TURGIDUS, Næg. (*Protococcus*, Kütz., Tab. Phyc., Vol. I, Pl. 6, Fig. 1.—*Hæmatococcus binalis*, Hassal, Fresh-water Algæ, p. 331, Pl. 82, Fig. 2.)

Cells bluish green, oval, usually single or binate, about .02^{mm} to .025^{mm} in diameter, surrounded by a thick cell-wall.

Cape Ann, *Mrs. A. L. Davis;* Europe. Fresh water and marine.

Found on slimy rocks and piers upon which species of *Calothrix, Lyngbya,* &c., are growing. Probably common throughout New England. The size of the cells varies very much. What we have given above is an average measurement.

GLŒOCAPSA, (Kütz.) Næg.

(From γλοιος, sticky, and καψα, a box.)

Cell division taking place in all directions, cells spherical, with thick walls, solitary or united in families, which are surrounded by a gelatinous substance which is generally in concentric layers around the cells. Spores known only in *G. stegophila*, Itzigs. (*G. Itzigsohnii*, Bornet mscr.).

This genus, if we adopt the views of the advocates of Schwendener's theory, forms the gonidia of the lichen genera *Synalissa, Omphalaria,* &c.

G. CREPIDINUM, Thuret, Notes Algologiques, p. 2, Pl. I, Figs. 1–3. (*Protococcus*, Thuret, in Mém. Soc. Natur. Cherbourg, Vol. II, p. 388; Le Jolis, Liste des Algues Marines de Cherbourg, p. 25; Farlow, List of Marine Algæ, 1876.—*Pleurococcus*, Rab., Flora Europ. Alg., Sec. III, p. 25.) **Pl. I, Fig. 1.**

Cells spheroidal, yellow, about .0035^{mm} to .005^{mm} in diameter, imbedded in an olive-brown gelatinous stratum, occasionally single, usually united in twos or some multiple of four.

Eastport, Maine; Gloucester, Mass.; Newport, R. I.; northern coast of France.

We found this species abundant in October, 1875, on the wharves of Eastport, where it formed thin gelatinous layers of a dark-brown color at high-water mark. It probably occurs at high-water mark on wharves along our whole coast. This species is said by Thuret to form the gonidia of *Verrucaria halodytes*, Nyl., a species which we are informed by Prof. Tuckerman is not known to lichenologists in this country. In the present species the concentric layers of the gelatinous envelope of the cells is wanting. The color of the cells is quite constantly brownish yellow, but occasionally they become dark green. The average diameter of the cells in American specimens seems to be slightly less than Thuret's measurement.

POLYCYSTIS, Kütz.

(From *πολυς*, many, and *κυστις*, a bladder.)

Cells spherical, densely aggregated, united by an intercellular mucus into solid masses.

In this genus we include *Microcystis* of Kützing, in which the colonies are isolated and not united in botryoidal masses, one being evidently an immature state of the other.

P. ELABENS, Kütz. (*Microcystis*, Kütz., Tab. Phyc., Vol. I, Pl. 8, Fig. 1.)

Cells bluish green, oblong, about .004^{mm} in diameter, closely packed in solid colonies, which are aggregated in botryoidal masses.

Wood's Holl, Mass.; Europe.

Common in summer on decaying algæ, over which it forms slimy masses, mixed with species of *Lyngbya*, *Microcoleus*, &c.

P. PALLIDA, (Kütz.).

Cells bluish green, oval, .005–7^{mm} × .007–9^{mm}.

Newport, R. I.; Gloucester, Mass.; Europe. On *Cladophoræ* and *Zostera.*

Differs mainly in the size of the cells from the preceding species. Our form agrees closely with European specimens.

CLATHROCYSTIS, Henfrey.

(From *κληθρον*, a lattice, and *κυστις*, a bladder.)

Cells minute, very numerous, imbedded in mucus, forming a colony which is at first solid, then hollow, and finally perforate.

C. ROSEO-PERSICINA, Cohn, in Beiträge zur Biologie, Vol. I, Part III,

p. 157, Pl. VI, Figs. 1–10. (*Microhaloa rosea*, Kütz., in Linnea, VIII, 341.—*Protococcus*, Kütz., Spec. Alg.—*Pleurococcus roseo-persicinus*, Rab., Flora Europ. Alg.—*Cryptococcus roseus*, Kütz., Phyc. Gen.; Le Jolis, Liste des Algues Marines; Crouan, Florule du Finistère; Farlow, List of Marine Algæ, 1876.—*Bacterium rubescens*, Lankaster, in Quart. Journ. Micros. Science, Vol. XII, new series, p. 408, Pl. 22 and 23.)

Cells very small, about .0025^{mm} in diameter, rose-colored.

Whole New England coast; Europe. Both marine and in fresh water.

Very common on decaying algæ and on the mud, which it covers with a purplish-red film. It is also found on codfish in the Gloucester market, causing what is known as the red fish. This alga, of which the detailed history is given by Cohn and Lankaster, l. c., after having been placed by different writers in several different genera, has finally been associated with *Clathrocystis æruginosa*, Henfrey, a common fresh-water alga of Europe and the United States. Both species are at first minute and solid, but as they grow older become hollow, and at length portions become detached, leaving holes in the circumference. Although in Europe the species is found in fresh water as well as in salt, it has not yet been observed in the interior of this country.

ENTOPHYSALIS, Kütz.

(From εντος and φυσαλις, a bladder.)

Cells united in colonies, which assume a dendritic form.

The genus is founded on *Entophysalis granulosa*, a species of the Mediterranean, referred by Zanardini to the *Palmellaceæ*, but more correctly by Thuret and Bornet to the *Chroococcaceæ*.

E. Magnoliæ, n. sp.

Cells dark purple, .004–6^{mm} in diameter, united in twos and fours and imbedded in jelly, which forms a densely branching mass.

Magnolia Cove, Gloucester, Mass. Rare. Autumn.

This alga forms a thin slime on exposed rocks, in company with *Glœocapsa crepidinum*. The ramifications of the frond are visible on careful dissection. The species is much smaller and differs in color from *E. granulosa* of Europe. The cells do not differ much in size from those of the *Glœocapsa*, but they are of an entirely different color and have the concentric arrangement of the cell-wall much better marked than in that species. The cells adhere together in twos, fours, or some multiple of four, and all are held together by a mucous mass, which branches in a very dense fashion. The genus *Entophysalis* is merely a *Glœocapsa*, which instead of being indefinitely expanded is densely ramified.

Suborder NOSTOCHINEÆ.

(*Nematogenæ*, Cohn in part.)

We have followed Thuret's *Essai de Classification des Nostochinées*, Ann. des Sciences, 6 série, Tome I, in the arrangement of the genera.

1. Filaments terminating in a hyaline hair 7
   Filaments destitute of a terminal hair 2

2. Filaments furnished with heterocysts 10
   Filaments destitute of heterocysts 3
3. Filaments spirally twisted .... *Spirulina.*
   Filaments not twisted 4
4. Filaments without a distinct sheath 5
   Filaments formed of one or more colored trichomata contained in a transparent sheath 6
5. Cells bluish green or purple .... *Oscillaria.*
   Cells colorless, or filled with minute black grains .... *Beggiatoa.*
6. Sheath containing several trichomata .... *Microcoleus.*
   Sheath containing only one trichoma .... *Lyngbya.*
7. Filaments free, forming tufts of indefinite extent .... *Calothrix.*
   Filaments united by a more or less firm gelatinous substance, frond of definite shape and extent 8
8. Heterocysts basal, *i. e.*, placed at the base of the principal filaments and branches 9
   Heterocysts intercalary .... *Hormactis.*
9. Frond hemispherical or vesiculose, filaments radiating from the base .... *Rivularia.*
   Frond plane, filaments parallel .... *Isactis.*
10. Filaments destitute of a sheath .... *Sphærozyga.*
   Filaments consisting of a trichoma in a sheath .... *Nodularia.*

SPHÆROZYGA, Ag.

(From *σφαιρα*, a sphere, and *ζυγος*, a yoke.)

Filaments free, destitute of sheath. Spores produced in the cells adjacent to the heterocysts.

S. CARMICHAELII, Harv., Phyc. Brit., Pl. 113 *a*. (*Cylindrospermum*, Kütz., Spec. Alg., p. 294.—*Anabaina marina*, Bréb.). **Pl. I, Fig. 3.**

Filaments flexuous, densely interlaced, forming slimy bluish-green expansions, cells cylindro-spherical, about .0035^{mm} in diameter, diminishing in size towards the end of the filament, terminal cell pointed. Heterocysts several in each filament. Spores oblong, usually one on each side of heterocyst, about .018^{mm} in length when ripe, rather more than twice as long as broad, at first green, then yellowish.

Noank, Conn.; Wood's Holl, Gloucester, Cambridge, Mass.; Europe. Summer.

Probably a common alga along our whole coast in midsummer and autumn on decaying algæ, looking like a shining emerald-green film. It occurs most frequently on the surface, but is also found at the depth of several feet. In his work on the Fresh-water Algæ of America, Prof. H. C. Wood, jr., mentions the present species as occurring at Camden, N. J. We cannot, however, agree with him in placing it in the genus *Dolichospermum* of Thwaites. Ralfs, in Annals and Mag. of Nat. History, Vol. V, 2d series (1850), p. 325, following C. A. Agardh, who first described the genus *Sphærozyga* (Flora, 1827), says that in *Sphærozyga* the spores are first formed from the cells nearest the vesicular cells (heterocysts), as is shown by Professor Wood's figure, Pl. 3, Fig. 3, to be the case with the species from Camden. Neither can we regard *S. Carmichaelii*, Harv., as a synonym of *Cylindrospermum polysporum*, Kütz., as given by Professor Wood. Although we have examined a large number of specimens, in only one instance have we found more than a single spore on each side of the heterocyst, which is quite different from *C. polysporum*, Kütz.

NODULARIA, Mertens.

(From *nodulus*, a little joint.)

Filaments free, trichoma inclosed in a definite sheath, cells discoidal. Heterocysts at regular intervals. Spores numerous, contiguous, not adjacent to the heterocysts.

The genus *Spermosira* of Kützing is included under the above.

N. HARVEYANA, Thuret, Class. des Nostoch. (*Spermosira Harveyana*, Thwaites, Phyc. Brit., Pl. 173 *c*.)

Filaments curved, cells discoidal, .0015–20 × .004^{mm}, heterocysts .0035^{mm} in diameter, spores numerous, about 4–8 together, spherical, .005–70^{mm} in diameter.

Charles River, Cambridge, Mass.; Europe.

Found in small quantities, mixed with *Sphærozyga*, in company with *Rhizoclonium*.

SPIRULINA, Turpin.

(From *spirula*, a small spiral.)

Filaments simple, without a proper sheath, oscillating, spirally twisted. Spores unknown.

S. TENUISSIMA, Kütz., Phyc. Brit., Pl. 105, Fig. 3; Farlow, List of Marine Algæ, 1876. **Pl. I, Fig. 4.**

Filaments intricately interlaced, .0035^{mm} in diameter, hyaline, spiral, closely twisted, cell divisions scarcely visible, oscillations rapid.

Eastport, Maine; Gloucester, Cambridge, Wood's Holl, Mass.; Europe.

This species is common at Eastport, where it forms, mixed with species of *Oscillaria*, dark purple-colored patches on the wharves at low-water mark, and it is without doubt to be found in similar localities along the whole coast.

We found at Wood's Holl, in 1876, a species of *Spirulina* which formed a greenish film on decaying algæ five or six feet below low-water mark, and the same species was collected by Mr. F. W. Hooper at Key West. It agrees closely with *S. Thuretii*, Crn., a species which differs from *S. tenuissima*, Kütz., in having slightly smaller filaments, which are also less tightly coiled. It hardly seems to us, however, as though the difference was sufficient to separate the two species. A *Spirulina* with much finer filaments than in *S. tenuissima*, and with a much more open spiral, occurs at Wood's Holl, but we have never found it in sufficient quantity to ascertain the species.

BEGGIATOA, Trevisan.

(Named in honor of *Franccsco Secondo Beggiato*, an Italian botanist.)

Filaments simple, hyaline, no proper sheath, rapidly oscillating, cells filled with opaque granules. Spores unknown.

A genus separated from *Oscillaria* only by its color, which is white to the naked eye, and by the granules of sulphur which often make the cell seem quite opaque when viewed with the microscope. The species give off a strong odor of hydric sulphate, and are found in both fresh and salt water, especially in hot springs. The diameter of the filaments, an uncertain mark, is about the only guide to the distinction of the species.

B. ALBA, Treves, var. MARINA (Warming, Videnskab. Middels., 1875, Pl. X, Figs. 6, 7).

Filaments .0036^{mm} in diameter, cell divisions indistinct, granules usually irregularly placed.

Cambridge; Europe.

In brackish ditches.

B. ARACHNOIDEA, Rab. (Warming, l. c., Pl. X, Figs. 2–4).

Filaments .005–7^{mm} in diameter, cells narrower than broad, granules usually in bands parallel to the transverse cell-walls.

Eastport, Maine; Wood's Holl, Mass.; Europe.

On dead algæ.

B. MIRABILIS, Cohn (Warming, l. c., Pl. X, Fig. 5).

Filaments .016^{mm} (20–40, Warming) in diameter, cells a third as long as broad, granules arranged in bands.

Cambridge, Mass.; Europe.

There is a doubt about the accuracy of the determination of the specimens referred to this species. It is much the largest of the genus found on our coast. The only specimens which we have measured were .016^{mm} in breadth, which agrees with the measurement of Cohn, but not with that of Warming. We have the impression, however, that we have seen larger specimens than those measured.

Leptothrix rigidula, Kütz., is found at Wood's Holl, on *Ectocarpus* and other algæ. The genus *Leptothrix* is now limited to small species related to *Bacillus*. The present species is parasitic on *Ectocarpus* and *Cladophora*, on which it forms white fringes in midsummer. The filaments are about .002^{mm} in diameter. The cell divisions are very indistinct. The species may possibly be the same as *Beggiatoa minima*, Warming, l. c., Pl. X, Fig. 10.

OSCILLARIA, Kütz.

(From *oscillo*, to vibrate.)

Filaments simple, destitute of distinct sheath, oscillating, bluish green or dark purple.

The species of this genus are found on mud, wharves, and wood work. They are not usually found pure, but mixed with *Spirulina*, *Lyngbya*, &c. The following are all to which we care to give a name, but not by any means all which occur with us.

O. LIMOSA, Kütz., var. CHALYBEA, Tab. Phyc., Vol. I, Pl. 41, Fig. 3; Le Jolis, Liste des Algues Marines.

Filaments .008–9^{mm} in diameter, flexuous, apex obtuse, oscillations marked, cells about half as long as broad, purplish colored.

Eastport, Maine; Europe.

Forming a slimy layer on piles. Our specimens seem to agree well with specimens from Cherbourg. *O. littoralis*, Harv., of Crouan's Alg. Finistère, No. 325, is apparently very near to this, if not the same.

O. SUBULIFORMIS, Harv., Phyc. Brit., Pl. 251 *b*.

Filaments .006–7½^{mm} in diameter, at the end tapering to an incurved point, cells about one-third as long as broad, bluish green.

Charles River, Cambridge; Europe.

O. SUBTORULOSA, (Bréb.). (*Phormidium subtorulosum*, Bréb., in Kütz. Tab. Phyc., Vol. I, Pl. 49, Fig. 5.)

Filaments .003–4^{mm}, cells nearly cuboidal, with rounded angles, so that the filament appears slightly crenate.

Eastport, Maine; Wood's Holl, Mass.; Europe.

To this species is doubtfully referred a form common on wharves at Eastport and on the government wharf at Wood's Holl, where it forms slimy patches, mixed with *Spirulina*, &c. The filaments of this species bear a decided resemblance to the trichomata of *Microcoleus chthonoplastes*, and it may perhaps be a question whether they are not really a stage of that species in which the trichomata have escaped from the enveloping sheath. Opposed to this view is the large quantity of filaments and apparently an entire absence of empty sheaths. That the trichomata of *M. chthonoplastes* often escape from the sheath can easily be seen, but how long they remain free and how rapidly they increase under such circumstances is uncertain.

MICROCOLEUS, Desmaz.

(From *μικρος*, small, and *κολεος*, a sheath.)

Filaments slowly oscillating, destitute of heterocysts, several united in a single gelatinous sheath, which is either simple or branching.

M. CHTHONOPLASTES, Thuret. (*Oscillatoria chthonoplastes*, Lyngbye—*Chthonoblastus Lyngbei*, Kütz.—*Microcoleus anguiformis*, Harv., Phyc. Brit., Pl. 249; Kütz., Tab. Phyc., Vol. I, Pl. 57.—*Chthonoblastus anguiformis*, Rab., Flora Europ. Alg., Sect. II, p. 133.) **Pl. II, Fig. 3.**

Sheaths elongated, fusiform, being six or more times broader in the center than at the extremities, simple, several twisted together so as to form a green stratum, filaments dark green, about .005^{mm} in diameter, intricately twisted together, three or four only at the extremity of the sheath, but very numerous at the center, where the sheath is frequently ruptured, allowing the filaments to protrude; cells as long as broad, or a little broader, terminal cell acutely pointed.

Wood's Holl, Mass.; Atlantic shore of Europe. Summer.

A species easily recognized and probably common along the New England coast in summer, but rarely found in sufficient quantities to make herbarium specimens. It is usually found in small streaks, so entangled with other *Nostochineæ* and *Confervæ* as to be quite inextricable. At times it is found tolerably pure on the old stalks of *Spartina*, between tide-marks. Pure specimens may be obtained by allowing specimens in which filaments of this species are entangled to remain overnight in a shallow dish of salt water, when the *Microcoleus* will have freed itself from other substances and come to the surface. As generally found, the plant looks like an attenuated cornucopia, owing to the rupture of the sheath in the middle, allowing the filaments to project. This is shown in Harvey's figure, l. c., and also in Pl. II, Fig. 3, where only half of the plant has been drawn. Normally the sheaths are about a quarter of an inch long, about .075^{mm} broad in the middle, and tapering to about .012^{mm} at the ends. Color a deep bluish green. The filaments readily escape from their sheath, and might in this condition pass for a species of *Oscillaria*.

MICROCOLEUS TERRESTRIS, Desmaz. (*Chthonoblastus repens*, Kütz.), and M. VERSICOLOR, Thuret, are not infrequently found in muddy places in the interior of New England.

LYNGBYA, Ag.

(Named in honor of *Hans Christian Lyngbye*, a Danish botanist.)

Filaments free, each provided with a distinct sheath, simple, destitute of heterocysts, no proper oscillations. Spores unknown.

L. MAJUSCULA, Harv.; *Mermaid's Hair*. (*Conferva majuscula*, Dillw.—*L. crispa*, Ag. in part,—*L. majuscula*, Harv., Phyc. Brit., Pl. 62; Ner. Am. Bor., Part III, p. 110, Pl. 47 *a*.) **Pl. I, Fig. 4**

Filaments long, forming floating tufts, crisped, about .028^{mm} to .032^{mm} in diameter, blackish green, sheath prominent, cells 8 to 10 times as broad as long.

Cape Cod, Mass., to Key West; Europe; Pacific Ocean. Common and widely diffused. Summer.

The largest, most striking, and most common of our marine *Lyngbyæ*, easily recognized by the length and diameter of its filaments and its color, which is a blackish green. It forms during the later summer months large tufts upon *Zostera* and various other algæ, and is often found floating free in considerable quantities. In the center of the masses the filaments are intricately twisted together, but on the surface they float out from one another, so as to deserve the common name of mermaid's hair. In the older specimens the filaments are very much curled and twisted, forming the *L. crispa* of some writers. The sheath is always well marked, although, as is the case in all the species, it varies so much in thickness under different circumstances as to render it impossible to give accurate measurements. The heterocysts, "cellulis interstitialibus sparsis," described by Rabenhorst in this species, Flora Europ. Alg., Part II, p. 142, have, in reality, no existence.

L. ÆSTUARII, Liebm. (*L. æruginosa*, Ag.—*L. ferruginea*, Ag., in Ner. Am. Bor., Part III, p. 102, Pl. 47 *b*; Phyc. Brit., Pl. 311.)

Filaments forming a verdigris-green stratum, about .016–18^{mm} in diameter, sheaths distinct.

Gloucester, Mass., *Mrs. A. L. Davis*, and southward; Europe. Summer.

A common species of the New England coast, abundant in shallow, brackish pools, where it covers the exposed algæ and *Zostera*. Much less striking than *L. majuscula*, Harv., from which it is distinguished at sight by its brighter green color, changing to yellowish rather than blackish, by the diameter of its filaments, which is about half that of *L. majuscula*, by its thinner sheath, and by forming thin strata rather than loose tufts. In the Ner. Am. Bor., Part III, the diameter of the filaments of *L. majuscula*, Harv., is given as .05 inch, and that of the filaments of *L. ferruginea*, Ag., as .001 inch, which is evidently incorrect, as one species is not fifty or even five times larger than the other.

L. LUTEO-FUSCA, Ag. (*L. fulva*, Harv., Ner. Am. Bor., Part III, p. 102, Pl. 47 *f.*)

Filaments fasciculate, erect, greenish yellow, .008–10^{mm} in diameter, sheath distinct.

EXS.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 48.

Stonington, Conn., *Bailey;* Noank, Conn.; Wood's Holl, Mass., *W. G. F.;* Europe.

Apparently a common alga of Southern New England, differing in its habit from all our other species of the genus, except *L. tenerrima*. It grows in large patches on stones and wood-work between tide-marks. The filaments are erect, from one to three inches high or somewhat higher, when in their best condition olive-colored, but more frequently a pale yellow. The thickness of the sheath, by which Harvey separated his *L. fulva* from *L. luteo-fusca*, Ag., is by no means constant, and the species cannot be kept distinct. As is the case in several of the species of *Lyngbya*, the sheath is sometimes two, three, or even a greater number of times thicker than at others.

L. TENERRIMA, Thuret, mscr.

Filaments slender, fasciculate, erect, bluish green, .0035^{mm} in diameter, sheaths very thin.

Gloucester, Mass., *Mrs. A. L. Davis;* Newport, R. I.; Europe.

This species was first detected near Gloucester, by Mrs. Davis, growing apparently on sand-covered rocks. The filaments are bluish green, and not over a quarter of an inch high. The species will be easily recognized by the diameter of the filaments, which is decidedly less than that of any other of our species. Dr. Bornet, to whom a specimen was sent, considers our plant the same as that collected by the late M. Thuret, at Biarritz, France, and named by him *L. tenerrima*. I have since found it in considerable quantity at the base of the cliffs near the Winans mansion, at Newport.

L. NIGRESCENS, Harv., Ner. Am. Bor., Part III, p. 102, Pl. 47 *d*.

"Filaments very slender, flaccid, densely interwoven into a fleecy, blackish-green stratum." (Harvey, l. c.)

Canarsie Bay, L. I., *Hooper;* Peconic Bay, *Harvey;* on mud and on *Zostera*, Gloucester, Mass., *Mrs. A. L. Davis.*

Var. MAJOR.

Filaments forming a dark-brown gelatinous stratum, .0152^{mm} in diameter, sheath thin.

Wood's Holl. Common on *Zostera*. Summer.

From Harvey's description, it would be difficult to recognize this species. From an authentic specimen in our possession, collected by Harvey at Peconic Bay, the filaments are seen to be from .0095^{mm} to .01115^{mm} in diameter. The sheaths are distinct, but less marked than in *L. æstuarii*, from which the present species differs in the shortness and smaller diameter of the filaments, and in the color, which is a dark purple, at times almost black. The filaments differ from those of both *L. majuscula* and *L. æstuarii* in being held together by an amorphous, gelatinous substance, supposed to be characteristic of the genus *Phormidium*. That genus, however, includes plants which are now properly assigned to other genera.

We have often searched for this alga, but have never found a form which seemed to correspond exactly to Harvey's specimen. The same alga has, however, been collected by Mrs. Davis at Gloucester. At Wood's Holl is a *Lyngbya*, distributed in Alg. Am. Bor., Farlow, Anderson & Eaton, No. 47, which is not uncommon, forming patches several inches long on *Zostera*, and which resembles *L. nigrescens* closely in everything but the greater diameter of the filaments. Its sliminess and the delicacy of the filaments cause it at first sight to be mistaken for diatomes. In drying, it becomes somewhat greenish. This species, which resembles closely *L. Kützingiana*, Thuret (*Phormidium*, Le Jolis), we can regard only as a large variety of Harvey's *L. nigrescens*.

CALOTHRIX, (Ag.) Thuret.

(From καλος, beautiful, and θριξ, hair.)

Filaments terminating in a hyaline hair, fixed at the base, free above, occasionally branching, growing in little tufts or strata of indefinite extent, heterocysts present in most of the species, no oscillations. Spores unknown.

We adopt the genus with Thuret's limitations, including, in part, the genera *Schizosiphon*, *Amphithrix*, *Leibleinia*, &c., of Kützing.

a. Species growing in little tufts.

C. CONFERVICOLA, Ag. (*Leibleinia chalybea* and *amethystea*, Kütz.—*C. confervicola*, Ag., Phyc. Brit., Pl. 254; Notes Algologiques, Pl. 3.) **Pl. I, Fig. 6.**

Tufts fasciculate, filaments dark bluish purple, attenuated, .018^{mm} in diameter, heterocysts all basal, generally few in number.

On algæ of all kinds. Summer. Very common. Europe.

C. CRUSTACEA, (Schousb.) Born. & Thur. (*Schizosiphon fasciculatus* and *lasiopus*, Kütz.—*Oscillatoria crustacea*, Schousb.—*Calothrix crustacea*, Bornet & Thuret, Notes Algologiques, p. 13, Pl. IV.)

Tufts fasciculate, filaments bright green, attenuated, .0125^{mm} in diameter, heterocysts intercalary, often very numerous.

EXS.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 49.

On algæ of all kinds, and on rocks. Summer. Very common. Europe.

The two species just described are very common, certainly from Wood's Holl to New York, and probably also northward, on all kinds of algæ, on which they form fine tufts or fringes. The two species usually grow mixed together, but may be easily distinguished under the microscope, *C. confervicola* being darker colored, the filaments thicker, and only furnished with heterocysts at the base, whereas in *C. crustacea* the heterocysts are scattered through the filament, often solitary, but sometimes as many as eight together, and frequently truncate. *C. crustacea* is also common on rocks.

b. Species forming expansions.

C. SCOPULORUM, Ag., Phyc. Brit., Pl. 58 *b*; Ner. Am. Bor., Part III, p. 105.

Filaments forming strata of indefinite extent, flexuous, usually branching, .008–12^{mm} in diameter, heterocysts basal and intercalary, sheaths thick, striate.

Var. VIVIPARA. (*C. vivipara*, Harv., Ner. Am. Bor., Part III, p. 106.)

Nahant, Wood's Holl, Mass., *W. G. F.*; Rhode Island, *Bailey*; Europe. Var. *vivipara* at Nahant, *W. G. F.*, and Seaconnet Point, *Bailey*.

Forming indefinite-shaped patches on rocks, on *Rhizoclonium*, and other prostrate algæ. Apparently much less common than the two preceding species. It differs from *C. crustacea* in the flexuous habit of the filaments, which are loosely twisted around one another, in the much rarer occurrence of intercalary heterocysts, and in the color of the filaments, which is not a bright green, but generally brownish. The sheaths, too, become thick, dark, and striated. As is the case in all species of *Calothrix* where the filaments are closely interwoven, the diameter of the filaments is greater and that of the sheath less, proceeding from within outwards. The variety *vivipara* is only a luxuriant form of the typical species.

C. PULVINATA, Ag. (*C. hydnoides*, Harv.)

Filaments densely packed, forming a dark-green spongy layer, united at the surface in tooth-like masses, flexuous, .006^{mm} to .0115^{mm} in diameter, heterocysts intercalary.

Exs.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 50.

Wood's Holl, on wharves. Common. Europe.

In this species the filaments are much more densely interwoven and flexuous than in any of the preceding species. It forms patches looking like a honeycomb, or like a small *Hydnum*, and can be torn from its attachment in pieces of considerable size.

C. PARASITICA, Thuret. (*Rivularia*, Chauvin.—*Schizosiphon*, Le Jolis.)

Filaments loosely united, forming a velvety film, bulbous at base, simple or only slightly branching, about .008–10^{mm} in diameter, heterocysts basal, obliquely truncate.

On *Nemalion multifidum*, Newport, R. I.; Europe.

Easily recognized by its bulbous base and obliquely truncate heterocysts, and its peculiar habitat.

RIVULARIA, Roth.

(Named from the fluviatile habitat of many of the species.)

Frond gelatinous, more or less globose, filaments radiating, attenuated, furnished with distinct sheaths, branching, a heterocyst at the base of each branch.

Few genera of algæ have been divided by different writers into so many artificial and unsatisfactory genera as *Rivularia*. Some of the described genera are characterized by striations or alterations of the sheath which arise from age or unfavorable external conditions. Other so-called genera are characterized by the presence of parasitic plants in the thallus of a true *Rivularia*. As understood in the present article, the genus differs from *Calothrix* in the fact that the filaments are imbedded in a mass of jelly and the thallus is of a definite shape and extent. From *Isactis*, which might be perhaps considered a subgenus, *Rivularia* differs in having its filaments radiate from a central point instead of being parallel to one another. From *Hormactis* it abundantly differs in the mode of formation of the filaments. In *Rivularia* the branches are formed by the division of the filament laterally, the upper part of the branch separating from the main filament, and the two being only in contact at the base of the branch, where a heterocyst is always to be found. In *Hormactis* the filaments push out sidewise in the form of an inverted V. The apex of the V then elongates upwards and, at the same time, the sides of the V elongate so that, in passing from the interior of the thallus outwards, instead of finding a series of filaments spreading out fan-shaped, we find the filaments converging two by two, which finally unite into single filaments near the surface of the thallus. Moreover, the heterocysts in *Hormactis* are intercalary, not basal. In none of our marine species of *Rivularia* have spores been seen, but spores are found in some fresh-water species of *Glœotrichia*, a genus closely allied to, if not to be included in, *Rivularia*.

R. ATRA, Roth. (*Zonotrichia hemispœrica*, Ag.—*Euactis amœna, atra, confluens, hemisphœrica, Lenormandiana, marina*, Kütz.—*Linckia atra*, Lyngb.—*R. atra*, Phyc. Brit., Pl. 239.) **Pl. II, Fig. 2.**

Thallus solid, globose or hemispherical, varying in size from that of a head of a pin to half an inch in diameter, dark glossy black, filaments straight, .0038–45^{mm} in diameter, heterocysts about as broad as or rather broader than the filaments, usually somewhat pointed.

Var. *confluens*, flattish, owing to the coalescence of several individuals.

Common along the whole coast, on stones, algæ, and stalks of *Spartina*, often in company with *Isactis plana*. Distinguished by its dark, shining color and usually hemispherical shape. It is generally minute in size, but occasionally grows as large as a pea or somewhat larger. The variety *confluens* resembles, to the naked eye, *Isactis plana*, but is decidedly thicker. Microscopically the two are quite different.

R. PLICATA, Carm., Phyc. Brit., Pl. 315. (*Physactis*, Kütz.)

Thallus at first solid, soon becoming hollow, plicato-rugose, folds sinuous, filaments flexuous, .003–4^{mm} in diameter, heterocysts nearly spherical, about as broad as the filaments.

On mud and *Spartina* roots. Cohasset Narrows, Wood's Holl, Mass., *W. G. F.* Common.

Although as yet known to occur only at the two above-named localities, this species will probably be found to be common along the whole New England coast, but it is certainly less common than the preceding species. Its favorite habitat is the mud in which *Spartina* is growing, between tide-marks. It attains a larger size than *R. atra*, is almost always hollow, and easily recognized by its cerebriformly plicate surface. The substance is softer than in *R. atra*, the filaments are slightly narrower and less closely packed together, and the heterocysts are rather more spherical than in that species.

R. HOSPITA, Thuret (*Euactis hospita* and *prorumpens*, Kütz.), which differs from the preceding species in having filaments .008^{mm} to .012^{mm} in diameter, was recognized by Dr. Bornet in company with *R. plicata* in a specimen from Cohasset Narrows. As we have not been able to recognize the species in any of our own specimens from the same locality, the presumption is that it is not very common.

ISACTIS, Thuret.

(From ισος, equal, and ακτις, a ray.)

Frond plane, composed of parallel filaments, held together by a tough, gelatinous intercellular substance, ending in a hyaline hair, heterocysts basal, ramifications few. Spores unknown.

This genus differs from *Rivularia* only in that the filaments are parallel to one another so as to form a flat frond, whereas in *Rivularia* they radiate from a central point and form more or less spherical fronds. It might with propriety be considered a subgenus under *Rivularia*.

I. PLANA, Thuret, l. c. (*Dasyactis*, Kütz.—*Physactis atropurpurea, obducens*, Kütz.) **Pl. I, Fig. 2.**

Frond flat, thin, dense, dark green, outline irregular, filaments .0076–95^{mm} in diameter, .12–.15^{mm} high sheaths often torn and striate.

Whole New England coast; Europe.

Very common on rocks, *Fucus, Punctaria*, and other algæ, forming dark-green spots, scarcely raised above the substance on which it is growing.

HORMACTIS, Thuret.

(From ὁρμος, a necklace, and ακτις, a ray.)

Frond gelatinous, globose, at first solid, then hollow and plicate, heterocyst intercalary, filaments simple at the surface of frond, bifurcating below. Spores unknown.

H. QUOYI, (Ag.) Bornet, in litt. (*Rivularia nitida*, Farlow, List of Marine Algæ, 1876. **Pl. II, Fig. 1.**

Fronds gregarious, dark green, plicato-rugose, from a quarter of an inch to two to three inches in diameter, filaments .0028–55^{mm} in diameter, tortuous, cells of external part of the frond thick and discoidal, becoming more oval in the interior of the frond heterocysts numerous, scattered, about .0038^{mm} × .0058^{mm}.

EXS.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 45.

Wood's Holl, Mass., *W. G. F.*; Falmouth, Mass., *Mr. F. S. Collins*; Marianne Islands.

This interesting species, although it has as yet only been found at Wood's Holl and the adjoining coast, will probably also be found at other localities on Long Island Sound. It grows in considerable quantities upon species of Fucus, at half tide, on the inner side of Parker's Point, Wood's Holl, and we have also found it washed ashore on the beaches of Buzzard's Bay, in the same township. It makes its appearance in June, and disappears in the month of September, being in perfection in the month of July. The fronds sometimes acquire a large size, two or three inches in diameter, but usually they are much smaller and densely aggregated, almost covering the Fucus stalks upon which they are growing. It first appears as solid green spots upon the *Fucus*, which soon swell out into thin bladders, which partly collapse on being removed from the water. The peculiar inverted V-shaped filaments are seen to greater advantage by dissecting with needles small pieces of the frond than by making sections with a razor.

The only other species of this genus is *Hormactis Balani*, Thuret, which grows on barnacles on the coast of France. It is a comparatively minute plant, much less striking than our own species, which seems rather to replace, on our coast, the *Rivularia nitida*, Ag., of the coast of Europe, which it resembles in general appearance and habit. The external resemblance to that species is so great that specimens were sent to Dr. Bornet as *R. nitida*, Ag. (?) By him it was recognized as a new species of *Hormactis*, *H. Farlowii*, under which name it was distributed in Alg. Am. Bor. Since then Dr. Bornet has recognized its identity with *Rivularia Quoyi*, Ag., of the Marianne Islands. It is not a little remarkable that the species is only known in two localities so widely remote from one another.

STIGONEMA MAMILLOSUM, Ag., occurs in a brook which empties into the sea at Rafe's Chasm, Magnolia Cove, in Gloucester; and CALOTHRIX PARIETINA, Thuret, is found in Nobska Pond, close to the sea, at Wood's Holl. The species named all belong in the present order, but are not strictly marine.

ORDER ZOOSPOREÆ.

Algæ either green or olive-brown in color. Reproduction by means of zoospores, which unite in pairs to form a zygospore.

This order includes all the marine *Clorospermeæ* attributed to New England in the Nereis Am. Bor., with the exception of the genus *Vaucheria*, as well as the greater part of the olive-brown sea-weeds, with the exception of the rock-weeds or *Fucaceæ*. The account of the order given in the introduction to the present article should be consulted in the present connection.

a. Green algæ, multicellular, zoospores of two kinds—macrozoospores with four and microzoospores with two terminal cilia.. *Chlorosporeæ*.
b. Green algæ, frond unicellular, branching .... *Bryopsideæ*.
c. Green algæ, frond unicellular, simple .... *Botrydieæ*.
d. Olive-brown algæ, zoospores of one kind, with two cilia laterally attached .... *Phæosporeæ*.

SUBORDER CHLOROSPOREÆ.

1. Fronds membranaceous .... (*Ulvæ*) 2
   Fronds filamentous 3
2. Cells in a single layer .... *Monostroma*.
   Cells in two layers .... *Ulva*.
3. Some of the cells furnished with long hyaline hairs..... *Bulbocoleon*.
   Cells destitute of hyaline hairs 4
4. Filaments branching throughout .... *Cladophora*.
   Filaments with short, root-like branches only......... *Rhizoclonium*.
   Filaments unbranched 5
5. Filaments rigid, setaceous .... *Chætomorpha*.
   Filaments soft and flaccid .... *Ulothrix*.

MONOSTROMA, (Thuret) Wittrock.

(From *μονος*, single, and *στρωμα*, a bed.)

Fronds membranaceous, consisting of a single layer of cells, which are either parenchymatous or separated from one another by more or less jelly.

As defined by Thuret, *Monostroma* differed from *Ulva* in having the cells embedded in jelly rather than arranged in the usual form of parenchymatous tissue. Wittrock includes in the genus all the *Ulvæ* consisting of a single layer. In most of the species the frond is at first sack-shape, but soon ruptures, the segments being composed of one layer of cells. The basal cells are prolonged downwards, but they become more or less circular in the upper part.

M. PULCHRUM, n. sp.

Fronds membranaceous, fasciculate, light green, lanceolate or cuneate-lanceolate, attenuated at the base, margin crisped, two to twelve inches long, two inches broad, substance very delicate, about .006 mm in thickness, cells irregular, more or less sinuous, intercellular substance small.

Watch Hill, Conn., *Prof. Eaton;* Gloucester, Mass., *Mrs. Bray;* Portland, Me., *Mr. C. B. Fuller.* Spring.

A beautiful and apparently not uncommon spring plant of New England, distinguished by its outline and delicate substance. When fully grown the fronds are most frequently attenuated at the base and rather obtuse at the summit. When young they are lanceolate, and seem to be always plane, never saccate, as in the next species. The color is a delicate green, and the plant cannot easily be removed from the paper on which it is pressed. This species has sometimes been distributed as *Ulva Linza*, to which it bears more or less resemblance in shape.

M. GREVILLEI, Wittrock. (*Ulva Lactuca*, Grev. *non* Linn.; Harv. Phyc. Brit., Pl. 243, and Ner. Am. Bor., Part III, p. 60.—*Enteromorpha Grevillei*, Thuret.)

Frond at first saccate, then split to the base into irregular segments, color light green, segments plane, unequally laciniate, frond about .012 mm thick, cells angular, intercellular substance small.

Boston Bay (Ner. Am. Bor.); Malden, Mass., *Mr. Collins;* Ives Point, Conn., *Mr. F. W. Hall;* Europe. Spring.

A common spring species of the Atlantic shores of Europe, but apparently not so common in New England. The cells of this species vary considerably, and in some specimens the intercellular gelatinous substance is tolerably prominent.

M. BLYTII, (Aresch.) Wittr. (*Ulva Blytii*, Aresch., Phyc. Scand., p. 186, Pl. 10 *g.*—*M. Blyttie*, Wittrock, Monog. Monostr., p. 49, Pl. IV, Fig. 11.)

Frond membranaceous, subcoriaceous, dark green, irregularly cleft, margin crisped, .028–40 mm in thickness, cells angular, closely packed, intercellular substance small.

EXS.—Nordstedt & Wittrock, Alg. Scand., No. 44; Alg. Am. Bor., Farlow, Anderson & Eaton, No. 98.

Eastport, Maine; Gloucester, Nahant, Mass.; Northern Europe. Autumn.

This, by far the most striking of our *Monostromata*, grows luxuriantly in the large tide-pool at Dog Island, Eastport, where it attains a length of one foot. In habit it resembles *Ulva lactuca* var. *rigida*, but it is of a deeper green. Our specimens were collected in the month of September. As it occurs at Nahant the species is not generally more than two or three inches long, and recalls the figure of *Ulva obscura*, Kütz., Tab. Phyc., Pl. 12, No. 2. It is found in the clefts of exposed rocks, late in the season. Its color is a deep green when growing, which becomes brownish in drying. It does not adhere well to paper.

M. CREPIDINUM, n. sp.

Fronds delicate, light green, one to three inches long, flabellately orbiculate, split to the base, segments obovate, .018–36^{mm} thick, cells roundish-angular, intercellular substance prominent.

Government wharf, Wood's Holl, Mass. August.

This small species is common on the piles of the wharf at Wood's Holl. It is very soft, and collapses on removing it from the water. It preserves its color well on paper. The above name is given provisionally, as we are not able to refer the species to any known form. It resembles *M. Wittrockii*, Bornet, a species, we believe, not yet described. Except in its small size, it is very near *M. orbiculatum*, Thur., but the thickness of that species, as given by Wittrock, is .032–40^{mm}. An examination of a specimen collected by Thuret, however, gives the same measurement as our species. If the species eventually is united with *M. orbiculatum*, the present must be regarded as a small form.

ULVA, (L.) Le Jolis.

(Supposed to be from *ul*, Celtic for water.)

Fronds simple or branching, consisting of two layers of cells, which are either in close contact with one another or else at maturity separate so as to form a tubular frond.

We have followed Le Jolis in uniting the old genera *Ulva* and *Enteromorpha*, and we might perhaps have gone farther and united *Monostroma* with *Ulva*, for if *Monostroma Grevillei* when young resembles an *Enteromorpha*, in its older stages it splits into membranes consisting of a single layer of cells, which are certainly imbedded in a certain amount of gelatinous substance, yet so little as to make it doubtful whether to call the frond parenchymatous or not.

U. LACTUCA, (Linn.) Le Jolis. (*Ulva latissima* and *rigida*, Ag. & Auct. recent.—*U. latissima*, Grev. & Harv.—*Phycoseris gigantea*, *myriotrema*, *australis*, &c., Kütz.) **Pl. III. Fig. 1.**

Frond flat, thick, unbranched, variously more or less ovate in outline, divided, the two layers of cells adherent.

a. Var. RIGIDA, (Ag.) Le Jolis. (*U. rigida*, Ag.—*U. latissima*, Harv., Phyc. Brit., partim.—*Phycoseris australis*, Kütz.)

Frond rigid, rather thick, generally deeply divided, laciniæ irregularly lacerate-erose, the base of frond more dense and deeply colored than the rest.

β. Var. LACTUCA, Le Jolis. (*U. latissima*, Harv., partim.—*Phycoseris gigantea*, Kütz.)

Frond orbicular, oblong or elongate-fasciate, simple, undivided or scarcely lobed, frequently spirally contorted.

γ. Var. LATISSIMA, Le Jolis.

Frond simple, at first cuneate-substipitate, afterwards broadly expanded.

Very common all over the world, especially in brackish waters.

The present species nearly corresponds to the *Ulva latissima* of the Nereis Am. Bor., but is not the *U. Lactuca* of that work. It is distinguished from the remaining species by being always flat, never tubular at any age, and by its more or less orbicular outline not becoming linear or ribbon-shaped. Var. α is the common *Ulva* on rocks and in pools exposed to the action of the waves. The frond, although not very large, is rigid, and does not adhere well to paper in drying. In outline it is orbicular, and is generally deeply incised. Var. β has a more elongated shape, and is generally plicato-undulate. Var. γ is very common in brackish places on the mud, and attains a very large size. When fully grown it has no definite shape, but is ragged on the margin and often perforated.

ULVA ENTEROMORPHA, Le Jolis.

Frond linear or lanceolate in outline, attenuated at base, the two layers of cells either entirely separating, so as to form a tubular frond, or slightly cohering, forming a flat frond.

α. Var. LANCEOLATA, Le Jolis. (*Ulva Linza*, Greville & Harvey.—*Phycoseris lanceolata* and *crispata*, Kützing.)

Frond narrow, flat, ribbon-shaped, unbranched, much attenuated at base, margin somewhat crisped, sometimes so much so that the frond appears spirally twisted.

β. Var. INTESTINALIS, Le Jolis. (*Enteromorpha intestinalis*, Auct.)

Frond simple, attenuated, and subcompressed at base, above tubuloso-inflated.

γ. Var. COMPRESSA, Le Jolis. (*Ulva compressa*, L.—*Enteromorpha compressa*, Auct.)

Frond tubuloso-compressed, generally proliferously branched, branches uniform, simple, attenuate at the base, broader and obtuse at the apex, color somewhat dingy.

Very common all over the world, particularly in brackish water.

This species includes the *Ulva Linza*, *Enteromorpha intestinalis*, and *Enteromorpha compressa* of the Nereis Am. Bor., which can only be regarded as varieties of one species. The species reaches its highest development in the var. β (*Enteromorpha intestinalis*, Auct.), which is excessively common in all shallow water along our coast, and is conspicuously disagreeable by its resemblance in shape to the swollen intestines of some animal. The species approaches *Ulva Lactuca*, L., in var. α, which is not so common as the other forms of the species whose long ribbon-like fronds are compressed instead of tubular, as in var. β. In var. γ, with branching instead of simple fronds, the species approaches *Ulva clathrata*. Innumerable varieties have been made of the various forms of this species, but an enumeration of them is quite uncalled for in this place.

ULVA CLATHRATA, Ag.

"Frond tubular, filiform, several times branched, branches attenuate at the apex, often very fine, cells arranged in rows." (Le Jolis, Liste des Algues Marines de Cherbourg.)

As usually defined by algologists, *Ulva clathrata* differs from *U. compressa* principally in the smaller size of the branches, a character by no means constant. We quote the specific distinctions as given by Le Jolis, l. c., which express more clearly than the descriptions of other writers the relations between the species:

"I think they (the specific characters) are to be found, first, in the general form of the fronds, which, broadened at the summit in the different varieties of *Ulva enteromorpha*, are, on the contrary, much attenuated at the extremity in *Ulva clathrata*. Secondly, in the ramification. While *Ulva compressa* and *intestinalis* are rather proliferous than branching in the true acceptation of the word—their branches being ordinarily of such a character that when they are given off from the lower part of the frond there does not exist, so to speak, any principal axis, or when borne towards the extremity of the frond reduced to simple proliferations; in *Ulva clathrata*, on the contrary, there exists a well-marked ramification, the fronds or primary axes bearing numerous secondary branches, which in their turn produce branchlets of an inferior order."

Of the species, as defined by Le Jolis, there are several varieties common on our coast, principally to be distinguished by the fineness of the branches and more or less complicated ramification. The variety *Agardhiana* of Le Jolis (*Enteromorpha Linkiana*, Grev.), rather coarse and rigid, is common in shallow water, as is also the form called by Harvey *Enteromorpha ramulosa*. The var. *Rothiana* forma *prostrata* is found in a ditch at Malden, Mass.

ULVA HOPKIRKII, (McCalla) Harv., Phyc. Brit., Pl. 263.

Frond capillary, excessively branched, ramuli ending in a single row of cells.

Greenport, L. I., *Mr. Hooper;* Gloucester, Mass., *Mrs. A. L. Davis;* Europe.

A beautiful species, looking much more like a fine *Cladophora* than an *Ulva*. It is in most cases easily recognized by its tenuity and light-green color. It grows in large tufts on other algæ and is about eight or ten inches long. It is by no means certain that this species should not be regarded as an extreme variety of *U. clathrata* in spite of the fact that the branches usually end in a single row of cells.

ULOTHRIX, (Kütz.) Thur.

(From ὕλη, a forest, and θρίξ, a hair.)

Filaments grass-green, soft and flaccid, unbranched, at first forming tufts attached at the base, afterwards becoming more or less entangled, cells never long in proportion to their diameter.

The genus *Ulothrix* here includes all the unbranching marine *Chlorosporeæ* of a delicate texture, and embraces the species included by Harvey in the genus *Hormotrichum* of Kützing, which can hardly be kept distinct from *Ulothrix*, an older genus of Kützing. When young the species of the genus are attached at the base and unbranched, but in some cases, when old, the filaments are twisted together, and it is not always easy to find the point of attachment.

The genus is too nearly related to *Chætomorpha,* from which it differs in substance, the filaments being more or less gelatinous in *Ulothrix* and rigid in *Chætomorpha.* Of all the filamentous marine *Chlorosporeæ* the species of *Ulothrix* are best adapted for the study of zoospores. The conjugation of zoospores in *Ulothrix zonata,* a fresh-water species, has been very fully described by Dodel-Port in Pringsheim's Jahrbücher, Vol. X.

U. FLACCA, (Dillw.) Thuret. (*Lyngbya flacca* and *Carmichaelii*, Harv., Phyc. Brit., Pl. 300 and 186 *a.*—*Hormotrichum Carmichaelii*, Harv., Ner. Am. Bor., Part III, p. 90.)

Filaments fine, lubricous, greenish yellow, one to three inches long, at first tufted, then entangled and forming strata of indefinite extent filaments .014–30^{mm} in diameter, becoming moniliform, cells .003–12^{mm} long, generally narrow, discoidal.

Eastport, Maine., on stones and *Rhodymenia*, August; Nahant, Mass., *Mr. Collins*, spring; Isles of Shoals, N. H., *Mrs. Davis*; Europe.

A species most luxuriant in the spring, but also found in summer. The form found at Eastport was the entangled stage which is common on wood-work at low-water mark.

U. ISOGONA, (Engl. Bot.) Thuret. (*Conferva Youngana*, Harv., Phyc. Brit., Pl. 328.—*Lyngbya speciosa*, l. c., Pl. 186 *b.*—*Hormotrichum Younganum*, Ner. Am. Bor., Part III, p. 89.—*Urospora penicilliformis*, Aresch. in part.)

Filaments fine, yellowish green, one to three inches long, at first tufted, afterwards forming strata, filaments .036–58^{mm} in diameter, moniliform, cells .015–50^{mm} long, from cuboidal becoming ovate, constriction at nodes marked.

New York, *Harvey;* Ives Point, Conn., *Mr. Hall;* Gloucester, *Mrs. Davis;* Nahant, *Mr. Collins;* Europe. Spring.

Distinguished from the last by its greater size and by the marked constriction between the cells at maturity. Apparently common on wood-work. Whatever name we may give to this species, it is the same form which is common in the northern part of Europe in spring and summer. It is the *Hormotrichum Younganum* of British authors, and the *U. isogona* of the French. It is the species referred by Areschoug, Observationes Phycologicæ, II, Act. Reg. Soc. Scient., Ser. III, Vol. 9, to *Conferva penicilliformis*, Roth, and made by him the type of the genus *Urospora.* Areschoug unites under the single species *U. penicilliformis* the following species of Phycologia Brittanica: *Lyngbya speciosa, L. Carmichaelii, L. Cutleriæ, L. flacca,* and *Conferva Youngana.* In the present case we have kept *U. flacca* and *U. isogona* distinct, but agree with Areschoug in uniting *U. speciosa* with *U. isogona.* Perhaps a further acquaintance with the species might lead us to unite the present two species under Areschoug's name.

The *Hormotrichum speciosum* of Eaton's list of Eastport algæ belongs to another genus. The *H. boreale,* l. c., is unknown to me.

U. COLLABENS, (Ag.) Thur.? (*Conferva collabens*, Harv., Phyc. Brit., Pl. 327.—*Hormotrichum collabens*, Kütz., Spec. Alg., p. 383.)

Filaments tufted, two to six inches long deep green, cells from .05–

.18^{mm} in breadth, once or once and a half as long as broad, nodes constricted.

To this species is referred, with considerable doubt, a rare *Ulothrix* found by Mr. Collins at Nahant. The filaments are six or seven inches long, very soft, and they can with difficulty be removed from the paper on which they are pressed. The cells average from .035–90^{mm} in breadth by .054–.324^{mm} in length. In Rhode Island Plants, by S. T. Olney, Providence Franklin Society, April, 1847, under No. 1189, is the following: "*Conferva collabens*, Ag.? 'or near it'—Harv. MSS. Sogonnet Point! Narragansett Pier!" In the Nereis Am. Bor., Part III, no reference is made to *C. collabens*, Ag., by Harvey, whom Olney quotes in his list. Harvey, however, in the Nereis, describes a new species, *Chætomorpha Olneyi*, which calls to mind *C. collabens*, and perhaps that is the plant referred to by Mr. Olney.

CHÆTOMORPHA, Kütz.

(From *χαιτη*, hair, and *μορφη*, shape.)

Filaments grass-green, coarse and rigid, unbranched, either attached in tufts or floating in masses, cells variable in length, often much longer than broad.

The species of this genus may be divided into two groups. In the first the filaments arise in tufts from a definite base. In the second the filaments are twisted together and form intricate masses, which rest upon stones and other algæ. It may be a question whether the members of the last-named group are not the advanced stage of the species of the first group, which, as they have developed, have become twisted together and torn from their attachments. It would be comparatively a simple matter to classify our own species taken by themselves, but in comparing them with foreign species it becomes very complicated in consequence of the confusion of names applied to some of the common European species. We can only briefly mention the synonyms, which are almost hopelessly confused.

C. MELAGONIUM, (Web. & Mohr.) Kütz. (*Conferva Melagonium*, Phyc. Brit., Pl. 99 *a*.)

Filaments erect, base scutate, coarse and wiry, dark glaucous green, cells .4–5^{mm} broad by .4–7^{mm} long.

In tide-pools.

Common from Boston northward; Northern Europe.

The most easily recognized species of the genus with us. It grows in deep tide-pools, attached to pebbles and rocks. The filaments can be recognized at a distance by their dark glaucous-green color and rigidity. It is generally a foot or more in length, and the filaments are usually free, but become more or less twisted together. It does not adhere well to paper in drying, and in spite of its coarseness it does not bear immersion in fresh water.

C. ÆREA, (Dillw.) Kütz. (*Conferva ærea*, Phyc. Brit., Pl. 99 *b*.)

Filaments erect, base scutate, setaceous, yellowish green, cells .25–40^{mm} long by .15–30^{mm} broad.

In high-tide pools.

New York Harbor, *Harvey;* New Haven, *Prof. Eaton;* Newport, *Bailey;* Gloucester; Europe.

This species has a wider range than the last, being found not only in the north of Europe, but also in the Mediterranean and other warm seas. With us it is not uncommon in Long Island Sound, but is little known north of Cape Cod. It grows in pools, sometimes near high-water mark, and resembles in habit *C. melagonium*, from which it differs in color, in being much less rigid, and in the smaller size of its cells. As found on our coast, the filaments are rather more slender than the average of European specimens.

C. Picquotiana, (Mont.) Kütz. (*Conferva Picquotiana*, Ann. Scien. Nat., 3d Ser., Vol. XI, p. 66.—*Chætomorpha Piquotiana*, Ner. Am. Bor., Part III, p. 85, Pl. 46 *c.*)

Filaments prostrate, intricately twisted together in masses, rigid, dark-green, cells .2–4^{mm} broad by .2–1.6^{mm} long, slightly oval in shape.

Deep water, and washed ashore.

Rather common from Boston northward; Staten Island, *Harvey;* Gay Head, Mass.

This species was first described by Montagne from specimens collected by Lamare-Picquot in Labrador. It is the largest of our prostrate *Chætomorphæ,* and north of Boston is not uncommon on beaches after a storm, but it has not been seen in tide-pools. The localities South of Cape Cod perhaps need revision. We have found the species washed ashore at Gay Head, from deep water. It reminds one of *C. melagonium* by its color, rigidity, and size of the filaments, and it seems to us probable that it is merely an advanced stage of that species which has broken from its attachments and become entangled without having lost its power of growth. It is certainly very unlikely that any alga of this suborder is throughout its whole period of existence unattached. The cells differ from those of *C. melagonium* in being sometimes several times longer than broad, but, on the other hand, they frequently are found no longer than broad. If the species is really distinct and not an older stage of *C. melagonium,* as we suspect, it is the largest and coarsest of our species, and is to be compared with *C. torulosa,* Zan, of which we have examined specimens collected by Hauck at Pirano, in the Adriatic. In drying, our species does not adhere to paper, and the cells contract at the joints so as to give a toruloid appearance.

C. Linum, (Flor. Dan.) Kütz. (*Conferva Linum*, Crouan, Algues Marines du Finistère, No. 353.—*Conferva Linum*, Areschoug, Alg. Scand., No. 183.—*Chætomorpha herbacea*, Kütz., in Hohenacker's Meeralgen, No. 355.—*Chætomorpha Linum*, Kütz., Spec. Alg., p. 378.—*Chætomorpha sutoria*, (Berk.) Harv., Ner. Am. Bor., Part 3, p. 87.—Non *Conferva Linum*, Alg. Danmon., No. 220, nec *Rhizoclonium Linum*, Herb. Thuret.)

Filaments prostrate, intricately twisted together in masses, rigid, bright green, cells .20–25^{mm} broad by .20–30^{mm} long, about as broad as long.

Just below low-water mark.

Common in Long Island Sound; Nahant, Ten Pound Island, Gloucester, Mass.; Europe.

The confusion which has arisen from the application of the name *Conferva Linum* to different species and the useless multiplication of names, especially on the part of Kützing, makes it exceedingly difficult to ascertain the name of this common species on our coast. It forms strata of considerable extent upon rocks and gravel just below

low-water mark. It can be distinguished from the preceding species by its lighter color, by being less rigid, and by the smaller size of the cells, which are rather uniformly as broad as long. If we may suspect that *C. Picquotiana* is only a form of *C. melagonium*, we may also suggest that the present is possibly the corresponding form of *C. ærea*. To unravel the synonymy of the species is quite hopeless. Our specimens agree with No. 353 of Crouan's Algues Marines du Finistère and No. 183 of Areschoug's Algæ Scandinavicæ, both of which are supposed to be the *Conferva Linum* of the Flora Danica. They are also identical with No. 355 of Hohenacker's Meeralgen, which purports to have been determined as *C. herbacea*, Kg., by Kützing himself. Whether they are the same as the *Conferva Linum* of the Phycologia Brittanica we cannot determine. They approach very near to, if they are not identical with, *C. crassa* of the Italian algologists. In fact, Crouan considers *C. Linum*, Fl. Dan., to be the same as *C. crassa*, Ag. The *Chætomorpha sutoria* of the Nereis Am. Bor. seems to us the same thing. We have examined Bailey's specimens, from which Harvey named the species in the Nereis, and have also examined Bailey's locality, at Stonington. To the naked eye, in Bailey's specimens, the filaments appear smaller than the typical form, but a microscopic examination gives the same measurements as specimens we collected ourselves, which agreed precisely with No. 353, Crouan. In saying that the New England specimens of *C. sutoria* should be considered to be rather *C. Linum*, we do not mean to imply that the European *C. sutoria* is not distinct. Whether our species is the same as *Rhizoclonium Linum*, Thuret, is, perhaps, doubtful. In specimens of the last-named species from Cherbourg the filaments appear to be somewhat smaller. The species usually, but not always, loses its color drying, and scarcely adheres to paper unless under considerable pressure.

SPECIES INQUIRENDÆ.

C. OLNEYI, Harv., Ner. Am. Bor., Part III, p. 86, Pl. 46 *d*.

"Filaments tufted, setaceous, straight or curved, soft, pale green; articulations once and a half as long as broad." (Harvey, l. c.)

Rhode Island, *Olney*.

C. LONGIARTICULATA, Harv., Ner. Am. Bor., Part III, p. 86, Pl. 46 *e*.

"Filaments capillary, curved, loosely bundled together, flaccid, soft, pale green; articulations 4–6 times as long as broad, swollen at the nodes; var. *β*, *crassior*, filaments more robust." (Harvey, l. c.)

In rock-pools, between tide-marks. Ship Anne Point, *Mr. Hooper;* Boston Bay, *Mrs. Asa Gray;* Little Compton, *Mr. Olney;* var. *β* in brackish ditches at Little Compton, *Mr. Olney*.

The two last species are only known from the descriptions in the Nereis. No authentic specimens exist in the Olney Herbarium, which is now the property of Brown University. The specimen of *C. Olneyi* mentioned in *Algæ Rhodiaceæ* by Olney was determined by the present writer, not by Harvey himself, and a recent examination of the specimen, for which we are indebted to the kindness of Professor Bailey, lead us to think that the specimen was not correctly determined.

RHIZOCLONIUM, Kütz.

(From ῥίζον, a root, and κλων, a branch.)

Filaments decumbent, entangled, branches short and root-like.

The genus is easily recognized, as a rule, by the root-like character of the branches. In some species the branches are frequent; in others, however, they are only occasionally found, and in that case the species may easily be mistaken for species of *Chætomorpha.*

R. RIPARIUM, Roth, Harv. Phyc. Brit., Pl. 328. (*R. salinum*, Kütz.)

Filaments decumbent, pale green, forming entangled masses, furnished with numerous short root-like branches, generally consisting of but few cells, but sometimes elongated, filaments from .02^{mm} to .025^{mm} in diameter, cells about as long as broad, or a little longer. **Pl. III, Fig. 2.**

Eastport, Maine; Nahant, Wood's Holl, Mass., *W. G. F.;* New Haven, Conn., *Prof. D. C. Eaton;* Europe.

An alga which is probably common all along the coast on wood-work and sandy rocks between tide-marks. It forms thin light-green masses on the substance on which it is growing. The root-like processes usually consist of not more than three or four cells, and not unfrequently they fork. Distinguished at sight from the next by its yellowish color. It often covers the ground at the base of *Spartina*, and it is found nearer high-water mark than the next species.

R. TORTUOSUM, Kütz. (*Conferva implexa* and *tortuosa*, Harv., Phyc. Brit., Pl. 54 *a* and *b*.—*Chætomorpha tortuosa*, Ner. Am. Bor.)

Filaments dark green, very much curled and twisted, forming prostrate masses, diameter of filaments, .035^{mm} to .058^{mm}, cells about twice as long as broad, branches few, short.

Common all along the New England coast; Europe.

The most common species of our coast, recognized by its dark-green color, and by the very much twisted filaments which form woolly strata over other algæ. Its favorite habitat is in tide-pools, where it is exposed at dead low water.

R. KOCHIANUM, Kütz. (*Conferva arenosa*, Crouan, Algues Marines du Finistère, No. 355.—*Conferva implexa*, var., Alg. Scand., No. 187.—*Rhizoclonium Kochianum*, Kütz., in Le Jolis's Liste des Algues Marines de Cherbourg.)

Filaments pale yellow, forming loose masses of indefinite extent, cells .010–14^{mm} broad by .036–54^{mm} long.

On algæ below low-water mark. Summer.

Gloucester, Mass.; Nahant, Mass., *Mr. Collins;* Europe.

Much finer than any of the species previously mentioned, covering algæ with a delicate pale-yellow fleece. It is apparently less common than our other two species, and we have only found it once growing over *Laminariæ* just below low-water mark, off Niles's Beach, Gloucester. The species agrees with French specimens of *R. Kochianum* in the size and general appearance of the cells, but the root-like processes characteristic of the present genus are not evident in our specimens, and the species is here retained in *Rhizoclonium* on the authority of Kützing, in Le Jolis's Liste des Algues Marines de Cherbourg. *R. Kochianum* is considered by Rabenhorst to be a variety of *R. flavicans*, Jürg., in which he also includes *Conferva arenicola* of Berk. Our specimens agree perfectly with No. 355 of Crouan's Algues Marine du Finistère, but are rather smaller than No. 187 of Areschoug's Algæ Scandinavicæ, which is referred with doubt to *Conferva arenosa.* The name which we have adopted refers our specimens without doubt to French forms, but the identity with the genuine *C. arenosa* of British botanists still remains to be settled. The species does not adhere well to paper, and would probably, at first sight, be referred by collectors to *Chætomorpha* rather than to *Rhizoclonium.*

CLADOPHORA, Kütz.

(From κλαδος, a branch, and φορεω, to bear.)

Filaments firm, not gelatinous, branching throughout.

A genus including the greater part of the branching *Chlorosporeæ,* which are found both in salt and fresh water. It differs from *Ulothrix* and *Chætomorpha* in having branching filaments, and from *Rhizoclonium* in having well-developed branches and not mere rhizoidal growths. The species abound on rocks and in tide-pools, as well as in ditches and shallow bays along the shore, and usually grow in tufts. Some of the species, however, especially those growing in brackish ditches, at maturity form dense layers upon the surface of the water or on the bottom. The number of described species of the genus is immense, but, in all probability, a great part are not distinct. It is at present impossible correctly to refer the New England species to European forms, since European botanists by no means agree as to their own species, and there has been a tendancy on the part of algologists of different countries to ignore the species of other countries in studying their own. The principal specific character is the mode of branching, which, in the present genus, is at best an uncertain mark. The young and old plants of the same species often differ very much in the appearance of the branches, so that the habit varies at different seasons. When old, some species are usually torn from their attachments and washed ashore in large masses, and, in this battered condition, it is often impossible to recognize the species, or perhaps even to distinguish the specimens from *Rhizoclonium* species. Unfortunately, names have been given to the battered forms until there is such a labyrinth of synonyms that one is tempted to reject all but a few well-marked species. In the present instance we have attempted merely to compare our specimens with those in the Algæ Danmonienses, the Algues Marines du Finistère, the Algæ Scandinavicæ of Areschoug, and with specimens received from Dr. Bornet, M. Le Jolis, Dr. Kjellman, and Dr. Wittrock. It is to be hoped that some responsible algologist will undertake the revision of this much-abused genus.

SUBGENUS SPONGOMORPHA, Kütz.

Plants spongy, at least towards the base, owing to the interlacing of the branches, some of which are strongly recurved and rhizoidal.

C. ARCTA, (Dillw.). (*Cladophora arcta,* Phyc. Brit., Pl. 135.)

Filaments slender, two to eight inches long, tufted and densely matted at base, becoming free and divergent above, color a bright green; branches near the base strongly recurved and interlaced, upper branches erect or appressed, numerous, opposite or scattered, apices obtuse; cells at base about twice as long as broad, cells of upper portion several times longer than broad, average diameter of cells about .08^{mm}.

On rocks between tide-marks. Winter and spring.

Common along the whole coast; Europe.

One of the few species which are recognized without difficulty, although it varies considerably in aspect at different seasons. When young the filaments are but slightly matted together, except at the very base, and the species is then the *C. vaucheriæformis* of Agardh; but when old they become spongy nearly to the tip, and constitute the *C. centralis* of some authors. The species is, as a rule, easily distinguished by its bright-green color and erect or appressed branches in the upper portion of the plant. The plant preserves its beautiful green color, and adheres to paper except when very old and spongy.

C. LANOSA, (Roth) Kütz. (*C. lanosa*, Phyc. Brit., Pl. 6.)

Tufts more or less globose; filaments one to three inches long, densely matted, color at first bright green, but soon becoming pale yellow; branches long, numerous, irregularly placed, often secund, given off at wide angles; cells .03–4^{mm} in breadth, as long as broad in lower part, becoming in upper part several times longer than broad.

On *Chondrus crispus* and other algæ.

Gloucester, Nahant, Mass.; common. Europe. Spring and early summer.

Var. UNCIALIS, Thuret. (*Cl. uncialis*, Harv., Phyc. Brit., Pl. 207.)

Filaments longer and looser than in the type, and of a lighter color.

On sandy rocks.

Long Island Sound; Nahant and Gloucester, Mass.; common. Spring. Europe.

An easily recognized species, probably common along the whole coast in spring and early summer. It grows attached to sea-weeds or to sand-covered rocks at low tide and below, and is often washed ashore in considerable quantities. It forms globose tufts, which, when growing, are bright green, but which soon lose their color, and, on drying, became pale and silky. The var. *uncialis*, which is more common in Long Island Sound, is less dense and forms looser tufts than the type. It does not adhere very well to paper.

SUBGENUS EUCLADOPHORA.

Plants tufted, or, at times, stratose, not united into spongy masses by rhizoidal branches or recurved branches.

C. RUPESTRIS, (Linn.) Kütz., Phyc. Brit., Pl. 180.

Filaments five to ten inches long, rigid, dark green, tufted; branches crowded, usually opposite or in fours, ultimate branches given off at an acute angle, short, subulate; cells constricted at the joints, average diameter of cells .08–16^{mm}.

On rocks near low-water mark.

Common along the whole coast throughout the year; Europe.

Recognized by its dark green color and rigidity, and by the numerous appressed ramuli which are given off two or three at a joint.

C. ALBIDA, (Huds.) Kütz., Phyc. Brit., Pl. 275.

Filaments slender, silky, forming dense tufts from a few inches to a foot long, color a pale green; branches irregular, often opposite, ultimate branches long, given off at wide angles; cells .02–3mm in diameter. cell-wall delicate, terminal cells blunt.

Staten Island, Beesley's Point, New York Bay, *Harvey;* in pools, Newport, R. I.; Europe. Summer.

Not yet observed north of Cape Cod. The species is recognized by forming dense tufts of a pale color and almost spongy consistency. The sponginess, however, is not, as in the subgenus *Spongomorpha*, due to the interlacing of short recurved branches and rhizoidal filaments, but to the fineness of the filaments, which are densely twisted together. The cells do not vary much in diameter throughout. This species, when dried, loses most of its color, and does not adhere well to paper.

C. REFRACTA, (Roth) Areschoug. (Non *C. refracta*, Alg. Danmon., No. 228, nec Phyc. Brit., Pl. 24.)

Filaments rather rigid, forming tufts from 2–8 inches long, color a glaucous green; branches flexuous, clothed throughout with nearly equal, short, frequently opposite branchlets, which are at first patent and furnished with erect or corymbose, afterwards reflexed, branchlets; cells .03–8mm in diameter, terminal cells blunt.

Common in deep tide-pools and on stones and sea-weeds at low-water mark throughout our limits. Spring and summer. Northern Europe.

We have refrained from quoting any synonyms in the description just given. The species, as we understand it, is one common in rocky places where the water is pure. It forms rather short tufts of a somewhat glaucous green, which is paler when the plant grows exposed to the sun. The branchlets, which are in general short, are at first erect, but, as usually found, are somewhat corymbose and ultimately decompound and reflexed. It is rather rigid and does not collapse when removed from the water. In drying it sometimes retains its color, but usually becomes yellowish and does not adhere well to paper. What we have described seems to be the *C. refracta* of Harvey's Nereis, but we have refrained from quoting the localities given by Harvey. The *C. refracta* of the French coast is considered by Le Jolis to be a variety of *C. albida*. The same is not true of our species, which is certainly distinct from *C. albida*. It may be that we have also the refracted variety of *C. albida* on our coast, but we have never met with it. The present species is much coarser and differs in habit and ramification from the *C. albida* of New England, which agrees well with European specimens. The American *C. refracta* is much nearer to, if not identical with, the species published by Areschoug in the Algæ Scandinavicæ, 2d series, No. 338, as *C. refracta*, (Roth). In coarseness it approaches *C. lætevirens*, but it certainly is not the same as No. 143, Algæ Danmonienses, which Harvey considers to be *C. lætevirens*. In short, we think that the *C. refracta* of New England is not the species to which the French botanists apply that name, but probably the species of Areschoug. Whether it is really the *Conferva refracta* of Roth is a point on which we can only follow the authority of others. At any rate, after the explanation given, the name can be retained without causing greater confusion than has hitherto existed.

C. GLAUCESCENS, (Griff.) Harv. (*Cl. glaucescens*, Phyc. Brit., Pl. 196.—*Cl. pseudo-sericea*, Crouan, Alg. Finist., No. 367.)

Filaments loosely tufted, 3–12 inches long, much branched, color light green; branches erect, pectinate, ultimate branchlets elongated, erect, given off at an acute angle; cells with delicate cell-wall, .03–6^{mm} in diameter, terminal cells acute.

On stones and wood-work near low-water mark. Summer.

From Halifax, N. S., to Charleston, S. C., *Harvey;* Newport, R. I.; Europe.

A delicate species which is characterized by its light color, loosely tufted habit, and slender branches, which are all given off at uniformly acute angles. When growing in exposed localities the tufts are short, but in quiet bays they become long and loose. This species, which has the light color and slender filaments of *C. albida,* differs from that species in not being spongy in consistence and in the length of the ultimate branchlets, which are always erect. Our Newport species resemble very closely the No. 120 *b* of Wittrock and Nordstedt, Algæ Scandinavicæ, which is considered by them a form of *C. crystallina,* (Roth), but differs from the *Cl. crystallina* of the algologists of Southern Europe. It may be remarked that *Cl. glaucescens,* (Griff.) Harv., has been referred to other older species, but not knowing the limits of *C. crystallina,* (Roth), and *C. sericea,* (Huds.), we have adhered to the latter name, as has also been done by Le Jolis and other French algologists. This species generally becomes very pale in drying and adheres well to paper.

The variety *β, pectinella,* of this species, mentioned by Harvey in the Nereis Am. Bor. as occurring in Charleston Harbor, is not known on our northern coast. In the variety the branches are said to be recurved.

C. LÆTEVIRENS, (Dillw.) Harv., Alg. Danmon., No. 142; Phyc. Brit., Pl. 190.

Filaments much branched, rigid, forming loose tufts 3–6 inches long, color a yellowish green; branches fastigiate, erect, often opposite or in threes, ultimate branches secund, of few cells, apex obtuse; diameter of cells .05–.15^{mm}.

In tide-pools.

New York Bay; Boston, *Harvey;* Gloucester, Mass., *Mrs Davis.*

A rather robust species, recognized by the denseness of the branches, which are crowded at the tips. Less robust and differing from *C. Hutchinsiæ* in having fastigiate branches. We have only seen one specimen, collected by Mrs. Davis, which corresponded exactly to the *C. lætevirens* of Algæ Danmonienses and to the *C. lætevirens* of the Nereis Am. Bor. It is doubtful whether the forms to which the same name has been given by French botanists belong to the same species as our own. Some of them, at least, appear to belong to a more slender and less densely branching species. The species does not adhere well to paper in drying.

C. HUTCHINSIÆ, (Dillw.) Kütz. (*Cl. Hutchinsiæ,* Phyc. Brit., Pl. 124.—*Cl. diffusa,* Harv., Phyc. Brit., Pl. 130.)

Filaments rigid, glaucous green, flexuous, forming loose tufts 6–12 inches long; branches scattered, rather distant; ultimate branches few, short, secund; cells .10–24^{mm} in diameter.

In tide-pools.

Gloucester, Mass., *Mrs. Davis.*

A single specimen which seems unmistakably to belong to this species was collected by Mrs. Davis. The species, which is one of the coarsest on the coast, is distinguished by the large size of the filaments and remoteness of the branches, together with the shortness of the ultimate branches. The *Cladophora diffusa* of the Phycologia Brittanica is now considered, with good reason, to be a form of *C. Hutchinsiæ* in which the branches are very long and nearly destitute of branchlets. Probably the *Cladophora diffusa?* of the Nereis Am. Bor., said by Harvey to be found in "New York Sound," is to be referred to the present species. Specimens which correspond well enough to the *C. diffusa* of the Algæ Danmonienses, No. 144, have been collected by Mrs. Davis and Mrs. Bray at Gloucester.

C. FLEXUOSA, (Griff.) Harv.

"Filaments very slender, pale green, tufted, flexuous, sparingly and distantly branched; branches elongate, subsimple, of unequal length, flexuous, sometimes nearly naked, sometimes ramuliferous; the ultimate ramuli secund or alternate, short or long, curved; articulations of the branches 3–4 times, of the ramuli twice as long as broad." (Nereis Am. Bor., Part III, p. 78.)

Rocks between tide-marks, &c.

Hingham and Boston, Mass.; Jackson Ferry and Hell Gate, N. Y.

We have quoted from the Nereis Am. Bor. the description given by Harvey of the present species, and have purposely refrained from adding any localities of our own. Harvey considers *C. flexuosa* very nearly related to *Cl. glaucescens*, if indeed it is distinct from it. On the other hand, the greater part of the French specimens of *C. flexuosa* which we have seen are quite distinct from *C. glaucescens*, and seem to approach some of the forms of *C. gracilis*. We have frequently seen at Wood's Holl, Newport, and Gloucester specimens which correspond pretty well with the *C. flexuosa* of Alg. Danmon., No. 227. As we understand the species, it is more rigid than *Cl. glaucescens*, and has shorter branches, which are at times refracted. The cells are .02–6^{mm} in diameter and not more than two or three times as long as broad as a rule. Le Jolis states that *C. flexuosa* lines the bottom of pools. The American forms which we would refer to this species are found in pools on rather exposed rocky shores.

C. MORRISIÆ, Harv.

"Tufts elongate, dense, somewhat interwoven, dark green; filaments very slender, much and irregularly branched; the penultimate branches very long, filiform, flexuous, simple, set with alternate or secund, short, erecto-patent ramuli, some of which are simple and spine-like, others pectinated on their upper side; articulations filled with dense endochrome, in the branches 2–3 times, in the ramuli about twice as long as broad, cylindrical, not contracted at the nodes." (Harvey, Nereis Am. Bor., Part III, p. 79, Pl. 45 *b*.)

Elsinborough, Del., *Miss Morris*.

We only know this species from the description and plate of Harvey.

C. RUDOLPHIANA, Ag.

Filaments very long and gelatinous, forming loose tufts one or two feet long, color yellowish green; branches opposite or irregular, very long and flexuous, given off at wide angles, clothed with long, secund, tapering branchlets; cells .02–8mm in diameter, those of the main branches many times longer than broad.

On stones and covering algæ just below low-water mark. Summer.

Jackson Ferry, N. Y., *Harvey;* Wood's Holl, Mass.; Europe.

One of the longest but at the same time most delicate of the genus. It forms intricately branching tufts, one or two feet long, attached to stones, or covers with a soft fleece algæ and *Zostera* growing in still, shallow bays, like the Little Harbor at Wood's Holl. It is more or less gelatinous and at once collapses on being removed from the water and adheres closely to paper in drying. In drying the cells shrivel very much, and the coloring matter is collected at the ends of the cells, which, in the main branches, are much longer than broad, and on moistening the cells do not recover their shape as readily as in other species.

C. GRACILIS, (Griff.) Kütz.

Filaments loosely tufted, 3–12 inches long, irregularly bent, provided at the angles with rather short branches, which are pectinate, with long recurved or incurved branchlets; color a yellowish green; cells .04–16mm in diameter.

On wharves or in muddy pools.

New Haven, *Prof. Eaton;* Wood's Holl, Mass.

a. Var. EXPANSA.

Very irregularly branched, forming masses one to two feet in extent.

Muddy pools.

β. Gloucester, Nahant, Mass.

Var. TENUIS, Thuret. (*Cl. vadorum*, Aresch.)

Branches remote, filaments more slender than in the type, .04–8mm in diameter.

Growing over *Laminariæ*.

Gloucester.?

A common and variable species, growing in rather muddy sheltered places and not on exposed spots. In its typical form it is recognized by its very irregular branches, which are more divergent than in most other species, and by its pectinate branchlets, which are at times flabellate. The species, although rather delicate in substance, is much stouter than *C. albida* or *C. glaucescens*, and does not adhere well to paper. The form which we have referred to, var. *tenuis*, Thuret, is doubtful. It formed masses of indefinite extent on *Laminariæ* and other algæ below low-water mark off Niles's Beach, Gloucester. What we have called var. *expansa* resembles somewhat *C. expansa*, Kütz., and like it is found in muddy places. It does not, however, form the dense masses of the last-named species, but floats loosely in the water in shallow places. The ordinary forms of the species are recognized without much difficulty, but one sometimes meets forms which are long and almost denuded of branches, in which case determination is difficult.

C. EXPANSA, Kütz.

Filaments of a dull-green color, at first tufted, then matted together, forming extensive strata; main branches irregularly flexuous, .10–15mm in diameter, clothed with secondary branches, which are divaricately divided and furnished with secund ultimate branches; cells several times longer than broad.

In brackish ditches. Summer.

Wood's Holl; Malden, Mass.

To the present species may be referred the greater part of the New England specimens of brackish water referred to *C. fracta.* It is at first tufted, but soon rises to the top of shallow ditches and coves, and forms an intricately interwoven mass. It is distinguished from *C. fracta* by the greater size of the main branches and the fact that the diameter of the secondary branches is always much less than that of the main branches, whereas in the true *C. fracta* the branches gradually diminish in size. In some specimens the branches are clothed at intervals with very short fasciculated ramuli. The species when in its tufted condition resembles some of the forms of *C. gracilis.* It also approaches the *C. fracta* of the Algæ Danmonienses, said by Harvey to be rather *C. flavescens.*

C. FRACTA, (Fl. Dan.) Kütz.

"Tufts irregular, entangled, often detached, and then forming floating strata, dull green; filaments rather rigid, distantly branched, the lesser branches somewhat dichotomous, spreading, with very wide axils; the ramuli few, alternate or secund; articulations 3–6 times as long as broad, at first cylindrical, then elliptical, with contracted nodes." (Harvey, Nereis Am. Bor., Part III, p. 83.)

Salt-water ditches and ponds.

West Point, *Prof. Bailey;* Beesley's Point, *Ashmead;* New York, *Walters;* Baltimore, Md.

We have quoted from the Nereis the description given by Harvey. It is doubtful whether under the name *C. fracta* he referred to the species of that name as recognized by Scandinavian botanists. The only marine locality of this species which we have examined is in the vicinity of the Marine Hospital, Baltimore. As we understand the species, it is much finer than *C. expansa,* the cells being from .02–8^{mm} in diameter, those of the main branches tapering gradually into those of the secondary branches, while in the last-named species the transition is sudden. The branches are less numerous and more irregular in their mode of branching in *C. fracta* than in *C. expansa.*

C. MAGDALENÆ, Harv., Phyc. Brit., Pl. 335 *a.*

Filaments one to three inches long, decumbent, entangled, coarse, blackish green; branches given off at obtuse angles, flexuous, with very few curved, irregularly-placed branchlets; cells .04–8^{mm} in diamter, about 2–4 times as long as broad.

Napatree Point, R. I., *Prof. Eaton.*

This rather unsightly and insignificant species is recognized by its procumbent habit and dingy green color, and by having but few branches, which are arranged without any definite order, and are given off at very obtuse angles from the main filaments. It may be doubted whether the species is not a reduced form of some other.

BULBOCOLEON, Pringsh.

(From βολβος, a bulb, and κολεον, a sheath.)

Filaments branching, creeping, composed of two kinds of cells, one producing numerous zoospores, the other bulbous at the base but drawn out into a tube, from the open extremity of which projects a long flexible hair.

This genus, consisting of a single species, was first described by Pringsheim in the Abhandlungen der königl. Akademie der Wissenschaften, Berlin, 1862, who founded it upon a small alga parasitic in the fronds of *Leathesia* and other *Phæosporeæ*, at Helgoland.

The genus resembles *Coleochæte*, a fresh-water genus, in the structure of the hairs, but in *Bulbocoleon* no reproductive bodies, except zoospores produced in the ordinary cells, have as yet been discovered. It is not impossible that oospores may at some time be found, and it will then be necessary to remove the genus from the present order.

B. piliferum, Pringsheim, l. c., p. 8, Pl. I.

Characters same as those of the genus.

Parasitic in the fronds of *Leathesia tuberiformis* and *Chordaria divaricata*. Summer.

Newport, R. I.; Wood's Holl, Gloucester, Mass.; Europe.

This minute species is found creeping among the cortical cells of *Leathesia* and *Chordaria*, generally in company with a *Streblonema*. It forms dark spots on the fronds, and, on microscopic examination, the hyaline hairs are seen projecting above the surface. The species is studied with difficulty when parasitic on *Leathesia*, owing to the density of the cortical part of the frond, but is more easily examined when it grows on *Chordaria*. It was found by Pringsheim on *Chorda filum*, *Chordaria flagelliformis*, and *Mesogloia vermicularis*, as well as on *Leathesia*. It probably will be found on several other *Phæosporeæ* of our coast, where it appears to be common.

The following genus described by Reinsch, including a species of which we have not been able to examine specimens, should be included in the account of the *Chlorosporeæ* of our coast:

Acroblaste, new genus of *Chroolepideæ*.

Plants microscopic, marine, forming densely aggregated tufts attached to stones and shells; threads erect, subsimple, branching from the base, arising from procumbent, densely interlaced threads; conceptacles in the upper part of the branches nearly spherical, at first unicellular, afterwards producing 20-35 spherical zoospores; after the discharge of zoospores elliptical, with a wide mouth; development of the branches and growth of the threads as in *Chroolepus* and *Cladophora*.

Acroblaste, spec. Contents of cells finely granular, distinctly circumscribed; color slightly glaucous green; cell-wall thick, sublamellated, twice as long as broad.

Height of plant, .336–.6^{mm}.

Diameter of filaments, .0050-80^{mm}.

Diameter of conceptacles, .0168–196^{mm}.

Diameter of zoospores, .0022^{mm}.

Hab.—Attached to shells and stones, Buzzard's Bay, Mass.

Reinsch., in Botanische Zeitung, 1879, No. 23, Pl. 3 *a*.

SUBORDER BOTRYDIEÆ.

Fronds minute green unicellar, spherical or pyriform, with a rhizoidal process at the base. Globose bodies produced in the cells, from which, when discharged, there is formed a large number of zoospores, with two cilia, which conjugate.

A small suborder, of which the development is known only in a single species, *B. granulatum*, of which Rostafinski and Woronin have given a full account. Probably the suborder may require to be united with the *Siphoneæ*, a group abundant in the tropics, but not strictly found with us.

CODIOLUM, A. Br.

(Named from the resemblance to species of *Codium*, a genus of marine algæ.)

Frond unicellular, at the base prolonged into a tapering, solid, hyaline stalk, above clavate, containing an oval chloropyllaceous mass, which ultimately is transformed into a large number of spores, development of spores unknown.

The present genus was founded by A. Braun on a species found by him at Helgoland in 1852 and described and figured in his work on unicellular algæ. A second species (*C. Nordenskioldianum*) was described by Kjellman.

The genus is placed by Braun and Kjellman near *Characium*, but until the development of the spores has been made out the position of the genus must remain doubtful. Braun compares the spores to those of *Codium*, but states that he had never seen cilia. In American specimens we have never seen the spores escape from the mother cell and swim about by means of cilia, but, on the other hand, the wall of the mother cell dissolves and the spores thus set free begin to grow at once. It often happens that the spores begin to grow inside the mother cell. The spores are oval and have a thick wall. Each spore either gives off a projection at one end, which grows into a long stalk, or else the contents of the spore become divided into a small number of cells by means of cross-partitions at right angles to its longer axis, thus forming a short filament, each cell of which gives off a stalk as previously described. There results in the last case a dense cluster of individuals, which adhere together by their bases. It may be that what we have seen was only the hypnosporic condition of the plant, and that Braun had examined a stage in which motile spores existed. Occasionally one finds two spore-bearing cells on a single stalk, one always being very much smaller than the other. The second cell is lateral and may be nearly sessile on the stalk or furnished with a short secondary stalk of its own.

Our plant recalls the hypnosporic condition of *Botrydium granulatum*, and in the Algæ Am. Bor. Exs. it was distributed under the name of *B. gregarium*. As the development is so little known, we have now thought best to retain the name *Codiolum*, on the supposition that our species is the same as that of Braun. The study of the development is rendered difficult because the plant grows inextricably entangled with other small algæ.

C. GREGARIUM, A. Br. (*C. gregarium*, Braun, Alg. Unicell., Genera nova et minus cognita, p. 20, Pl. 1.—*Botrydium gregarium*, Farlow, in Alg. Am. Bor. Exs., No. 99.)

Cells densely aggregated, average length of cells, including stalk,

.35–60^{mm}, sporiferous mass .04–8^{mm} broad by .10–15^{mm} long. Spores .015^{mm} by 020^{mm}.

On wharves and rocks between tide-marks, mixed with *Calothrix scopulorum* and *Ulothrix.*

Eastport, Me.; Gloucester, Mass.; Europe.

Probably common in the autumn along our northern coast, and at once recognized by the long terminal stalk, which appears to be an appendage of the cell-wall. The size is so variable that no accurate measurements as to length can be given. Those above stated represent the size of fully-grown sporiferous individuals.

SUBORDER BRYOPSIDEÆ.

Fronds green, unicellar, filamentous, branching; reproduction by zoospores, with two cilia, formed in the occluded branches.

A small suborder, including with us a single species of *Bryopsis* and a single species of *Derbesia,* a genus whose position is uncertain and which may prove to be more nearly related to *Vaucheria* than to *Bryopsis,* although in the present article we have placed it with the latter.

BRYOPSIS, Lam.

(From *βρυον*, a moss, and *οψις*, an appearance.)

Fronds bright-green, unicellular, branching, usually pinnately divided; reproduction by spores formed in occluded portions of the branches; spores of two (?) kinds—either green zoospores, furnished with two apical cilia, or orange-colored.

The genus *Bryopsis* includes perhaps not far from twenty species, which are characterized by the mode of branching. Most of them are pinnately compound, and the different forms pass so gradually into one another that the species cannot be said to be well marked. The fronds are unicellular except at the period of reproduction, when some of the smaller branches are separated by partitions from the rest of the frond. The position of the genus is still doubtful, as the development is not known. The reproductive bodies generally found are green zoospores which have two terminal cilia. Whether they conjugate or not is not known, although as Thuret reports the occurrence of zoospores with four cilia, such is probably the case. A second form of reproductive bodies was found by Pringsheim in *Bryopsis,* orange-colored motile bodies furnished with two terminal cilia. The development of these bodies has not been observed. Janczewski and Rostafinski have expressed the opinion that they may be parasites, but Cornu confirms the statement of Pringsheim that they are really organs of the *Bryopsis.*

B. PLUMOSA, (Huds.) Ag., Phyc. Brit., Pl. 3. **Pl. IV, Fig. 1.**

Fronds 2–6 inches long, often gregarious, 2–4 times pinnate, pinnules pyramidal in outline, naked at the base, in the upper part clothed with short pinnulæ, which are constricted at base.

On muddy wharves and stones at low-water mark.

A beautiful species, not uncommon along our whole eastern coast, and also frequently found on the shores of California. It is very widely diffused, being found in nearly all seas. *B. hypnoides,* which occurs at Key West, passes almost insensibly into *B. plumosa,* but the typical *B. hypnoides* is not known in New England.

? DERBESIA, Sol.

(Named in honor of *Prof. Alphonse Derbes,* of Marseilles.)

Fronds green, simple or slightly branching, unicellular, or sometimes with cross-partitions at the base of the branches; fructification consisting of ovoidal sporangia containing zoospores, which are of large size and have a hyaline papilla at one end, at the base of which is a circle of cilia; oospores unknown.

The genus *Derbesia* was founded by Solier on two Mediterranean species, *D. marina* and *D. Lamourouxii.* The position of the genus is doubtful. The *Derbesiæ* resemble in habit the more delicate species of *Vaucheria* and *Bryopsis,* and like them are often unicellular, but it is, however, not uncommon to find at the base of some of the sterile branches a short cell, separated by a wall both from the branch above and the main filament below. A similar cell is always present at the base of the sporangia, and the same cell is found in some species of *Vaucheria. Derbesia* differs from *Bryopsis* in having zoospores provided with a circle of cilia, borne around the base of a terminal hyaline papilla as in *Œdogonium.* It differs from *Vaucheria* in not having oospores, so far as is known. The zoospores of *Derbesia,* according to Solier, germinate at once and are apparently of a non-sexual character, so that we may expect that hereafter either oospores or conjugating zoospores will be found. As we have said, the zoospores bear a striking resemblance to those of *Œdogonium,* and perhaps the relationship to the last-named genus is closer than has usually been supposed. In this connection it should be mentioned that, in the formation of the cells sometimes found at the base of the branches, the cell-wall ruptures in the same way as in *Œdogonium,* and if we do not have the same rings forming a cap at the end of the cells as in *Œdogonium* it may be because in *Derbesia* the formation of new cells is very limited.

D. TENUISSIMA (De Not.), Crouan. (*D. marina,* Solier, Ann. Sci. Nat., 3 série, Vol. VII, p. 158, Pl. 9, Figs. 1–17.—*Bryopsis tenuissima,* De Not., Fl. Capr.—*D. tenuissima,* Crouan, Florule du Finistère, non *D. marina,* Crouan, Algues Marines du Finistère, No. 398.—*Chlorodesmis vaucheriæformis,* Harv., Ner. Am. Bor., Part III, p. 30, Pl. 40 *c.*) **Pl. IV, Fig. 4.**

Filaments tufted, bright green, one to two inches long, .04^{mm} in diameter; branches few, erect, constricted, and often with a cuboidal cell at the base; sporangia on short branches, ovoidal or pyriform, .09–.12^{mm} broad by .20–.30^{mm} long, resting on a cuboidal basal cell; spores large, few, about 15 in number.

Forming tufts on algæ.

Eel Pond Bridge, Wood's Holl, Mass.; Key West; Europe.

We have found this species but once on our coast, in May, 1876. With us it is apparently rare, but the species is not uncommon in some parts of Europe, especially on the shores of the Mediterranean. Our form is very well developed and the sporangia are rather longer than in the European specimens which we have seen.

SUBORDER PHÆOSPOREÆ.

Reproduction by means of olive-brown zoospores which have two laterally attached cilia; sporangia of two kinds—unilocular, containing a large number of zoospores, and plurilocular, compound sporangia, each cell of which contains a single zoospore; conjugation of zoospores known in a few species; marine plants, of an olive-brown color, whose fronds vary greatly in structure, but which all agree in reproducing by zoospores.

A large group, first correctly defined by Thuret. Previous writers had regarded the structure of the frond to the exclusion of the organs of reproduction, and the species here included were placed in different orders. In the Nereis they were placed partly in the *Dictyotaceæ*, *Sporochnaceæ*, *Laminariaceæ*, *Chordariaceæ*, and *Ectocarpaceæ*. The four last orders have been kept as families, but the true *Dictyotaceæ* are a distinct order. All the olive-brown sea-weeds of New England, except the rock-weeds, belong to the present suborder. In no order of plants do the species vary so widely in habit as in the present. A large number, as the *Ectocarpi*, are filamentous and resemble in habit the *Cladophoræ*. The *Laminariæ* have expanded flat fronds, and in *Macrocystis* and *Egregia*, the most highly organized of the order, there are stems, distinct leaves, and air-bladders, and in *Egregia* special fructiferous leaflets. Many of the species are of microscopic size, but *Macrocystis* grows to be several hundred feet long.

SPHÆNOSIPHON, Reinsch.

(From σφην, a wedge, and σιφων, a tube.)

Fronds formed of single cells placed side by side so as to form a more or less coherent mass; cells pyriform-cuneate or oblong-elliptical; contents of cells transformed into a number of very small spherical bodies (zoospores ?).

In the Contributiones ad Algologiam et Fungologiam, Reinsch places the genus *Sphænosiphon*, of which he describes nine species, in the order *Melanophyceæ*. One of the species occurs in fresh water and the rest are marine. They all form minute spots on other algæ, and consist simply of cells placed side by side, the whole forming a thin membranous expansion. If the small bodies described and figured by Reinsch in the interior of the cells are really zoospores, and if the cells themselves are olive-brown, we must regard the genus *Sphænosiphon* as the lowest of the *Phæosporeæ*. The development of the zoospores has not been observed, and as Reinsch describes the color of some of the species as bluish green and rose-colored, we must consider the position of the genus to be in doubt. Species of *Sphænosiphon* are not unfrequent on our coast, but they have not yet been sufficiently studied. Those which we have seen are more like the *Cyanophyceæ* than the *Phæosporeæ* in color. The following descriptions, which may apply to some of our species, are taken from Reinsch, l. c.

S. SMARAGDINUS, Reinsch, l. c., Pl. 35, Fig. 4.

Cells pyriform or broadly cuneiform, rounded at the apex, prolonged at the base into a hyaline pedicel; cells .0168–333^{mm} long, .0084–112^{mm} broad at apex, .002^{mm} at base; color bluish green; base hyaline.

On *Plocamium coccineum*, Labrador.

On *Polysiphonia*, Anticosti.

S. OLIVACEUS, Reinsch, l. c., Pl. 36, Fig. 2 *a*.

Cells pyriform or cuneiform, broadly rounded at apex, contracted at base; color olive-green; cells .013–24^{mm} long, breadth .0096–168^{mm}.

On *Ceramium rubrum*, Anticosti and Labrador.

S. ROSEUS, Reinsch.

Cells broadly ellipsoidal, placed loosely together, and surrounded by a thick hyaline mucus; rose-colored; .0041–50^{mm} long, .004–5^{mm} broad.

On zoophytes, Labrador.

As an account of the families into which the suborder is divided has already been given on pp. 15–17, it is unnecessary to repeat them here, but the reader will find them briefly described in their order on subsequent pages, together with a synopsis of the genera found on our coast belonging to each family.

Family SCYTOSIPHONEÆ.

Fronds unbranching, either membranous or tubular; plurilocular sporangia in short filaments, densely covering the whole surface of the fronds; unilocular sporangia not well known.

Fronds expanded membranes .... *Phyllitis.*
Fronds tubular .... *Scytosiphon.*

PHYLLITIS, (Kütz.) Le Jolis.

(From φυλλιτης, a name given by Dioscorides to an unknown plant.)

Fronds olive-brown, simple, membranaceous, composed of a cortical layer of minute colored cells and an internal layer of larger, oblong, colorless cells, which are sometimes prolonged downwards in the form of short filaments; plurilocular sporangia formed from the cortical cells, covering the surface of the fronds, consisting of a few (4–6) cells arranged in short filaments, which are closely packed together at right angles to the surface of the fronds; unilocular sporangia and paraphyses unknown; growth from the base.

A genus consisting of two species, formerly placed in the genus *Laminaria* in consequence of their membranous habit, but differing essentially from the true *Laminariæ* in the structure and disposition of their sporangia.

P. FASCIA, Kütz. (*Laminaria fascia*, Ag.)

Fronds gregarious from a disk-like base, three to six inches long, a quarter to half an inch wide, linear-elongate, contracted at the base into a short stipe.

Var. CÆSPITOSA. (*Phyllitis cæspitosa*, Le Jolis, Études Phycol., p. 10, Pl. 4.—*Laminaria cæspitosa*, Ag.—*Laminaria fascia*, Harv., in Phyc. Brit., Pl. 45.—*Laminaria debilis*, Crouan, Alg. Finist., No. 81.) **Pl. IV, Fig. 3.**

Fronds stipitate, cuneiform, often falcate and undulate.

Very common on stones between tide-marks; widely distributed over all parts of the world.

About the limits of the present species there is a diversity of opinion. Le Jolis regards the *L. fascia* and *L. cæspitosa* of Agardh as distinct species, but by Harvey they were considered as merely different forms of the same species. Harvey's opinion seems to us to be correct, for it is impossible to draw the line between the two forms as found on our coast.

SCYTOSIPHON, (Ag.) Thuret.

(From σκυτος, a whip, and σιφων, a tube.)

Fronds simple, cylindrical, usually constricted at intervals, hollow, cortex of small colored cells, inner layer of vertically elongated, colorless cells; sporangia as in *Phyllitis;* paraphyses single-celled, oblong-obovate, interspersed among the sporangia.

The present genus is founded on the *Chorda lomentaria* of older writers. The genus *Scytosiphon,* as proposed by Agardh, included both *C. lomentaria* and *C. filum.* The latter species, which is still kept in the genus *Chorda* by most writers, has the surface of the frond covered with club-shaped paraphyses, between which are situated the oval unilocular sporangia. In *S. lomentarius* the bodies called paraphyses are only occasionally found, and their real nature is a little uncertain. Both Bornet and Areschoug consider them to be paraphyses, and the latter has figured them in Observationes Phycologicæ, Part III, Pl. 2, Fig. 1. As at present understood, *Scytosiphon* differs from *Phyllitis* only in the fact that the frond is tubular instead of membranous, and in the presence of paraphyses, which have not yet been found in *Phyllitis.*

S. LOMENTARIUS, Ag. (*Chorda lomentaria,* Lyngb.; Phyc. Brit., Pl. 285.—*Chorda filum* var. *lomentaria,* Kütz., Spec. Alg.)

Fronds gregarious, three to eighteen inches long, attached by a disk-like base, shortly stipitate, expanding into a hollow tube, from a quarter of an inch to an inch in diameter, at first cylindrical, afterwards constricted at intervals.

Very common on stones between tide-marks; found nearly all over the world.

A species easily recognized, except when quite young, by its tubular and constricted frond, but chiefly interesting in consequence of the smaller species of algæ which grow upon it. At Eastport a very large form is found, nearly an inch in diameter, and much twisted.

FAMILY PUNCTARIEÆ.

Fronds unbranching, forming expanded membranes or cylinders; fructification in spots (sori) on the surface of the fronds; plurilocular sporangia ellipsoidal, composed of few cells; unilocular sporangia spheroidal.

PUNCTARIA, Grev.

(From *punctum,* a point, referring to the dots formed by the sporangia and hairs.)

Fronds olive-brown, simple, membranaceous, attached by a discoidal base, composed of several (2-6) layers of cuboidal cells of about the same dimensions in all parts of the fronds; unilocular sporangia immersed in the frond, collected in spots, spherical-cuboid, formed from the superficial cells; plurilocular sporangia collected in spots, immersed except at the apex, formed from the superficial cells; fronds covered with clusters of hairs; paraphyses wanting.

A small genus, containing probably not more than half a dozen good species, which are widely diffused. In the Nereis Am. Bor. the genus is placed by Harvey in the *Dictyotaceæ*. That order is now restricted to a group, not represented, as far as is known, on the coast of New England, in which there are quiescent spores, tetraspores, and antheridia, but no zoospores, and *Punctaria* is evidently related to the *Phæosporeæ*, judging by its sporangia. *Litosiphon pusillus*, a small parasite on various algæ, is closely related to *Punctaria*, but differs in having a filamentous frond and more simple sporangia. It probably occurs on our coast, but has not yet been observed.

P. LATIFOLIA, Grev.; Phyc. Brit., Pl. 8; Études Phycol., p. 13, Pl. 5.

Fronds pale olive-green, gregarious, shortly stipitate, lanceolate or obovate, four to twelve inches long, one to five inches broad, substance tender.

Var. ZOSTERÆ, Le Jol. (*P. tenuissima*, Phyc. Brit., Pl. 248.)

Fronds thin, pale, lanceolate at both extremities, narrow, margin undulated.

On different algæ at and below low-water mark. Spring and summer. Europe.

P. PLANTAGINEA, (Roth) Grev.; Phyc. Brit., Pl. 128. **Pl. IV., Fig. 5.**

Fronds deep brown, gregarious, broadly lanceolate, attenuated at base, one to three inches broad, three inches to a foot long, substance somewhat coriaceous.

Orient, L. I.; Point Judith, R. I., *Olney;* Wood's Holl, Gloucester, Mass.; Europe. Summer.

It is not altogether easy to distinguish our two species in some cases, although as a rule they are sufficiently distinct. *P. latifolia* is much the more delicate of the two, and has a greenish tinge. When in fruit it is punctate, the dots being the sori. Both forms of sporangia are often found simultaneously on the same frond. In *P. plantaginea* the frond is decidedly brown and rather coriaceous, and the punctate spots are caused by the dense clusters of hairs which are often found to correspond on both sides of the frond. Both species are common in spring and summer, and although often washed ashore in considerable quantities on exposed beaches, they prefer quiet bays.

FAMILY DESMARESTIEÆ.

Fronds branching, cylindrical or compressed, with an axis of filaments composed of elongated cells and a cortex composed of spheroidal cells; unilocular sporangia formed by the direct transformation of the cortical cells; plurilocular sporangia unknown.

DESMARESTIA, Lamx.

(In honor of *A. G. Desmarest*, a French naturalist.)

Fronds olive-brown, solid, cylindrical or compressed, much branched, attached by a disk, cortical layer composed of small polygonal cells, internal portion consisting of an axial filament formed of a single row of rather large cylindrical cells, surrounded by a mass of oblong cells sometimes mixed with smaller winding cells; in the spring fronds covered with branching hairs, which drop off later in the season; unilocular sporangia formed directly from the cortical cells, which do not undergo any change in shape or size; growth trichothallic.

A small genus, consisting of about fifteen described species, a considerable portion of which bear a close resemblance to *D. aculeata.* They are inhabitants of the colder seas in both the northern and southern hemispheres. Our two species are very widely diffused, but *D. ligulata,* a common species of California as well as of Europe, is wanting on our coast. The genus is easily distinguished from its allies by the axial filament and the formation of the zoospores in the unchanged superficial cells.

D. ACULEATA, Lamx., Phyc. Brit., Pl. 49; Ner. Am. Bor., Vol. I, Pl. 4 *b*.

Fronds dark olive-brown, one to six feet long, terete below, compressed above, naked at the base; branches alternate, numerous, long and virgate, lower branches longer than upper, several times pinnate, clothed in spring with hairs, which fall off and leave alternate, distichous, spine-like processes.

Common on exposed shores below low-water mark. Throughout the year. Europe.

A coarse and homely species as usually found; often washed ashore in large masses. Not likely to be confounded with any other of our species. In spring it presents a feathery appearance, owing to the tufts of hairs with which the frond is beset. It is one of the species used as a fertilizer on the northern coast of New England.

D. VIRIDIS, Lam. (*Dichloria viridis,* Grev.—*Desmarestia viridis,* Phyc. Brit., Pl. 312.)

Fronds light olive, one to three feet long, cylindrical or but slightly compressed; branches all opposite, distichous, several times pinnate, ultimate branches capillary.

Common on stones at and below low-water mark. Europe.

A smaller and much more delicate species than the last, for which it can never be mistaken, rather resembling in some of its conditions a *Dictyosiphon.* The name is derived from the fact that on decaying or on being placed in fresh water it turns quickly to verdigris-green. Harvey mentions that air-cavities are to be seen in cross-sections of the filaments. The air-cavities are, however, merely the sections of the larger cells which are surrounded by dense masses of smaller cells, whereas in *D. aculeata* a cross-section shows the axial filament surrounded by a mass of cells of nearly equal diameter.

FAMILY DICTYOSIPHONEÆ.

Fronds branching, filiform, axis composed of elongated cuboidal cells, the cortex of smaller roundish cells; unilocular sporangia spherical, scattered or aggregated, formed from the subcortical cells; plurilocular sporangia unknown.

DICTYOSIPHON, Grev.

(From δικτυον, a net, and σιφων, a tube.)

Fronds olive-brown, filiform, branching, solid above, becoming hollow below, cortex composed of small, irregularly polygonal cells, interior of larger, colorless, longitudinally elongated cells; branches corticated throughout; growth from an apical cell (scheitel-zelle); unilocular sporangia spherical, scattered, immersed in the cortex; paraphyses and plurilocular sporangia unknown.

The genus was founded on *D. fœniculaceus*, a species placed by C. A. Agardh and Lyngbye in *Scytosiphon*. Under *D. fœniculaceus* were included a number of forms which have since been separated by Areschoug and placed in two different genera, *Phlœospora* and *Dictyosiphon*. In the former the unilocular sporangia are formed directly from the cortical cells and cover the surface in dense patches, at maturity projecting above the surface of the frond. In the latter genus the sporangia are scattered and immersed. In *Dictyosiphon*, moreover, the growth is from an apical cell, but in *Phlœospora* it is trichothallic, and in the former genus the superficial cells are polygonal and irregularly placed, while in the latter they are quadrate and arranged in regular series. The genus is divided by Areschoug into two subgenera, *Dictyosiphon* proper and *Coilonema*, the latter of which is referred by Gobi to *Cladosiphon*, since the cortical layer consists of very short filaments rather than a continuous cellular membrane. Our two species belong to *Dictyosiphon* proper, but species of *Coilonema* and *Phlœospora* are to be expected in the region of Eastport. By Harvey the genus was placed in the *Dictyotaceæ*, from which order it was necessarily removed when the true nature of the sporangia was discovered.

D. FŒNICULACEUS, Grev. (*Scytosiphon fœniculaceus*, Ag.—*D. fœniculaceus*, Phyc. Brit., Pl. 326; Areschoug, Phyc. Mar., Pl. 7.)

Fronds yellowish brown, six inches to two feet long, much branched; branches alternate or occasionally opposite; superficial cells angularly quadrate.

Common on stones and algæ at low-water mark. Spring and summer. Europe.

A variable species as found on our coast, but one which cannot well be subdivided at present. Early in the season the fronds are light colored and delicate in substance, but later they become more rigid. Perhaps some of the forms which we have here included may properly be placed under var. *flaccidus* of Areschoug. Such, at least, appears to be the case with some of the specimens collected in May at Wood's Holl.

D. HIPPUROIDES, (Lyngb.) Aresch.? (*Scytosiphon hippuroides*, Lyngb., Hydr., Pl. 14 *b*.—*D. fœniculaceus α*, Aresch., Phyc. Mar., Pl. 6 *a* and *b*.—*Chordaria flagelliformis* var. β and γ, Agardh, Sp. Alg., Vol. I, pp. 66 and 67.)

Fronds dark brown, four inches to two feet long; main branches rather densely beset with flagellate, scattered, subequal secondary branches; superficial cells in the lower part arranged in horizontal series, above irregular.

Exs.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 95.

On stones at low tide.

Eastport, Maine; Cape Ann, Mass.

We have referred to the present species a rather large form found abundantly in September, 1877, at Eastport, near Dog Island, where it grows with *Chordaria flagelliformis*, which it somewhat resembles in habit. It is much coarser than *D. fœniculaceus*, and of a darker color, and the branches are long and flagellate, and furnished with comparatively few secondary branches. The Cape Ann specimens are smaller and approach nearer *D. fœniculaceus*. The Eastport form can hardly be regarded as an extreme state of *D. fœniculaceous*, but whether it is really the *D. hippuroides* of Areschoug admits of some doubt, as Areschoug describes his species as being only six or seven inches long. According to Areschoug, the conjugation of zoospores has been observed in this species.

Family ECTOCARPEÆ.

Fronds filamentous, monosiphonous or sometimes partly polysiphonous, cortex rudimentary or wanting; sporangia either in the continuity of the filaments or external, sessile or stalked; unilocular sporangia globose or cuboidal; plurilocular sporangia muriform (formed of numerous small rectangular cells densely aggregated in ovoidal or lanceolate masses); growth trichothallic.

Fronds polysiphonous above, monosiphonous below, densely beset above with very short horizontal branches .... *Myriotrichia.*

Fronds generally monosiphonous throughout, branches free, opposite or alternate .... *Ectocarpus.*

MYRIOTRICHIA, Harv.

(From *μυριος*, a thousand, and *θριξ*, a hair.)

Fronds olive-brown, filamentous, at first consisting of a single row of cells, which by transverse and longitudinal division afterwards form a solid axis; branches short, closely approximated, radiating in all directions, formed by outgrowths from the superficial cells of the axis; unilocular sporangia spherical, borne on the axis between the branches; plurilocular sporangia unknown; main axis and branches ending in hyaline hairs.

A genus comprising three species which are hardly distinct. They form small tufts or fringes on different *Phæosporeæ*, especially on *Scytosiphon*, and are recognized by the numerous short branches which in some cases almost cover the main axis and cause it to resemble a *Stigonema*. The development of the frond is given in detail by Nægeli in Die neuern Algensysteme.

M. CLAVÆFORMIS, Harv., Phyc. Brit., Pl. 101. (*M. Harveyana*, Næg. partim.)

Fronds half an inch to an inch in length, club-shaped in outline, axis clothed throughout with branches, upper branches longer than lower and bearing secondary branches.

Var. FILIFORMIS. (*M. filiformis*, Harv., Phyc. Brit., Pl. 156.—*M. Harveyana*, Næg. partim.)

Fronds filiform in outline, axis furnished only at intervals with branches.

On various algæ, especially *Scytosiphon lomentarius*.

Gloucester, Mass., *Mrs. Bray*.

Var. *filiformis*, Penobscot Bay, Maine, *Hooper*; Newport, R. I.; Europe.

A species forming small tufts on different *Phæosporeæ*, probably abundant on our coast, but as yet only recorded in a few localities. Nægeli has shown, l. c., that the two species of Harvey are merely forms of a single species, the variety *filiformis* being less fully developed than *M. clavæformis*, which was first described.

ECTOCARPUS, Lyngb.

(From εκτος, external, and καρπος, fruit.)

Fronds filamentous, monosiphonous or occasionally partly polysiphonous by radial division of some of the cells; plurilocular sporangia ovate, cylindrical or siliculose, consisting of numerous small cells arranged in regular longitudinal and transverse series; unilocular sporangia cylindrical or oval, either stalked or formed by the direct transformation of the cells of the branches.

The genus is here accepted in an extended sense, and includes a number of genera of modern writers which we have preferred to consider subgenera. Perhaps *Pylaiella* should be kept distinct, as in this subgenus both the unilocular and multilocular sporangia are formed by the direct transformation of some of the cells in the continuity of the filaments rather than in special branches. But in *Capsicarpella* we have the multilocular sporangia formed in the continuity of the branches as in *Pylaiella*, while the unilocular sporangia are partly emergent and seem to be intermediate between those of *Pylaiella* and *Ectocarpus* proper. *Streblonema*, if separated from *Ectocarpus* by its creeping habit, resembles it perfectly in its fruit, and, as the different species of *Streblonema* vary considerably as to their procumbent habit, it seems, on the whole, better not to retain the genus. The described species of *Ectocarpus* proper are very numerous, but unfortunately they are not well characterized. The greater part of the species may be grouped around *E. confervoides* and *E. fasciculatus* as types, but exactly how far differences in ramification and dimensions of the sporangia are to be considered specific rather than mere variations is a matter about which botanists do not agree. One thing is certain, that specific analysis has been carried too far in this group, and it is especially true with regard to the species of Kützing. In describing a species of *Ectocarpus* it is important to have both the unilocular and plurilocular conditions. In most of the species, however, only one form is known. The unilocular sporangia are often difficult to determine, because the *Ectocarpi*, especially those growing on dirty wharves, are infested by parasites, *Chytridium*, &c., which produce globular swellings of the cells, which might then, especially in dried specimens, be mistaken for unilocular sporangia.

Besides the two forms of sporangia, Thuret and Bornet have recorded the existence of bodies to which they have given the name of antheridia. It has been suggested that the antheridia were cells distorted by parasites. We have never seen antheridia in American specimens, and are not in a position to express any opinion. The fact that a conjugation of the zoospores has been observed by Goebel in *E. pusillus* would, however, incline one to consider that the antheridia in this genus were not proper male bodies.

Some of the species of *Ectocarpus* described by Harvey in the Nereis were founded on sterile specimens, but, at the present day, algologists agree in thinking that the presence of sporangia is necessary for the determination of species of *Ectocarpus*, and we have, accordingly, omitted the Harveyan species founded on sterile plants as being inadequate.

SUBGENUS STREBLONEMA, Derb. & Sol. (*Entonema*, Reinsch).

Primary branches procumbent, creeping in or over the substance of other algæ; secondary and fructifying ramuli erect.

E. CHORDARIÆ, n. sp.

Filaments much branched, irregularly nodose, about .02^{mm} in diameter, sunk in the tissue of the host-plant; hairs and fertile branches erect, the former projecting above the surface; unilocular sporangia on short stalks, solitary or clustered, oval, about .07^{mm} broad by .14^{mm} long; plurilocular sporangia unknown.

Parasitic in the fronds of *Chordaria divaricata*, *Leathesia tuberiformis*, and other *Phæosporeæ*.

Wood's Holl, Gloucester, Mass.; Newport, R. I.

A common but insignificant species which grows in the cortical portion of different *Phæosporeæ*, especially *Chordaria divaricata*, and usually in company with *Bulbocoleon*. It forms dark-colored spots on the surface of the plant in which it is growing, and, on a hasty microscopic examination, would pass unnoticed, so great is the resemblance of the sporangia to those of *Chordaria*. Our plant resembles *S. sphæricum*, Thuret, but differs from the Mediterranean forms of that species in having oval, not spherical, sporangia, which are often clustered. The filaments, too, are composed of very irregular-shaped cells, and are never moniliform as in well-developed specimens of *S. sphæricum*. It may, however, be the case that what we have considered specific marks are only local variations. It may also be asked whether the present species is not the form of *S. fasciculatum*, Thuret, which bears unilocular sporangia. At present only the plurilocular form of sporangium is known in that species as it occurs in Europe.

E. REPTANS, Crouan, Florule du Finistère, p. 161; Kjellman, Bidrag till Känn. Skand. Ect. Tilop., p. 52, Pl. 2, Fig. 8.

Filaments forming circular spots on the host-plant, primary branches very densely branching, so that they almost form a membrane, furnished with numerous erect branches, which are .5–7^{mm} high and gradually taper to a hyaline hair; cells at base about .01^{mm} broad; plurilocular sporangia arising from the primary filaments, sessile or on short stalks, ovate-acute, .012–20^{mm} broad by .038–76^{mm} long.

On *Phyllitis* and *Dictyosiphon*. Summer.

Newport, R. I.; Europe.

A larger species than the preceding and growing more superficially, so that the filaments may be said to creep over the surface rather than in the substance of the host-plant. Owing to the dense branching of the prostrate filaments and the abundance of the erect branches, this species forms a connecting link between *Ectocarpus* and *Myrionema*.

SUBGENUS EUECTOCARPUS.

Filaments monosiphonus, erect, occasionally corticated by the growth of descending filaments which are given off from some of the cells; both unilocular and plurilocular sporangia formed by the transformation of special branches.

E. TOMENTOSUS, (Huds.) Lyngb., Phyc. Brit., Pl. 182. (*Spongonema tomentosum*, Kütz., Spec. Alg., p. 461; Tab. Phyc., Vol. V, Pl. 83 *a*.)

Filaments erect, two to four inches long, densely interwoven into rope-like, spongy masses, irregularly much branched; primary branches scarcely distinct; cells .008–12^{mm} broad by .012–70^{mm} long; plurilocular sporangia linear-oblong, straight or incurved, .010–15^{mm} broad by .025–75^{mm} long, sessile or on short pedicels, which are given off at right angles to the branches; unilocular sporangia "subovate on short pedicels" (Areschoug).

On *Fucus* and other plants.

Boston Bay, *Harvey;* Magnolia, Mass.; Europe.

This species, which is easily recognizable by its spongy, rope-like habit, and by the microscopic characters above enumerated, seems to be rather scarce on our coast. It is not rare, however, on the shores of Europe. The species is to be sought in summer, and it grows attached to the larger algæ. Only the plurilocular sporangia are known on our coast.

E. GRANULOSUS, (Eng. Bot.) Ag.; Phyc. Brit., Pl. 200.

Filaments tufted, rather rigid, two to four inches long, main branches opposite or whorled, corticating filaments often numerous; cells .07–10^{mm} in diameter; secondary branches short, opposite, given off at very wide angles, often revolute at the tip; ultimate branches secund, short, acute; plurilocular sporangia broadly ovate, obliquely truncate on the inner side, .04–6^{mm} broad by .06–8^{mm} long, sessile on the ultimate and penultimate branches; unilocular sporangia?

Var. TENUIS. (*Ectocarpus Durkeei*, Harv., Ner. Am. Bor., Vol. I, p. 142, Pl. 12 *f*.)

Filaments more slender than in the type; cells .05–8^{mm} broad; branches usually alternate; plurilocular sporangia ovate or ellipsoidal, but slightly truncate at the base.

Boston, *Harvey;* Newport, R. I.

Var. *tenuis*, Portsmouth, N. H.; Nantucket, Mass., *Harvey;* Wood's Holl, Mass.

A species not rare in Europe and apparently common on the coast of California but not often found with us. The species occurs in summer, and forms small tufts on other algæ. It is distinguished from our other species by the short, broad, and sessile sporangia. In the type the branching is opposite and compact, and the corticating filaments are sometimes so numerous, especially in the Newport specimens, as to lead one to admit the validity of Kützing's genus *Corticularia*. But in other cases the corticating filaments are few in number.

E. CONFERVOIDES, (Roth) Le Jolis. (*Ectocarpus siliculosus*, Phyc. Brit., Pl. 162; Ner. Am. Bor., Vol. I, p. 139.)

Filaments erect, two to twenty inches long, loosely entangled at the base, becoming free and feathery above; branches alternate or secund, gradually tapering; cells of larger branches .04–5^{mm} in diameter; plurilocular sporangia ovate-acute or acuminate, sessile or stalked, sometimes rostrate average size of sporangia .025–40^{mm} broad by .15–40^{mm} long; unilocular sporangia oval or ellipsoidal, .023–30^{mm} broad by .035–50^{mm} long.

a, var. SILICULOSUS, Kjellman. (*Ectocarpus viridis*, Harv., Ner. Am. Bor., Vol I, p. 140, Pl. 12 *b* and *c*.)

Plurilocular sporangia subulate or linear-subulate, sessile or subsessile, frequently rostrate.

β, var. HIEMALIS, Kjellman. (*Ectocarpus hiemalis*, Crouan.)

Plurilocular sporangia elongated, conical or subacuminate, .08–15^{mm} long by .02–3^{mm} broad, generally rostrate.

Very common on algæ and wood work along the whole coast.

Var. *a*, most common south of Cape Cod.

Var. *β*, Wood's Holl, Mass.?

The largest, most variable, and most common summer species of our coast, and found in nearly all parts of the world. It has been subdivided by Kützing into a large number of species, which are scarcely to be recognized from his descriptions and plates. Formerly some of the different forms of *E. littoralis* were referred to the present species, but the true *E. littoralis* is now recognized as belonging to the subgenus *Pylaiella*. Those interested in tracing the synonymy of *E. confervoides* should consult Kjellman's Bidrag till Kännedomen om Skandinaviens Ectocarpeer och Tilopterider, Stockholm, 1872. As seen on our own coast, what we have called the typical *E. confervoides* forms tufts of indefinite extent on wharves, and especially on the larger algæ, varying in length from a few inches to a foot and a half long. It frequently fringes the fronds of *Chorda filum* with its soft, silky tufts. In the type the plurilocular sporangia, which are much more common than the unilocular, are ovate-acuminate, and only occasionally rostrate. In the variety *siliculosus* the pluri locular sporangia are long and comparatively very narrow. The variety *hiemalis* is found in the winter and spring, and has plurilocular sporangia, which are almost always rostrate and somewhat cylindrical in form, so that they may be said to resemble those of the subgenus *Pylaiella*. The color of the present species when growing is a light brown approaching yellowish, which in drying often turns to a yellowish-green, especially in the variety *siliculosus*, of which herbarium specimens might be mistaken for *Cladophoræ*. The winter forms are deeper brown than those found in summer. *E. amphibius*, mentioned in the supplement to the Nereis as occurring near New York in brackish water, is a form of the present species.

E. FASCICULATUS, Harv.

Filaments one to eight inches long, erect, tufted, entangled below but free and feathery above; cells of main branches .05mm in diameter, about as long as broad; secondary branches alternate, short, given off at an obtuse angle; ultimate branches very numerous, secund, ending in a hair; plurilocular sporangia ovate-acuminate or subulate, sessile or on short stalks, borne principally on the upper side of the penultimate branches, very variable in size, but averaging from .018–25mm broad by .070–150.mm long; unilocular sporangia sessile, oval, .04–6mm by .03–45mm.

Very common on the larger algæ along the whole coast; Europe.

When found in its typical form the present species is easily recognized, but it varies considerably, so that the extreme forms are not easily determined. It is very common on fronds of *Laminaria* and other large *Phæosporeæ*, on which it forms a dense fringe one or two inches high. The larger forms are much looser and feathery and the tips of the branches are fasciculate when seen with the naked eye. When long and slender it becomes the var. *draparnaldioides* of Crouan. The most puzzling forms are those in which the filaments are short and thick and the rather stout plurilocular sporangia are arranged without order on the branches. In this species the unilocular and plurilocular sporangia are more frequently found growing together on the same individual than in any of the other species found on our coast.

E. LUTOSUS, Harv., Ner. Am. Bor., Vol. I, p. 140, Pl. 12 *a*.

Filaments tufted, two to four inches long, densely interwoven in spongy masses; lower branches opposite, .03–4mm broad; upper branches irregular, ending in long hairs; plurilocular sporangia .04–5mm broad by .15–20mm long, cylindrical in outline, ending in very long hairs, which occasionally fork; unilocular sporangia?

Greenport, L. I., *Harvey;* Wood's Holl, Mass.

The above description is taken from a species common on *Fucus* at Wood's Holl, in May, 1876, which corresponds very well to the *E. lutosus* of the Nereis Am. Bor., a species which Harvey states is not clearly defined. It differs from the description given by Harvey in the fact that the sporangia are not very long, and it is not impossible that our plant may not be the same as that described by Harvey. The present species, as we understand it, is short and tufted and the filaments are densely interwoven into rope like masses as in *E. tomentosus*,. The species seem to connect *Pylaiella* with *Euectocarpus*, resembling on the one hand *E. siliculosus* var. *hiemalis*, and on the other *E. firmus*. From the former it differs in the branching and the shape of the plurilocular sporangia, which are strictly cylindrical, never being in the least acuminate. From the latter it differs in being more slender and in having the sporangia always at the base of very long hairs, which sometimes branch, and not in the continuity of the branches themselves. The ramification is very like that of *E. firmus*. In drying the species becomes decidedly yellow.

E. MITCHELLÆ, Harv., Ner. Am. Bor., Vol. I, p. 142, Pl. 12 *g*.

"Tufts feathery; filaments very slender, decompoundly much branched; the branches and their lesser divisions alternate; the ultimate ramuli approximated; angles wide, and branches and ramuli patent; ramuli attenuate; articulations of the branches twice or thrice as long as broad, of the ramuli once and a half as long; propagula elliptic-oblong or linear, quite sessile and very obtuse, transversely striate, several together." (Harvey, l. c.)

Nantucket, *Miss Mitchell.*

Only known from the description and plate in the Nereis.

SUBGENUS PYLAIELLA, Bory.

Both forms of sporangia formed from the cells in the continuity of the branches, and not by a transformation of special branches.

In the present subgenus one might, at first sight, be inclined to include *E. siliculosus* var. *hiemalis* and *E. lutosus*, but in those species the sporangia are rather situated at the end of branches, which are prolonged beyond the sporangia in the form of hairs, than in the continuity of the branches themselves.

E. LITTORALIS, Lyngb. (*Ectocarpus firmus*, Ag.—*Pilayella littoralis*, Kjellman.)

Filaments tufted or irregularly expanded at the base, two to ten inches long; branches numerous, usually opposite, given off at wide angles, erect; cells .02–4^{mm} broad; plurilocular sporangia irregularly cylindrical, very variable in size; unilocular sporangia formed of from two to thirty contiguous cells, .02–3^{mm} broad; fertile branches moniliform.

Var. ROBUSTUS. (*Ectocarpus Farlowii*, Thuret, in Farlow's List of the Marine Algæ of the United States, 1876.)

Filaments three or four inches long, densely branching; branches robust, opposite or irregular; cells .03–5^{mm} in breadth; fertile branches short and rigid, often transformed through nearly their whole length into unilocular sporangia, which are stout and cylindrical, only slightly moniliform at maturity; cells .04^{mm} broad and .03–4^{mm} in length.

Very common along the whole coast.

Var. *robustus* in exposed places from Nahant northward.

A very common species on our coast, which, although offering numerous forms, cannot, as it seems to us, be well specifically divided. When growing on wharves, where it is very common, or on other wood work, it forms expansions of indefinite extent from which rise tufts several inches long. The basal or prostrate portions branch very irregularly, and the cells are infested with *Chytridia* and other parasites. If species of *Ectocarpus* could be formed from sterile specimens, the basal portions of *E. littoralis* would offer a rich field to the species-maker. What is called var. *robustus* has not yet been found south of Cape Cod, but is common on the northern coast on *Fuci* and other algæ exposed to the action of the waves. The original *E. Farlowii* was founded on specimens collected by Mr. Higbee, at Salem, in November, 1874, and pronounced by the late M. Thuret, in a letter dated April 26, 1875, to be distinct from *E. littoralis.* In the Contributiones ad Algologiam et Fungologiam, Pl. 20, Reinsch figures, under the name of *Ectocarpus anticostiensis,* a form which, as far as can be judged from the figure, is the same as *E. Farlowii.* Although in the present instance we have considered *E. Farlowii* to be a variety of *E. littoralis,* it must be admitted that it differs considerably from the form of *E. littoralis* common on the coast of France and England. Our reason for not considering it distinct is that we have large sets of specimens in which we have been unable to say with certainty whether they should be referred to *E. littoralis* or *E. Farlowii,* and with so many connecting links it seems best to regard *E. Farlowii* as an extreme form found in northern localities. Should the variety be eventually considered distinct the name of *E. anticostiensis* should be adopted, as no description of *E. Farlowii* has been published, and the species would be characterized by the robustness of the filaments and by the unilocular sporangia, which are broader than long, and borne in short, stout, patent branches. It is of frequent occurrence that some of the unilocular sporangia are binate. The plurilocular sporangia are common in spring and early summer, and the unilocular in the autumn.

E. BRACHIATUS, Harv.

"Finely-tufted, feathery, much branched; the branches free, opposite or quarternate; ramuli opposite, very patent; propagula forming oblong or elliptical swellings in the smaller branches, or at the point where two opposite ramuli issue." (Harv., Ner. Am. Bor., Vol. I, p. 138.)

South Boston, Lynn, Mass., *Harvey.*

We have never found this species, which is only known on our coast from Harvey's description. Le Jolis considers that the *E. brachiatus* of the Phyc. Brit., Pl. 4, is not the true *Conferva brachiata,* Engl. Bot., and he gives to the former the name of *E. Griffithsianus.* Never having seen American specimens, we cannot tell whether the American form mentioned by Harvey belongs to the *E. Griffithsianus* or not.

SUBGENUS CAPSICARPELLA, Kjellman.

Filaments erect, monosiphonous or in part polysiphonous; unilocular sporangia partly immersed in the frond; plurilocular sporangia formed by direct transformation of the cells of the branches.

E. SPHÆROPHORUS, Harv., Phyc. Brit., Pl. 126. (*Capsicarpella sphærophora,* Kjellman, Bidrag, p. 20, Pl. 1, Fig. 2.)

Filaments one to three inches long, tufted, densely branching; main branches opposite or whorled, often polysiphonous; secondary branches opposite or alternate, monosiphonous; unilocular sporangia spherical, about .04^{mm} in diameter, solitary, often binate, sometimes whorled, the cell from which the sporangia are formed dividing into at least three cells; plurilocular sporangia ?

On *Ptilota elegans.* May.

Nahant, *Mr. Collins*; Europe.

A rare species which has only been collected by Mr. Collins. The main filaments are at intervals polysiphonous, and remind one of a *Sphacelaria.* In Mr. Collins's specimens the sporangia were numerous and in some cases whorled, as is occasionally seen in European specimens. The species is to be sought in spring and early summer, and may be commoner than is now supposed, having escaped the observation of collectors on account of its small size.

INSUFFICIENTLY DESCRIBED SPECIES.

E. Landsburgii, Harvey, Ner. Am. Bor., Vol. I, Pl. 12 *d*.
Halifax, N. S.

E. Hooperi, Harvey, l. c., Pl. 12 *e*.
Greenport, L. I. (?)

E. Dietziæ, Harvey, l. c., p. 144.
Greenport.

Family SPHACELARIEÆ.

Fronds branching, polysiphonous, terminating in a large apical cell, often with a cortex formed of densely interwoven rhizoidal filaments; fructification same as in *Ectocarpeæ*.

Corticating cells wanting or confined to the base of the frond. *Sphacelaria*.
Main branches corticated throughout.
  Branches opposite, distichous .... *Chætopteris*.
  Branches whorled .... *Cladostephus*.

SPHACELARIA, Lyngb.

(From σφακελος, gangrene, referring to the tips of the branches, which are black and shriveled when dried.)

Fronds olive-brown, filamentous, branching; axis and branches terminated by a large apical cell, from which, by transverse, longitudinal, and oblique divisions, a solid frond is formed whose external surface is composed of rectangular cells arranged in regular transverse bands; hairs slightly developed or wanting; rhizoidal filaments few, rarely interwoven so as to form a false cortex; unilocular and plurilocular sporangia spherical or ellipsoidal, on short pedicels; non-sexual repro-production by peculiarly modified branches called propagula.

The old genus *Sphacelaria* was divided by Kützing into a number of genera, and his views have been adopted by many recent writers, especially in Germany. In *Stypocaulon* and *Halopteris* the branches arise from lateral divisions of the apical cell itself, while in *Sphacelaria* proper, *Chætopteris* and *Cladostephus*, the branches arise from cells below the apex. Whether this difference in the apical growth can be considered a generic mark is not altogether certain, and there hardly seems to be sufficient ground for separating *Halopteris* from *Sphacelaria*, and a number of writers, among whom may be named Harvey and Le Jolis, even include *Stypocaulon*. *Cladostephus* is markedly distinct; and *Chætopteris*, which differs from *Sphacelaria* principally in the corti-

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Giraudia sphacelarioides, Derb. & Sol., a common Mediterranean alga, which occasionally occurs as far north as the Scandinavian coast, may perhaps be found on our shore. It resembles a small *Sphacelaria*, but its growth is trichothallic, not from an apical cell, and the small unilocular sporangia cover the frond in dense patches. The plurilocular sporangia resemble those of some *Ectocarpi*, and are found at the base of the plant according to Areschoug.

cation of the main branches, is kept distinct by most writers. We have but a very imperfect representation of the Sphacelarioid group in this country. *Stypocaulon* and *Halopteris* are entirely wanting, and of *Sphacelaria* we have only *S. cirrhosa* and *S. radicans* on the northeastern coast, *S. tribuloides* in Florida, and what is supposed to be *S. fusca* in California. The species of *Sphacelaria* are variable, and the determination sometimes uncertain. The apical cells of our *Sphacelariæ* are frequently attacked by the unicellular parasite, *Chytridium sphacelarum*, Kny.

S. CIRRHOSA, (Roth) Ag.; Phyc. Brit., Pl. 178.

Fronds olive-brown, densely tufted half an inch to two inches high; main filaments erect, several times pinnate with opposite or irregularly spreading branches; rhizoidal filaments few or wanting; unilocular sporangia .06–7^{mm} long, globose; plurilocular sporangia .05^{mm} broad by .08^{mm} long, broadly ellipsoidal, secund on lateral branches, with unicellular pedicels; propagula rather stout, three (2–4) rayed, usually borne on distinct plants.

Common on *Fucus*, on which it forms dense globose tufts. Europe.

A variable species, sometimes with regularly opposite branches, at times with irregularly placed long branches. The propagula vary very much in size, and are generally found on plants which do not bear sporangia. With us they are much more common than the sporangia. An excellent account of the propagula is given by Janczewski in the Annales des Sciences, Series 5, Vol. XVII. In the Nereis Am. Bor. the word propagulum is used by Harvey to signify the contents of the apical cells, and this use of the word should not be confounded with its present application. The word propagulum as used in the Nereis is rather equivalent to the term sphacela of other writers. Sporangia are more common in the winter months, but are found occasionally in summer.

S. RADICANS, (Dillw.) Harv. (*S. olivacea*, var., Ag.; Pringsheim, l. c., Pls. 9 and 10.—*S. radicans*, Phyc. Brit., Pl. 189.)

Fronds olive-brown, half an inch to an inch high, forming dense turfs; filaments erect or prostrate, branches few, somewhat appressed, rhizoidal filaments often numerous; unilocular sporangia globose, .04–5^{mm} in diameter, numerous on the branches, on very short unicellular pedicels; plurilocular sporangia unknown; propagula slender, elongated.

On mud-covered rocks between tide-marks.

Newport, R. I.; Wood's Holl, Mass., and common from Nahant northwards; Europe.

The present species is smaller than the last, and forms small, indefinitely expanded turfs, especially on the under side of mud-covered rocks, often in company with *Ceranium Hooperi*. Numerous rhizoidal filaments are sometimes found at the base, so that different plants are bound together, but the species is without a false cortex. The name originally proposed for the species by Dillwyn was *S. radicans*. Agardh adopts Dillwyn's later name, *S. olivacea*, making of the form with numerous rhizoidal filaments a variety, *radicans*. Apart from their different habit and place of growth, it is difficult to assign exact marks by which to distinguish in all cases *S. cirrhosa* and *S. radicans*. In the latter the secondary branches are few and appressed, irregularly placed, never opposite, while in the former they are numerous, given off at wide angles, and frequently opposite. In *S. cirrhosa* the sporangia are generally scattered on the secondary branches, while in *S. radicans* they are often clustered on the main branches. In both cases the pedicels are usually one-celled. In both species the propagula are so variable in outline that they cannot be described in few words, but those of *S. cirrhosa* are more robust than those of *S. radicans*.

Sphacelaria dedalea, Reinsch, Contrib. ad Alg. et Fung., p. 22, Pl. 30, described from the coast of Labrador, does not correspond to any form known to us from New England.

CHÆTOPTERIS, Kütz.

(From χαιτη, a hair, and πτερις, a fern.)

Fronds olive-brown, filamentous, branching; branches opposite, distichous, apical growth as in *Sphacelaria;* rhizoidal filaments very numerous, densely interwoven, so as to form a false cortex; plurilocular sporangia borne on the branches, shortly pedicillate, unilocular sporangia "globose on the tips of short special filaments" (Areschoug).

A genus founded on the old *Sphacelaria plumosa* of Lyngbye. It differs from *Sphacelaria* in the false cortication of the main branches by the interlacing of rhizoidal filaments, and from *Cladostephus* by the opposite, not whorled branches. The genus does not rest on a firm basis, for it occasionally happens in some of the species of *Sphacelaria* that the rhizoidal filaments form a rudimentary cortex. *Chætopteris squamulosa*, Kütz., is made by Geyler the type of a new genus, *Phloiocaulon*.

C. PLUMOSA, (Lyngb.) Kütz. (*Sphacelaria plumosa*, Lyngb., Phyc. Brit., Pl. 87.—*Chætopteris plumosa*, Kütz., Phyc. Gen., p. 293; Tab. Phyc., Vol. 6, Pl. 6, Fig. 1; Areschoug, Obser. Phyc., Part III, Pl. 2, Figs. 4 and 5.)

Fronds two to six inches long, tufted, rigid, attached by a small disk, main branches sparingly branched, secondary branches plumose; plurilocular sporangia numerous, secund on the upper side of short special branches, shortly stipitate, elliptical in outline; unilocular sporangia globose, terminal on short branches. (Areschoug, l. c.)

Prince Edward's Island, *Mrs. Davis*, and northward; Northern Europe.

A beautiful species, common in Northern Europe and Greenland, but not yet found farther south than Prince Edward's Island on the American coast. It may, however, be expected at Eastport and our northern border.

CLADOSTEPHUS, Ag.

(From κλ δος, a branch, and στεφος, a crown.)

Fronds olive-brown, branching, secondary branches (leaves) whorled, apical growth as in *Sphacelaria;* main stems densely corticated by growth of rhizoidal filaments, secondary branches (leaves) naked, hairs borne in tufts just below the apex of branches; unilocular and plurilocular sporangia on special branches (leaves), stipitate.

A genus comprising eight described species, several of which are undoubtedly merely forms of the common and widely diffused *C. verticillatus*, whose structure is minutely described by Pringsheim, l. c. The term leaves is applied by Pringsheim to the secondary branches. He considers the branching of the axis to be monopodial. The sporangia are produced in the winter months, the two kinds on separate plants or sometimes together.

C. VERTICILLATUS, Ag.; Phyc. Brit., Pl. 33; Pringsheim, l. c., Pls. 1–7.

Fronds four to ten inches high, slender, subdichotomous, secondary branches distinctly whorled, falcate, acute at apex, attenuate at base, furnished externally with a few spine-like branchlets; hairs numerous; unilocular sporangia globose, plurilocular sporangia irregularly ellipsoidal, borne on short pedicels on small special branches, which grow from the axis between the insertions of the secondary branches.

Var. SPONGIOSUS. (*Cladostephus spongiosus*, Ag.; Phyc. Brit., Pl. 38.)

Fronds more compact, whorls approximate, indistinct, secondary branches usually destitute of hairs and spine-like branchlets.

On stones in pools and below low-water mark.

Newport, R. I.; Orient, L. I.; Martha's Vineyard; Cape Ann, Mass.; Europe.

A plant at once recognized by its resemblance to a small *Ceratophyllum*. Rather common in several places south of Cape Cod, but seldom seen on the northern coast. It prefers somewhat exposed shores, and occurs at considerable depths. Although the close resemblance between *C. verticillatus* and *C. spongiosus* has long been noticed, the two species have generally been considered distinct. Geyler says that *C. spongiosus* is characterized by the absence of hairs and the external spines on the branches. Although this is in general true, one not unfrequently finds hairs and small spines on some of the branches, and *C. spongiosus* is evidently merely a variety of *C. verticillatus*. Nor is it the case, as some have supposed, that the verticillate form is confined to deeper water, while the spongiose form is found in tide-pools and near low-water mark.

FAMILY MYRIONEMEÆ.

Fronds minute, forming spots or thin expansions on other algæ, consisting of prostrate filaments united into a horizontal membrane, from which rise short vertical filaments, between which are borne the sporangia; unilocular and pluriocular sporangia as in *Ectocarpeæ*.

MYRIONEMA, Grev.

(From μυριος, numberless, and νημα, a thread.)

Fronds olive-brown, forming thin expansions on other algæ, composed of a horizontal layer of cells lying on the substratum, from which arise very numerous vertical filaments, closely packed together; unilocular and plurilocular sporangia between the vertical filaments, either sessile on the horizontal layer or on short pedicels; hairs arising from horizontal layer; growth peripheral.

A genus of minute algæ which form small brown spots on other plants. The species are ubiquitous, but the specific characters are not well defined, and a good share of the described species are merely different forms of the very common *M. vulgare.* The two different kinds of sporangia are sometimes found together, but are usually on different plants. The genus is most nearly related to *Ralfsia*, which may be said to be a *Myrionema* in which the horizontal layer has become much thickened, and the vertical filaments, with the interspersed sporangia, instead of covering the surface uniformly, have been confined to certain circumscribed portions. The two genera are closely connected by *Ralfsia clavata*, Crn., which was first described as a *Myrionema* by Carmichael. In *Ralfsia* the vertical filaments must be considered to be paraphyses, and perhaps those of *Myrionema* should also be so considered.

M. VULGARE, Thur. (*M. strangulans*, Grev.; Phyc. Brit., Pl. 280.—*M. punctiforme*, Harv., Phyc. Brit., Pl. 41 *b*.—*M. maculiforme*, Kütz., Tab. Phyc., Vol. VII, Pl. 93, Fig. 2.)

Fronds .04–8^{mm} in thickness, vertical filaments (paraphyses) slightly club-shaped and moniliform, unilocular sporangia oval, .019–27^{mm} broad by .03–4^{mm} long, sessile or borne on short pedicels.

Everywhere common on various algæ.

In Le Jolis's Liste des Algues Marines de Cherbourg, Thuret is quoted as authority for uniting several of the species of *Myrionema* of Harvey and Kützing. The alleged specific distinctions are plainly nothing but modifications of the same species, dependent on the place of growth. When found on small cylindrical fronds, as in some *Enteromorphæ*, the *Myrionema* surrounds the frond and constitutes the *M. strangulans* of Greville, and when growing on flat surfaces the form known as *M. punctiforme* is found. In this country the unilocular sporangia are very common, but we have never seen the plurilocular sporangia, while in the next species the plurilocular sporangia are more numerous, although both kinds are found.

M. LECLANCHERII, (Chauv.) Harv., Phyc. Brit., Pl. 41 *a*. Pl. 6, Fig. 5.

Fronds .06–10^{mm} in thickness, vertical filaments (paraphyses) cylindrical, unilocular sporangia oval, plurilocular sporangia .008–10^{mm} broad by .023–30^{mm} long, ovate, oblong, sessile or on very short pedicels.

On *Rhodymenia palmata.*

Gay Head, Mass.; Europe.

This species forms rather larger spots than the last on the common dulse. That it is really distinct from *M. vulgare* admits of doubt. There appears to be a difference in the paraphyses of the two, but such differences cannot be considered of much value. We have found both unilocular and plurilocular sporangia in the present species, but unfortunately have not preserved measurements of the latter. The plurilocular sporangia are sometimes very numerous and stand side by side without intervening paraphyses.

FAMILY LEATHESIEÆ.

Fronds lubricous or gelatinous, indefinitely expanded or irregularly globose, consisting of a basal portion, composed of irregularly branching filaments formed of large, colorless cells, and a cortical portion of closely packed, short, colored filaments; paraphyses often present;

Fructification borne at the base of cortical filaments; plurilocular sporangia cylindrical, composed of few cells in a row; unilocular sporangia globose.

Fronds forming small tufts on other algæ.
  Cortex with a series of exserted colored filaments...... *Elachistea.*
  Cortex destitute of exserted filaments .... *Myriactis.*
Fronds irregularly globose, hollow at maturity.............. *Leathesia.*

ELACHISTEA, Duby.

(From ελαχιστα, very small.)

Fronds olive-brown, tufted or pulvinate, basal portion solid, somewhat parenchymatous, composed of densely packed branching filaments, which become free at the surface and branch corymbosely so as to form a layer of short filaments (paraphyses), at the base of which are borne the sporangia of both kinds and a series of long exserted filaments; hairs formed at the base of the paraphyses, exserted; unilocular sporangia rhombic-ovoid, plurilocular sporangia cylindrical, composed of a few cells in a linear series.

A genus consisting of a few species, all of which form small tufts on other algæ, especially on *Fucaceæ.* They may be recognized by the double series of filaments borne on the surface of the solid and but slightly developed basal portion. The longer filaments and hairs float freely in the water, but the shorter paraphyses are packed rather closely together, forming as it were a definite cortical layer over the basal portion. The unilocular sporangia are common. The more or less solid basal portion of the fronds in some of the species gives off filaments which penetrate into the substance of the algæ on which they are growing, and by the growth and persistence of these filaments it may be that the species are propagated from year to year, as happens in the case of certain fungi. In other species no penetrating basal filaments have as yet been found.

The limits of the species are pretty well defined except in the case of *E. fucicola*, *E. lubrica*, and *E. flaccida*, where it must be confessed the species show a tendency to run into one another. In the present case we have included in *Elachistea* only the species in which, besides the paraphyses which cover the surface, there are long projecting colored filaments as in *E. scutulata*, on which Duby founded his genus *Elachistea* in the Botanicon Gallicon. Here undoubtedly belong *E. fucicola* and its allies, but the same can hardly be said of *E. pulvinata*, which was made by Kützing the type of his genus *Myriactis.* In this species the surface of the frond is covered by the paraphyses, but there is not in addition a series of elongated filaments as in *E. fucicola*, for the exserted hairs in *E. pulvinata* are of a quite different nature. We have referred *E. pulvinata* to the genus *Myriactis*, not, however, limiting the genus as Kützing has done, for some of the forms placed by him in *Phycophila* should be referred to *Myriactis*, although the greater part of them are correctly placed by algologists in *Elachistea.* It may be that there exist forms intermediate between the true *Elachisteæ* and *Myriactis*, but, from the study of dried specimens, we have not been able to come to such a conclusion. It should be remarked that *M. pulvinata* is placed in *Elachistea* by the most prominent algologists, as Thuret and Bornet, Agardh, Harvey, Le Jolis, and others. The unilocular sporangia are most common in summer, and the plurilocular sporangia are more frequent early in the season.

E. FUCICOLA, Fries; Phyc. Brit., Pl. 240; Ner. Am. Bor., Vol. I, Pl. 11 *b*. (*Phycophila fucorum* and *P. Agardhii*, Kütz., Tab. Phyc., Vol. VIII, Pl. 95, Fig. 2, and Pl. 96, Fig. 1.) Pl. 7, Fig. 3.

Fronds tufted, half an inch to an inch in thickness, basal portion distinct, subglobose, exserted filaments about .05^{mm} broad, attenuated at base, obtuse at apex, cells of lower portion broader than long, becoming longer in the upper portion; paraphyses recurved, clavate, submoniliform; unilocular sporangia .07–8^{mm} broad by .15–20^{mm} long, pyriform or obovate-rhombic.

Common on *Fuci* along the whole coast.

On submerged wood work, Eastport, Peak's Island, Maine.

A common parasite, forming small tufts on *Fuci.* There seems to be but one species on the coast of New England, although *E. lubrica*, Rupr., may be expected on *Halosaccion.* According to Areschoug, *E. lubrica* differs from *E. fucicola* in the shorter cells and the decidedly elongated base of the free filaments, but in these respects European specimens of *E. fucicola* vary greatly. Possibly the form occurring on wood at Eastport may be rather referred to *E. lubrica.* Ruprecht, in Phycologia Ochotensis, mentions an *Elachistea* from Canada parasitic on *Halosaccion*, which he considers distinct from both *E. lubrica* and *E. fucicola*, to which he gives the provisional name ot *E. canadensis.* It is distinguished from *E. fucicola* "by the thicker filaments, which never give off free branches at the base, by the dense, indistinctly filamentous structure of the basal layer, and by the greater number of short filaments and few long filaments." From Ruprecht's description it is hardly likely that the species will ever be recognized by American collectors. The views of Ruprecht with regard to development in algæ are curiously shown in his remarks on *Elachista*, *Myrionema*, and *Leathesia.* He thinks it very probable that the genera named were "originally organs of fructification of *Halidrys*, *Cystoseira*, &c., which in course of time have not developed, and have in this way formed what appear to be stereotyped species." Although the fact is not as Ruprecht supposed, this pronounced tendency to Darwinism is remarkable when we think that Ruprecht wrote in 1850.

MYRIACTIS, Kütz., emend.

(From *μυριος*, countless, and *ςκτις*, a ray.)

Fronds as in *Elachistea*, but destitute of exserted colored filaments.

A comparison of the two admirable plates of *Elachistea scutulata* and *Elachistea* (*Myriactis*) *pulvinata* in the Études Phycologiques of Thuret and Bornet will give a clear notion of the difference of the two genera.

M. PULVINATA, Kütz. Var. MINOR. (*Elachistea pulvinata*, Harv., in Études Phycologiques, p. 18, Pl. 7—*Elachistea attenuata*, Harv., Phyc. Brit., Pl. 28.)

Fronds forming minute tufts, basal portion slightly developed, giving off lateral filaments, which penetrate the substratum; paraphyses slightly curved, fusiform, attenuated at base, somewhat moniliform; cells .0075–180^{mm} broad, two or three times as long; plurilocular sporangia very numerous, clustered at the base of the paraphyses, cylindrical, 0076^{mm} broad by about .057^{mm} long, composed of 8–10 cells in a row; unilocular sporangia.

Parasitic in the cryptostomata of *Sargassum vulgare*. Summer.

Wood's Holl, Mass.

This species forms minute tufts on *Sargassum*, and is so small as easily to escape detection. It is furthermore likely to be mistaken for the hairs normally found at certain seasons in the cryptostomata. The description given above applies to the plant found at Wood's Holl, which is smaller than the typical *M. pulvinata* of Europe, which grows in the cryptostomata of various *Cystoseiræ*. In the European specimens examined the paraphyses were decidedly stouter, rarely being less than .018^{mm} in breadth, whereas with us they are seldom more than .010–12^{mm} broad. Our plant is throughbut smaller than the European, but, in proportion, the paraphyses are longer and slenderer. It remains to be seen whether we are correct in considering our form a mere variety, or whether it should be kept distinct. Perhaps it may be the *Phycophila arabica* of Kützing, Tab. Phyc., Vol. 8, Pl. 1, Fig. 2, which grows on *Cystoseira myrica*. The species is not uncommon in summer at Wood's Holl, and both forms of sporangia occur together, the unilocular being much less abundant than the plurilocular.

LEATHESIA, S. F. Gray.

(Named in honor of *Rev. G. R. Leathes*, a British naturalist.)

Fronds olive-brown, gelatino-carnose, forming irregularly globose masses, solid when young, but soon becoming hollow; internal portion composed of radiating, dichotomous filaments, formed of large, irregular, colorless cells, the terminal ones bearing a series of short, simple, colored filaments (paraphyses), which are densely packed together, constituting the cortical layer of the frond; sporangia and hairs borne at the base of the paraphyses; plurilocular sporangia cylindrical, composed of few cells in a single row; unilocular sporangia pyriform or ovoid.

A small genus, comprising not more than half a dozen species, of which *L. difformis* is common in the North Atlantic. *Leathesia Berkeleyi*, Harv., now placed in the genus *Petrospongium*, Näg., although found not rarely in Europe and apparently tolerably common on the coast of California, has not yet been detected in New England, but may be expected. It forms rather leathery expansions on rocks at low-water mark.

L. DIFFORMIS, (Linn.) Aresch. (*Tremella difformis*, Linn., Syst.—*Rivularia tuberifor mis*, Engl. Bot., Pl. 1956.—*Corynephora marina*, Ag., Syst.—*Leathesia tuberiformis*, Gray, in Phyc. Brit., Pl. 324, and Ner. Am. Bor., Vol. I, Pl. 10 *c*; Thuret, in Ann. des Sciences, Ser. 3, Vol. XIV, Pl. 26, Figs. 5–12.) (**Pl. V, Fig. 1.**)

Fronds from half an inch to two inches in diameter, solitary or aggregated, at first globose and solid, becoming irregularly lobed and hollow; plurilocular sporangia produced early in the season, unilocular sporangia in summer.

Common on algæ and on sand-covered rocks at low water along the whole coast.

Not to be mistaken for any other alga on our coast. The gelatinous balls which this species forms are found growing in large quantities at low-water mark, and are sometimes called potatoes by the unromantic dwellers on the shore.

FAMILY CHORDARIEÆ.

Fronds cylindrical, branching, usually gelatinous, with an axis of longitudinal filaments formed of long slender cells, and a cortex composed of short, densely packed horizontal filaments formed of subspherical cells; sporangia borne among the cortical filaments or formed directly from them.

Fronds tough and elastic, cortical filaments densely united to one another .... *Chordaria.*
Fronds gelatinous, cortical filaments only adhering loosely to one another.
  Upper cells of the cortical filaments producing the plurilocular sporangia.. *Castagnea.*
  Upper cells of cortical filaments not producing sporangia. *Mesogloia.*

CHORDARIA, Ag.

(From *chorda*, a chord.)

Fronds olive-brown, cartilaginous, filiform, branching; axial layer composed of longitudinally elongated cylindrical cells and smaller winding cells packed closely together in a solid mass; peripheral layer composed of short, simple, horizontal filaments, densely packed together; unilocular sporangia oblong, borne at the base of the peripheral filaments (paraphyses), plurilocular sporangia unknown.

The distinction between the genera *Chordaria* and *Mesogloia*, in the absence of a knowledge of the development of the fronds, must be quite arbitrary. In the present instance we have considered that the genus *Chordaria* should be limited to the forms having a tough cartilaginous substance and solid axis, of which we have only one representative, *C. flagelliformis*. *C. divaricata*, both in its consistency and the development of the frond, seems to belong to *Mesogloia*, accepting that genus in an extended sense as we have done.

C. FLAGELLIFORMIS, Ag.; Phyc. Brit., Pl. 3. **Pl. V, Fig. 2.**

Fronds blackish, solitary or gregarious, attached by a disk, coriaceous, lubricous, one to two feet long, filiform, solid, main axis usually undivided, furnished with numerous long, subequal, flagelliform branches, which are given off at wide angles, simple or with few, irregular, secondary branches; peripheral filaments (paraphyses) few-celled, cylindrical or slightly club-shaped; unilocular sporangia ovoid or pyriform.

Var. DENSA.

Fronds six to eight inches long, main axis densely clothed with very numerous short branches.

Common on stones near low-water mark along the whole coast.

The var. *densa* at Gloucester, Mass., *Mrs. Davis.*

A common species, recognized by its tough, somewhat elastic substance, and reminding one of bunches of small leather shoe-strings. When soaked in water it gives out a large amount of slime, and is not easily mounted. To the naked eye it resembles some of the forms of *Dictyosiphon*, but the microscopic structure is very different. The variety has been collected several times at Gloucester, but has not been received from other localities.

MESOGLOIA, Ag.

(From *μεσος*, the middle, and *γλοιος*, slimy.)

Fronds olive-brown, gelatinous, filiform, branching; axial layer composed of filaments rather loosely united into a solid mass, which soon becomes fistulose; peripheral layer of short horizontal filaments, packed in a gelatinous substance; unilocular sporangia oval, borne at the base of peripheral filaments; plurilocular sporangia unknown.

The old genus *Mesogloia* has been divided by modern algologists into a number of genera. In the present instance we have kept in *Mesogloia* the species in which the peripheral filaments are not transformed into plurilocular sporangia, and have placed in *Castagnea* the species in which they are so transformed. The distinction between *Mesogloia* and *Castagnea* is artificial, because the plurilocular sporangia of *Mesogloia* proper are unknown, and it is not impossible that they may be formed from the peripheral filaments themselves, as in *Castagnea*. The development of the fronds is not well known, and the genera founded upon the variations in the mature fronds in the present group are plainly artificial. As regards its development, *M. divaricata* resembles very closely *C. virescens*. From a disk-like expansion, composed of a single layer of cells, which form spots on the substance upon which it is growing, arise vertical filaments, which end in a hair such as is found in *Ectocarpus* and other *Phæosporeæ*. The vertical filaments produce, usually only on one side, fasciculated branches terminated by a hair, beneath which is a cluster of short moniliform filaments. Besides these there arise, at a later period, rhizoidal filaments. The mature fronds of the two species above named may be regarded as a collection of filaments with a trichothallic growth, which have become twisted together and partially united by means of the rhizoidal filaments, and whose fasciculated branches constitute what, in the mature plant, seems to be a distinct cortical layer. In *Castagnea virescens* the separate filaments, with their lateral fasciculate branches, can easily be isolated by dissecting the smaller branches, and the same thing can also be accomplished with *Chordaria divaricata*, although not so easily. The species of *Mesogloia* and *Castagnea* should not be dried under too heavy pressure, and alcoholic specimens are much better for study than those mounted on paper.

M. DIVARICATA, Kütz. (*Chordaria divaricata*, Ag.; Phyc. Brit., Pl. 17; Ner. Am. Bor., Vol. I, Pl. 11 *a*.)

Fronds tufted, lubricous, six inches to two feet long, branching very irregular, generally without a definite main axis; branches flexuous, ultimate branches very numerous, short, and divaricate, at first solid, afterwards becoming fistulose and tubular; peripheral filaments short, few-celled, the last cell obovate and several times larger than the other cells; unilocular sporangia ovoid.

On algæ and stones near low-water mark.

Very common from Cape Cod southward; Niles Beach, Gloucester, Mass.; Europe.

A characteristic species of Long Island Sound, where it is probably more abundant than in any other part of the world. It abounds in still, shallow bays. North of Cape Cod it is of small size, and is only occasionally met with. It assumes a number of different forms, none of which, however, can be considered as distinct varieties. It first appears in May, and reaches perfection in August and September. At first the fronds are small and solid, but they grow to be two feet long, or even longer, and the main branches become hollow and finally collapsed. Except that they are more luxuriant, our forms agree well with Norwegian specimens.

M. VERMICULARIS, Ag.; Phyc. Brit., Pl. 31.

Fronds tufted, gelatinous, one to two feet long, branches long, irregularly pinnate, thick, vermiform, flexuous; peripheral filaments clavate, somewhat incurved, moniliform cells spheroidal; unilocular sporangia ovoid.

On stones and algæ between tide-marks.

Halifax, N. S., *Harvey;* Europe.

A rather common plant of Europe, and probably occurring within our limits, but as yet only reported at Halifax on the American coast. The species is rather thick and clumsy, and very gelatinous; not at all likely to be confounded with *M. divaricata,* which is less gelatinous, has a different mode of branching, and whose peripheral filaments are terminated by a cell much larger than the others. Dried specimens may be mistaken for *Castagnea virescens,* a more slender plant, with longer and more slender peripheral filaments, the upper cells of which are transformed into plurilocular sporangia. We have only examined dried specimens of this species.

CASTAGNEA, (Derb. & Sol.) Thuret, emend.

(In honor of *Louis Castagne,* a French botanist.)

Fronds and unilocular sporangia as in *Mesogloia;* plurilocular sporangia formed by outgrowths from the uppermost cells of the peripheral filaments.

C. VIRESCENS, (Carm.) Thuret. (*Mesogloia virescens,* Carm., in Phyc. Brit.; Ner. Am. Bor., Vol. 1, Pl. 10 *b;* Ann. Sci. Nat., Ser. 3, Vol. 14, Pl. 27.) Pl. 7, Fig. 1.

Fronds filiform, gelatinous, three inches to a foot and a half long, axis clothed with numerous, irregular, flexuous branches, ultimate branches short, given off at wide angles; fronds at first solid, becoming fistulous; peripheral filaments slender, clustered, recurved or incurved, cylindrical or only slightly moniliform, cells ellipsoidal, .015–20^{mm} in diam eter; unilocular sporangia ovoidal or rhombic-ovate; plurilocular sporangia siliculose, composed of three to six cells, formed from the terminal cells of peripheral filaments, often secund on the upper side.

On sand-covered rocks and algæ at and below low-water mark.

Wood's Holl, Nahant, Gloucester, Mass.; Portland, Maine, *Mr. Fuller;* Europe.

A species which is rather common in the spring months, but which disappears with us about the 1st of July. The fronds are more slender than in *M. vermicularis,* but when dried under too great pressure, or when allowed to remain some time in fresh water, they somewhat resemble that species. The distinction is best seen in the peripheral filaments. Those of *M. vermicularis* are shorter, decidedly clavate, less curved, and are formed of spheroidal cells In *C. virescens* they are longer, more nearly cylindrical, recurved, and formed of ellipsoidal cells. The number and size of the plurilocular sporangia vary very much.

C. ZOSTERÆ, (Mohr.) Thuret. (*Myriocladia zosteræ,* Ag.—*Mesogloia vermicularis,* var. *zosteræ,* Kütz., Spec. Alg.—*M. virescens,* var. *zostericola,* Harv., Phyc. Brit., Pl. 82.—*M. zosteræ,* Aresch., in Ner. Am. Bor., Vol. I, p. 127, Pl. 10 *a.*) Pl. 7, Fig. 2.

Fronds filiform, gelatinous, three to eight inches long, subsimple, furnished with a few short, remote branches, given off at wide angles; peripheral filaments erect, rather rigid, cylindrical below, moniliform above; cells spheroidal, .02–4^{mm} in diameter; unilocular sporangia ovate; plurilocular sporangia siliculose, composed of three to six cells, usually forming dense tufts on the upper part of the peripheral filaments.

On eel-grass.

Wood's Holl, Gloucester, Mass.; Europe.

A small species with very few branches, which, although it has been by some considered a variety of *C. virescens,* is sufficiently distinct both in its microscopic structure and the season of growth. *C. virescens* is a spring form, which disappears in early summer, while *C. Zosteræ,* at least on our coast, occurs in summer and autumn. The appearance of the peripheral filaments is different in the two species. In *C. virescens* they are slender and curved and in *C. zosteræ* rather stout and erect and more densely packed together, in this respect resembling *M. vermicularis,* in which, however, the filaments are distinctly clavate and moniliform, and do not prcduce plurilocular sporangia at the extremity. A section of the frond of a well-developed *C. virescens* shows a circle of roundish cells around a central cavity and on the outside a series of branching filaments, which end in the proper peripheral filaments and sporangia. In *C. Zosteræ* there is also a circle of cells surrounding a central cavity, but the peripheral filaments seem to be given off directly from the circle of cells. The figure in the Nereis Am. Bor. does not correctly represent the structure of *C. Zosteræ,* for the clusters of peripheral filaments are not outgrowths from special colored filaments, but from the uncolored cells. American specimens agree perfectly with the specimens of *Mesogloia zosteræ,* No. 100, of Areschoug's Alg. Scand.

FAMILY RALFSIEÆ.

Fronds horizontally expanded, sometimes crustaceous; fructification in raised spots (sori), composed of few-celled club-shaped paraphyses and spheroidal unilocular sporangia.

RALFSIA, Berkeley.

(In honor of *John Ralfs*, an English botanist.)

Fronds olive-brown, forming flat coriaceous or crustaceous expansions of indefinite extent, composed of a single horizontal layer, from which arise short vertical filaments, which are firmly united to one another so as to form a solid parenchymatous structure; fruit scattered over the surface of the fronds in spots (sori), which are composed of club-shaped, several-celled paraphyses, at whose base are borne the unilocular sporangia; hairs arising from crypts in the frond; plurilocular sporangia unknown; growth peripheral.

A genus containing only about half a dozen species. In its mode of growth the frond resembles that of *Myrionema*, but the vertical filaments are not free, as in that genus, but united so as to form a solid mass. *R. verrucosa*, the typical species, has a well-developed frond, but in *R. clavata* the frond is minute and the fruit-dots are usually confluent, so that the species has by some been placed in *Myrionema*.

R. VERRUCOSA, Aresch. (*R. deusta*, Berk.; Phyc. Brit., Pl. 98.)

Fronds licheniform, adherent throughout, crustaceous or membranaceous, at first orbicular, at length becoming indefinite in outline, one to six inches in diameter, zoned and irregularly tuberculated, the newer lobes overlapping the older; sori scattered; paraphyses .06–12^{mm} long, clavate, few-celled; unilocular sporangia ovoid or pyriform, .038^{mm} long by .019^{mm} broad.

Common on rocks in pools at half-tide from Nahant northward; Europe.

A homely, dark-colored species, which has more the habit of a lichen than an alga. It abounds on the northern coast in shallow exposed pools, and is found at all seasons. At first the crusts are of small size and adhere closely to the rocks, but afterwards, as they increase in size, they become lobulated and rough and are easily detached. The species, contrary to the statement of Janczewski, is furnished with tufts of hairs at certain seasons of the year. It may occur also south of Cape Cod, but, if so, it must be in a reduced form.

R. DEUSTA, J. Ag.

Fronds licheniform, membranaceous, attached at center, margin free, irregularly orbicular, with overlapping marginal lobes, marked with concentric zones and with radiating striæ; spores?

At low water mark.

Eastport, Maine.

A larger and more foliaceous species than the preceding, being about .25–30^{mm} in thickness. Both the concentric zones and radiating striæ are well marked, and the species is comparatively loosely attached to the substratum. On sectioning the fronds of *R. deusta*, the cells are seen to be arranged in lines which curved upwards and downwards from a medial plane, while a section of the frond of *R. verrucosa* shows the cells arranged in lines which curve upwards from the attached base.

R. CLAVATA, (Carm.) Crouan, Florule du Finistère. (*Myrionema clavatum*, Carm., in Phyc. Brit., Pl. 348.)

Fronds thin, forming closely adherent crusts or coriaceous expansions, at first orbicular and afterwards irregular; paraphyses clavate, rather uniformly diffused over the frond; unilocular sporangia pyriform, .06–7^{mm} broad by .15–.18^{mm} long, attached to the base of the paraphyses.

On stones and wood work

Eastport, Maine; Wood's Holl, Malden, Mass.; Europe.

A small species, whose position is doubtful. It was placed by Harvey in *Myrionema*, from the typical species of which it differs in having a frond composed of several layers of horizontal cells. By Crouan it was placed in *Ralfsia*, but the erect filaments rather resemble the paraphyses in *Myrionema*. In short, the species may be said to be a *Ralfsia* with diffuse fructification and slightly developed frond, or a *Myrionema* with an excessively developed basal portion. American specimens resemble perfectly the No. 56 of Crouan's Algues Marines du Finistère. The alga described by Areschoug under the name of *Lithoderma fatiscens* bears a striking resemblence to the present species. The species is much smaller and thinner than *R. verrucosa*, not exceeding on the average .15^{mm} in thickness, and covers stones and wood work at Eastport, sometimes in company with *R. verrucosa*. Further inquiry will probably show that the plant is common along the whole coast.

FAMILY ASPEROCOCCEÆ.

Fronds tubular or compressed, usually simple, occasionally branched; fructification in external scattered sori, composed of cylindrical few-celled paraphyses and spherical unilocular sporangia.

ASPEROCOCCUS, Lam.

(From *asper*, rough, and *κοκκος*, a berry.)

Fronds olive-brown, simple or branched, hollow, composed of a few layers of cells, those of the interior being larger and colorless, those of the surface smaller and colored; fruit external, scattered in spots (sori) over the fronds; sori composed of paraphyses and unilocular sporangia, which are formed from the superficial cells of the fronds; paraphyses numerous, cylindrical or club-shaped; unilocular sporangia globose, sessile between the paraphyses; plurilocular sporangia unknown; hairs tufted, arising from the superficial cells; growth of fronds basal.

The genus *Asperococcus* is distinguished by the external scattered fruit, consisting of paraphyses and unilocular sporangia. In the Nereis Am. Bor. it was placed by Harvey in the order *Dictyotaceæ*, but the fructification in that order is now known to be very different. The genus comprises a small number of species, which are widely diffused, although as yet only one has been found on the New England coast. The *Asperococci* resemble, to a certain extent, species of *Phyllitis* and *Scytosiphon*, but are easily distinguished by the fruit, which is almost always present. Plurilocular sporangia are unknown in the true *Asperococci*, and the old *A. sinuosus*, which is found in Florida and California, is considered by Bornet to belong to the genus *Hydroclathrus*, which has plurilocular sporangia of the same type as *Phyllitis* and *Scytosiphon*. *A. compressus* and *A. bullosus* are to be expected to occur with us. The *A. compressus* of the List of the Marine Algæ of the United States, in the Proc. Am. Acad. Arts and Sciences of March, 1875, is an error. The only specimen seen was collected at Gloucester by Mrs. Lusk, and proves to be a bleached and brownish fragment of *Halosaccion*.

A. ECHINATUS, Grev.; Phyc. Brit., Pl. 194. (Pl. V, Fig. 3.)

Fronds gregarious, simple, attached by a small disk from two inches to a foot and a half long, about half an inch in diameter, tapering at base, often twisted but not constricted, color a dingy brown, spotted with the very numerous sori.

Attached to algæ between tide-marks.

Common along the whole coast; Europe.

A homely species, usually found in tufts four or five inches long, and of about the substance of *Scytosiphon lomentarius*, but usually spotted with the numerous fruit-dots. The diameter, which is nearly uniform throughout, is about that of a clay pipe-stem. *A. bullosus* is much larger and more sack-like and often decidedly constricted.

Family SPOROCHNEÆ.

Fronds cylindrical or tubular, branching, composed within of elongated cuboidal cells, which become smaller and roundish at the surface; fructification in external scattered sori, composed of club-shaped filamentous paraphyses and sporangia; unilocular sporangia spheroidal; plurilocular sporangia cylindrical formed of a single row of cells.

Fronds solid, sori irregularly scattered .... *Stilophora.*
Fronds hollow, sori arranged in transverse lines .... *Striaria?*

STILOPHORA, Ag.

(From στιλη, a point, and φορεω, to bear.)

Fronds olive-brown, filiform, branching, solid, becoming hollow, composed internally of elongated colorless cells, which become smaller and colored towards the surface; fruit external, scattered in spots (sori) over the surface; sori hemispherical, consisting of club-shaped filamentous paraphyses, at whose base are borne the sporangia; unilocular sporangia ovoidal; plurilocular sporangia cylindrical, formed of a single row of cells.

A genus placed by Agardh and Harvey in the *Dictyotaceæ*, but by other algologists considered more nearly related to the *Sporochneæ*. It includes only a small number of species, probably not more than eight, and is readily recognized by the external fruit in which the sporangia are borne at the base of clavate few-celled paraphyses. The development of the frond has not been made out, but at the tips of the branches is a complicated mass of filaments ending in hairs like those of *Ectocarpus*, at whose base are borne a few short, incurved, moniliform filaments. At a short distance below the apex of the frond the moniliform filaments disappear and the surface appears to consist of roundish cells where not interrupted by the numerous sori. It is probable that, as has been suggested by Janczewski in speaking of *Sporochnus*, the frond of *Stilophora* grows in a manner similar to that of *Cutleria*, which may be said to belong to the compound trichothallic type.

S. RHIZODES, Ag. (*Sporochnus rhizodes*, Ag., Spec.—*Spermatochnus rhizodes*, Kütz., Spec.—*Stilophora rhizodes*, J. Agardh; Phyc. Brit., Pl. 70; Ann. Sci. Nat., Ser. 3, Vol. XIV, Pl. 28.) (**Pl. V, Fig. 4, Pl. VI, Fig. 2.**)

Fronds attached by a disk, filiform, solid, becoming somewhat fistulous, six inches to two feet long, branching subdichotomously, destitute of distinct axis, branches becoming attenuated, ultimate divisions erect; sori very numerous, scattered irregularly over the frond; paraphyses few-celled, clavate, somewhat incurved; unilocular sporangia oval; plurilocular cylindrical.

Not uncommon at various points in Vineyard Sound and Long Island Sound on algæ and eel-grass below low-water mark.

The present species is sometimes found at the base of eel-grass and the larger algæ, but it is more commonly found in entangled masses a foot or two long washed ashore in sheltered bays after a heavy blow. The determination is not altogether satisfactory, for our plants are generally coarser than the European forms of the species. Nor do they correspond to *S. Lyngbyei*, which is coarser and more tubular, and has finer ultimate branches and sori which are somewhat remote and arranged in transverse bands, if we follow Harvey's description. Another species, hardly coming within our limits, was found by Bailey in the Chesapeake and referred by Harvey, with considerable doubt, to *S. papillosa*, Ag.

STRIARIA, Grev.

(From *stria*, a ridge, referring to the arrangement of the sporangia in transverse lines.)

Fronds attached by a disk, tubular, branched, cells of the interior large, roundish, of the exterior smaller and subrectangular; fruit con-consisting of sporangia (or spores?), arranged in transverse lines.

A genus whose position is very doubtful, because the structure of the fruit is not sufficiently well known. By most writers it is placed in the *Dictyotaceæ*, but it is not certain that the typical species, *S. attenuata*, possesses the peculiar antheridia and tetraspores of that order. According to Areschoug, there are two forms of fruit, one immersed, as in *Punctaria*, the other external, as in *Asperococcus*.

S. ATTENUATA, Grev., Phyc. Brit., Pl. 25; Ner. Am. Bor., Vol. III, Suppl., p. 123.

Fronds a few inches to a foot long; branches usually opposite, attenuated to a fine point.

Flushing, L. I., *Bailey*.

The only American specimen known is that mentioned by Harvey in the Supplement to the Nereis Am. Bor. as having been found at Flushing, L. I.

FAMILY LAMINARIEÆ.

Fronds large and coarse; species on our coast usually attached by root-like processes, and with a stipe and expanded lamina, in one genus cylindrical; fructification in broad bands or large irregular spots, or occasionally covering the whole surface of frond, composed of large broadly clavate or wedge-shaped paraphyses and oval unilocular sporangia.

Fronds cylindrical.. *Chorda.*
Fronds with a midrib.
  Fronds perforated with holes .... *Agarum.*
  Fronds entire, with lateral leaflets at the base of lamina.... *Alaria.*
Fronds destitute of midrib.
  Cryptostomata present .... *Saccorhiza.*
  Cryptostomata wanting.................................. *Laminaria.*

CHORDA, Stack.

(From *chorda*, a string.)

Fronds olive-brown, attached by a disk, simple, cylindrical, hollow, with diaphragms at intervals; cells of tubular portion elongated, hexagonal in section, lined on the inside with filaments, which at intervals are woven together so as to form the diaphragms; whole surface of the frond clothed with cuneate-clavate cells (paraphyses), which form a cortical layer; unilocular sporangia ellipsoidal, situated between the paraphyses, growth basal; plurilocular sporangia unknown.

A small genus, consisting of three or four species, which are by some writers placed in the *Chordariaceæ* and by others in the *Laminariaceæ*. The typical species, *C. filum*, may be regarded as the lowest representative of the *Laminariaceæ*, inasmuch as it has the basal mode of growth and the unicellular paraphyses of that order, but a simple frond in which there is no distinction of stipe and lamina. See, also, remarks under *Scytosiphon*.

C. FILUM, Linn. (*Scytosiphon filum*, Ag.—*Chorda filum*, Phyc. Brit., Pl. 107; Annales des Sciences, Ser. 3, Vol. XIV, Pl. 29, Figs. 5–10.) **Pl, VI, Fig. 1.**

Fronds gregarious, cartilaginous-lubricous, quarter of an inch in diameter, from one to twelve feet long, attenuate at base, densely clothed with hyaline hairs; paraphyses cuneate-clavate, slightly longer than the sporangia and overlapping them.

On stones at low-water mark and below.

Common along the whole coast; Europe.

At once recognized by its cord-like appearance. The early form, which is densely covered with hairs, constitutes the *C. tomentosa* of some writers. Areschoug, however, considers that the true *C. tomentosa* of Lyngbye is distinct, and characterized by its elongated linear paraphyses, which are scarcely as long as the sporangia, which ripen early in the season, while those of *C. filum* ripen in the latter part of summer and autumn.

LAMINARIA, Lamx.—*Devil's Aprons.*

(From *lamina*, a plate.)

Fronds attached by a branching base,* stipitate, stipe expanding into a ribless entire or laciniate lamina; fruit forming bands or sori in the central part of the lamina, consisting of unicellular paraphyses and unilocular sporangia densely packed together; cryptostomata wanting.

A genus comprising not far from twenty-five species, which inhabit principally seas in high latitudes. They all grow in pools at low-water mark and in deep water, and some attain a very large size. The limits of the genus are well fixed, but the same can by no means be said of the species, with regard to which writers differ very much. The difficulty arises partly from the fact that the species lose some of their characteristic marks in drying, so that the study of herbarium specimens is unsatisfactory, but still more from the fact that the species vary greatly in outline and habit according to the season and the place of growth, whether at an exposed or sheltered coast or whether submerged or partly exposed at low tide. In general, the species may be classed in two groups, those in which the frond is ribbon-like, that is, long in proportion to the breadth and not split up into segments, and those in which the frond is proportionately broader and fan-shaped and, except when young, laciniate. To the former group belongs the *L. saccharina* of older writers, to the latter *L. digitata*, and it is with regard to the extent to which subdivision shall be carried in the two cases mentioned that recent writers differ very widely. Our species have not been sufficiently studied in situ to warrant us in giving the determinations with any degree of confidence. More information with regard to their winter condition is very much needed. The most detailed account of the *Laminariæ* of the eastern coast is to be found in the paper of De la Pylaie in the Annales des Sciences Naturelles, Ser. 1, Vol. IV, 1824, entitled "Quelques observations sur les productions de l'île de Terre-Neuve, et sur quelques algues de la côte de France appartenant au genre *Laminaire*." The article is accompanied by a plate in which is sufficiently well shown the habit of our common species. The same writer in 1829 gave a more extended account of his collections in the "Flore de Terre-Neuve et des îles Saint Pierre et Miclon," an incomplete work comprehending the *Laminariaceæ* and *Fucaceæ*, of which, however, the plates were never published. The species of De la Pylaie have not been accepted without question by algologists, and all agree that he was too liberal in the formation of new species. Harvey ignores the greater part of them in the Nereis. Agardh and Le Jolis give them a more respectful consideration, and the former especially is inclined, in his paper on the *Laminariaceæ* and *Fucaceæ* of Greenland, to admit several of De la Pylaie's species. In the present case we do not feel at liberty to make use of the notes with regard to American forms which have been kindly furnished by European correspondents, but must content ourselves with a superficial account of the perplexing forms of this exasperating genus, adding that the identity of our forms with those of Europe is not in all cases proved.

Of the species of *Laminaria* given in the Nereis, *L. fascia* in now placed in *Phyllitis; L. lorea* and *L. dermatodea* refer to the same plant, which is now placed in *Saccorhiza; L. longicruris* is still kept as in the Nereis; *L. saccharina* and *L. digitata* are kept with limitations; and *L. trilaminata* is, as Harvey suspected, merely an abnormal winged form of some other species, corresponding to the trilaminate condition mentioned under *Agarum Turneri*.

The marks used in distinguishing the species are the arrangment of the root-fibers; the structure of the stipe, whether solid or hollow, whether provided with distinct cavities containing mucus (muciparous glands) the shape of the lamina, more particu-

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* A few species, as *L. solidungula*, Ag., have a disk-like base, and *L. sessilis*, Ag., including *L. apoda*, Harv., found on our west coast, has no stipe properly speaking.

larly of its basal portion; the presence or absence of a series of alternate depressions and elevations within the margin; and the position of the fruit. The growing portion of the *Laminariæ* is at the base of the lamina, and the apex of the stipe and the old fronds are pushed off by the newly formed ones below. The fruit is perfected in autumn and winter.

L. LONGICRURIS, De la Pyl. (*L. longicruris*, Ann. Sci., l. c., Pl. 9 *a* and *b;* Phyc. Brit., p. 339; Ner. Am. Bor., Vol. I, Pl. 6.)

EXS.—Algæ Am. Bor., Farlow, Anderson & Eaton, No. 117.

Fronds solitary or gregarious, attached by numerous long, slender, branching fibers; stipe six to twelve feet long, one to two inches thick, slender and solid at the base, becoming hollow and inflated at the middle and upper part, contracted at the apex; lamina ovate-lanceolate, five to twenty feet long, two to three feet broad; margin very wavy, within the margin two rows of depressed spots; fruit forming a continuous band in the center of the frond; color lightish brown; substance rather delicate.

Common in deep water, and at Eastport at low-water mark.

From Nahant, Mass., northward; North Atlantic and Arctic Oceans.

A striking species, easily recognized when in typical condition, but unfortunately variable, though not so much so as our other species. The root-fibers are long, rather slender, and much branched. The stipe is slender at the base, but expands gradually upwards until it is at times two inches in diameter. The greatest diameter is about two-thirds of the way up the stipe, which is then contracted, sometimes quite suddenly. When young and only a few inches long, the center of the stipe is filled with a solid mass of delicate filaments, but it soon becomes hollow. When torn from their attachments by storms, large specimens, in consequence of the hollow stipes, float in a peculiar way, the upper part of the stipe projecting above the water like an elbow and the lamina dipping below the surface. The lamina is, in comparison with the stipe, shorter and broader than in our other species. This is especially the case in young specimens, where the stipe may be several times longer than the lamina. In mature plants, however, the comparative length of the lamina varies very much with the place of growth. The present species has never been certainly known to occur south of Cape Cod. Specimens resembling *L. saccharina*, but with hollow stipes, have been collected in Long Island Sound. Whether really belonging to *L. longicruris* is doubtful, and the subject requires farther investigation.

L. SACCHARINA, (Linn.) Lam.x.?

Frond attached by numerous branching fibers; stipe solid throughout, terete, somewhat swollen in the middle, three inches to four feet long; lamina elongated, lanceolate, fusiform or cuneate at base, three to thirty feet long, six to eighteen inches wide; margin wavy, a row of depressions on each side of lamina; fruit forming a central band.

Var. PHYLLITIS, Le Jol. (*L. phyllitis*, Phyc. Brit., Pl. 192.)

Fronds small, lamina thin, margin slightly wavy, base of lamina fusiform.

Var. CAPERATA, (De la Pyl.). (*L. caperata*, Ann. Sci., l. c., Pl. 9 *c.*)

Stipe long in proportion to the lamina; lamina thick, one to two feet broad, cuneate at base.

Common on stones at low-water mark along the whole coast; var. *caperata* common north of Cape Cod.

In the present species we include all the New England forms which have a solid stipe and undivided lanceolate or ovate-lanceolate frond. It is very probable that two, or possibly three, really distinct species are thus united, and it is also doubtful whether any of our forms are the same as *L. saccharina* of Europe, as limited by recent writers. Clearly to distinguish them is, however, at present out of the question. In going northward the forms here included become broader, and the base of the lamina is more frequently obtuse, and possibly the extreme forms should be referred to *L. latifolia*, Ag. The exact determination of the New England forms referred to *L. saccharina* cannot be successfully undertaken without an examination of European herbaria. Probably we have most of the forms described by De la Pylaie in the Flore de Terre-Neuve, but that writer has not displayed a commendable caution in the description of new species; and as European botanists differ as to what species the forms of De la Pylaie are to be referred, American botanists would not help the matter by pretending to give accurate determinations. De la Pylaie says that at Newfoundand *L. saccharina* does not occur, but is replaced by *L. longicruris*. The statement is singular, since, from De la Pylaie's own description, *L. caperata* closely resembles *L. saccharina;* and if any species may be said to replace *L. saccharina*, it is *L. caperata*, rather than the abundantly distinct *L. longicruris*.

L. DIGITATA, (Turn.) Lamx. (*L. digitata*, Ner. Am. Bor.—*L. stenoloba*, De la Pyl., Ann. Sci. Nat., l. c., Pl. 9 *k.*)

EXS.—Algæ Am. Bor., Farlow, Anderson & Eaton, No. 119, sub. nom. *L. flexicaulis.*

Fronds attached by fibers, which are often arranged in whorls; stipe solid, stout, one to five feet long, more or less round below, compressed above, destitute of muciparous glands; lamina at first oval or lanceolate, afterwards split into digitate segments, two to six feet long, one to three feet wide; base fusiform or ovate; fruit in dispersed patches on the segments.

Montauk, L. I.; Gay Head, Mass.; and common north of Cape Cod.

With regard to the limits of *L. digitata* a difference of opinion prevails; and in the present case we have retained, without criticism, the older name to designate the common digitate form of our coast. Of the two species described by Le Jolis it is probable that we have *L. flexicaulis* comprehended in the present form. The species is common with us in pools at low-water mark and below. The stipe varies considerably in length, according to the place of growth, and when well developed is stout and much compressed above, so that it projects rigidly above the surface of the water at low tide. The lamina is usually more or less fusiform at the base, but is sometimes oval, and the segments vary considerably, sometimes being very numerous.

L. PLATYMERIS, De la Pyl., Ann. Sci. Nat., l. c. Pl. 9 *i.*

Fronds attached by stout, irregularly placed fibers; stipe six inches to a foot long, solid, roundish, compressed, provided with muciparous glands, passing abruptly into a broadly ovate or cordate lamina, which splits up into a few broad segments; substance thick, color blackish.

Deep water.

Peak's Island, Maine; Gloucester, Mass.

Distinguished from the last by its short, thick stipe, which is furnished with muciparous glands, and which terminates abruptly in a broad, thick lamina, which is usually decidedly cordate at the base. It is an inhabitant of deep water, and is occasionally found washed ashore in the autumn, but is always much less common than the last species. Le Jolis considers that *L. platymeris* is, at least in part, the same as his *L. flexicaulis;* but what seems to us to be the true *L. platymeris* differs from *L. flexicaulis* in having muciparous glands in the stipe, a peculiarity which, according to Le Jolis, is found in *L. Cloustoni*, but not in *L. flexicaulis.*

SACCORHIZA, De la Pyl.

(From σακκος, a sack, and ῥιζα, a root.)

Fronds attached at first by a disk-like base, from which are given off later a few short root-like fibers; stipe compressed, plane, gradually passing into a ribless lamina; cryptostomata scattered on both sides of the frond; fruit as in *Laminaria.*

A genus differing from *Laminaria* principally in the form of the basal attachment and in the presence of cryptostomata on both surfaces of the frond. The typical species, *S. bulbosa*, not found on our coast, is attached by a sack-like base, and the fruit is borne on the marginal upper portion of the stipe. In the present genus were at one time included all the *Laminariæ* whose attachment is discoidal rather than by branching root-like fibers. There are, however, forms still retained in the genus *Laminaria*, as *L. solidungula*, in which the base is a disk, and our own species *S. dermatodea*, although in its younger stages attached by a disk, soon has a series of short fibers, which, as the plant increases in size, become branched. The cryptostomata are small pits sunk in the surface of the frond, from which arise groups of hairs, as in the *Fucaceæ.* They are visible to the naked eye in the young plants, but disappear with age.

S. DERMATODEA, De la Pyl. (*Laminaria dermatodea*, De la Pyl., Ann. Sciences, l. c., Pl. 9 *g*, non Agardh nec Harvey.—*L. lorea*, Ag. Spec.; Harvey, in Ner. Am. Bor.)

Exs.—Algæ Am. Bor., Farlow, Anderson & Eaton, No. 120.

Fronds usually gregarious, base at first discoidal, afterwards with a whorl of short, thick, usually simple fibers; stipe six inches to two feet long, compressed, gradually expanding into a thick, coriaceous-lanceolate or lance-ovate lamina, one to six feet long, six to eighteen inches wide, at first entire, but afterwards torn above into several segments; fruit in scattered sori, which become confluent at the base of the frond; paraphyses narrowly club-shaped, about .15^{mm} long; sporangia .12^{mm} long by .02^{mm} broad.

From Marblehead, Mass., northward.

A characteristic species of the North Atlantic. Its southernmost limit is Marblehead, where only one specimen has been collected. It is less rare at Gloucester, and is rather common on the coast of Maine, but much less abundant than other *Laminariæ*. It is the most easily recognized of our *Laminariæ*, in spite of its great variability in outline. The substance is more tough and leathery than any of our other species and the margin is thick and never wavy. At Eastport it is found in deep pools, but elsewhere it is an inhabitant of deep water. As usually seen washed ashore it resembles one of the digitate forms of *Laminaria*, for it is usually torn into segments, and not rarely split to the very base. It is at once distinguished from our digitate *Laminariæ* by its uniformly flat stipe, very short root-fibers, and cryptostomata. In most cases the stipe expands very gradually into the blade, but occasionally in old specimens the base is cordate. The fruit is found in the autumn and winter. In the specimens which we have examined the paraphyses were very narrowly club-shaped and colored to the tip, being destitute of the hyaline tip found in *Laminaria*.

AGARUM, (Bory) Post. & Rupr.

(From *agar-agar*, a Malayan word referring to some edible sea-weed.)

Fronds stipitate, attached by a branching root-like base; lamina perforated with roundish holes; stipe prolonged into a midrib; fruit scattered in patches (sori) over the fronds, consisting of club-shaped, one-celled paraphyses and ellipsoidal unilocular sporangia; plurilocular sporangia unknown.

A genus differing from *Laminaria* in having the lamina perforated with round holes and furnished with a distinct midrib. It includes four described species, which differ in the size of the perforations, in the shape of the lamina, and the prominence of the midrib, characters which an observation of our common species shows to be very variable. The species inhabit the Arctic Ocean, the northwestern shore of the Atlantic, and the North Pacific. The New England form, *A. Turneri*, also occurs in the Pacific, extending as far south as Japan, and, on the west coast, *A. fimbriatum*, Harv., considered by Agardh to be the same as *Fucus pertusus*, Mertens, extends as far south as Santa Barbara, Cal.

A. TURNERI, Post. & Rupr.—*Sea Colander.* (*Fucus cribrosus*, Mertens.—*F. agarum*, Turner, Hist. Fuc., Pl. 75.—*Laminaria agarum* and *L. Boryi*, De la Pyl., Flore de Terre-Neuve.—*Agarum Turneri*, Post. & Rupr., Illustr. Alg., Pl. 22; Ner. Am. Bor., Vol. I, Pl. 5.)

EXS.—Algæ Am. Bor., Farlow, Anderson & Eaton, No. 112.

Base much branched, stipe two inches to a foot long, cylindrical below, flattened above and prolonged into a distinctly marked midrib; lamina menbranaceous, one to four feet long, ovate-oblong, cordate and much crisped at base, margin wavy; perforations very numerous, orbicular, irregularly scattered with a smooth or wavy margin; fruit in irregular patches in the central part of the frond; sori .05–6^{mm} in thickness; paraphyses club-shaped, colored below, expanded and hyaline at the top; sporangia narrow, ellipsoidal, .035^{mm} long by .012^{mm} broad.

Common from Nahant northward in deep water and at Eastport in pools; North Pacific.

One of the curiosities of our marine flora, which is washed ashore from deep water at the southern limit of its growth, but farther north grows in pools at low-water mark.

The plant is perennial and young specimens are entirely without perforations until they have attained a length of two or three inches. The perforations, which are supposed by the fishermen to be the work of animals, are formed in the lower part of the frond and increase in size as they grow older, so that the perforations are larger in the upper and central parts of the frond. New holes are also formed between those already formed, so that there is a difference in size depending upon the age of the holes in all parts of the frond except the base. The formation of the holes begins by an elevation of small portions of the frond, which appears as if some small point like that of a pencil had been pressed against it; at length the frond ruptures circularly and the hole formed is minute and above the plane of the frond. The margins of the large holes are often wavy, and when dried with a slight pressure the waviness becomes so marked as to lead one to suppose that the specimens belong to a distinct species. The midrib varies considerably in breadth and occasionaly it grows out, forming a lamina at right angles to the frond. The usual perforations are found in the additional lamina, which sometimes grows to be as large as the original lamina. The fruit of *Agarum*, which is incorrectly figured in the Nereis as having a form of tetraspores, resembles veiy closely that of *Laminaria*. The species apparently does not bear fruit on the Massachusetts coast, at least we have never been able to find any; but at Eastport the fruit is formed as early as September. The sori are scattered irregularly over the central part of the frond and are most easily seen after the frond has been out of the water a short time. The sori are not so thick as in *Alaria* and *Laminaria* and the paraphyses do not have so prominent a hyaline extremity as in those genera. Harvey states that the lamina are sometimes ten or twelve feet long, but this is probably an overestimate.

ALARIA, Grev.

(From *ala*, a wing.)

Fronds attached by a branching root-like base, stipitate, membranaceous, with a distinct midrib; fruit borne in special lateral leaflets below the lamina, consisting of club-shaped, one celled paraphyses and ellipsoidal unilocular sporangia; plurilocular sporangia unknown.

A genus readily known by the small, ribless leaflets given off from the stipe below the lamina, in which the the fruit is borne in the autumn. The genus inhabits the colder waters of the northern hemisphere and the species sometimes attain a length of fifty feet. The number of species does not exceed half a dozen, and the specific marks, such as the shape of the midrib, the lateral leaflets, and the base of the lamina, are variable, so that all the species cannot be said to be well marked.

A. ESCULENTA, Grev. (*A. esculenta*, Phyc. Brit., Pl. 79.—*Laminaria musæfolia*, De la Pyl., Ann. Sci. Nat., Ser. 1, Vol. IV, Pl. 9 *d*.—*L. linearis*, De la Pyl., l. c., Pl. 9 *f*.)

Stipe cylindrical-compressed, from four inches to a foot long, a quarter to half an inch wide; midrib solid, scarcely wider than the stipe; lamina one to ten feet long or even longer, two to ten inches from side to side, decurrent on the stipe, margin wavy; fructiferous leaflets numerouse, shortly stipitate, three to eight inches long, half an inch to two inches broad, linear-ovate or linear-spathulate.

Var. LATIFOLIA, Post. & Rupr. (*Laminaria Pylaii*, Bory, in Flore de Terre-Neuve.—*Alaria Pylaii*, Ner. Am. Bor.—*A. esculenta*, var., Post. & Rupr., Illustr. Alg., Pl. 18.)

Base of lamina cuneate, fructiferous leaflets obovate-spathulate.

Common on exposed coasts at low-water mark and below, from Nahant northward. The variety at Eastport, Maine, Northern Europe, and Pacific coast.

As yet no species of *Alaria* has been found south of Cape Cod, although it is probable that they occur at exposed points like Gay Head and Montauk. In the Annales des Sciences, De la Pylaie mentions three varieties of *A. esculenta—platyphylla, tæniata,* and *remotifolia*—as occurring at Newfoundland, and in the Flore de Terre-Neuve he makes two new species—*Laminaria musæfolia*, including *L. esculenta*, var. *platyphylla* and var. *remotifolia*, and *L. linearis*, including *L. esculenta* var. *tæniata*. These species are characterized by the different forms and position of the fructiferous leaflets, which, it must be admitted, are so variable and so constantly pass into one another, that De la Pylaie would have done better in retaining them all as forms of one species. *Laminaria Pylaii*, Bory, founded on a single specimen brought by De la Pylaie from Newfoundland, also seems to be merely a variety of *L. esculenta*, in which the lamina is cuneate at the base. At Eastport the broader forms are common, and one sees all stages from decurrent to cuneate laminæ. Agardh refers to *L. Pylaii*, Bory, the *Alaria esculenta* var. *latifolia*, of Postels and Ruprecht, whose plate represents excellently the extreme forms found at Eastport. The present species is used as food in Scotland and Ireland, where it is called badder-locks, henware, murlins, and also in Iceland, but it is not eaten with us.

ORDER III. OOSPOREÆ, Sachs.

Male organs (antheridia) composed of sacks borne on simple or branching filaments, sometimes sessile, containing motile antherozoids; female organ (oogonium) in the form of a sack, whose contents change into one or more spherical masses (oospheres), which are directly fertilized by the antherozoids and become oospores.

In the order *Conjugateæ* there was a direct union of similar bodies called zoospores, and no clear distinction of male and female cells. In the *Oosporeæ* the males are small-motile bodies (in algæ), which directly impregnate the spherical masses of protoplasm, called oospheres, either before or after they have escaped from the mother-cell, the oogonium. As a result of the impregnation, a wall of cellulose is formed round what was before merely a mass of protoplasm, and the so-called oosphere becomes an oospore and capable of germinating. The marine plants of the order may be divided into two suborders, as follows:

a. Large olive-green plants, having the antheridia and oogonia in nearly closed sacks borne in a definite part of the plant; fronds foliaceous, often provided with air-bladders .... FUCACEÆ.

b. Minute grass-green plants forming turfs or tufts; antheridia and oogonia naked, sessile, or pedicellate, borne laterally on the unicellular branching frond........................ VAUCHERIEÆ.

Suborder FUCACEÆ, C. Ag.

Plants diœcious or hermaphrodite, fructifying organs borne in conceptacles or cavities lined with sterile filaments and opening outwards by a narrow pore; antheridia in ovoid sacks borne on branching threads and filled with minute antherozoids having two lateral cilia; oospores spherical, borne 1–8 in a mother-cell. Marine plants of an olive-green color, attached by a disk-like base, fronds usually branching dichotomously, rarely indefinitely expanded, often provided with air-bladders and with cryptostomata.

An order characterized by the presence of antherozoids borne in sacks and by oospores, varying in the different genera from one to eight in a mother-cell, both antheridia and oospores being contained in hollow conceptacles, which are produced either in definite parts of the frond or on special branches or rarely indefinitely scattered over the frond. The fertilization in this order was first described by Thuret in the Annales des Sciences, Ser. 4, Vol. 2. The fronds vary very much in the different genera. In *Durvillæa* the frond resembles a large *Laminaria*, and from this simple form there are all degrees of complication, until in *Sargassum*, the most highly developed genus, there are distinct stems, leaves, air-bladders, and branching fructiferous receptacles. In high latitudes the order is chiefly represented by the common rockweeds, *Fuci*, which line the rocks between tide-marks, while in low latitudes the gulf weeds, species of *Sargassum*, abound. The Southern Ocean abounds in curious and varied forms of this order, Australia being particularly rich in species. The New England coast is especially poor in representatives of the order, the genera *Halidrys*, *Himanthalia*, *Pelvetia*, and *Cystoseira*, common on the coast of Europe, being entirely wanting with us. The fronds are dotted with small pits, called cryptostomata, from which grow tufts of hairs.

SYNOPSIS OF GENERA.

Fronds with distinct stems and leaves.................... *Sargassum.*
Fronds without distinct stems and leaves—
  Lamina provided with a midrib, receptacles terminal, continuous with the frond .... *Fucus.*
  Midrib wanting, receptacles on special lateral branches.. *Ascophyllum.*

ASCOPHYLLUM, (Stackh.) Le Jolis, emend.

(From *ασκος*, a sack, and *φυλλον*, a leaf.)

Fronds attached by a disk, linear, compressed, destitute of a midrib, irregularly dichotomous, furnished with air-bladders; receptacles on distinct, simple, lateral branches; spores four in a mother-cell.

A genus including the *Fucus nodosus* of older writers, which differs from the true *Fuci* in having a linear frond destitute of a midrib and spores in fours instead of in eights. The generic name *Ozothallia* proposed by Decaisne and Thuret, who were the first to give a detailed account of the conceptacles of *F. nodosus*, was referred by Le Jolis to the older genus *Ascophylla* of Stackhouse.

A. NODOSUM, Le Jolis. (*Fucus nodosus*, L.; Phyc. Brit., Pl. 158; Ner.

Am. Bor., Vol. I, p. 68.—*Fucodium nodosum*, J. Ag.—*Ozothallia nodosa*, Dcne. & Thuret.—*Ascophyllum nodosum*, Le Jolis; Études Phycologiques, Pls. 18–20.)

Fronds diœcious, one to five feet long, coriaceous, compressed, subdichotomous, margin distantly toothed; air-bladders oblong, broader than the frond; receptacles ovoid or ellipsoidal, terminating short lateral branches, which are borne either solitary or clustered in the axils of the teeth.

Common between tide-marks from New Jersey northward; Europe; Arctic Ocean.

One of our most common species, easily recognized by the large bladders in the continuity of the frond, which is thick and narrow and entirely destitute of a midrib. The fruit is found in lateral branches in winter and spring, and in June the receptacles fall off and are sometimes found in immense quantities covering the bottoms of tide-pools.

FUCUS, (L.) Dcne. & Thuret.

(From φυκος, a sea-weed.)

Fronds diœcious or hermaphrodite, attached by a disk, plane, costate, dichotomous, margin entire or serrate, often furnished with air-bladders; receptacles terminal, continuous with the frond; spores eight in a mother-cell.

In the beginning of the present century the name *Fucus* was used not only to designate all the plants included in the present order, but was applied to all marine algæ. Since that date the word has been used in a more and more restricted sense, and is now only applied to those members of the *Fucaceæ* in which the spores are in eights and in which the frond is plane and costate. In some of the species, however, the midrib is rather indistinct. Most of our species are very abundant and very variable, and older writers have described as species a good many forms which are now considered to be merely varieties. Hence the synonymy of the species is in confusion, although our species, none of which are peculiar to America, can be referred to definite European forms. The species described by De la Pylaie in the Flore de Terre-Neuve are most of them to be referred to older species. The New England species naturally fall into two different groups. In the first, of which *F. vesiculosus* is the type, the fronds are diœcious and the midrib distinct throughout. In the second, represented by *F. evanescens*, they are hermaphrodite and the midrib indistinct.

F. VESICULOSUS, L.; Phyc. Brit., Pl. 204; Études Phycol., Pl. 15.

Fronds diœcious, six inches to three feet long, stipitate, midrib distinct throughout, margin entire, often wavy; bladders spherical or slightly elongated, usually in pairs; receptacles swollen, ellipsoidal or oval, often forked.

Exs.—Algæ Am. Bor., Farlow, Anderson & Eaton, No. 109.

Var. LATERIFRUCTUS, Grev.

Lateral branches, which bear the receptacles, narrow and densely dichotomously flabellate.

Var. SPHÆROCARPUS, Ag.

Ultimate divisions of frond repeatedly forked, bearing very numerous small receptacles.

Var. SPIRALIS.

Fronds short and spirally twisted.

Everywhere common between tide-marks.

The varieties of this very common species are so numerous that it is useless to describe the greater part of them. The southernmost limit of the species on the eastern coast is, as far as known, the coast of North Carolina, where it is reported to have been collected by Rev. E. M. Forbes in Curtis's account of the botany in the Geological and Natural History Survey of North Carolina. *Fucus bicornis* and *F. microphyllus* of De la Pylaie appear to be merely forms of *F. vesiculosus*. The species with which the present is likely to be confounded along our northern coast is *F. evanescens*, a broad plant, whose midrib is only distinct in the lower part of the frond, and whose conceptacles are hermaphrodite, not diœcious, as in the present species. It fruits most abundantly in autumn and winter, but the fructification can be seen at any season of the year.

F. CERANOIDES, L.; Phyc. Brit., Pl. 271.

"Frond plane, coriaceo-membranaceous, linear-dichotomous, midribbed, without vesicles, margin very entire; lateral branches narrower than the principal divisions, repeatedly forked, level topped, bearing fruit at their apices; receptacles spindle-shaped or bifid, acute." (Ner. Am. Bor., Vol. I, p. 70.)

New York, *Agardh;* Europe.

The authority for the existence of this species on our coast is Agardh. Harvey had never seen American specimens, nor have we ever found any. The species, judging from herbarium specimens, resembles very closely *F. vesiculosus*, especially var. *laterifructus*, but is said to be thinner and to be destitute of air-bladders. It inhabits rather brackish waters.

F. SERRATUS, L.; Phyc. Brit., Pl. 47; Études Phycol., Pls. 11–14.

Fronds diœcious, two to six feet long, midrib distinct throughout, margin serrate; bladders wanting; receptacles serrate, flattish, pointed.

Newburyport, Mass., *Captain Pike;* Pictou, N. S., *Rev. J. Fowler;* Europe.

A very common species of Europe, but very rare on our coast, being known in only two localities. In the supplement to the Nereis it is reported from Newburyport, having been once detected by Captain Pike, but not seen there since. The only other locality is Pictou, where it was detected by Rev. J. Fowler, who sent specimens to Professor Eaton in 1869. The species is easily recognized by its serrated margin, and grows lower down in the water than *F. vesiculosus*.

F. EVANESCENS, Ag., Icon. Ined., Pl. 13. (*Fucus platycarpus*, in Farlow's List of the Marine Algæ of the United States.)

Fronds hermaphrodite, one to two feet long, stipitate, midrib distinct below, but widening and scarcely visible in the upper part, margin broad, entire, somewhat wavy; bladders usually wanting, when present much elongated; receptacles swollen, broad, usually united in pairs, and sometimes with a small margin formed of the unchanged frond.

Exs.—Algæ Am. Bor., Farlow, Anderson & Eaton, No. 107.

Eastport, Maine; coast of Massachusetts; Northern Europe; Arctic Ocean.

A species apparently common north of Cape Cod, and at Eastport quite as common as *F. vesiculosus*, for which it might be mistaken. As found with us, it is broader than the last-named species and is usually without bladders, and when these occur they seem more like irregularly inflated portions of the frond than spherical cavities. The receptacles contain both antheridia and oospores, the latter occupying the base and the former the upper part of the conceptacle. The receptacles are broader and less swollen than in *F. vesiculosus* and are often in pairs, the pairs being united below. The whole plant is shorter, stouter, and more foliaceous than *F. vesiculosus*. The species as found in the Arctic regions is variable, and several forms have been described. The form which occurs at Eastport comes very near the typical form. *F. miclonensis* of De la Pylaie is probably a small form of the present.

F. FURCATUS, Ag., Icon. Ined., Pl. 14.

Fronds hermaphrodite, branching very regularly dichotomous, stipitate, one to three feet long, midrib distinct below, scarcely visible above, margin narrow, rigid, entire; bladders wanting; receptacles flat, narrow, linear-fusiform, sometimes forking.

Exs.—Algæ Am. Bor., Farlow, Anderson & Eaton, No. 108.

Peak's Island, Maine; coast of Massachusetts north of Boston; Northern Europe; Arctic Ocean; North Pacific.

A common and beautiful species on exposed coasts north of Boston. It is found lower down than *F. vesiculosus*, at the limit of low-water mark. The frond is narrow, tough, and destitute of bladders, and the branching very regular, almost flabellate. It is easily distinguished by the receptacles, which are not in the least swollen and are narrow and longer than in any other species, being sometimes four inches long. The color is dark. Our form corresponds perfectly to specimens from Spitzbergen. The species is less variable than most of the genus and is found at all seasons of the year.

F. FILIFORMIS, Gmelin. (*F. distichus*, L., in Farlow's List of the Marine Algæ of the United States.)

Fronds hermaphrodite, three to six inches long, flabellately dichotomous, stipitate below, midrib present but indistinct; air-bladders wanting; receptacles linear-oblong, swollen, borne in pairs, sometimes forking.

In pools near high-water mark.

Nahant, Marblehead, Mass.

Our smallest species, found only in spring and in pools where the water is not very pure. Our form is the same as No. 201 of Areschoug's Algæ Scandinavicæ, from Finmark, which Agardh refers to *F. filiformis*. Whether *F. distichus*, L., is not the same as *F. filiformis*, Gmelin, admits of doubt. The present form seems to be the *F. filiformis* of the Flore de Terre-Neuve, mentioned under *F. distichus* in the Nereis Am. Bor.

SARGASSUM, Ag.

(From *sargazo*, the Spanish name for the gulf-weed)

Fronds attached by a disk having branching stems, leaves with a midrib and distinctly stalked air-bladders; fruit in special compound branches; conceptacles hermaphrodite; spores single in the mother-cell.

The most highly organized and by far the largest genus of the *Fucaceæ*, of which at least 150 species have been described. They inhabit the warmer waters of the globe, where they replace the *Fuci*. Australia, Japan, and the adjacent coast of Asia are particularly rich in species. We have one species which does not come north of Cape Cod, but which is common southward. The genus has been subdivided by Kützing, but even with his limitation the species of *Sargassum* are very numerous.

S. VULGARE, Ag. (*Fucus natans*, Turner's Hist. Fuc., Pl. 46, non Linn.—*S. vulgare*, Phyc. Brit., Pl. 343.)

Fronds two to five feet long, stem filiform, smooth, irregularly branching, leaves shortly petiolate, linear-lanceolate or oblong-lanceolate, one to three inches long, a quarter to half an inch wide, sharply serrate, midrib distinct, cryptostomata numerous on both sides of the midrib; air-bladders spherical, quarter of an inch in diameter, stalked, arising from a transformed leaf, the upper part of which often remains as an appendage; stalks naked or slightly winged; receptacles filiform, branching cymosely, one to two inches long.

Var. MONTAGNEI. (*S. Montagnei*, Bailey, in Ner. Am. Bor., Vol. I, Pl. 1 *a*.)

Leaves narrowly linear, elongated, receptacles two to four inches long.

Below low-water mark in warm, shallow bays from Cape Cod southward.

In spite of its variations, with the exception of *S. bacciferum*, which is sometimes washed ashore, we have but one species of *Sargassum* on our coast. As usually found, it is more slender in all its parts than the typical *S. vulgare* of the West Indies, but it is occasionally found of the typical form. In var. *Montagnei*, which is common, we have an extreme form, in which the fructifying branches are much elongated, but one sees all variations from short to long.

S. BACCIFERUM, Ag.—*Gulf-weed.* (*Fucus natans*, L.; Turner's Hist. Fuc., Pl. 47.—*S. bacciferum*, Phyc. Brit., Pl. 109.)

Fronds six inches to a foot and a half long, stems filiform, smooth, leaves linear-lanceolate, two to four inches long, midrib distinct, cryptostomata usually wanting; air-bladders stalked, spherical, tipped with a filiform point; receptacles short, cylindrical, forked.

Washed ashore at Bath, L. I., *Mr. A. R. Young*, and found floating off the coast near the Gulf Stream; West Indies, and floating in the Atlantic.

The common Gulf-weed, which grows attached in the West Indies, where it fruits, and which is found floating and infertile in the course of the Gulf Stream and in the so-called Sargasso Sea, between 20° and 45° N. and 40° W. It is rarely washed ashore in New England, but is frequently brought in by fishing vessels. It is said that there is a large mass of this sea-weed in the ocean not far from Nantucket, but there is no definite information on the subject. The species in its floating form is distinguished from the last by its narrower leaves, destitute of cryptostomata, its darker color, and denser habit.

SUBORDER VAUCHERIEÆ.

Comprising a single genus, *Vaucheria*, whose characters are given below.

VAUCHERIA, D. C.

(Named in honor of *Jean Pierre Vaucher*, of Geneva.)

Fronds green, unicellular, composed of long, irregularly or falsely dichotomously branching filaments, monœcious or diœcious; oogonia sessile or stalked, containing a single oospore; antheridia either short ovoid sacks or formed at the tips of branches, which are frequently spirally twisted; antherozoids very small, with two cilia; non-sexual reproduction by very large zoospores, which are covered with cilia, or by motionless spores formed at the ends of short branches.

The *Vaucheriæ* abound both on our coast and in inland waters, and some species grow upon damp ground in gardens and meadows. They either form thick turfs of a dark-green color when growing in places which are not constantly submerged, or else extend in indefinite-shaped masses when growing where there is plenty of water. They are generally easily recognized at sight, and are known under the microscope by the long branching filaments of a deep-green color, destitute of cross-partitions except when the fruit is forming. Although very abundant on our shore, the species are little known, because the specific characters depend upon the fruit. The determination of sterile specimens is out of the question, and, even when fruiting, dried specimens are of comparatively little value. A considerable number of species of *Vaucheria* have been described, but as a great part of them have been described from individuals bearing the non-sexual spores only, recent writers, as Walz and Nordstedt, have reduced the number of species very much by omitting imperfectly characterized forms. Nordstedt admits nineteen species in Europe. The American species have never been critically studied. Specimens should be kept in fluid rather than mounted on paper, and sketches of the fruit should be made at the time of gathering. It should not be forgotten by the collector that some of the species are diœcious, and also that a species is not perfectly known unless the non-sexual spores are described as well as the oospores.

V. THURETII, Woronin, Beit. zur Kenntniss der Vaucherien, in Bot. Zeit., Vol. XXVII, p. 157, Pl. 2, Figs. 30–32.

Monœcious; filaments .03–8^{mm} in diameter, forming short, dense turfs; antheridia sessile, oval, .05–7^{mm} broad by .10–14^{mm} long; contents of antheridia colorless; oogonia either sessile or on short lateral branches, obovoid or pyriform, inclined, .25–30^{mm} long by 20^{mm} wide; oospores spherical, .15–18^{mm} in diameter, yellowish brown; cell-wall rather thin;

non-sexual spores (?) .08mm broad by .10–12mm long, motionless, borne on short branches, which are at right angles to the main filaments, from which they break off, allowing the spores to escape from the ruptured end.

Exs.—Wittrock & Nordstedt, Alg. Scand., No. 228.

On muddy shores and sides of ditches, where it forms large patches of a dark velvety green. Summer.

Wood's Holl, Mass.; Eastport, Maine; Perth Amboy, N. J., *Wolle;* Europe.

This species, which is apparently common on muddy shores of New England, agrees so well with the description and figure of Woronin, l. c., that there can be no doubt about the identity of our plant with that of the European coast. The non-sexual fruit was unknown to Woronin. At Wood's Holl we found what appeared to be the non-sexual fruit of the species. It consisted of oval spores, smaller than the oospores, borne at the tips of short branches, which were given off at right angles to the main filaments. The branches with the spores fall off, and the latter, after some time, escape from the ruptured end of the cell. The spores are motionless and destitute of cilia, reminding one of the non-sexual spores in *V. geminata*, Walz. During the four or five days which we were able to watch them they underwent no change. In the specimen of Wolle, above mentioned, similar bodies are found, but Nordstedt thinks it probable that they belong to a species different from *V. Thuretii.* He is led to this conclusion apparently from the fact that the filaments bearing the non-sexual spores are rather smaller than those which bear the oospores and antheridia. In the Wood's Holl specimens the filaments were, as a rule, somewhat smaller than those bearing the oospores; but the difference is very slight, and one sometimes finds oosporiferous filaments measuring only .03mm in diameter, while the non-sexual spore-bearing filaments average from .04–5mm in diameter. In one case we found an antheridium on the non-sexual spore-bearing filament, which resembled precisely the antheridia of *V. Thuretii.* We conclude then that the non-sexual spores probably belong to the present species, but the question requires further examination. A specimen of what appears to be the same species exists in the collection of the Boston Society of Natural History. It was collected by Prof. J. W. Bailey from some locality near New York, and is labelled, in his own handwriting, *V. velutina.*

V. LITOREA, Nordstedt (Ag., Spec. Alg., p. 463.—*V. clavata*, Lyngb., Hydrophyt. Dan., p. 78, Pl. 21 *d.*—*V. litorea*, Nordstedt, in Botan. Notiser., 1879, p. 180, Pl. 2, Figs. 1–6.—*V. piloboloides*, Farlow, List of Marine Algæ, 1876.)

Diœcious; filaments densely tufted, rather rigid, .10mm in diameter; antheridia?; oogonia club-shaped, borne on a short sterile cell at the tips of short recurved branches, .20mm broad by about .35mm long; oospores filling the upper part of oogonium, spheroidal, .18–19mm broad by .23–25mm long; cell-wall dense, .02mm in thickness; non-sexual spores?

At low-water mark in the gravel.

Parker's Point, Wood's Holl, Mass.; Europe.

We refer to the present species a *Vaucheria* much coarser than the species last described, which forms rather bristly tufts of a dingy green, from two to four inches high, in gravelly places. Only one specimen, collected in August, 1876, was in fruit, and at the time, as there were no antheridia, we hastily inferred that the spores were non-sexual. It now seems probable that the plant is the *V. litorea* of Nordstedt, l. c., a diœcious species. The species was common at Wood's Holl in August, 1879, but constantly sterile. The antheridia of *V. litorea*, Nordstedt, are long and cylindrical and borne on a short sterile cell at the tips of the branches. The antherozoids are discharged by openings at the apex and sides of the antheridium. Our plant will be easily recognized by its habit and the recurved branches bearing the oogonia.

ORDER IV. FLORIDEÆ.

Algæ of a red or purple color; antheridia containing spherical, hyaline antherozoids, which are without cilia; sexual fruit or cystocarps developed from a procarp, which consists of a trichogyne, at whose base is a trichophore, the spores formed either from the trichophore or the adjacent cells which compose the carpogenic system; spores at maturity either naked or inclosed in a pericarp; non-sexual reproduction by tetraspores, bispores, and seirospores; fronds filamentous, crustaceous, membranaceous, or irregularly expanded, varying from gelatinous to cartilaginous in substance, occasionally calcareous. Principally marine.

The *Florideæ*, which are the same as the *Rhodospermeæ* of Harvey, include a large number of species, all of which have some shade of red, although it may be nearly black on the one hand or approach shades of green on the other. In decay, however, the color becomes orange and finally green. It is not to be inferred, however, that all red algæ belong to the *Florideæ*. There are a few *Cyanophyceæ* in which the color is pink, but in these species the frond is merely an agglomeration of red cells, each of which is practically a distinct individual, whereas in the *Florideæ* the cells are organically united, and constitute a single plant. The structure of the frond in this order varies in the different genera, and we have forms which correspond closely to the fronds of the *Phæosporeæ*, as, for instance, in *Nemalion* we have a frond which, apart from its color, is undistinguishable from that of *Mesogloia*, and so on. The non-sexual reproduction is by tetraspores, cells which divide into four parts—rarely by bispores or two-parted cells—and seirospores, or chains of oblong cells formed directly from the branches. The sexual fruit, known as the cystocarp, is developed from a procarp, as has already been explained. The division into suborders is founded principally on the differences in the cystocarpic fruit, the full development of which is not known in many cases. Differences in the fronds and tetraspores serve to mark the genera. Agardh and Harvey divide the *Florideæ* into two series—the *Desmiospermeæ*, in which the spores are arranged in a definite series with regard to a placenta or common point of attachment, and *Gongylospermeæ*, where the spores are heaped together without order. A study of the development, however, shows that this distinction has not the value which it was formerly supposed to have, and certain suborders with differently arranged spores are by those who lay stress upon the development placed in proximity to others in which the spores are irregularly grouped. Although, owing to modern researches, we know much more about the real nature of the cystocarps than was known a few years ago, it must be admitted that the suborders of *Florideæ* are far from satisfactory. As a matter of fact, the order is a very natural one, and, as is the case with most natural orders, the species and genera pass so gradually into one another that sharply marked divisions are out of the question. At the base of the order is a small number of genera whose position is doubtful, owing to our lack of information about the fructification. Then come the *Porphyreæ*, in which we have fronds of a single layer of cells (*Porphyra*) and certain cells grow out so as to form a very short trichogyne. After fertilization, the contents of the cell at the base of the trichogyne divide, quadrant fashion, and we have a number of spores produced at once from the original cell. In *Nemalion* the trichophore, or swollen base of the trichogyne, divides, and the divisions grow out laterally and form short filaments, each cell of which becomes a spore, so that at maturity the cystocarpic fruit consists of a dense tuft of radiating, moniliform filaments. In the *Ceramieæ* we have *favellæ,* or cystocarps, in which the carpogenic cells bud out and produce several lobes, each of which divides into a number of very short filaments, which do not separate from one another, but remain adherent. The cells of the filaments are changed into spores, which form irregular groups, but are still held together by the mass of jelly which surrounds them. In the more highly developed suborders the spores either radiate in filaments from a sort of placenta which is produced from the carpogenic cells or else are terminal on short stalks. The pericarps are special sacks or conceptacles, inclosing the spores and developed from the cells below the procarp, or we may have the cystocarps borne in the interior of solid fronds, whose external portion may then be said to form a pericarp around them. It will be seen that the structure of the *Florideæ* is more complicated than that of the other orders of algæ, and the student cannot expect to obtain a clear idea of the different suborders without considerable study. The following key will aid somewhat, and the reader should consult the plates appended to this paper:

1. Spores formed in the cells of the frond itself........... *Porphyreæ.*
2. Spores (cystocarps) not formed directly from the cells of the frond, but from a special procarp.............................. 3
3. Spores without a special covering or pericarp................ 4
   Spores with a special covering.............................. 10
4. Spores naked.. 5
   Spores immersed in the frond................................ 7
   Spores immersed in external warts........................... 6
5. Spores free on the surface of a lobulated mass .... *Spermothamnieæ.*
   Spores irregularly grouped in masses which are surrounded by a gelatinous envelope.............................. *Ceramieæ.*
6. Fronds erect, cylindrical................................ *Spongiocarpeæ.*
   Fronds horizontally expanded.......................... *Squamarieæ.*
7. Spores arranged in dense tufts of radiating moniliform filaments.. *Nemalieæ.*
   Spores on an axile placenta in swollen branches.......... *Gelidieæ.*
   Spores in numerous radiating tufts around a central placenta or carpogenic cell.. *Solierieæ.*
   Spores arranged without order................................ 8
8. Spores forming a single mass or nucleus and entirely buried in the frond.. 9
   Spores in several masses, separated by the tissue of the internal part of the frond and rising in swellings above the surface... *Gigartineæ.*
9. Fronds hollow and tubular................................ *Dumontieæ.*
   Fronds solid .... *Cryptonemieæ.*
10. Spores arranged without regular order......................... 11
    Spores in small, scattered tufts, borne on branching filaments— *Hypneæ.*
    Spores in radiating moniliform filaments...................... 12

Spores pyriform, on simple or branching stalks from a basal placenta 13
11. Wall of the conceptacle thin, composed of the divisions of an involucre united by jelly .... *Spyridieæ.*
Wall of conceptacle thick, sporiferous masses arranged around a placenta .... *Rhodymenieæ.*
12. Filaments arising from a single cell at the base of a thin membranaceous conceptacle which is sunk in the frond... *Scinaia* (*Nemalieæ*).
Filaments arising from a distinct basal placenta, conceptacles external .... *Sphærococcoideæ.*
13. Fronds coated with a calcareous incrustation........... *Corallineæ.*
Fronds without incrustation........................... *Rhodomeleæ.*

FLORIDEÆ INCERTÆ SEDIS.

TRENTEPOHLIA, (Ag.) Prings.

(Named in honor of *Johann Friederich Trentepohl,* of Oldenburg.)

Fronds arising from a cellular base, filamentous, branching, composed of short cells placed end to end, branches ending in a hair; spores single, borne in oval cells terminating lateral branches; antheridia and tetraspores unknown.

A genus which in the present paper comprises a number of small marine species placed by some writers in *Callithamnion* and by others in *Chantransia.* In the Nereis Am. Bor., Harvey placed *T. Daviesii* and *T. virgatula* in *Callithamnion.* But cystocarps and antheridia are wanting, and according to Thuret and Bornet, Areschoug, and Pringsheim, the spores are undivided, although, on the other hand, Agardh and Harvey state that they are tripartite tetraspores. We have never seen any indication of division in American specimens. The genus *Chantransia* as limited by Thuret included not only marine species, but a number of fresh-water forms. Sirodot, however, in his *Étude sur la Famille des Lémanéacées,* Annales des Sciences, 5th Series, Vol. XVI, has shown that at least some of the fresh-water species of *Chantransia* are nothing but the initial stage of different species of *Lemaneæ.* On the other hand, *Chantransia investiens,* Lenor., a minute fresh-water alga which grows on different species of *Batrachospermum,* and which is made the type of the genus *Balbiania* by Sirodot, has distinct antheridia, trichogynes, and cystocarps, and this is also the case with the marine species *C. corymbifera* described by Bornet and Thuret in Notes Algologiques. The species of *Chantransia,* then, may be divided into two sets. In the first, including *C. investiens* of fresh water and the marine *C. corymbifera,* we have autonomous species related to *Callithamnion,* and differing in the simpler procarp and cystocarp and in the undivided non-sexual spores. In the second set we have the numerous fresh-water *Chantransiæ,* in which there are no cystocarps, in which the species are not autonomous, but merely prothalloid stages of other species.

The question remains as to the relations of the marine *Chantransiæ* in which no cystocarps nor antheridia have been found. Judging from analogy, if they are initial stages of other plants, those plants must be members of the *Nemalieæ.* But the habitat seems to forbid such an assumption, since the marine *Chantransiæ* abound on *Zostera, Rhodymenia,* and other algæ on which certainly no species of *Nemalion* or other related genera occur on our coast. We have thought best, in the absence of direct information with regard to cystocarps and antheridia in the species here included, to retain the name *Trentepohlia* which was once adopted by Harvey, and at a later date also by Pringsheim, since it sufficiently indicates that the species in question should be kept distinct from *Callithamnion*, and at the same time does not assume the existence of cystocarps like those described by Thuret and Bornet in *C. corymbifera*.

T. VIRGATULA, (Harv.). (*Callithamnion virgatulum*, Harv., Phyc. Brit., Pl. 313; Ner. Am. Bor., Part II, p. 243.) **Pl. X, Fig. 3.**

Fronds minute, tufted, branches erect, straight, alternate or secund; spores sessile or on short stalks, borne either singly or in twos and threes along the branches.

Var. SECUNDATA. (*Callithamnion luxurians*, Ner. Am. Bor.—*C. secundatum*, Lyngb.)

Branches patent, with attenuated, naked, secund, secondary branches.

On *Ceramium*, *Laminaria* stems, and other algæ. The variety especially on *Zostera*.

Common in Long Island Sound; Gloucester, Mass.; Peak's Island, Maine.

A common species found in summer on different algæ. On the filamentous species it forms small tufts, and on *Zostera* it fringes the margins of the leaves with a fine plush scarcely more than a quarter or half an inch high. The synonymy of the species is very complicated, it having been confused with the next by some writers. The variety is common on *Zostera*, and is usually found in American herbaria bearing the name of *C. luxurians*. There is little doubt that it is the *C. luxurians* of the Nereis Am. Bor., but whether it is the species described under that name by Agardh is doubtful.

T. DAVIESII, Harv. (*Conferva Daviesii*, Engl. Bot., Pl. 2329.—*Callithamnion Daviesii*, Phyc. Brit., Pl. 314.)

Fronds minute, tufted, branches scattered, patent, bearing in their axils fasciculated ramuli, at whose tips are borne the spores.

On *Rhodymenia*.

Gloucester, Mass.

The limits of the species are not well marked. The extreme form is found in *C. efflorescens*, Thuret, kept as a distinct species by most writers, in which the branches are few, long, and given off at wide angles, and the spores borne in dense corymbs or heads in the axils. This form has been found on *Cystoclonium purpurascens* at Gay Head.

Among the genera whose relations to the *Florideæ* must be considered doubtful are *Choreocolax* and *Pseudoblaste*, described by Reinsch in *Contributiones ad Algologiam et Fungologiam*. Of the last-named genus a single species, of the former five species, are attributed to the eastern coast of America. The species of *Choreocolax* consist merely of rose-colored filaments, which are parasitic in the fronds of different *Florideæ*, upon the surface of which they produce irregularly swollen masses, composed in part of the threads of the *Choreocolax* and in part of the distorted tissues of the host-plant. The species of *Pseudoblaste* consist of aggregations of cells arranged in longitudinal series, which form hemispherical masses on the surface of different *Florideæ*. In neither genus is any form of reproduction known, and, for this reason, the descriptions of Reinsch must be regarded as inadequate, since it by no means follows that plants consisting of rose-colored filaments belong to the *Florideæ*. One often finds on our coast *Florideæ* whose

Suborder PORPHYREÆ.

Fronds brownish purple, composed of cells imbedded in a gelatinous net-work, arranged in filaments or in membranes formed of a single layer of cells; spores formed by the division of a mother-cell into eight cells, arranged by fours in two layers; antherozoids spherical, colorless, destitute of proper motion, formed by division of a mother-cell into 32–64 parts.

The present suborder comprises the genera *Porphyra* and *Bangia*, and perhaps also *Erythrotrichia* and *Goniotrichum*. In *Porphyra* the frond consists of a single layer of cells, of which those near the base send downwards root-like appendages, by means of which the fronds are attached to the substratum. The spores are formed at the marginal portion of the frond by the division of the vegetative cells, at first into two cells by a vertical partition, and the subsequent division of the two cells into four by cruciate partitions. Thus, when mature and seen from above, the eight spores seem to be arranged in two superimposed series of four. The spores escape by the dissolution of the outer part of the frond, leaving behind the empty gelatinous net-work. When free they are found to consist of protoplasm without a cellulose wall, and they move about for a short time with an amœboid motion. The antherozoids are also formed by the division of the vegetative cells, but the division is carried farther than in the production of the spores, for, in addition to the vertical and cruciate partitions described in the latter case, a second vertical and cruciate division takes place, so that the original vegetative cell is divided into 32–64 cells. Janczewski applies the name antheridium to the collective mass of antherozoids formed from a single vegetative cell. As the division takes place the antherozoids lose their color. When mature they are spherical and escape in a manner similar to that of the spores. Bornet and Janczewski state that the antherozoids are destitute of any proper motion, and we can confirm

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fronds are distorted by parasites, which produce deformities like those described by Reinsch as due to species of *Choreocolax*. Such distortions are perhaps most frequently found on *Cystoclonium purpurascens*. In our present ignorance of the fructification, specific identification is out of the question, and, in this connection, it is only necessary to quote the generic descriptions of Reinsch, l. c., with an enumeration of the species attributed to our coast:

CHOREOCOLAX. True vegetable parasites; fronds consisting of two portions, one of which extends through the tissue of the infected plant, the other of which swells above the surface of the infected plant, forming a convex mass, which is hemispherical or spherical, semi-ellipsoidal or irregular in outline; the cells which are contained in the infected plant either more slender than the others or of the same shape, cells of external portion equal or unequal, arranged without order in densely intricate subramose threads, terminal cells sometimes longer and more slender; fructification?; polysporangia?

C. RABENHORSTI. On *Delesseria sinuosa*, Anticosti; Gloucester, Mass.

C. POLYSIPHONIÆ. On *P. fastigiata*, Atlantic shore of North America.

C. MIRABILIS. On *Rhodomela subfusca*, Atlantic shore of North America.

C. AMERICANUS. On *Lophura Royana*, &c., Atlantic shore of North America.

C. TUMIDUS. On *Ceramium involutum*, West Gloucester, Mass.

PSEUDOBLASTE. False vegetable parasites; frond convex, more or less regular in outline, formed of similarly shaped cells, generally arranged in longitudinal series, arising from a densely appressed base (the cells without any organic connection with the cells of the infected plant); propagation?

P. IRREGULARIS. On *Lophura Royana*, Atlantic coast of North America.

this statement by our own observations, although Koschtsug maintains the contrary. The genus *Bangia*, except that the cells composing the frond are arranged in cylindrical filaments instead of expanded membranes, differs in no essential respect from *Porphyra* and the production of spores and antherozoids is the same.

The development and structure of the species of this order have formed the subject of a number of important papers, viz: *Porphyra laciniata*, in Études Phycologiques, by Bornet and Thuret; *Études Anatomiques sur les Porphyra*, by Janczewski, in Annales des Sciences, Ser. 5, Vol. XVII; and *Ueber die Geschlechtspflanzen von Bangia fusco-purpurea*, in Pringsheim's Jahrbücher, Vol. II. In the Nereis. Am. Bor., Harvey placed *Porphyra* and *Bangia* with the *Ulvaceæ*, which they resemble in so far as they consist of simpls membranes and filaments some of whose cells change directly into spores. The sporee of the *Porphyreæ*, however, are motionless bodies, not zoospores as in the *Ulvaceæ*, and their color is not green, but brownish red. The systematic position of the order has been in doubt, because, although there were well-known spores and bodies to which the name of antheridia was applied, no one had succeeded in detecting trichogynes and procarps, which must necessarily exist if the *Porphyreæ* are to be classed with the *Florideæ*. Dr. G. Berthold, however, has recently published in the Mittheilungen aus der zoologischen Station zu Neapel a communication in which he claims to have discovered trichogynes in species of *Bangia* and *Porphyra*. According to him, the cells produce short trichogynes to which the antherozoids adhere, and as a result the contents of the cell divide and produce the spores at once. In other words, the *Porphyreæ* are the simplest of the *Florideæ;* a vegetative cell produces a trichogyne and is itself the carpogenic cell from which the spores are formed. Dr. Berthold goes further and says that some of the spores are nonsexual and are true tetraspores, but his article is not accompanied by illustrations. Bornet, to a certain extent following Cohn, suggests a possible connection of the *Florideæ* with the *Phycochromaceæ* by means of the *Porphyreæ*. Admitting that *Erythrotrichia* and *Goniotrichum* are related to *Porphyra* and *Bangia*, we have in *Goniotrichum* algæ composed of rose-colored discoidal cells packed in a thick gelatinous tube, from which they escape much as in some of the *Phycochromaceæ*.

PORPHYRA, Ag.

(From *πορφυρα*, a purple dye.)

Fronds gelatinous, membranaceous, composed of a single layer of brownish-red cells, those near the base sending out root-like processes; spores borne near the margin of frond, eight arising from a single mother-cell; antheridia marginal, consisting of 32–64 spherical, colorless antherozoids.

A small genus, the species of which are characterized by the relative position of the spores and antheridia and by the shape of the frond. Most of the species have been founded on variations in the outline of the frond, and recent writers agree in uniting many of the species of the older algologists.

P. LACINIATA, Ag.—*Laver*. (*P. linearis*, Grev.; Phyc. Brit., Pl. 211, Fig. 2.—*P. vulgaris*, Harv., Phyc. Brit., Pl. 211, Fig. 1.—*P. laciniata*, Harv., Phyc. Brit., Pl. 92; Études Phycol., Pl. 31.)

Fronds three inches to a foot and a half long, persistent throughout the year, color livid purple, substance gelatinous but firm, at first linear, but becoming widely expanded and finally much lobed and laciniate; antheridia and spores forming a marginal zone, usually borne on different individuals, or when borne on the same individual not intermixed, but on separate portions of the frond.

Common on stones near low-water mark.

Found in all parts of the world.

This common species abounds on rather smooth stones and pebbles, and when the tide falls covers them with slimy films, which make walking over them difficult. The shape of the fronds is very variable, but as generally found they are much folded and laciniate. The species is used for making soups in Europe, but is not used in this country, except by the Chinese, who import it from China, not knowing that it occurs abundantly on our own coast. *P. leucosticta* probably occurs in New England, but has not yet certainly been observed. It is a spring species, softer and brighter colored than *P. laciniata*, and the antheridia and spores are found on the same individual, forming spots within the margin rather than a marginal zone.

BANGIA, Lyngb.

(Named in honor of *Niels Hofmann-Bang*, of Copenhagen.)

Fronds gelatinous, simple, filamentous, cylindrical, densely tufted, composed below of a single row of cells, which, by repeated vertical division, become densely cellular above; antheridia and spores formed by transformation of the cells of the upper part of the filaments.

A small genus, of which most of the species are marine, but some are found in fresh water. The species are not well characterized, for the differences in the length of the filaments, color, and number of cells seen in cross-section, marks upon which most writers have relied, depend to a great extent upon the age of the plant and its place of growth.

B. FUSCO-PURPUREA, Lyngb.; Phyc. Brit., Pl. 96; Reinke, l. c., Pls. 12, 13.

Filaments blackish purple, two to six inches long, clustered in dense masses, lubricous; antheridia and spores usually on different individuals.

On wharves and rocks between tide-marks.

Rather common along the whole coast.

Easily recognized by the fine, soft, dark-purple filaments, which cover rocks and wood work in patches of considerable size with a dense gelatinous fleece. Although found on wharves in sheltered localities, it also occurs on rocks exposed to the waves.

ERYTHROTRICHIA, Aresch.

(From ερυθρος, red, and τριχιον, a small hair.)

Fronds rose-colored, simple, filamentous, composed of a single row of similar cells placed end to end; cell contents discharged in a spherical mass, which forms a spore.

A small genus, whose principal representative, *E. ceramicola*, is by many writers placed in *Bangia*. As we understand the genus, it differs from *Bangia* in that there are no antheridia or tetraspores, the reproduction being accomplished by the discharge of the cell contents in a single mass or spore. If *Bangia ciliaris* of the Nereis, which occurs at Charleston but is not known farther north, is also to be included in the present genus, then the definition given above will have to be modified so as to include plants having more than one row of cells, an extension of the genus apparently adopted by Thuret, but not originally adopted by Areschoug.

E. CERAMICOLA, (Lyngb.) Aresch. (*Bangia ceramicola*, Chauvin; Phyc. Brit., Pl. 317.—*E. ceramicola*, Le Jolis, Liste des Algues Marines de Cherbourg, Pl. 3, Figs. 1, 2.)

Filaments diffuse, forming a web or fringe on algæ, cells about as long as broad.

On algæ, especially the smaller *Florideæ*, in tide-pools. Late summer and autumn.

Gloucester, Mass., *Mrs. Davis*, *Mrs. Cochrane;* Peak's Island, Maine, *W. G. F.;* Europe.

In examining with the microscope the filamentous *Florideæ* one often meets with a few filaments of this species. It is not, however, common to find it in such abundance on the shore as to attract the eye of the collector who is not especially in search of it. It attains its full size in the month of September.

? GONIOTRICHUM, Kütz.

(From γωνια, an angle, and τριχιον, a small hair.)

Fronds filamentous, branching, composed of rose-colored, disk-shaped cells, embedded in jelly.

A genus composed of only two or three species. Kützing describes two species, but his limitation of them is not now kept by algologists. Zanardini describes and figures a *G. cærulescens*, which is not red in any sense. The systematic position of the genus is very doubtful, and were it not for the color of the cells, *G. elegans* would probably be placed in the *Nostochineæ*. The only reproduction known consists in the escape of the cells from the gelatinous sheath and a division into two new cells, then into four, and so on until a new filament is formed.

G. ELEGANS, Zanard. (*Bangia elegans*, Chauv.; Phyc. Brit., Pl. 246.)

Filaments about .02^{mm} in diameter; cells cuboidal or ovate, about .009–10^{mm} in diameter.

On *Dasya elegans*.

Cotuit Port, Mass., *Mrs. J. T. Lusk;* Europe.

A small and rare plant, growing in tufts scarcely a tenth of an inch high. We have only one American specimen, collected by Mrs. Lusk, of Gloucester. The locality was incorrectly given in the *List of the Marine Algæ of the United States*, Proc. Am. Acad., 1875, the specimen not having been found by Mrs. Lusk at Gloucester, but at Cotuit, Mass.

SUBORDER SQUAMARIEÆ.

Fronds forming horizontally expanded crusts, usually membranaceous, occasionally somewhat incrusted with lime, composed of closely packed vertical filaments arising from a horizontal stratum of cells; fructification either in external protuberances composed of parallel filaments or immersed in the frond; antherozoids formed from the cells of the protuberances or the superficial cells of the frond; cystocarps composed of few spores arranged end to end in a few rows, or in filaments which branch slightly; tetraspores zonate or cruciate, stalked or attached laterally to the filaments of the frond or protuberances.

A small order, more abundant in tropical seas than on our coast, comprising species which in habit resemble lichens rather than algæ. A few species, as *Peyssonnelia squamaria* and *P. australis*, attain a considerable size, and are distinctly foliaceous. The greater part of the species, however, form closely adherent crusts, which are sometimes more or less gelatinous and sometimes slightly calcareous. The structure of the fronds is simple. From a horizontal base, composed of a single layer or a few layers of cells, arise vertical filaments, which in some genera are densely united so as to form a parenchymatous frond, or in others are only slightly held together by a gelatinous intercellular substance. The fructification is found either in external raised spots or sunk in the frond. The antheridia are either formed directly from the cells of the filaments which constitute the protuberances or from the external cells of the fronds themselves. The tetraspores are either cruciate or zonate, and their position constitutes an important generic mark. The development of the cystocarps is known in only a few species. In *Peyssonnelia*, according to Dr. Bornet, the procarp is formed from the cells of the filaments, which form the protuberances. The upper cell elongates and forms the trichogyne, and the fertilization consists merely in the change of the cells of the procarp into spores, thus constituting a very simple form of cystocarp, to which Zanardini has given the name of *cystidie*. According to Prof. Fr. Schmitz, in *Cruoriopsis cruciata*, Dufour, there are winding filaments like those described by Thuret and Bornet in *Dudresnaya*. We have but few *Squamarieæ* on our coast, and the study of the suborder cannot easily be pursued with us.

PEYSSONNELIA, Decaisne.

(Named in honor of *J. A. Peyssonnel.*)

Fronds horizontally expanded, attached by the under surface; substance parenchymatous throughout; fructification in external convex protuberances (nemathecia) composed of slender parallel filaments, on which are borne the antheridia, cystocarps, and tetraspores; antherozoids produced in all the cells of the nemathecial filaments; tetraspores cruciate, oblong, sessile or shortly stalked; cystocarps composed of few spores, placed one over another in one or two rows or in short, branching filaments.

A small genus, comprising probably not more than twelve or fifteen good species. *P. squamaria*, common in Southern Europe, is not known with us. It may be that several of the species described by Crouan in the Annales des Sciences and the Florule du Finistère occur with us; but it must be confessed that from the description given by Crouan it would be by no means an easy matter to recognize them. Those who have an opportunity for dredging on shelly bottoms at localities like Gay Head, Block Island, Montauk, or Eastport should make a careful search for species of the present genus.

P. Dubyi, Crouan; Phyc. Brit., Pl. 71; Florule du Finistère, Pl. 19, Fig. 130; Proc. Am. Acad. Arts & Sciences, 1877, p. 239.

Fronds dark purple, thin, completely adherent to the substratum, somewhat calcareous beneath; cystocarpic spores few in number (4–6), arranged in one or two rows.

On shells and stones at low-water mark and in deep water.

Eastport, Maine; Magnolia, Mass.; Europe; California.

As yet only found in a sterile condition, apparently not common. The species might possibly be mistaken for *Petrocelis cruenta* at first sight. It is, however, more decidedly reddish and thicker. Under the microscope the structure of the frond is seen to be parenchymatous throughout, while in *Petrocelis* the vertical filaments are nearly free from one another. *P. imbricata*, Kütz., Tab. Phyc., Pl. 90, from Newfoundland, is a doubtful species, which is not likely to be recognized by future botanists.

PETROCELIS, J. Ag.

(From πετρος, a stone, and κηλις, a stain.)

Fronds gelatino-coriaceous, horizontally expanded, indefinite in outline, adhering closely to the substratum, vertical filaments united below, but above rather loosely held together by a gelatinous substance; antheridia and cystocarps unknown; tetraspores spherical, cruciate, formed directly from some of the cells of the vertical filaments.

A genus represented by a single species, which is widely diffused in the North Atlantic. At once recognized by the peculiar position of the cruciate tetraspores, which are in the continuity of the vertical filaments. There is usually only a single tetraspore in each filament, but Ruprecht, in Phycologia Ochotensis, figures a form in which several contiguous cells are transformed into tetraspores.

P. cruenta, J. Ag. (*Cruoria pellita*, Harv., in Phyc. Brit., Pl. 117, non *C. pellita*, Lyngb.) Pl. 14, fig. 1.

Covering rocks and stones near low-water mark with a dark purple, velvety stain.

Common from Nahant northward; Europe.

The present species often accompanies *Hildenbrandtia rosea*, from which it is distinguished at sight by its darker color and velvety gloss when moist. It is also decidedly thicker and more easily scraped from the rocks. The species is not yet known south of Cape Cod, but may be expected. The fronds of the present species are infested by a green unicellular parasite, which is frequently seen in the shape of ovoid sacks, drawn out at the lower end into a slender stalk amongst the vertical filaments. It is, in all probability, the parasite mentioned by Cohn, in Ueber einige Algen von Helgoland, as occurring in *Cruoria pellita*, to which, as far as we know, no name has as yet been given.

HILDENBRANDTIA, Nardo.

(Named in honor of *Prof. Franz Edler Hildenbrandt*, of Vienna.)

Fronds crustaceous, without calcareous deposit, forming thin, reddish, horizontal expansions of indefinite extent, composed of cuboidal cells arranged in vertical lines and arising from a horizontal basal layer;

tetraspores lining the walls of immersed conceptacles, zonate, cruciate, or irregularly placed; cystocarps unknown.

A small genus, comprising half a dozen species, which form thin crusts on rocks and stones both in salt and fresh water. The systematic position of the genus is doubtful, and must remain so until the cystocarps are known. Since the tetraspores are borne in special conceptacles, the genus has been placed by some writers with the *Corallineæ,* although the species are not strictly calcareous. By others it is placed with the *Squamarieæ.* Antheridia are only known in *H. rivularis,* where they are said by Borzi to be long cylindrical cells formed from the superficial cells of the thallus, each cell containing a number of spherical antherozoids arranged one above another.

H. ROSEA, Kütz. (*H. rubra,* Harv., Phyc. Brit., Pl. 250; Farlow, in Report of U. S. Fish Comm. for 1871.)

Fronds thin, closely adherent to the substratum, cells of nearly the same size in all parts of the frond; conceptacles numerous, completely immersed, spherical; tetraspores either zonate or irregularly divided, lining the walls of the conceptacles and mixed with filiform, slender paraphyses.

On stones and rocks near low-water mark.

Everywhere common.

One of our commonest species, which forms continuous thin crusts, often of considerable extent, tinging the rocks with a pinkish or somewhat brownish color; not easily mistaken for any other alga on our coast, except possibly young forms of *Petrocelis,* which is, however, thicker, more velvety in appearance, and darker in color.

Suborder NEMALIEÆ.

(*Helminthocladieæ,* Agardh & Harvey.)

Fronds more or less gelatinous or occasionally coated with a calcareous deposit, filamentous, branching, formed of an axial portion composed of elongated longitudinal filaments, which give off short, corymbose, horizontal branches, which constitute the cortical portion; antheridia in tufts on the superficial cells; cystocarps immersed in the frond, borne on the peripheral filaments, composed of densely packed chains of spores radiating from a central cell, either without any proper envelope, or with a filamentous involucre or surrounded by a proper membranous pericarp; tetraspores?

A comparatively small suborder, comprising species whose fronds, except in color, resemble the fronds of the *Chordarieæ* in the *Phæosporeæ,* since they consist of an axis composed of longitudinal filaments and a cortex of short, much-branched horizontal filaments. All our species are soft and somewhat gelatinous, but the species of *Liagora,* which abound in the tropics and are found in Southern Europe and in this country in Florida and California, have a more or less distinct coating of carbonate of lime. The procarps and cystocarps in this suborder are very simple. There are a few species belonging to the genus *Batrachospermum* which occur in fresh water. In that genus the formation of the cystocarps is very simple. The trichogyne and trichopore are represented by a single large cell, constricted near the base. After fertilization the chains of spores are formed directly from the part below the constriction. In

Nemalion the procarp consists of a short branch composed of a few cells, the upper of which enlarges and bears a hair-like trichogyne. The fruit in *Nemalion* has no special covering, but in *Helminthora* and *Helminthocladia* the lower cells of the procarp produce whorls of filaments which form an involucre around the spores, and in *Scinaia* they produce a membranous sack which opens at the apex, so that when ripe the fruit consists of a conceptacle opening outwards, at whose base is borne a tuft of spores arranged in filaments. With regard to the tetraspores in the present suborder, a difference of opinion exists. Contrary to what is found in other *Florideæ*, the cystocarpic individuals are common, whereas tetrasporic individuals are unknown except in *Nemalion*, in which genus, on the authority of Agardh, they are borne in the superficial cells and are tripartite.

NEMALION, Duby.

(From νημα, a thread.)

Fronds gelatinous, cylindrical, solid, repeatedly dichotomous, cortical filaments corymbose, giving off descending branches, which unite with the axial filaments; antheridia in tufts on the superficial cells; procarps borne at the base of the corymbose branches, consisting of few cells; cystocarps immersed, without special covering, sporiferous filaments radiating from the trichophore; "tetraspores tripartite in the superficial" cells. (Agardh.)

A small genus, comprising seven or eight species, only one of which, *N. multifidum*, is widely diffused.

N. MULTIFIDUM, Ag., Phyc. Brit., Pl. 36. (*Mesogloia multifida*, Ag., Syst.) **Pl. 12, Fig. 1.**

Fronds brownish purple, lubricous, two to eight inches long, cylindrical, several times dichotomous, axils obtuse.

On exposed rocks at low-water mark. Summer.

From Watch Hill, R. I., northward; Europe.

Not uncommon on rocks exposed to the action of the waves. Commonly found with cystocarps, but no tetraspores have been seen on American specimens. In the Nereis the species is said to have been collected at Bangor, Maine, by Mr. Hooper. This must be an error, however, since Bangor is on the Penobscot River, above the limit of salt water. Specimens of the present species are so gelatinous as to dry with difficulty. They should be exposed in the air for two or three hours before pressing.

SCINAIA, Bivona.

(In honor of *Domenico Scina*, of Palermo.)

Fronds subgelatinous, dichotomous, cylindrical or compressed, axis small, composed of slender colorless filaments, horizontal filaments ending in short corymbs of small, round, colored cells, the centers of all the corymbs bearing large, colorless, cylindrical cells, which by their juxtaposition form an epidermis over the whole frond; antheridia in small tufts on the superficial cells; cystocarps borne just below the cortical layer, consisting of membranous sacks opening externally, with a tuft of spore-bearing filaments attached to the base; tetraspores unknown.

A small genus, containing at the most only four or five species, of which *S. furcellata* is widely distributed. The genus is unmistakable on microscopic examination by the slender axis and large colorless cylindrical cells which cover the surface of the fronds, and by the peculiar cystocarps which are visible to the naked eye as dark red grains just under the surface. The species should be studied from living or alcoholic specimens, since, owing to the delicate substance, pressed specimens are badly distorted.

S. FURCELLATA, Bivona. (*Ginannia furcellata*, Mont.; Phyc. Brit., Pl. 69.—*S. furcellata*, Notes Algologiques, Pl. 6.)

Fronds solitary or clustered, cylindrical, rising from a disk-like base, several times dichotomous, divisions regular, apices obtuse.

On stones and shells in five to ten fathoms.

Newport, R. I., *Bailey;* Gay Head, Mass., *W. G. F.*

A rare species with us, but widely distributed throughout the world, being found in most warm seas. In size and regularity of its dichotomous branching it resembles *Polyides rotundus*, but is much more delicate in substance and brighter colored. With us it is only known at a considerable depth and in rather cold waters, but in the Mediterranean it is frequent in warm shallow waters. It is not uncommon on shells of *Mytilus* near the Devil's Bridge, Vineyard Sound, Mass., and is found washed ashore in the neighboring beach of Gay Head. The Californian form of what is supposed to be the same species is much more robust, and the var. *undulaa*, which Montagne considered a distinctspecies, is somewhat compresed and constricted at intervals. When pressed the specimens are quite flat and the axis is plainly seen, giving the appearance of a membranous frond with a midrib.

SUBORDER SPERMOTHAMNIEÆ.

Fronds filamentous, monosiphonous, branching; antheridia tufted; cystocarps involucrate, spores borne free on the surface of a lobulated mass produced by the carpogenic cells.

In this suborder we would place *Spermothamnion* and *Bornetia*, separated from *Callithamnion* and *Griffithsia*, respectively, in consequence of the spores being borne free.

SPERMOTHAMNION, Aresch.

(From *σπερμα*, a seed, and *θαμνιον*, a small bush.)

Fronds tufted, composed of procumbent monosiphonous filaments attached to the substratum by disk-shaped cells and vertical branching filaments; antheridia sessile on the inner side of the branches, composed of oval or cylindrical masses of small cells; cystocarps terminal on the branches, surrounded by an involucre of short incurved branchlets, spores free from one another and not surrounded by a gelatinous envelope; tetraspores tripartite, single or aggregated, borne on the inner side of the branchlets.

A small genus, comprising, as far as known, less than half a dozen species, separated from *Callithamnion* because the spores at maturity are borne free on the surface of a lobulated mass which arises from the development of the carpogenic cells, and not, as in *Callithamnion*, held together by a gelatinous envelope. The trichophoric apparatus and the early stages of the development of the cystocarps, however, scarcely differ in the two genera. The species of *Spermothamnion* have been considered related to *Wrangelia*, but if we are to regard *W. penicillata* as the type of the last-named genus, as has been done by Thuret and Bornet in Notes Algologiques, the resemblance is not close. In spite of the fact that the fruit of *Spermothamnion* is not a true favella, there is little doubt that the genus should be placed in the *Ceramieæ*, near *Callithamnion*. The development of the genus has been very thoroughly studied and has formed the subject of several admirable papers, among which may be mentioned Pringsheim's account of *S. roseolum*, in his Beiträge zur Morphologie der Meeres-Algen; Nægeli on *S. Turneri* and *hermaphroditum*, in Beiträge zur Morphologie und Systematik der Ceramiaceæ; and Thuret and Bornet on *Spermothamnion flabellatum*, in Notes Algologiques.

S. TURNERI, Aresch. (*Callithamnion Turneri*, Ag.; Phyc. Brit., Pl. 179; Ner. Am. Bor., Part III, p. 241.—*S. roseolum*, Pringsh., l. c.?—*Herpothamnion Turneri*, Næg.)

Fronds forming densely matted tufts, procumbent filaments branching, attached by disk-like cells, vertical filaments one to three inches high, simple or slightly branching, naked below, pinnate above with opposite or sometimes alternate spreading pinnate branches, ultimate branches long and slender, often ending in a hair; antheridia ovate or cylindrical, sessile on the upper side of the branches; cystocarps involucrate, terminal on the branches; tetraspores tripartite, borne on the upper side of the ramuli, either solitary and pedicellate or clustered and sessile on short fastigiate branches.

Var. VARIABILE, Harv.

Branches and branchlets alternate or secund.

In very dense tufts on algæ at low-water mark or in deep water.

Common in Long Island Sound; var. *variabile*, Boston, *Dr. Durkee*.

A species which is often found washed ashore in dense globose tufts from our southern limit to Nantucket. At the latter locality it is often found in very large quantities washed from deep water by the surf on Siasconsett Beach. The filaments are delicate and of a pleasant lake color. North of Cape Cod the species is hardly known with certainty. Specimens collected at Noank, Conn., have both tetraspores and young cystocarps on the same individual, but we have never seen antheridia on American specimens. Our plant seems to be the same as that figured by Pringsheim under the name of *S. roseolum*, and also corresponds closely to the species of that name in Algæ Scandinavicæ, No. 83. It appears without doubt to be the *C. Turneri* of the Phycologia Britannica and the Nereis, but we are unable to say whether it is the true *C. roseolum* of Agardh.

SUBORDER CERAMIEÆ.

Fronds filamentous or compressed, either monosiphonous or with a more or less corticated monosiphonous axis; antheridia in sessile tufts or patches or in a series of whorls; cystocarps (favellæ) composed of spores arranged without order and surrounded by a gelatinous envelope, naked or involucrate.

A large order of filamentous algæ, many of which are monosiphonous throughout, while others are corticated either throughout or partially. The position of the antheridia and tetraspores varies in the different species. The cystocarp is a favella, which is either naked or surrounded by an involucre arising from the cells below the carpogenic cells. In cases where the frond consists of an axis with dense whorls of branches the favellæ may be partly concealed but not really immersed in the frond. The order is tolerably distinct. The fronds resemble closely those of the *Wrangelieæ*, and on the other hand the order passes gradually into the *Cryptonemieæ* by the genera *Gloiosiphonia*, *Calosiphonia*, and *Nemastoma*, in which the fruit is properly a favella, but is immersed in the comparatively dense outer portion of the frond instead of being free as in the *Ceramieæ*. In fact, it is difficult to say in which suborder *Gloiosiphonia* should be placed.

1. Tetraspores external, occupying the place of a branchlet or ultimate cell 3
2. Tetraspores wholly or partly immersed, formed from the corticating cells 4
3. Fronds filamentous, monosiphonous, or with a false cortex composed of descending filaments, favellæ naked or with only a rudimentary involucre .... *Callithaminon.*
   Fronds filamentous, monosiphonous, dichotomous, favellæ involucrate .... *Griffithsia.*
   Fronds filamentous, branches densely whorled on the axis, favellæ involucrate .... *Halurus.*
   Fronds compressed, corticated, decompound-pinnate, favellæ involucrate .... *Ptilota.*
4. Fronds filamentous, monosiphonous, cortications at the nodes and extending over the internodes .... *Ceramium.*

CALLITHAMNION, Lyngb.

(From καλλος, beauty, and θαμνιον, a small shrub.)

Fronds filamentous, branching, filaments either monosiphonous throughout or becoming corticated by the growth of descending, rhizoidal filaments; antheridia forming hemispherical or ellipsoidal tufts on the branches; cystocarps composed of irregular masses of roundish spores covered by a gelatinous envelope (favellæ); tetraspores tripartite, cruciate, or polysporic; seirospores present in some species.

A large and beautiful genus, of which nearly 150 species have been described. Although the genus has been divided into a number of smaller genera, the number of species still retained in *Callithamnion* proper is large. Nægeli, in his paper on the Morphology of the Ceramiaceæ, divides *Callithamnion* into a number of genera and subgenera, but we have thought best to retain the genus in an extended sense, regarding Nægeli's division as subgenera. *Spermothamnion*, included by Nægeli in *Herpothamnium*, has been separated because the cystocarpic fruit is not strictly a favella as in *Callithamnion* proper. *Seirospora* is still retained, although it is possible that it could safely be separated as a distinct genus. The frond in *Callithamnion* is composed, in the beginning, of rows of cells arranged in branching filaments. In the subgenus *Rhodochorton*, whose relative position is doubtful because the cystocarps have not yet been observed, there are procumbent filaments, from which arise vertical branching filaments. In the other species of *Callithamnion*, as here understood, the procumbent filaments are wanting or imperfectly developed, and the erect filaments either remain throughout monosiphonous, that is composed of single rows of cells, or become corticated by the growth of descending filaments, which proceed either from the base of the branches or from the cells of the main filaments. The false cortication formed by the interlacing of these filaments is precisely analogous to what is found in some species of *Ectocarpus* and related genera. The filaments in *Callithamnion* are either all indeterminate in growth, or else, as in the subgenus *Antithamnion*, they are of two kinds; the main filaments being indefinite and the branches definite, so that we have indefinitely elongating stems clothed with short, definite branches, or, to use the expression of Nægeli, with leaves. The antheridia are generally in the form of short tufts of hyaline cells, situated on the upper branches. In the present genus it is not rare to find species in which antheridia, cystocarps, and tetraspores are borne on the same individuals, a union rarely to be seen in the *Florideæ.* The cystocarps are often binate, which is easily understood if one considers the structure of the procarp, which is formed as follows: One of the cells of the young branches enlarges and is then divided by partitions parallel to the length of the branch into a central or axial cell and a number of peripheral cells, generally four. One of the peripheral cells is then divided into an upper and one or more lower cells by a transverse partition, and the upper cell then loses its color and grows upwards into a very long trichogyne. The antherozoids unite with the tip of the trichogyne, and the fertilizing influence is propagated through the trichogyne and the cells at its base to the two lateral peripheral cells, which then enlarge and divide on opposite sides of the axis and form eventually a bipartite favella. The tetraspores are either tripartite or cruciate. In the subgenus *Seirospora* there is a form of non-sexual spore known as seirospores, in which at the extremity of the branches are formed tufts composed of chains of oval bodies, each one of which is capable of germinating.

As is apt to be the case in a large genus, the species of *Callithamnion* are not well defined. Certain groups of species are distinct, but writers are not agreed as to the limits of the species in each group. By some a great many species are allowed which others regard as mere varieties. On our coast *C. Baileyi*, *C. byssoideum*, *C. corymbosum*, and perhaps others might be indefinitely split up, but we have preferred to adopt the opposite view. Within certain limits collectors may be expected to make out our species of *Callithamnion*, but it must often happen that forms are found which cannot with certainty be referred to any of the described species. That such forms are, as a rule, new species cannot be accepted, but botanists having large sets of species of the present genus soon become very liberal in the interpretation of specific limitations.

SUBGENUS RHODOCHORTON, Næg.

Fronds composed of procumbent filaments, from which arise vertical monopodial filaments; cortications wanting; tetraspores cruciate.

C. ROTHII, Lyngb. (*Rhodochorton Rothii*, Næg.—*Thamnidium Rothii*, Thuret, in Le Jolis's Liste des Algues Marines de Cherbourg, Pl. 5, Figs. 1–2.—*C. Rothii*, Phyc. Brit., Pl. 120 *b*.)

Fronds forming indefinite patches half an inch high, vertical filaments slender, naked below, bearing a few erect, appressed branches above, which become at the time of fructification congested and corymbose, bearing at their tips cruciate tetraspores; antheridia and cystocarps unknown.

Forming dense velvety patches on rocks between tide-marks.

Common from New York northward; California; Europe.

A common species, especially frequenting the under surface of rocks and stones near low-water mark. It has not yet been found with us in fruit, but Californian specimens bear tetraspores. In Europe the time of fructification is the spring, and the species should be examined at that season on our own coast. Harvey states that the tetraspores are tripartite, but other writers—as Thuret, Agardh, and Nægeli—agree in asserting that they are cruciate. In Californian specimens the formation of the tetraspores is somewhat irregular, and although in most cases the cruciate division is plain enough, in others it seems to be rather tripartite.

SUBGENUS ANTITHAMNION, Thuret.

Branches opposite or whorled, without cortication; tetraspores cruciate.

C. CRUCIATUM, Ag. (*Antithamnion cruciatum*, Næg.—*C. cruciatum*, Phyc. Brit., Pl. 164.)

Fronds tufted, one or two inches high, main branches sparingly and irregularly branched, secondary branches short, borne in twos or fours just below the nodes, always regularly opposite, and when in twos the succeeding pairs at right angles to one another, below subdistant, at the apex densely approximate and corymbose, pinnate with erect, alternate, distichous branchlets; tetraspores cruciate, sessile, or shortly stalked at the base of the secondary branches.

On wharves at low-water mark and on algæ in shallow water.

Red Hook, N. Y., *Harvey;* Orient, L. I.; Noank, Conn.; Wood's Holl and several localities in Vineyard Sound, *W. G. F.;* Europe.

Not common, but, on the other hand, not rare south of Cape Cod. It is a small and not very beautiful species when growing, but rather pretty when pressed. It is distinguished from the following species by its small size and sparingly branched main branches and by its tetrastichous, not distichous, secondary branches, which are densely approximate at the tips, so that in dried specimens the plant is rather pale except at the tips. Cystocarps and antheridia have never been found on our coast. Crouan states that the cystocarps, which are rare, are large, rounded, and slightly lobed. The branches of the present species, as well on our own shore as in Europe, are beset with small cysts with oily contents—the *Chytridium plumulæ* of Cohn. The same parasite is also found on the branches of *C. Pylaisæi* and *C. plumula* on the New England coast.

C. FLOCCOSUM, Ag. (*C. floccosum*, Phyc. Brit., Pl. 81.—*Pterothamnion floccosum*, Næg.)

Fronds three to six inches long, capillary, main branches irregularly and sparingly branched below, above with numerous alternate branches, which give the tips of the frond a rhombic-ovoid outline, clothed throughout with short, simple, opposite, distichous, subulate, secondary branches; tetraspores cruciate, sessile or on short stalks on the lower part of the secondary branches.

On submerged algæ.

Eastport, Maine, *W. G. F.;* Portland, Maine, *C. B. Fuller;* Gloucester, Mass., *Mrs. Bray* and *Mrs. Davis;* South Boston, *Dr. Durkee;* Northern Europe.

A beautiful and easily distinguished species, found only in the colder waters of the Atlantic, a variety occurring as far south as South Barbara, on the coast of California. It is apparently not uncommon in spring from Boston northward, sometimes occurring in company with *C. Pylaisœi.* It is rare, however, on the northern coast of Scotland. It is easily distinguished from its allies in this latitude by the simple, subulate, secondary branches with which the main branches are clothed throughout.

C. PYLAISÆI, Mont. (*Wrangelia Pylaisœi,* Ag. Sp.—*C. Pylaisœi,* Ner. Am. Bor., Part II, Pl. 36 *b.*—*Pterothamnion Pylaisœi,* Næg.)

Fronds three to six inches long, main branches alternately decompound, secondary branches short, rather stout, opposite, distichous, once or twice pinnate with short subulate ramuli; tetraspores cruciate, sessile on the ramuli; favellæ binate on the upper branches.

On wharves and algæ below low-water mark.

Orient, L. I., *Miss Booth;* Wood's Holl, Mass.; and common from Nahant northward.

A common species of the Atlantic coast from Boston northward, but much less abundant southward. It is found early in the spring on wharves and washed ashore with other algæ, but in the summer it is only seen in a dwarfed and battered condition. It is sometimes found in company with *C. Americanum,* and it is by no means beyond a doubt that the two species are really distinct. In *C. Pylaisœi* the filaments are more robust, and the cells themselves shorter and broader than in *C. Americanum,* the main branches are less decompound and spreading, and the apical branches are more erect and compact. It is, however, in the secondary branches that the difference is best seen. In *C. Pylaisœi* they are short and thick, and the ultimate divisions are broadly subulate. In *C. Americanum* they are long, slender, and flexuous. Those who have only seen the typical forms of the two species would scarcely believe that they were not very distinct species. The collector, however, especially on our northern coast, often finds transitions between the two. At the time the Nereis was written the cystocarpic fruit was unknown, and the species seemed to Agardh to belong rather to the genus *Wrangelia.* The fruit, which is not uncommon in the spring, is distinctly the same as in *Callithamnion,* and is a true favella. The antheridia differ from those of *C. corymbosum* and its allies. Instead of forming sessile, hemispherical tufts on the internodes of the branches, as in the last-named species, the antheridia of *C. Pylaisœi* are in the form of rather loosely branching tufts inserted at the nodes of the secondary branches, and occupy the position of the ultimate branches, reminding one somewhat of the antheridia of *C. graniferum,* Menegh., figured by Zanardini in Phycologia Adriatica, Pl. 11, or the figure of *C. polyspermum* in Phycologia Britannica. As far as our observations go, the antheridia and cystocarps of the present species are on different individuals. The color, when dried, is usually somewhat brownish, and decidedly less rose-colored than in *C. Americanum.*

C. AMERICANUM, Harv., Nereis Am. Bor., Part II, p. 238, Pl. 36 *a.* (*Pterothamnion Americanum,* Næg.)

Fronds three to six inches long, capillary, main branches alternately many times branched, ultimate divisions plumose, secondary branches rather long and slender, opposite, in twos or occasionally in fours, generally distichous, widely spreading, once or twice pinnate, ultimate divisions opposite or secund, long and slender; tetraspores cruciate, sessile on the upper side of the secondary branches; favellæ binate.

Exs.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 89.

On wharves and algæ below low-water mark. Spring.

From New Jersey northward.

A common and very beautiful species, more abundant in Long Island Sound than farther northward. It varies considerably in the compactness of the branching and the tenuity of the cells. The species with which it is likely to be confounded is *C. Pylaisæi*, as already indicated. The long and slender secondary branches are less regularly placed than in some other species of the subgenus, and they are not always distichous nor opposite, although that is generally the case. We have also seen a specimen on which both tetraspores and cystocarps were found together.

C. PLUMULA, Lyngb., Phyc. Brit., Pl. 242.

Fronds two to four inches long, main branches alternately decompound, secondary branches opposite or in fours, distichous, short, recurved, pectinate on the upper side with 1–3 pinnated branchlets; tetraspores cruciate, shortly pedicellate on the branches.

On wharves and on shells in deep water.

Long Branch, N. J., *Harvey;* Orient, L. I., *Miss Booth;* on steamboat wharf, Newport, R. I.; dredged in 8–10 fathoms, Gay Head, *W. G. F.;* off Block Island, *Professor Eaton.*

A rare species on the American coast, and known in but few localities. It is found occasionally on wharves just below low-water mark, but more frequently on shells in from five to ten fathoms. It is tolerably abundant off the Devil's Bridge, near Gay Head, where it is found in company with *Lomentaria rosea.* It is one of the most easily recognized species of the genus found on our coast. The branches are beautifully symmetrical and distichous, two opposite branches being given off from each cell, or occasionally there are four in a whorl, two being smaller than the others. The branches are recurved and furnished on the upper side only with 1–3 pinnate branchlets.

SUBGENUS PLEONOSPORIUM, Næg.

Fronds erect, pinnate, cortication wanting; antheridia cylindrical on the upper branches; favellæ terminal, involucrate; tetraspores polysporic.

C. BORRERI, Ag., Phyc. Brit., Pl. 159.

Fronds diœcious, densely tufted, monosiphonous, with a few rhizoidal filaments at the base, filaments one to four inches long, capillary, main branches several times pinnate, branches beset in lower part with usually simple, elongated branchlets, distichously pinnate above, ultimate ramifications broadly ovate or triangular in outline, branchlets naked below; antheridia cylindrical; tetraspores sessile on the upper branchlets, numerous, tripartite or polysporic; favellæ terminal on lateral branches, usually composed of several distinct lobes, furnished with an involucre by the growth of a few incurved accessory branches below.

On wharves and *Fuci*.

New York, *Harvey;* New Haven, *Professor Eaton;* Newport; New Bedford; Wood's Holl; Europe.

Apparently rather a common species, especially on wharves and *Fuci* at low-water mark. The species is easily recognized, when in fruit, by the polysporic tetraspores and by the favellæ, which are terminal, not lateral, as in the rest of our species, and have a sort of involucre formed by the growth of accessory ramuli from the cells just below the favellæ. When sterile the species may be recognized by the regular, broadly pinnate tips, at the end of nearly naked branches. We have found both polyspores and favellæ on American specimens; and in spite of the fact that our plants are always more slender than European forms of the species, there can be almost no doubt that we have the true *C. Borreri.* Whether all the sterile forms referred by American botanists to *C. Borreri* are correctly determined is doubtful. Some perhaps belong rather to *C. roseum.* The present species is placed by Bornet in the genus *Corynospora,* because of the terminal and involcurate favellæ and polysporic tetraspores. As writers differ about the limits of *Corynospora,* we have kept the species in *Callithamnion,* although in some respects it differs from the rest of the genus, and the young stages of the cystocarps remind one strongly of *Spermothamnion.* The fruit is, however, a true favella. The number of spores in the polyspores in American specimens rarely exceeds 8 or 10, whereas Nægeli puts the number as high as 20–28 in European specimens. As usually found in early summer, the species is small and delicate, but later it becomes coarse. Specimens collected as late as possible in the autumn are to be desired, and the number of spores in a polyspore should be ascertained more definitely. In Contributiones ad Algologiam et Fungologiam, p. 44, Pl. 23, Fig. 1, Reinsch describes and figures a *Callithamnion Labradorense,* which is said to have polyspores—whether a polysporic condition of *C. floccosum* or not can hardly be determined from the description.

Subgenus EUCALLITHAMNION.

Fronds erect, cortications generally present; antheridia in tufts, either on the nodes or internodes of the branchlets; tetraspores tripartite; favellæ usually binate, lateral.

Sect. I. Pennatæ.

Growth monopodial, fronds distichously pinnate, pinnæ alternate, cortications rudimentary or wanting.

C. roseum, (Roth), Harvey. (*C. roseum*, Phyc. Brit., Pl. 230.—*Phlebothamnion roseum*, Kütz.)

Fronds capillary, two to four inches high, filaments diffusely branched below, main branches slightly corticated, secondary branches long, flexuous, distichously pinnate, pinnæ crowded at the ends of the branches, long, spreading or slightly incurved; antheridia in tufts on the nodes of the branchlets; tetraspores tripartite, sessile on the branchlets; favellæ binate on the upper branches.

New York Harbor, *Mr. A. R. Young;* Wood's Holl, Mass.

There must remain some doubt as to the correct determination of American specimens of the present species in the absence of fruit of any kind. Sterile specimens of *C. roseum* are likely to be mistaken for varieties of *C. polyspermum* or *C. Borreri.* In *C. polyspermum* the pinnæ are short and subequal, so that the outline of the tips of the branches is linear or oblong, while in *C. roseum* the pinnæ, which are crowded at the ends of the branches are long, gradually diminishing in size towards the apex, so that the plumose tips are pyramidal or broadly ovate in outline. The filaments of *C. roseum* are finer and more nearly rose-colored than those of *C. Borreri,* and the pinnæ are less regularly distichous. Furthermore, there are no polyspores in *C. roseum,* and the favellæ are not terminal and subinvolucrate as in *C. Borreri.* All three of the species above named are distinct from the species of the following group in their distichously pinnate ramification, and all three are reddish, inclining to a brownish color. They collapse when removed from the water, but are hardly gelatinous, although all adhere well to paper in drying.

C. POLYSPERMUM, Ag. (*C. polyspermum*, Phyc. Brit., Pl. 231.—*Phlebothamnion polyspermum*, Kütz.)

Fronds capillary, cortications wanting, two to three inches high, main branches irregularly divided, with few secondary branches below, distichously pinnate above, branches linear or oblong in outline, simply pinnate, pinnæ alternate, short, subequal, incurved, upper pinnæ sometimes pinnulate; tetraspores tripartite, sessile on the upper side of branchlets; favellæ binate near the ends of the branches.

Hell Gate, N. Y.; Jackson Ferry, *Harvey;* Europe.

The only localities for this species within our limits are the two given by Harvey. We have seen Californian specimens collected by Mr. Cleveland near San Diego, but have never found the plant on the New England coast. The species is related to *C. roseum* and is distinguished from it by the short, subequal ultimate branches.

Sect. II. FRUTICOSA.

Growth sympodial, main axis and branches densely corticated: branchlets pectinate or pinnate, ultimate divisions alternate or secund.

C. TETRAGONUM, Ag. (*C. tetragonum*, Phyc. Brit., Pl. 136.—*C. brachiatum*, Harv., l. c., Pl. 13.—*Dorythamnion tetragonum*, Næg.)

Fronds monœcious, two to six inches high, coarse and spongy, shrublike, pyramidal in outline, color dark purple, main filaments densely corticated, smaller filaments monosiphonous; main axis percurrent, attached by a disk, pinnate with long, undivided, alternate branches, which are once or twice pinnate, the ultimate divisions beset on all sides with short, stout, incurved, acutely pointed, fasciculate branchlets; cells stout, not much longer than broad; antheridia in tufts on the upper internodes; tetraspores tripartite, sessile on the upper branchlets; favellæ binate.

Common on stones and algæ below low-water mark.

Long Island Sound; Europe.

Our most robust and coarsest species, not uncommon in Long Island Sound, but not yet recorded north of Cape Cod. The color is dark, and in the water almost black, and the substance is rather spongy, the plant not collapsing when removed from the water, as do most of the New England species of the genus.

C. BAILEYI, Harv. (*C. Baileyi*, Harv., Ner. Am. Bor., Part III, Pl. 35 *b.*—*Dorythamnion Baileyi*, Næg.) **Pl. XI, Figs. 1-2.**

Fronds monœcious, two to four inches high, setaceous, shrub-like, pyramidal in outline, color purplish red, main filaments densely corticated, the rest monosiphonous; main axis percurrent, attached by a disk, pinnate with long, undivided, alternate branches, which are once or twice pinnate, the ultimate divisions beset on all sides with rather slender, flexuous, recurved or incurved, fasciculate branches; cells several times longer than broad; tetraspores tripartite, sessile on the upper branchlets; antheridia in tufts on the upper internodes; favellæ binate.

Var. LAXA.

Cortications less marked than in the type, branchlets long and slender, divisions widely spreading below, fastigiate at the apex.

On *Zostera*, stones, sponges, and algæ below low-water mark.

Common from New Jersey to Cape Cod; Boston Bay, *Harvey;* Portland, *C. B. Fuller.*

As is suggested by Harvey in the Nereis Am. Bor., the present species is not only very variable in habit, but it is also difficult to distinguish some of the forms from *C. tetragonum.* We are inclined to believe that it would be better to consider the present species as a delicate form of *C. tetragonum*, in which the cells are longer and more slender, the branchlets less dense and robust, the color less inclined to blackish, and the substance more delicate. If we are to unite *Rhodomela subfusca, R. gracilis*, and *R. Rochei* in one species, as has been done by Agardh, with good reason as it seems, it would be equally correct to unite *C. Baileyi* and *C. tetragonum*, since the difference in habit might result from variations of habitat and season. With us, the form here referred to the typical *C. Baileyi* is more common than *C. tetragonum*, and is found on wharves, on *Zostera*, shells, and stones in rather warm waters and sheltered places, while *C. tetragonum* frequents places where there is a current of water, or grows on algæ in somewhat exposed pools. The var. *laxa* has a diffuse ramification and the cortications are not prominent, and we at one time supposed that it might be the *C. Dietziæ* of the Nereis, as far as we could recollect the specimens of that species in the Harveyan Herbarium at Dublin. In such cases, however, it is not safe to trust to one's memory, and in the present article we are unwilling to express an opinion about *C Dietziæ.*

Sect. III. BYSSOIDÆ.

Branching monopodial or dichotomous, cortications present at the base, ultimate branches decompound, very delicate, usually ending in a hyaline hair.

C. BYSSOIDEUM, Arn. (*C. byssoideum*, Phyc. Brit., Pl. 262.—*Phlebothamnion byssoides*, Kütz.—*Pœcilothamnion byssoideum*, Næg.)

Fronds globosely tufted, one to three inches high, filaments very delicate, slightly corticated at base, main branches many times divided, secondary branches long and flexuous, pinnate with numerous pinnately compound branchlets; antheridia sessile in tufts at the nodes of the branchlets; tetraspores tripartite, sessile on the upper side of branchlets; favellæ binate on the upper branches.

Var. UNILATERALE, Harv.

Fronds small and very delicate, branches and branchlets often secund.

Var. FASTIGIATUM, Harv.

Branches fastigiate, the lesser ones densely ramulose at the tips.

Var. WALTERSII, Harv.

Upper branches distichously compound-pinnate, branchlets patent.

On *Zostera* and different algæ.

Common in Long Island Sound; Gloucester, Mass.

The forms which have been referred on our coast to *C. byssoideum* and *C. corymbosum* are hopelessly confused. Although as described by algologists the two species are sufficiently distinct, in practice it is difficult to say where one begins and the other ends. According to the books, the ramification of the upper branches is dichotomous in *C. corymbosum*, whereas it is always alternately pinnate in *C. byssoideum*. In some of the forms of the last-named species, however, the tips are corymbose and the cells of the axis are short and zigzag to such a degree that the tips at least appear to be dichotomous. Of the two species in question, *C. corymbosum* is the less delicate and gelatinous, and is not so decidedly rose colored as *C. byssoideum*, but, as far as our present information goes, although in its typical form *C. byssoideum* is not only common—apparently more common than in Europe—but also easily recognizable, its extreme forms are not sufficiently well known. The Kützingian method would be to split the species up into four or five new species. According to Crouan and Bornet, this species has seirospores.

C. CORYMBOSUM, (Engl. Bot.) Lyngb. (*C. corymbosum*, Phyc. Brit., Pl. 272; Études Phycol., Pls. 32–35.—*Pœcilothammion corymbosum*, Næg.)

Fronds tufted, two to three inches high; filaments very delicate, cortications wanting except at base, main branches several times pinnately or irregularly divided, secondary branches pinnate with dichotomously-multifid, fastigiate branches which end in hyaline hairs; tetraspores tripartite sessile at the nodes of the branchlets, occupying the place of an ultimate branchlet; antheridia in tufts, sessile on the upper internodes; favellæ binate on the upper part of the branches.

Var. SECUNDATUM, Harv.

Lesser branches frequently secund, ultimate branchlets irregular, scarcely corymbose.

On *Zostera*.

Halifax, Boston Bay, New London, Providence, *Harvey*. The var. *secundatum*, Massachusetts Bay, Greenport, *Harvey*.

We have only quoted the localities given by Harvey, although we have found what we take to be *C. corymbosum* at Newport, Wood's Holl, and in considerable abundance at Nahant, always growing on *Zostera*. An examination of the different published exsiccatæ of European writers would lead one to think that several different species had been included under the name of *C. corymbosum*. One might doubt whether the form of Crouan, No. 139, and Areschoug, No. 15, belong to the same species. At Nahant the same form occurs as that distributed by French algologists.

C. DIETZIÆ, Hooper.

"Fronds capillary, pellucidly-articulate nearly to the base, the lower part percurrent, distichously-pinnate, stem veiny, branches alternate, simple, set at each node with short, alternate, subsimple or pinnato-dichotomous plumules, and often terminated by a dense fascicle of ramuli, rachides zigzag; articulations of the stem six or eight times, of the rachides three or four times, of the ramuli eight or ten times as long as broad; apices subattenuate, obtuse, or subacute; tetraspores elliptical, tripartite, solitary on the uppermost ramuli." (Ner. Am. Bor., Part II, p. 236.)

Greenport, *Mrs. Dietz.*

Only known through the description given by Harvey in the Nereis. Harvey states that it is related to *C. corymbosum* and *C. versicolor*. The specimens referred to Wood's Holl in Proc. Am. Acad., 1875, p. 376, were probably incorrectly determined.

SUBGENUS SEIROSPORA, Harv.

Fronds erect, main branches corticated; antheridia in tufts on the outer side of short branches; tetraspores tripartite; bispores and seirospores present; cystocarps destitute of enveloping jelly.

C. SEIROSPERMUM, Griff. (*Seirospora Griffithsiana*, Harv., Phyc. Brit., Pl. 21.—*Phlebothamnion seirospermum*, Kütz.—*C. versicolor*, var. *seirospermum*, Harv., in Hooker's Journ. Bot.; *Pœcilothammon seirospermum*, Næg.)

Fronds diœcious, capillary, two to six inches high, pyramidal in outline, main axis percurrent, pinnate with alternate, undivided, lateral, branches, which bear secondary branches beset with delicate, erect, dichotomo-multified, corymbose branches, main branches corticated, smaller branches monosiphonous and byssoid; antheridia in tufts on the outside of short branchlets; tetraspores tripartite, sessile on the upper branchlets, sometimes replaced by bispores; seirospores oval, in moniliform tufts at the ends of the branches; cystocarps composed of radiating chains of spores without gelatinous envelope (Bornet.)

On *Zostera*, shells, and stones below low-water mark.

Common throughout Long Island Sound; Salem, Mass., *Harvey.*

One of the commonest and most beautiful of the genus south of Cape Cod, but only known in one locality north of the Cape. It is often brought up on fishermen's nets, and, as a rule, inhabits deeper water than most of the genus. It often attains the height of four or five inches, and is broadly pyramidal in outline. The main branches are rather stout and distinctly corticated, but the ultimate ramifications are very soft and flaccid. With us seirosporic specimens are very common, making the species easily distinguishable, but no form of tetraspore or bispore has been observed on American specimens. According to Bornet, tetraspores, bispores, and seirospores sometimes occur on the same individual. From a comparison of our plant with authentic European specimens there can be no doubt of the specific identity of the two. Accepting the account of the cystocarps given by Bornet, it is extremely doubtful whether the species should be kept in the present genus, and perhaps the genus *Seirospora* should be restored, not, however, as originally adopted by Harvey.

SPECIES INQUIRENDÆ.

C. TENUE, Harv., Ner. Am. Bor., Part III, p. 130. (*Griffithsia tenuis*, Ag.)

"Filaments tufted, ultra-capillary, irregularly much branched, diffuse, flexuous, the branches and their divisions very generally secund, springing from the middle of the internodes; ramuli few and distant, patent, filiform, beset toward the attenuated apices with whorls of minute byssoid fibers; articulations cylindrical, those of the branches 4–6 times, those of the ramuli 3–4 times as long as broad, and gradually shorter towards the extremities."

Beesley's Point, N. J., *Harvey*.

Two specimens which can probably be referred to the present species have been received from Nantucket, one presented by Mrs. Lusk, the other by Mr. Collins. In the absence of fruit the genus cannot be determined. Nægeli, in Beiträge zur Morphologie und Systematik der Ceramiceæ, says that the tetraspores are terminal on a single-celled pedicel. According to Harvey, the species is distinguished by the branches, which are all given off from the middle of the internodes of the branches of the preceding grade. Nægeli says that this species has normal branches like those of *Griffithsia barbata*, and he regards those given off from the internodes as adventive branches.

C. TOCWOTTONIENSIS, Harv. MSS., *fide* Bailey.

Providence, *Bailey*; Warwick, *Hunt*.

As far as we know, this species, mentioned by S. T. Olney in his List of Rhode Island Plants, fortunately for printers and the throats of American algologists, has never been described.

GRIFFITHSIA, Ag.

(Named in honor of *Mrs. Griffiths*, of Torquay.)

Fronds filiform, monosiphonous, without cortications, dichotomously branching, branches of two kinds, the vegetative of indeterminate, the fructiferous of determinate growth; antheridia sessile and covering the upper surface of the terminal cells in tufted whorls at the nodes, or in densely whorled pyramidal tufts on involucrate branches; tetraspores tripartite, clustered in involucrate whorls at the nodes or on the inner side of short fascicled branches; cystocarps (favellæ) involucrate.

A beautiful genus, comprising between 30 and 40 species, but only represented on our Eastern coast by a single species and on the Western coast by two doubtfully determined species. The genus is distinguished from *Callithamnion* by the involucrate favellæ and by the disposition of the tetraspores. As we have *Spermothamnion* separated from *Callithamnion* in consequence of the absence of the gelatinous envelope found in true favellæ, so we have *Bornetia* separated in a similar way from *Griffithsia.* The genus can generally be recognized at sight by the rather large but very delicate cylindrical, oval, or, at times, globose cells, which do not bear immersion in fresh water even for a short time, and by the branching, which is dichotomous or a modification of the dichotomous type. The accurate specific determination from sterile specimens alone is generally impossible, so great is the resemblance of the fronds in the different species. The antheridia vary very much in the different species. In our only species they are sessile on the upper half of the globose terminal cells; in *G. corallina* they surround the nodes in tufts; and in *G. setacea* they are in dense approximate whorls, attached to the inner side of incurved branchlets. The tetraspores also vary in the different species. In *G. Bornetiana* and *G. corallina* they are in whorls at the nodes, and are attached to the inner side of short simple branches, which form a whorl around the node. In *G. setacea* the tetraspores occupy a position which corresponds to that of the antheridia. The favellæ are always truly involucrate and, as far as is known, terminal, in our species occupying the place of a suppressed dichotomy. The development of the procarp of *C. corallina* has been fully studied by Janczewski. In that species he found two trichogynes to each carpogenic system, as is also the case in the genus *Ceramium.* A non-sexual mode of propagation, by means of cells which give off root-like processes, has been described by Janczewski in *G. corallina*, and a similar process takes place in *G. Bornetiana.*

G. Bornetiana, Farlow. (*G. corallina ?* Harv., Ner. Am. Bor., Part II, p. 228, non Agardh.—*G. globulifera*, Kütz., Tab. Phyc., Vol. XII, Pl. 30.—*G. globifera*, J. Ag. in part.—*G. Bornetiana*, Proc. Am. Acad., 1877.)

Exs.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 88.

Fronds diœcious and dimorphous.

Male plant.—Globosely tufted, one to three inches high; filaments repeatedly dichotomous; lower cells cylindrical-obovoid, several times longer than broad, becoming shorter and broader above; terminal cells globose-pyriform; antheridia sessile, densely covering the upper half of terminal cell. **Pl. X, Fig. 4.**

Female plant.—Two to five inches high, loosely tufted, filaments repeatedly dichotomous; lower cells cylindrical-obovoid, becoming broadly pyriform above and then gradually diminishing in size toward the tip; favellæ solitary on the upper part of the superior cells; cells of involucre 10–20, unicellular, club-shaped, somewhat incurved. **Pl. XI, Fig. 3.**

Tetrasporic plant.—More slender than the female plant; tetraspores tripartite, densely clustered around the nodes of special branches; cells of involucre short and suberect. **Pl. X, Fig. 5.**

On wharves, sponges, shells, and occasionally on *Zostera.*

Common from Nantucket southward.

A summer plant which attains perfection during the month of July, disappearing later in the summer. It is sometimes found washed ashore in large quantities after a storm. The species has been known for some time, but until recently it has passed for a form of *G. corallina*, a species common in Europe. It differs from that species in several respects. The antheridia form a sort of cap over the top of the terminal cells of the male plant, which is considerably smaller than the female plant and has a different habit, in consequence of which it was called a variety, var. *globifera*, by Harvey. The female and tetrasporic plants more closely resemble the true *G. corallina*. They do not end in large globose cells, as in the male plant, but the largest cells are below the tip, which is tapering and acute. When the tetrasporic plant has narrower and more acute cells than usual it constitutes the var. *tenuis* of the Nereis. The slenderest specimens, however, are usually sterile. In the structure of the procarp this species differs considerably from *G. corallina* as described by Janczewski. There is only one trichogyne instead of two, as in the last-named species. The procarp begins by the growth of a hemispherical cell at the upper part of an articulation. The cell is then divided into two parts by a partition parallel to the base. It is from the lower cell thus formed that the involucre is formed, and from the upper arise the carpogenic cells in the following way: By usually four oblique partitions there are formed four external hemispherical cells and a central pyramidal cell with a broad base. By subsequent division of one of the hemispherical cells, generally of the one lying nearest the axis of the plant, there is cut off a cell which divides into three smaller granular cells, the upper of which grows into a trichogyne. The spores are formed by the subsequent growth of the other three hemispherical cells. There are two sets of hair-like organs which arise from the upper border of the cells in this species; one set is short and granular, consisting of a cuboidal basal cell with short corymbose filaments; the other set occupies a similar position, but the hairs are long and hyaline, consisting of a long basal cell, which bears at its apex a whorl of three or more cells, which in turn bear other whorls, the whole hair being several times compound.

HALURUS, Kütz.

(From *αλς*, salt, and *ουρα*, a tail.)

Fronds monosiphonous, branching, beset throughout with short, approximate, incurved, di-trichotomous, whorled, secondary branches; tetraspores tripartite, attached to the inner side of special branches, arranged in whorls one above another; antheridia in similar position, forming closely verticillate tufts; favellæ terminal on short branches.

A genus composed of one, or according to some writers two, species, separated from *Griffithsia* principally by the character of the frond.

H. EQUISETIFOLIUS, Kütz. (*Griffithsia equisetifolia*, Ag.; Phyc. Brit., Pl. 67.)

Fronds four to eight inches long, arising from a disk, irregularly branching, secondary branches trichotomous below, dichotomous above, much incurved, densely covering the branches, rhizoidal descending filaments given off from some of the lower branches.

Brooklyn, N. Y.?

A plant resembling a *Cladostephus*, except that its color is a dirty red. The species is very doubtfully known on our coast. It is mentioned in the Nereis as having been sent to Harvey by Mr. Hooper, of Brooklyn, but there is no definite information as to the locality where the plant was collected.

PTILOTA, Ag.

(From πτιλωτος, feathered.)

Fronds compressed, ancipital, decompound, branches distichous, pectinate-pinnate, composed of a monosiphonous pinnate axis of larger quadrate cells and a cortex of smaller cells; antheridia terminal on short corymbose branches; tetraspores tripartite; cystocarps (favellæ) terminal on the branches, usually involucrate.

An easily recognized genus, comprising about twenty species, of a deep red or reddish-brown color, only scantily represented on our coast, but represented on the Californian coast by a number of beautiful species. The genus reaches its greatest development in Australia. The growth is by an apical cell, from which arises a monosiphonous axis of indefinite growth and short secondary branches. The origin of the cortications has been fully explained by Nægeli in Die neuern Algensysteme, page 206. The monosiphonous axis is clearly seen on holding specimens up to the light, and is also visible at the growing tips where the cortications are wanting. The cortications do not form a true solid tissue, but rather, as shown by Nægeli, densely interwoven branching filaments. A detailed account of the development of the frond in different species is given by Cramer in Physiologisch-systematische Untersuchungen über die Ceramiaceen. The development of the procarp is given by Bornet in Notes Algologiques, page 15. The position of the tetraspores is variable, and serves as a specific mark.

P. ELEGANS, Bonnem. (*Ptilota sericea*, Harv., Phyc. Brit., Pl. 191.—*P. plumosa*, var. *tenuissima*, Ag.)

Fronds brownish red, three to six inches high, main branches filiform, irregularly branching, secondary branches compressed, closely pinnate, with opposite pinnate branchlets, ultimate divisions without cortication; favellæ terminal on the branches, irregularly lobed, naked or with a short involucre; tetraspores solitary on the ends of the branchlets, at first tripartite, becoming polysporic.

On the under side of rocks between tide-marks and on shells and algæ in deep water.

Throughout our whole limit; Europe.

A much more delicate species than the next, and recognized at once by the fact that the younger parts of the branches are without cortications, whereas in the next species the cortications extend nearly to the apex. It also differs in the position of the tetraspores, and the favellæ are usually naked, while in the following species they are surrounded and almost concealed by a well-marked involucre. The usual color is a grayish black, but in fading it often becomes pinkish. North of Cape Cod the species is usually found clinging to the under surfaces of rocks at low-water mark, in company with *Ceramium Hooperi*, *Rhodochorton Rothii*, and *Sphacelaria radicans*. In such situations the specimens are small. At Newport and Gay Head the plant attains a much larger size, and is abundantly washed ashore from deep water.

P. SERRATA, Kütz.

Fronds dark red, three to six inches long, compressed, ancipital, decompound-pinnate, pinnæ opposite, one pinna being short, undivided, straight or falcate, sharply serrate, especially on the lower side, and the opposing pinna pinnately divided or compound; pinnæ nearly at right angles to the axis, apices acute; tetraspores borne in dense ellipsoidal cluster either at the ends of the simple pinnæ or on the serrations and tips of the compound pinnæ; tetrasporic masses interspersed with monosiphonous incurved branches; favellæ in similar position to the tetraspores, nearly concealed by the large, incurved, usually serrate divisions of the involucre.

On algæ, especially on stems of *Laminaria*, below low-water mark.

Common north of Boston; Thimble Islands, near New Haven, and dredged off Block Island, *Prof. Eaton.*

A common and characteristic alga of our northern coast, extending through Greenland to the northern coast of Europe, and also found in the North Pacific. The present species, together with *Euthora cristata* and *Delesseria sinuosa,* form the greater part of the specimens collected for ornamental purposes by ladies on the Northern New England coast. *P. serrata,* when dried, is usually very dark colored, unless it has previously been soaked for some time in fresh water, and it does not adhere well to paper unless under considerable pressure. It cannot be mistaken for any other species growing on our coast. Whether it is a variety of *P. plumosa* is a question about which writers do not agree, but, although in this connection our form has been kept as a distinct species, it is highly probable that it is really nothing more than a coarser northern form of *P. plumosa.* The typical form of *P. plumosa* is certainly unknown in New England. The type is more slender, and the pinnæ are pectinate, not serrate. The position of the fruit is the same, the principal difference being in the more strongly marked involucre of the favellæ and in the tetraspores, which are borne on densely fastigiate branches, which have no cortications, and some of which are incurved and project beyond the general sporiferous mass. In *P. plumosa* the tetraspores are also borne on the tips of monosiphonous branches, but they are not densely conglomerate, nor are the projecting incurved ramuli prominent. The present species is very rare south of Cape Cod, being known in only two localities and in a much reduced form.

CERAMIUM, Lyngb.

(From *κεραμιον,* a small pitcher.)

Fronds filiform, dichotomous or occasionally subpinnate, monosiphonous, composed of a series of large ovate or quadrate cells, with bands of small corticating cells at the nodes, and in some species also extending over the internodes; antheridia forming sessile patches on the upper branches; tetraspores tripartite, formed from the corticating cells; cystocarps (favellæ) sessile at the nodes, usually involucrate.

A universally diffused and easily recognized genus, of which, however, the species are by no means easily recognized. The genus is distinguished by the monosiphonous, dichotomous frond, with bands of small corticating cells at the nodes, or, in some cases, covering the internodes as well. The tips of the filaments are forked and usually decidedly incurved, whence the generic name is derived. The apical growth and formation of the cortex is fully detailed by Nægeli and Cramer in Pflanzenphysiologische Untersuchugen, Part IV. The procarp in *Ceramium* is furnished with two trichogynes and a single carpogenic cell formed from the cortical cells on the convex side of the tips of the branches. The genus has been split up into a number of different genera by Kützing, but by most writers his divisions are only accepted as subgenera. Sterile specimens are not easily determined and it is always desirable to have tetrasporic plants. Although we have an abundance of the genus on our coast, the number of species is comparatively small, and the group of species having spines at the nodes is, as far as is known, quite wanting.

SECT. I. *Fronds without spines, cortical cells decurrent from the nodes and more or less completely covering the internodes.*

C. RUBRUM, Ag. (*C. rubrum*, Phyc. Brit., Pl. 181.)

Fronds robust, dichotomous, subfastigiate, branches erect, apices incurved or forcipate, nodes contracted below; tetraspores in irregular series at the nodes, immersed; favellæ lateral, solitary, with a short involucre.

Var. PROLIFERUM, Ag. (*C. botryocarpum*, Phyc. Brit., Pl. 215.)

Fronds beset on all sides with numerous, lateral, simple or forked branchlets.

Var. SECUNDATUM, Ag.

Branchlets generally secund.

Var. SQUARROSUM, Harv.

Fronds small, regularly dichotomous, fastigiate, with very few, short, lateral branchlets, lower divisions distant, spreading, upper divisions close together, widely spreading, apices often revolute.

Everywhere common; var. *squarrosum* on *Zostera*, Massachusetts Bay.

A ubiquitous and variable species, of which we have enumerated only the principal forms. The typical form is easily recognized, and the same is true of most of the varieties. The var. *decurrens* has the internodes partly naked, especially in the upper part. The var. *decurrens* of the Nereis is referred by Agardh to the next species, and is distinguished from the true var. *decurrens* of *C. rubrum*, which has immersed tetraspores, by the large tetraspores arranged in a regular circle at the nodes and projecting decidedly above the surface.

C. CIRCINNATUM, Kütz.

Fronds setaceous, dichotomous, fastigiate, divisions erect, patent, apices forcipate, internodes partly corticated by the cells which are decurrent from the nodes; tetraspores large, projecting in a ring around the upper nodes.

Glencove, L. I., *Mr. Young*; Dartmouth, Mass., *Miss Ingraham*; Magnolia, Mass., *Mrs. Bray*.

Agardh, in his Epicrisis, refers to the present species the *C. decurrens* of Harvey (Phyc. Brit., Pl. 276), which in the Nereis Am. Bor., is made a variety of *C. rubrum*. There is a var. *decurrens* of *C. rubrum* which is admitted by Agardh, which, if we understand correctly, has small immersed tetraspores. This form occurs also with us, but we have no notes as to the locality. To the present species we refer forms in which the upper internodes are scarcely corticated at all and in which the large, projecting tetraspores are in a single ring at the upper nodes.

SECT. II. *Fronds without spines, cortical cells confined to a definitely limited band round the nodes, the internodes diaphanous.*

C. DIAPHANUM, Roth; Phyc. Brit., Pl. 193.

Fronds brownish red, filaments two to four inches high, loosely tufted, main branches setaceous, rather stout, distantly forking, beset with short, lateral, dichotomous branchlets, apices incurved; tetraspores immersed, in whorls at the nodes; favellæ lateral, involucrate.

Nahaut, New Bedford, Mass.; Providence, R. I.; New York Bay, *Harvey;* Europe; California.

The localities given are quoted from the Nereis. As far as our own experience goes, the present species is of very infrequent occurrence on the New England coast, although we have specimens collected at Lynn, Mass., and others from the vicinity of New York, collected by Mr. A. R. Young, which may possibly be referred to *C. diaphanum.* In almost all cases the *C. diaphanum* of American collectors is the *C. strictum* of the Phycologia Britannica a species closely related to the present, and agreeing with it in the fructification, but differing in ramification. *C. diaphanum* has rather stout leading branches, which are beset with secondary dichotomous branches which are alternately given off from the main branches, and which are much finer than the main branches, the tips being capillary. The general outline of the frond is pyramidal, and that of the principal branches and their ramifications is oval-elongated. In *C. strictum* there are no leading branches, but the filaments are of a pretty nearly uniform diameter, regularly dichotomous throughout, and form globose tufts. Both species differ from our other species, except *C. Hooperi,* in being of a brownish-purple rather than of a distinctly rose-colored tint, and both adhere closely to paper in drying.

C. STRICTUM, (Kütz.) Harv. (*C. strictum*, Phyc. Brit., Pl. 334.—*Gongroceras strictum*, Kütz.)

Fronds brownish red, filaments capillary, two to six inches high, densely tufted, branches uniformly dichotomous throughout, divisions erect, fastigiate above, apices forcipate; tetraspores immersed, whorled at the nodes.

On *Zostera* and other marine plants.

Common from New York to Cape Cod.

This species forms large tufts at the base of *Zostera* in warm, shallow bays, and is often in company with *Polysiphonia Olneyi.* In the Little Harbor at Wood's Holl it is found in large quantities, after a heavy blow, lying unattached on the mud, just below low-water mark.

C. HOOPERI, Harv. (*C. Hooperi*, Harv., Ner. Am. Bor., Part II, p. 214.—*C. Deslongchampsii*, Farlow, in Report U. S. Fish Comm., 1875.)

Fronds dark purple, one to four inches high, filaments procumbent and densely interwoven at base, above dichotomous, with short, erect, irregularly placed lateral branches, apices straight, erect, cortical cells forming a sharply defined band at the nodes, axile cells short above, becoming twice as long as broad below; rhizoidal filaments unilateral, single at the nodes, numerous, usually unicellular, often ending in irregular disks; tetraspores in a circle at the nodes, immersed in the cortical cells; favellæ?

Forming tufts on mud-covered rocks at low tide.

New Haven, *Prof. Eaton;* near New York, *Mr. Young;* Newport, R. I.; common from Nahant to Eastport.

This species is not, as Harvey and Agardh supposed, very distinct, but, on the contrary, can scarcely be distinguished from *C. Deslongchampsii*, except in the tetraspores, which are immersed, not projecting as in that species. Both species inhabit similar localities, both are deep purple in color, are procumbent at the base, and have numerous rhizoids; the branching and erect tips are the same in both. Furthermore, as it occurs with us, *C. Hooperi* not unfrequently bears precisely such irregular botryoidal masses as are found on *C. Deslongchampsii* in Europe, and which are figured in the Phycologia Britannica. Harvey, as well as Nægeli and Cramer, doubts whether these masses are really favellæ, and, judging from American specimens, they are more probably monstrosities. In one case we found the distortions on a specimen bearing tetraspores, and Nægeli and Cramer have observed a similar case, a presumption against the favelloid nature of the swellings. Fully-matured tetraspores are to be desired, and it may be that they will be found to be prominent, as in *C. Deslongchampsii*, in which case the validity of the species would be more than doubtful.

C. FASTIGIATUM, Harv., Phyc. Brit., Pl. 255.

Fronds lake-red, densely tufted, two to five inches high, filaments capillary, dichotomous throughout, divisions erect, level-topped, apices erect or slightly incurved; tetraspores secund on the outer side of the branches, prominent; favellæ small, lateral, with a short involucre.

On *Zostera.*

Massachusetts Bay; Greenport; Newport; Long Branch, *Harvey.*

This species is at present a puzzle. In American herbaria one frequently finds specimens labelled *C. fastigiatum*, and some specimens bear Harvey's own handwriting. Unfortunately, the species is persistently sterile, for we have only twice found tetraspores in what seemed to be this species, and sterile specimens are hardly sufficient for determination in the genus *Ceramium*. What was apparently considered by Harvey to be his *C. fastigiatum* is common south of Cape Cod and forms beautiful tufts on *Zostera*. The color is a lake-red, the filaments are all capillary and regularly dichotomous, the upper segments being level-topped, so that when spread on paper the species has a regular outline. The apices are erect, not rolled inwards at the tip, and short rhizoidal processes are given off from some of the nodes. Harvey states that the tetraspores are prominent and secund on the outer edge of the branches, while Agardh says they are whorled at the nodes. In one specimen we found them as described by Harvey. It must be admitted that when sterile the species approaches too near *C. tenuissimum*, and it is much to be desired that a large set of fruiting specimens be examined to settle the disputed question of the tetraspores. *C. fastigiatum* is a species apparently not well known to continental botanists, who seem to have at times included it in other species without reference to British specimens. With us it is common, although, considering that there may be a doubt about the determination, we have only quoted the localities given by Harvey. By Agardh *C. fastigiatum* is considered closely related to *C. Deslongchampsii*, but judging by Harveyan specimens, both from Ireland and New England, we can hardly think that the two species are immediately related.

C. CORYMBOSUM, Ag.

"Fronds capillary, rather regularly decompound-dichotomous, branches erecto-patent, corymbose, fastigiate, apices forcipate, lower joints four to five times longer than broad, upper joints subequal; tetraspores naked, emergent, secund on the outer side of the branches, lower portion resting on the cortical layer." (Agardh, Epicrisis, p. 93.)

Atlantic coast of North America.

This species is said by Agardh to resemble *C. fastigiatum* in its ramifications, but with more expanded branches, and to differ in having a violet color and a different arrangement of the tetraspores. From this it would appear that the two species are practically distinguished by the different position of the tetraspores. With regard to their position in *C. fastigiatum*, as has already been said, Agardh and Harvey do not agree.

C. TENUISSIMUM, (Lyngb.) Ag.

Fronds rosy-red, two to four inches high, densely tufted, capillary, decompound-dichotomous, branches erect, patent, apices forcipate; tetraspores borne on the swollen nodes, usually on the outer side, often several together; favellæ lateral, involucrate.

Var. ARACHNOIDEUM, Ag.

Fronds more slender than in the type, tetraspores exserted, secund on the outer side of the branches, solitary or several together.

Var. PATENTISSIMUM, Harv.

Fronds small, dichotomies distant and patent, the branches ending in dichotomo-multifid, divaricating, corymboso-fastigiate branchlets.

On *Zostera* and algæ.

Common in Long Island Sound; Gloucester, Mass., *Mrs. Davis;* Europe.

The present species, according to Agardh, includes the *C. nodosum* of the Phycologia Britannica, but Harvey's plate certainly does not correctly represent the tetraspores of the typical form of the species. In the type the nodes are swollen, especially on the upper margin, and the rather large tetraspores project beyond the cortical cells, usually on the outer side of the node, and there are frequently from two to four together. In the var. *arachnoideum* the tetraspores become almost naked, being only slightly covered by the cortical cells in their lower part. The var. *patentissimum* of Harvey has a somewhat different ramification from the type. It must be admitted that the limits of *C. tenuissimum* are not well marked, and it may be that in the present case we have confused two distinct species.

C. CAPRI-CORNU, (Reinsch). (*Hormoceras Capri-Cornu*, Reinsch, Contrib. ad Alg. et Fung., p. 57, Pl. 47.—*C. Youngii*, Farlow, Rept. U. S. Fish Comm., 1875.)

Fronds brownish purple, one to three inches high, filaments setaceous, repeatedly dichotomous, divisions erecto-patent, ultimate divisions subfastigiate, apices much incurved, branches beset throughout with very short incurved or recurved branchlets, cells in upper part scarcely as long as broad, two to three times as long below, corticating cells forming a sharply defined band at the nodes; tetraspores and favellæ?

In eight feet of water.

Canarsie, L. I., *Mr. A. R. Young.*

This curious species has unfortunately never been found in fruit. We have only seen three specimens, which were all collected by Mr. Young. The largest was about three inches high and the filaments were coarser than those of *C. diaphanum* and *C. strictum.* It is easily recognized by the numerous short incurved branchlets which arise singly or in twos and threes at the nodes. It is possible that a large series of specimens would have shown that the present is a form of some other species, but when received from Mr. Young in 1875 it seemed so distinct that the name *C. Youngii* was given to it, and under that name it was mentioned in the Report of the U. S. Fish Commission for 1875, but without any description. The *Hormoceras Capri-Cornu* of Reinsch, from Anticosti, judging from the plate and description in the Contributiones, published in 1874–'75, is apparently the same as *C. Youngii,* and the name of Reinsch has the priority.

Suborder SPYRIDIEÆ.

Fronds filiform, monosiphonous, formed of longer branching filaments of indeterminate growth, from which are given off short, simple branches of determinate growth, cells of main filaments corticated throughout, the secondary branches corticated only at the nodes; antheridia borne on the secondary branches, arising from the nodes and finally covering the internodes; tetraspores tripartite, borne at the nodes of secondary branches; cystocarps subterminal on the branches, consisting of obovate masses of spores in dense whorls around the central cell, with a pericarp formed of monosiphonous filaments packed together in a gelatinous substance.

An order consisting of a single genus and a small number of species, most of which are tropical. The systematic position of the order is a matter of dispute. The fronds resemble closely those of the *Ceramieæ*, as do also the tetraspores, but the cystocarps are peculiar and not closely related to those of any other order. A section of the mature fruit, which is usually either two or three parted, shows a monosiphonous axis, around the upper cells of which the spores are arranged in irregularly whorled groups. The whole is surrounded by a wall, which is formed by the union, by means of a jelly, of the elongated tips of subdichotomous filaments which arise from the cortical cells of the nodes just below the sporiferous cells. The antheridia are first formed at the nodes, but soon extend over the internodes for a considerable distance. The development of the frond is fully given by Cramer, l. c. In the Nereis the order is placed next to *Ceramiaceæ,* and in the Epicrisis of Agardh between the *Dumontiaceæ* and the *Areschougieæ.*

SPYRIDIA, Harv.

(From σπυρις, a basket.)

Characters those of the genus.

S. FILAMENTOSA, Harv., Phyc. Brit., Pl. 46. **Pl. X, Fig. 1, and Pl. XII, Fig. 2.**

Fronds filamentous, in expanded tufts four to eight inches high, branches irregularly placed, spreading, repeatedly divided, secondary branches subequal, spirally inserted, ending in a mucronate tip composed of two or three hyaline cells; tetraspores tripartite, sessile at the nodes of branchlets, solitary or clustered; cystocarps two or three lobed.

Var. REFRACTA, Harv., Ner. Am. Bor., Part III, Pl. 34 *a*.

Fronds robust, subdichotomous, the branches naked, divaricating, with very wide axils, arched, the terminal ones frequently revolute.

On *Zostera*, wharves, and mud below low-water mark.

Common from Cape Cod southward; Massachusetts Bay, *Harvey;* most warm seas.

Rather a beautiful species when growing, but which becomes brownish in drying and does not adhere very well to paper. It does not collapse when removed from the water, but remains covered with drops which adhere to the branchlets. The branches, although rather coarse, are brittle. The species is more common in Long Island Sound than in Europe, certainly than on the Atlantic coast. It may be recognized under the microscope by the monosiphonous corticated branches and hyaline branchlets, corticated only at the nodes and with a mucronate tip. The antheridia, of which, so far as we know, no description has hitherto been given, surround the branchlets, covering several cells near the base. They arise from divisions of the cortical cells, which form closely packed, short filaments, and extend over the internodes, those from the different nodes becoming confluent. The individuals which bear the cystocarps are distinct from those which bear the antheridia, and may be recognized by their more dense habit.

SUBORDER CRYPTONEMIEÆ.

Fronds solid or becoming hollow with age, cylindrical, compressed or membranaceous; antheridia forming superficial spots or small tufts; tetraspores usually cruciate and scattered in the cortical layer, sometimes in localized spots; cystocarps consisting of a single mass of irregularly placed spores surrounded by a gelatinous envelope, but not provided with a special cellular pericarp, immersed in the substance of the frond, spores discharged by a narrow passage formed between the cells of the cortex.

An order comprising about 14 or 15 genera and between 125 and 150 species, most of which are inhabitants of warm seas, and vary in consistency from subgelatinous to coriaceous and cartilaginous. Our only two species belong to the tribe *Nemastomeæ*. There are numerous species on the Californian coast, nearly all difficult of determination owing to the great variation in shape. The suborder approaches very closely to the *Ceramieæ*, since the cystocarps are in many of the species true favellæ, which, instead of being naked, are concealed in the fronds. It is in fact merely an arbitrary matter whether one places *Gloiosiphonia* in one suborder or the other. The fronds are more complicated than those of the *Ceramieæ*. In genera like *Gloiosiphonia* and *Nemastoma* there is an axis formed respectively of a monosiphonous filament or bundle of filaments, and an ill-defined cortex formed simply of the loosely united lateral filaments. In other genera, as in *Halymenia*, the cortex is more distinctly marked, and in *Prionitis* and *Cryptonemia* the frond is dense and coriaceous.

GLOIOSIPHONIA, Carm.

(From γλοιος, sticky, and σιφων, a tube.)

Fronds monœcious, gelatinous, cylindrical, branching, solid above, and formed of a monosiphonous axis, whose cells in their central portion bear whorls of four secondary branches, which divide so as to form umbels, which collectively form the cortex; descending filaments formed from the lower part of secondary branches; lower portion of fronds hollow; tetraspores cruciate, borne at the summit of the cortical filaments; antheridia forming spots on the surface of the fronds; cystocarps borne on the lower part of the cortical filaments, consisting of tufts of branching, radiating filaments densely packed in a single mass and surrounded by jelly.

A genus containing but a single certainly known species, found both in Europe and this country. The genus has been placed by some writers in the *Cryptonemieæ* and by others in the *Ceramieæ*. It in fact connects the two suborders, the fruit being a favella in which the spores all arrive at maturity at the same time, forming, in the terminology of some algologists, a simple nucleus. The ripe cystocarps are concealed in the frond, as in the *Cryptonemieæ*, but, on the other hand, the structure of the so-called cortical layer is like the outer portion of *Dudresnaya*, which is generally placed in the *Ceramieæ*. A detailed account of the development of the cystocarp in *G. capillaris* will be found in Notes Algologiques, p. 41.

G. CAPILLARIS, Carm. (*G. capillaris*, Carm., Phyc. Brit., Pl. 57; Notes Algologiques, Pl. 13.)

Fronds gelatinous, four inches to a foot long, solid above, hollow below, main branches subsimple, terete, naked below, densely beset above with decompound lateral branches, branchlets tapering at both extremities; cystocarps abundant, frequently forming nodosities.

In pools below low-water mark.

New London, *Harvey;* Nahant, *W. G. F.;* Chelsea, *Miss Brewer;* Gloucester, *Mrs. Bray* and *Mrs. Davis;* Hampton Beach, *Dr. Durkee;* Peak's Island, Maine, *Prof. Goode.*

A widely diffused but locally rare species, found in early summer and disappearing in August. It is easily recognized at sight by its delicate gelatinous substance and brilliant rose color and by the tapering branchlets. Cystocarpic specimens are not unfrequently found, but tetrasporic plants are rare and have never been observed in this country. The species shrinks very much in drying and adheres closely to paper.

NEMASTOMA.

(From νημα, a thread, and στομα, a mouth.)

Fronds gelatino-carnose, compressed-cylindrical or plane, dichotomous or subpinnate, composed of an axial layer of densely woven longitudinal filaments, from which are given off short, lateral, dichotomous, fastigiate filaments, which are united by a gelatinous substance to form a peripheral layer; tetraspores cruciate, borne in the peripheral layer; antheridia borne on the superficial cells of the periphery; cystocarps (favellæ) buried in the peripheral layer, spores escaping by a narrow opening between the peripheral filaments.

A genus comprising not far from a dozen species, which inhabit principally the warmer waters of the globe, the genus being particularly well represented in Australia. The fronds of the different species vary from only slightly compressed and linear to broad and palmate, and in *G. marginifera* the frond resembles in shape that of *Rhodymenia palmata*. The substance is rather gelatinous and the microscopic structure resembles very closely that of the fronds of some of the *Nemalieæ*. The fruit of *N. marginifera* is described by Bornet, in Notes Algologiques, as being a true favella like that of *Callithamnion*. The genus is generally placed near *Gloiosiphonia*, and, like that genus, closely connects the *Ceramieæ* with the *Cryptonemeæ*.

N. (?) Bairdii, Farlow, Proc. Am. Acad. Arts and Sciences, 1875, p. 351.

Fronds purplish-rose colored, gelatinous, four inches long, one inch wide below, vermiform, once or twice dichotomously divided, axils acute, apices attenuated; tetraspores cruciate, borne on the tips of the peripheral filaments; cystocarps

Washed ashore at Gay Head, *W. G. F.*

A very rare species, of which only a single specimen is known. It was found on the beach near the light-house at Gay Head, Mass., in company with *Scinaia furcellata*, in August, 1871. The specimen was a fragment, without the base of the plant, but with abundant tetraspores, which were borne on the tips of the peripheral filaments. In the absence of cystocarpic specimens the genus cannot be ascertained with certainty, and botanists who visit Gay Head, should seach for the plant by dredging off the Devil's Bridge in five to ten fathoms. The specimen collected was at first supposed to be a portion of a broad specimen of *Nemalion purpureum*, a species not yet known on our coast. The peripheral filaments are loosely united together by a gelatinous mass, as in the subgenus *Gymnophlœa* of Agardh.

Suborder DUMONTIEÆ.

Fronds tubular, branching or proliferous; cystocarps immersed in the frond, composed of a single mass of irregularly placed cells, similar in most respects to those of the *Cryptonemieæ*.

A small suborder, included by Harvey in the *Cryptonemieæ*. The development of the cystocarps is not well known, and on our coast there is no material to be obtained for the study of the suborder. The common *Dumontia filiformis* of Northern Europe is wanting with us, and the genus *Halosaccion*, of which we have one representative, has never yet been found with cystocarpic fruit, the genus being referred to the present suborder in consequence of the resemblance of the frond to that of *Dumontia*. According to Bornet, the spores in *D. filiformis* are borne directly on the carpogenic cell, whereas in the nearly related genera of *Cryptonemieæ* there are sterile cells between the spores and the carpogenic cell.

HALOSACCION, Kütz.

(From αλς, the sea, and σακκιον, a small sack.)

Fronds hollow, tubular or sack-shaped, simple or proliferously branched, consisting of an internal layer of large, roundish, angular, colorless cells, usually arranged in linear series and packed closely together by a gelatinous substance; tetraspores cruciate, immersed in the cortical layer; cystocarps?

A small genus, including about ten species, of which *H. ramentaceum* is common in the North Atlantic, the other species being confined to the North Pacific and extending as far south as California on the east coast and Japan on the west coast. The species are all coarse and somewhat cartilaginous, and are either in the form of elongated obovate sacks or tubular and proliferous. The cystocarpic fruit is unknown, and the genus is placed conjecturally near *Dumontia* in consequence of the structure of the frond.

H. RAMENTACEUM, (L.) Ag. (*H. ramentaceum*, Ner. Am. Bor., Part II, Pl. 29 *a.*—*Ulva sobolifera*, Fl. Dan., Pl. 356.)

Fronds brownish purple, six to fourteen inches high, cylindrical-compressed, attenuated at the base, simple or irregularly branched, more or less densely beset with scattered or crowded, simple or forked, lateral proliferations; tetraspores large, spherical, cruciate; cystocarps?

Var. GLADIATUM, Eaton, Trans. Conn. Acad., Vol. II, p. 347.

Proliferations long, simple, somewhat incurved, inflated.

On algæ in deep pools and on mud-covered rocks at low-water mark.

From Gloucester, Mass., northward; North Atlantic and Pacific. The variety at Eastport.

A characteristic species of our northern coast, occasionally found at Gloucester and becoming very common at Eastport. The fronds are very variable in shape, yet, on the whole, easily recognized. The most marked form is the var. *gladiatum*. The robustness depends a good deal on the place of growth. In exposed pools the fronds are short and very densely proliferous; in sheltered harbors, like that of Eastport, the proliferations grow long, and are of rather delicate texture, approaching *H. microsporum*, which hardly seems a distinct species. Kjellman, in Spetzbergens Marina klorofyllförande Thallophyter, mentions certain hemispherical protuberances on the fronds of this species, and the same are found on our coast. As before stated, the specimen of *Asperococcus compressus* credited to Gloucester, Mass., was an error, the specimen being in reality a sterile and partly bleached *Halosaccion*.

SUBORDER GIGARTINEÆ.

Fronds terete, compressed or membranaceous, fleshy or cartilaginous; antheridia in superficial spots or sunk in small crypts; tetraspores cruciate or zonate, usually collected in nemathecia or in superficial spots (sori), sometimes scattered; cystocarps composed of numerous masses of irregularly placed spores, between which are found portions of the tissue of the interior of the frond, the whole sporiferous mass being covered by the swollen surfaces of the frond, which are sometimes raised in subspherical conceptacles; spores discharged through special carpostomes.

A large suborder, comprising species which are sometimes more or less cylindrical in shape, but which are more frequently expanded and of a coarse, subcartilaginous consistency. Some of the largest *Florideæ* are found among the *Gigartineæ,* and perhaps no other suborder contains so many ill-defined species as the present. Owing to the thickness and opacity of the fronds, the study of the development of the cystocarps is attended with very great difficulty, and as yet no full account of the formation of the fruit of any of the species has been published. In the Notes Algologiques, Bornet, however, gives a brief account of the formation of the cystocarp in *Gymnogongrus patens.* In all the species the spores are irregularly grouped in several distinct masses, which are imbedded in the tissue of the frond, the cells of which undergo a change as the spores ripen, their walls becoming thick and lamellated, and traversed by numerous small canals. In *Callophyllis* and some other genera the sporiferous mass and the enveloping tissue of the frond form subglobose swellings external to the surface of the fronds, but in other genera, as *Gymnogongrus,* the sporiferous mass occupies the central part of the frond, which swells on all sides. The cystocarps discharge their spores through carpostomes or narrow canals formed in the cortex of the fronds. Sometimes there is a single carpostome, but in some genera, as *Gymnogongrus* and *Ahnfeldtia,* there are several.

1. Fronds terete 3
2. Fronds compressed 4
3. Substance rigid, horny .... *Ahnfeldtia.*
   Substance soft, succulent .... *Cystoclonium.*
4. Fronds thin, leaf-like .... *Phyllophora.*
   Fronds cartilaginous or subcartilaginous 5
5. Cystocarps external in special leaflets .... *Gigartina.*
   Cystocarps immersed 6
6. Central part of frond composed of roundish polygonal cells. *Gymnogongrus.*
7. Central part of frond formed of slender anastomosing filaments. *Chondrus.*

PHYLLOPHORA, Grev.

(From φυλλον, a leaf, and φερω, to bear.)

Fronds stipitate, stipes expanding into a rigid-membranaceous, flat, simple or cleft lamina, proliferous from the disk or margin, composed internally of oblong polygonal cells, with a cortical layer of minute, colored, vertically seriated cells; antheridia contained in small cavities; tetraspores cruciate, arranged in moniliform filaments, which are packed together in external excrescences (*nemathecia*); cystocarps external, globose, sessile or pedicellate, containing within a thick pericarp several irregular masses of spores imbedded among the cells of the frond; spores discharged by a narrow carpostome.

The genus comprises eight or nine species of the North Atlantic and Mediterranean, one species, *P. Clevelandii*, being found on the coast of California. The species are dark red, rather coarse and rigid, not adhering to paper, and are very apt to be covered with *Bryozoa*. They inhabit rather deep water, and are characterized by their external fruit, the tetraspores being arranged in nemathecia or warts composed of densely packed filaments, each cell of which becomes a cruciate tetraspore. Some of the broader forms pass with collectors for species of *Rhodymenia*.

P. BRODIÆI, Ag.; Phyc. Brit., Pl. 20.

Stipes cylindrical at base, compressed upwards, branched, the branches expanding into oblong or wedge-shaped, simple or forked, membranaceous laminæ, often proliferous at the summit; cystocarps globose, sessile on the laminæ; nemathecia spherical, pedunculate, at the tips of the laminæ.

In five to ten fathoms of water.

Newport, R. I.; Wood's Holl, Mass.; and common from Nahant northward.

P. MEMBRANIFOLIA, Ag.; Phyc. Brit., Pl. 163.

Stipe cylindrical, filiform, branched, the branches expanding into broadly wedge-shaped bifid or dichotomous laminæ; cystocarps ovoid, stipitate, rising from the branches or laminæ; nemathecia forming broad, dark-colored, convex patches in the center of the laminæ.

In deep water on stones.

Common from Long Island Sound northward; North Atlantic.

Our two species of *Phyllophora* are perfectly easy to identify when tetrasporic specimens are obtained. *P. Brodiæi* is a larger plant than *P. membranifolia*, and the laminæ are longer and larger and less broad at the base than in *P. membranifolia*. *P. Brodiæi* varies considerably, however, and in the spring the bright-red broad laminæ are often broken from the stipes and washed ashore, when they might be mistaken for some species of *Rhodymenia*.

GYMNOGONGRUS, Mart.

(From γυμνος, naked, and γογγρος, an excrescence.)

Fronds dark red or purple, carnoso-coriaceous, terete, compressed or flat, dichotomous, composed of a medullary stratum of roundish, angular, colorless cells and a cortical stratum of closely packed short filaments formed of small colored cells; tetraspores cruciate, borne in hemispherical nemathecia; cystocarps immersed in the swollen frond, consisting of several irregular masses of spores imbedded among the cells of the frond; spores discharged by a carpostome.

A genus of about thirty species, found principally in the warmer parts of the world, all rather coriaceous, but not attaining any great size. The genus is distinguished from *Chondrus*, to which several of the species were formerly referred, by the structure of the frond and the arrangement of the tetraspores; from *Phyllophora* by the absence of a stipe and the immersed cystocarps.

G. NORVEGICUS, J. Ag. (*Sphærococcus Norvegicus*, Ag.—*Chondrus Norvegicus*, Lyngb.; Phyc. Brit., Pl. 187.—*Oncotylus Norvegicus*, Kütz.)

Fronds deep red, two to four inches high, linear, dichotomous, flat, fastigiate, axils rounded, patent, apices obtuse; cystocarps immersed in the upper segments projecting on both sides of the frond; nemathecia sessile, hemispherical, on both sides of the frond.

In deep pools on rocks.

Penobscot Bay, *Mr. Hooper;* Peak's Island, Maine, *W. G. F.;* Nahant, *W. G. F.;* Beverly, Mass., *Miss Alexander.* Europe.

Our plant, which is apparently rather rare, is the same as that of Europe, although narrower forms are sometimes seen which perhaps might be referred to the *G. Torreyi* of Agardh. *G. Griffithsiæ* is to be expected with us, as it is common in Europe. The present species is found only in the autumn and winter, either in deep cold pools or below low-water mark. Its resemblance to the simpler forms of *Chondrus crispus* is so great that it is perhaps mistaken for that species by amateur collectors. Its color, however, is red rather than purple, and the whole plant is thinner and more delicate than *C. crispus*, which, moreover, has quite a different microscopic structure.

G. TORREYI, Ag.

Frond compressed, flattish, dichotomous, fastigiate, segments linear, very narrow, the axils rounded.

New York, *Prof. Agardh.*

A species known only by the above description of Agardh. Bailey, in Am. Jour. Sci., Vol. VI, 1848, p. 39, makes the singular statement, in speaking of *Dasya elegans*, Ag., that he has examined a fragment of the original specimen of *Sphærococcus Torreyi* in the Torrey Herbarium, "which," he says, "unless I am greatly mistaken, was founded on a battered specimen of this plant."

AHNFELDTIA, Fries.

(Named in honor of *Nils Otto Ahnfeldt*, of Lund.)

Fronds cartilagineo-corneous, subterete, dichotomous or irregularly branched, composed of densely packed elongated cells within and a horizontal layer of closely packed short filaments formed of small colored cells; cystocarps immersed in the fronds; tetraspores in nemathecia which surrounded the branches (?).

A small genus, comprising stiff, wiry, or cartilaginous algæ, whose fructification is not well known. As it is, the genus is distinguished from *Gymnogongrus* rather by the rigidity and terete character of the fronds than by any more definite character, since the fact that the tetraspores in the present genus are in the nemathecia which surround the branches, even if fully proved, which is not the case, would hardly constitute sufficient ground for the separation of the genera. In the only common species of the North Atlantic cystocarps have never been seen and the nemathecia have not been satisfactorily examined. In *Ahnfeldtia gigartinoides* of the west coast the cystocarps form nodose swellings in the upper part of the branches, and there are numerous carpostomes by which the spores are discharged. However ill defined the present genus may be, there is no difficulty in recognizing at sight our only species.

A. PLICATA, Fries. (*Gymnogongrus plicatus*, Kütz.; Phyc. Brit., Pl. 288.—*Gigartina plicata*, Lamx.—*Sphærococcus plicatus*, Ag.)

Fronds horny, terete, filiform, very irregularly branched, entangled, branches di-trichotomous, with lateral, often secund, branches, axils rounded, terminal divisions elongated; cystocarps and tetraspores?

Var. FASTIGIATA.

Fronds regularly dichotomous, terminal segments equal.

On rocks and algæ in exposed tide-pools.

From New York northward; Europe; North Pacific.

Forming very irregularly branched, rigid tufts several inches in diameter. The color is usually nearly black, becoming on exposure yellowish or greenish. More wiry and rigid than any of our other *Florideæ*.

CYSTOCLONIUM, Kütz.

(From κυστις, a bladder, and κλωνιον, a small twig.)

Fronds fleshy, succulent, terete, decompoundly branched, composed of three strata of cells, an axile series of loosely interlaced filaments formed of delicate elongated cells, surrounding which is a layer of large rounded cells and a cortical layer of small roundish-angular cells; antheridia in spots on the upper part of the fronds, interspersed among the unchanged cortical cells; tetraspores zonate, scattered in the cortical layer; cystocarps large, immersed in the frond, usually prominent at one side, with a single carpostome.

The account given above of the structure of the frond refers to the appearance presented in sectioning the mature plant. A study of the development shows that the external and medial layers really are derived from the axial filaments, or rather that all three are formed from a common set of filaments at the apex of the frond. The frond of *Cystoclonium* might be mistaken for that of *Rhabdonia*, but the fruit is very different. The genus comprises about half a dozen described species, but only one is at all well known.

C. PURPURASCENS, Kütz. (*Hypnea purpurascens*, Harv., Phyc. Brit., Pl. 116.)

Fronds brownish rose-colored, six inches to two feet long, an eighth to a quarter of an inch in diameter, terete, subpinnately decompound, much branched, branches alternate, elongate, beset with alternately decompound branchlets which taper at each end; cystocarps numerous, large, often forming nodose swellings in the branches.

Var. CIRRHOSA.

The branches drawn out into long, twisted tendrils.

In tide-pools and just below low-water mark.

Very common from New York northward; Europe.

With the exception of *Ceramium rubrum*, the present is probably the most common species of *Florideæ* found on our coast. It not unfrequently attains a length of a foot and a half, and when washed from its attachment and exposed to the sunlight assumes a bright orange color, which is attractive to many collectors. The *Solieria chordalis*, said by Mr. Samuel Ashmead* to have been collected in Greenland by the Hayes Arctic expedition, was probably a sterile plant of *Cystoclonium purpurascens*.

GIGARTINA, Lamx.

(From *γιγαρτον*, a grape-stone.)

Fronds fleshy, cartilaginous, compressed, composed of an internal layer of longitudinal, slender, anastomosing filaments, which pass horizontally outwards and divide dichotomously into short moniliform filaments, the whole set in a gelatinous substance; antheridia in superficial spots; tetraspores cruciate, densely aggregated, forming spots just below the surface; conceptacles external.

A genus of which nearly fifty species have been described, but some of which are of doubtful value. They abound in the Pacific Ocean, several species being found in California, but we have only one species.

G. MAMILLOSA, Ag.; Phyc. Brit., Pl. 199.

Fronds dark purple, three to six inches high, half an inch to two inches broad, flattish, channelled, linear, decompound, dichotomous, fastigiate, upper segments wedge-shaped, bifid; cystocarps borne in short papillæ given off from the surface and margin of the frond.

On rocks at low-water mark, in company with *Chondrus crispus*.

Common from Boston northward; Europe.

Bearing some resemblance to the common Irish moss, with which it usually grows, but distinguished by the numerous papillæ which cover the surface of the fronds and bear the fruit. The present species may occur in California, but most of the specimens of *G. mamillosa* from the west coast belong rather to *G. papillata*, Ag.

CHONDRUS, Stack.

(From *χονδρος*, cartilage.)

Fronds and tetraspores as in *Gigartina*; cystocarps immersed in the frond.

A small genus as limited by modern writers, but formerly made to include a large number of forms. The three genera *Gigartina*, *Chondrus*, and *Iridæa* are very nearly related. In the first-named genus the cystocarps are borne in external conceptacles, and in the last two they are immersed.

C. CRISPUS (Linn.), Stack.; Phyc. Brit., Pl. 63.—*Irish moss.*

Fronds purple, three to six inches high, stipitate, flabelliform, dichotomous, fastigiate, flat, the segments linear-cuneate; cystocarps immersed in the frond and usually projecting on one side.

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*Proceed. Acad. Nat. Sci. Philadelphia, Vol. XV, p. 93.

On rocks at low-water mark.

Common from New York northward.

The common Irish moss which is used for culinary purposes, and also for clarifying beer. It is also said to be used in the manufacture of cheap cotton cloths. Although very variable in shape, it is not likely to be mistaken for any other species, except possibly sterile specimens of *Gigartina mamillaris* or *Gymnogongrus Norvegicus*, which is, however, a rare species. When growing exposed to the light, the color is a yellow-green.

SUBORDER RHODYMENIEÆ.

Fronds membranaceous or filiform, solid or tubular; antheridia forming superficial patches; tetraspores tripartite, cruciate, or zonate, either scattered in distinct spots or sometimes sunk in crypts; cystocarps external, containing densely packed subdichotomous filaments, arranged in distinct masses around a basal placenta with a thick pericarp, which is connected by numerous filaments with the placenta.

The present suborder is exceedingly ill-defined, and no two writers agree exactly as to its limits. In the typical genera we find a distinct basal placenta on which are borne masses of spores, which when young are seen to be formed of subdichotomous filaments, but which when mature are arranged without order and held together by a gelatinous envelope. Diverging from the type, we have genera like *Cordylecladia*, in which, even at maturity, the spores preserve to a certain extent a moniliform arrangement, and we then have a cystocarp but little different from that of *Gracilaria*, which belongs to the *Sphærococcoideæ*. On the other hand, we have the order connected with the *Cryptonemieæ* by *Chrysymenia*, which is now placed by Agardh in the *Rhodymeniaceæ*. The position of *Rhodophyllis* and *Euthora* is doubtful. Here we have no distinct basal placenta, but rather a central placenta or carpogenic cell, reminding one somewhat of the genus *Rhabdonia* and its allies, which have been included in the *Solierieæ*. *Euthora*, at any rate, demands a more accurate study, and our own species of *Rhodophyllis*, *R. veprecula*, does not well correspond with the typical members of the suborder in relation to its cystocarpic fruit. *Lomentaria* and *Champia* agree with the *Rhodymenieæ* in their fruit, although the fronds are peculiar, and we have kept them as a division of the present.

Tribe I. RHODYMENIEÆ proper.

Cystocarps with a basal placenta, fronds solid.

Fronds dichotomous or palmate .... *Rhodymenia.*
Fronds pinnately compound .... *Plocamium.*
Fronds filiform .... *Cordylecladia.*

? Tribe II. RHODOPHYLLEÆ.

Cystocarps with a central placenta, fronds membranaceous.

Tetraspores zonate, fronds dichotomous or pinnate .... *Rhodophyllis.*
Tetraspores cruciate, fronds dentato-pinnate .... *Euthora.*

Tribe III. LOMENTARIEÆ.

Cystocarps with a basal placenta, fronds tubular.

Fronds constricted at the joints, but with no proper diaphragms, tetraspores sunk in depressions of the frond .... *Lomentaria.*
Fronds with numerous diaphragms, tetraspores superficial .... *Champia.*

RHODYMENIA, (Grev.) J. Ag.

(From ροδεος, red, and υμην, a membrane.)

Fronds flat, membranaceous, dichotomous or palmate, composed of an internal layer of large roundish-angular cells and a cortical layer of smaller cells, in some cases arranged in short horizontal filaments; tetraspores cruciate, either collected in superficial spots (sori) or scattered in the cortex; cystocarps external, sessile, with a distinct carpostome, spores irregularly grouped in masses attached to a basal placenta and surrounded by a gelatinous envelope.

A genus which formerly was made to include a large number of flat membranous species, a large part of which have by recent writers been removed to other genera. We have but one species on our coast, *Rhodymenia palmata*, the common dulse, of which, unfortunately, the cystocarpic fruit is unknown, and the study of the fruit of the genus is out of the question with us.

R. PALMATA, (Linn.) Grev.; Phyc. Brit., Pls. 217, 218; Ann. Sci. Nat., Vol. III, Ser. 4, Pl. 3, Fig. 8.—*Dulse.*

Fronds purplish red, broadly wedge-shaped, six to twelve inches long and four to eight inches broad, irregularly cleft, palmate or dichotomous, sometimes repeatedly laciniate, the margin often winged with leaflets; tetraspores cruciate, scattered in patches over the frond, immersed in the cortex; cystocarps?

Var. SARNIENSIS.

Divisions very numerous, narrow, sublinear.

On *Fuci*, *Laminariæ*, and other algæ, between tide-marks, and extending into deep water.

Common from New York northward; North Atlantic; California?

This, with *Chondrus crispus*, forms the only species eaten in New England. The present species, although one of the commonest red sea-weeds in the North Atlantic, has never been known to bear cystocarps, and hence the generic position is doubtful. The description given applies to the typical form, and although the fronds are very variable in outline, the species is easily recognized. It is sold in the seaport towns, where it is to be found dried on the fruit-stands of the women who sell green apples, corn-balls, and other dainties. It is said to possess anthelmintic properties, which, if one can judge by its disagreeable taste, is very probable.

PLOCAMIUM, Lyngb.

(From πλοκαμος, a lock of hair.)

Fronds compressed, membranaceous, pinnately decompound, the pinnules alternately secund in twos, threes, fours, or fives, composed of an inner layer of longitudinal, oblong cells and a cortical layer of smaller polygonal cells; tetraspores zonate borne in special branchlets; cystocarps external, sessile or pedicellate, with a distinct carpostome, spores in several masses composed of closely packed radiating filaments borne on a basal placenta.

A beautiful genus, comprising about twenty-five species, the most striking of which are found in Australia, New Zealand, and at the Cape of Good Hope. *P. coccineum* is very widely diffused in the North Atlantic and Pacific, and possibly also in the southern hemisphere; but it has only been observed once on the coast of New England, and that perhaps requires verification. The genus is at once recognized by the branching. The frond is linear and distichously pinnated, the pinnules, which are always alternately secund in groups of from two to five, being of two kinds; the lowest pinna is short, simple, and acute, while the remaining pinnæ are pinnulate or pectinato-decompound. The cystocarps of *Plocamium* are similar to those of *Rhodymenia*, and the zonate tetraspores are in special branchlets or leaflets, known as stichidia.

P. COCCINEUM, Lyngb.; Phyc. Brit., Pl. 44.

Fronds narrowly linear, without a midrib, decompound pinnate, pinnæ alternately secund in threes or fours, the lowest subulate and entire, the upper pectinate on the upper side; conceptacles marginal, solitary, sessile; tetraspores zonate on divaricately branching processes borne on the inner side of the pectinated branchlets.

Boston Bay, *Miss Hawkshurst.*

The above-named locality, given in the Nereis, is the only one known on the New England coast, for this widely diffused species, if we except the vague statement of Bailey in the American Journal of Science, Vol. III, 1847, p. 84, that it has been found by Rev J. L. Russell on the coast of Massachusetts. One sometimes finds forms of *Euthora cristata* labelled *P. coccineum* in American herbaria. The common Californian form of the species is coarser than the European, and has been named by Kützing *P. Californicum.* It is not, however, distinct.

CORDYLECLADIA, J. Ag.

(From κορδυλη, a club, and κλαδος, a branch.)

Fronds filiform, irregularly branched, carnoso-cartilaginous, formed of two strata of cells; medullary layer of oblong, longitudinal cells, cortical of roundish, colored, subseriated, vertical, minute cells; conceptacles sessile on the branches, subspherical, furnished with a cellular pericarp at length perforate, containing a densely packed globular mass of roundish angular spores, formed by the evolution of much-branched filaments issuing from a basal placenta; tetraspores immersed in the periphery of pod-like ramuli, oblong, cruciately parted.

? C. HUNTII, Harv.

"Fronds densely tufted, springing from a common, expanded, crust-like disk, livid purple, tereti-compressed, once or twice forked or secundly branched; branches subulate, alternate, acute; fruit?" (Ner. Am. Bor., Part II, p. 155.)

Narragansett Bay, *Mr. George Hunt.*

A species only known from the description in the Nereis, which is quoted above, and from the specimen in Herb. Harvey for an examination of which we are indebted to Prof. E. Perceval Wright. In the absence of fruit, the genus must remain in doubt, and it is hardly likely that the species, as described by Harvey, will be again recognized by American algologists.

RHODOPHYLLIS, Kütz.

(From ῥοδον, a rose, and φυλλον, a leaf.)

Fronds membranous, dichotomously compound, with proliferous or pinnatifid margins, composed of an internal layer of large roundish-angular cells and a cortical layer of smaller cells; tetraspores zonate, immersed in the cortex of the frond or marginal processes; cystocarps external, subspherical, borne usually on the margin of the frond or on lateral processes, spores arranged around a central carpogenic cell in masses composed of densely packed radiating filaments, whose cells at maturity become irregularly placed.

A genus comprising about twenty species, which mostly inhabit the Australian coast. They have membranously expanded fronds resembling those of the genus *Rhodymenia*, but they are as a rule smaller and thinner, the internal layer consisting of usually two series of cells. The genus is distinguished from *Rhodymenia* by the zonate tetraspores, and by having the carpogenic cell or placenta in the center of the conceptacle instead of at its base. In the typical species of Kützing, *R. bifida*, there is, according to Dr. Bornet, a large carpogenic cell at the center of the conceptacle, around which the sporiferous masses are gathered, and the same is true with regard to our own *Rhodophyllis veprecula*.

R. VEPRECULA, J. Ag. (*Ciliaria fusca*, Rupr.—*R. veprecula* and *Calliblepharis ciliata*, Harv., Ner. Am. Bor., Part II, pp. 105, 152, non *Calliblepharis ciliata*, Kütz.)

Fronds deep red, attached by a branching base, two to five inches long, a quarter of an inch to an inch and a half broad, decompoundly dichotomous, margin pinnate, pinnæ linear-lanceolate, ciliate, with short subulate or forked teeth; tetraspores zonate, borne in the cortex of the cilia; cystocarps subglobose, usually borne at the base of the cilia, often densely aggregated, sometimes borne on the surface of frond.

Var. CIRRHATA, Harv.

Fronds very narrow, dichotomous, the apices cirrhiform, repeatedly forked.

On the larger algæ in five to ten fathoms, and rarely in deep tide-pools. Autumn and winter.

Campobello Island, Grand Menan, Maine, *Prof. Eaton;* Gloucester, Mass., *W. G. F.;* Arctic Ocean.

The present species is a characteristic Arctic form which occurs as far south as Cape Ann, where it is not rare although hardly common. It is usually found washed ashore late in the autumn or in winter. It is recognized by its beautiful red color and frond destitute of a midrib and with a ciliated margin. It bears a close resemblance to *Calliblepharis ciliata*, Kütz., which is a common European species, and it was introduced under that name in the Nereis, in which work *Rhodophyllis veprecula* was cited on the authority of Agardh. But subsequent observation and examination of the cystocarpic fruit has shown that the *C. ciliata* of the Nereis is the same as *Rhodophyllis veprecula*, Ag. Gobi states that *R. veprecula* of Agardh is the *Fucus dichotomus* of Lepechin, and he considers that *C. ciliata*, Kütz., should also be included with it under the name of *Rhodophyllis dichotoma* (Lepechin). We have retained the name of Agardh because we only wish to assert that our plant is a *Rhodophyllis* already described by Agardh, but do not wish to go so far as to express an opinion with regard to the identity of the two European plants, since we have never been able to examine the fruit of *C. ciliata* in good condition. Our form, as found on the Massachusetts coast, is well developed and agrees perfectly with specimens collected by Dr. Kjellman in Greenland. The narrow variety was found by Harvey at Halifax. In Herb. Gray is a narrow specimen from Labrador, marked *Calliblepharis jubata*, apparently in Lenormand's handwriting.

EUTHORA, Ag.

(Derivation uncertain.)

Fronds membranaceous, subdichotomously pinnate, formed internally of large oblong cells, between which is a network of slender branching filaments with a cortical layer of small cells; tetraspores cruciate, immersed in the cortex of the thickened apices; cystocarps external, subspherical, marginal, containing a central nucleus attached to the walls of the conceptacle composed of tufts of radiating sporiferous filaments around an ill-defined cellular placenta.

A small genus of only two species, one of which is found in the North Atlantic and the other in the North Pacific. The structure of the frond in our species is peculiar and is the same as that of the genus *Callophyllis*. Between the rather large cells of the interior run small branching filaments, best seen in longitudinal sections. The genus is separated from *Rhodymenia*, in which it was formerly included, in consequence of the peculiar frond and cystocarp. The structure of the latter is not at all well known and should be studied on our coast, where there is an abundance of material. The conceptacles are small and are borne on the margin of the frond, and the carpostome is not at all prominent. The arrangement of the spores is complicated and not easily described. They are arranged in tufts of short filaments, radiating from a common point, and the different tufts, which are very numerous, apparently surround a central cellular placenta, not at all sharply defined. At any rate, there is no large carpogenic cell, either at the center, as in *Rhodophyllis*, or at the base, as in *Rhodymenia*, and it is by no means certain that the genus should be placed in the present suborder.

E. CRISTATA, J. Ag. (*Sphærococcus cristatus*, C. Ag.—*Rhodymenia cristata*, Grev.; Phyc. Brit., Pl. 307.—*Callophyllis cristata*, Kütz.)

Fronds rosy-red, one to five inches high, membranaceous, flabellately expanded, main divisions widely spreading, alternate, repeatedly subdivided, upper divisions alternate, linear, laciniate at the tips, with a fimbriated margin; tetraspores cruciate, in the thickened tips of the frond; cystocarps small, marginal, nearly spherical.

On algæ, especially on *Laminariæ*, in deep water.

Staten Island; Newport, R. I., *Bailey;* dredged off Napatree Point, R. I., *Prof. Eaton;* Gay Head, in eight or ten fathoms; and common from Nahant northward.

Together with *Delesseria sinuosa*, this species forms the bulk of the membranaceous red sea-weeds collected by ladies on our northern coast for ornamental purposes. Probable in no part of the world are more beautiful and luxuriant specimens found than at Magnolia Cove, Gloucester, Mass. Specimens vary very much in breadth. Some have the main divisions an inch wide and the terminal divisions are densely flabellate. Others are scarcely an eight of an inch wide and the terminal divisions are rather diffuse, the fimbriations being prolonged into sharp teeth. The first-mentioned form approaches the figure in the Phycologia Britannica, while the last resembles *Sphærococcus coronopifolius*. The Long Island forms are scarcely an inch high. The species is found at all seasons of the year, and inhabits rather deep water, its favorite habitat being the roots of *Laminariæ*.

LOMENTARIA, (Gaill.) Thuret.

(From *lomentum*, a pod with constricted joints.)

Fronds filamentous, branching, hollow, with constricted nodes, formed of one or more layers of roundish-angular cells with a few longitudinal filaments in the interior; tetraspores tripartite, borne in cavities formed by the infolding of the cortex; cystocarps external, sessile, containing a nucleus composed of oblong masses of irregularly radiating spores attached to a placenta surrounding a large basal carpogenic cell, which is connected with the pericarp by filaments.

A small genus, containing species which have been placed by some writers in *Chylocladia* and *Chrysymenia*. As limited by Thuret, the genus includes species in which the tetraspores occupy small cavities hollowed out in the cortex. The development of the fronds has not been fully studied. They are hollow and much constricted at the joints, but in our species there are no distinct diaphragms as in *Champia*. The walls of the filaments are composed of a membrane consisting of a single layer of roundish-angular cells, or there are two or three layers, the outer cells being smaller than the rest. The inner side of the wall is traversed by long, slender filaments, to which are attached, laterally, small round cells, by which the filaments are attached to the walls. The cystocarps are external, and, in section, one sees a large basal triangular-ovoid carpogenic cell surrounded by closely packed sporiferous lobes, in which the cells are at first arranged in the form of densely radiating filaments, but at the time of maturity become irregularly placed. The pericarp is rather broadly ovate, with a distinct terminal carpostome, and its walls are connected with the carpogenic cell by filaments, between the bases of which lie the sporiferous masses, around which is a gelatinous envelope.

L. UNCINATA, Menegh., in J. Ag., Spec. (*Chylocladia Baileyana*, Harv., Ner. Am. Bor., Part II, p. 185, Pl. 20 *c*.—*Chylocladia uncinata*, Ag., Zan. Icon. Adr., Pl. 43.—*Chondrosiphon uncinatus*, Kütz.)

Fronds brownish red, densely tufted, two to five inches high, tubular, irregularly much branched, branches about one-tenth of an inch in diameter, divaricated, secund or scattered, often recurved, branchlets narrowly fusiform, much contracted at base, secund; tetraspores tripartite in cavities on the branchlets; cystocarps sessile on the branches, ovoid, with a distinct terminal carpostome.

Var. FILIFORMIS, Harv., l. c.

Slender, elongate, with longer and less arching branches.

On wharves, sponges, &c., below low-water mark.

Quincy, Mass., *Harvey;* common from Cape Cod southward.

A common and characteristic species of Long Island Sound, forming very densely branching tufts. The branches are usually arched backwards and bear secund branchlets which are much constricted at base. The arrangement of the tetraspores in cavities can easily be seen in fresh or alcoholic specimens, but not well in pressed plants. It is principally on the authority of Zanardini that our species is united with his *C. uncinata*, and as he had plenty of material for comparison his opinion is probably correct. The Adriatic specimens of *C. uncinata* which we have examined corresponded better with the var. *filiformis* than with the more common secund form of Long Island Sound.

L. ROSEA, (Harv.) Thuret. (*Chrysymenia rosea*, Harv., Phyc. Brit., Pl. 358 *a.*—*Chylocladia rosea*, Harv., Ner. Am. Bor., Part II, p. 186.)

Fronds rose-colored, compressed, hollow, triangular in outline, main divisions simple or once or twice forked, one and a half to three inches long, an eighth to a quarter of an inch broad, tapering at the apex, pinnate with simple or pinnate, opposite, distichous branchlets, which are much contracted at the base; tetraspores tripartite, sunk in cavities in the cortex of branches.

On stones and shells in ten fathoms.

Portsmouth, N. H.; Newport, R. I., *Harvey;* Gay Head, *W. G. F.;* Northern Europe.

A rare and beautiful species, easily distinguished from the last by being broader and flattened, with beautifully regular, opposite, distichous pinnæ. As far as we know, the cystocarpic fruit of this species has never been seen. It is tolerably abundant on shells of *Mytilus*, in company with *Scinaia furcellata*, off Gay Head.

CHAMPIA.

(In honor of *M. Deschamps*, a French botanist.)

Fronds filamentous, branching, hollow, nodose, formed of one or more layers of roundish-angular cells with cellular diaphragms at the nodes, traversed internally by a few longitudinal filaments; tetraspores tripartite, scattered in the cortex; cystocarps as in *Lomentaria*.

A small genus, comprising about a dozen species, most of which are tropical or Australian, our species, *C. parvula*, being the most widely diffused. The genus resembles *Lomentaria* very closely in the cystocarpic fruit. The fronds, however, are not only constricted at the joints, but are nodose throughout, a diaphragm composed of a single layer of cells extending across the nodes. The tetraspores are not contained in sunken cavities as in *Lomentaria*. A section of the cystocarps of *C. parvula* and *L. uncinata* shows the same arrangement of the spores, but in the first-named species the carpogenic cell is larger and projects further into the conceptacle.

C. PARVULA, (Ag.) Harv. (*Chylocladia parvula*, Phyc. Brit., Pl. 210.—*Champia parvula*, Ner. Am. Bor., Part II, p. 76.) **Pl. XV, Figs. 2, 5.**

Fronds brownish red, globosely tufted, two to four inches high, intricately branching, branches opposite, alternate, or whorled, nodose, joints once or twice as long as broad, apices obtuse; tetraspores tripartite, scattered in the cortex; conceptacles scattered, sessile, ovoid, with a distinct carpostome.

On *Zostera* and algæ below low-water mark.

Common from Cape Cod southward; Europe; Pacific Ocean.

A homely species, which does not collapse when removed from the water. The conceptacles are larger than in our species of *Lomentaria*, and better adapted for the study of the arrangement of the spores.

SUBORDER HYPNEÆ.

Fronds filiform or subcompressed, branching; tetraspores zonate; cystocarps external or partly immersed, filled with a spongy cellular mass, in which the spores are borne in small, scattered tufts on a branching filamentous placenta.

A small suborder, in which the cystocarpic fruit is peculiar. Sections of the cystocarps show a loose cellular structure which fills the interior, and scattered through the mass are small tufts of spores which remind one of the cystocarps of the *Gigartineæ*. In the present instance, however, the spores are not arranged irregularly in globose groups, but they are attached to filaments which branch among the general cellular mass which fills the conceptacle. In the Notes Algologiques an account of the development of the fruit in *H. musciformis* is given by Bornet.

HYPNEA, Lam.x.

(From *Hypnum*, a genus of mosses.)

Fronds filiform, virgately or divaricately branched, with subulate branchlets, composed of an internal layer of large roundish-angular cells, which become smaller outwards, and a cortex of small, colored, polygonal cells; tetraspores zonate, borne in swollen branchlets; cystocarps external, subglobose, borne on the branchlets, containing a placenta composed of filaments which form a network, to which are attached at intervals tufts of spores.

A genus of about twenty-five or thirty species, most of which are tropical and rather ill-defined, since the sterile and fertile plants of the same species vary considerably in aspect. Most of the species have the tips of the branches swollen and rolled inwards. The cystocarps are peculiar, and in sections one sees small tufts of pyriform spores, scattered through a nearly solid tissue composed partly of a network of branching filaments which form a sort of placenta and partly of the cells of the frond itself.

H. MUSCIFORMIS, Lam.x.

Fronds filiform, purplish red, tufted, virgately branched, six to twelve inches long, branches elongated, irregularly placed, clothed below with numerous, short, subulate branchlets, thickened and nearly naked near the apex, which is often much incurved; tetraspores zonate, borne in somewhat swollen branchlets; cystocarps subglobose, numerous, on divaricately branched spinescent branchlets.

New Bedford, Mass., *Harvey;* Wood's Holl, *W. G. F.;* Orient, L. I., *Miss Booth;* and southward to the West Indies.

In four or five fathoms of water.

A common species of the West Indies, and probably not rare in Long Island Sound, although not very common. It is usually found washed ashore in sheltered places like the Little Harbor, Wood's Holl, after a heavy blow, where one sometimes finds intricately twisted tufts two feet in diameter. With us cystocarps have not been seen, but the frond is very well developed on our coast. It may be recognized by the yellowish-purple color, by the long branches covered with short, subulate branchlets, and especially by the swollen, naked apices, which are rolled strongly inwards or almost circinate. Fertile specimens from the West Indies are more robust and do not so frequently have inrolled apices. The species does not adhere well to paper in drying.

SUBORDER GELIDIEÆ.

Fronds of a dense cartilaginous structure, filiform or compressed, branching; antheridia in superficial patches; tetraspores cruciate, borne in the cortical layer; cystocarps formed in swollen branches and composed of spores arranged singly or in short filaments on the surface of an axile or parietal placenta, carpostomes present, often two in number;

Rather a small order of dark-colored, rigid sea-weeds, whose fronds are formed of densely packed cells, and whose cystocarps are born in swollen terminal branches, but are not strictly external. In *Gelidium* the spores are sessile on an axile placenta, and there are two carpostomes on the opposite surfaces of the fronds. In *Pterocladia* the placenta is attanched to the lateral wall of the cystocarp, the spores are borne few in a row, and there is but one carpostome.

GELIDIUM, Lam.x.

(From *gelu*, frost, and, secondarily, gelatine.)

Fronds cartilaginous, terete or compressed, decompound-pinnate, formed of long cylindrical cells in the axis, surrounded by roundish cells which become small and polygonal at the surface; antheridia in superficial patches; tetraspores cruciate, scattered in the cortex; cystocarps immersed in swollen branchlets, containing oblong or pyriform spores borne on an axile placenta which is attached by filaments to the walls of the cystocarp; carpostomes usually one on each side of the frond.

A genus of narrowly linear or nearly terete algæ of a dense structure, found in nearly all parts of the world. The limits of the species are not well marked, because the ramifications on which the principal specific distinctions depend are very variable. The genus is recognized on our coast by the peculiar cystocarps, which are formed in small branchlets, which become swollen and usually have an opening on each side for the escape of the spores. A longitudinal section shows an axile placenta which passes through the cystocarp, on which the spores are borne, not in chains but singly. Numerous filaments connect the placenta with the wall of the cystocarp. The account given above of the frond applies merely to what one sees in sections of the mature branches. A section of the younger portions shows that there is originally an axile filament, from which are given off other filaments which are nearly parallel to the axis, and which afterwards turn outwards and form the cortical layer, the cells of which they are composed becoming rounder and short. The genus differs from *Pterocladia* merely in the position of the placenta, which in the last-named genus is not central, but is attached laterally to the wall of the cystocarp.

G. CRINALE, J. Ag., Epicr. (*Gelidium corneum*, var. *crinale*, auct.—*Acrocarpus lubricus* and *crinalis*, Kütz., Tab. Phyc., Vol. XVII, Pls. 32, 33.)

Fronds cæspitose, dark purple, setaceous, one to three inches high, primary axis procumbent, from which arise erect, subterete, once or twice pinnate branches, pinnæ distichous, alternate, short, patent, acute, often pinnatifid; tetraspores cruciate, borne in thickened subspathulate or pinnatifid apices.

Forming tufts on mud-covered rocks and stones at low-water mark.

Portland, Maine; Red Hook, N. Y., *Harvey;* New Haven; Wood's Holl, *W. G. F.;* Malden, Mass., *Mr. Collins;* Europe; California.

We have followed Agardh in separating the var. *crinale* from the polymorphic and very widely diffused *G. corneum*. The typical form of the latter occurs in Florida and on our west coast. *G. crinale* has been as yet recorded in but few localities, but it is probably common along our whole coast. It is a homely, insignificant species, usually not much thicker than a bristle, and forms small blackish patches on mud-covered rocks.

SUBORDER SOLIERIEÆ.

Fronds filiform or compressed; tetraspores cruciate or zonate; cystocarps immersed in the frond, usually prominent at one side, spores arranged in short filaments and arranged in tufts around a large central carpogenic cell or a central placenta, which is attached to the wall of cystocarp by filaments; carpostome distinct.

A small suborder, of which we have but a single species. It is characterized by having the spores produced few in a row and attached either, as in *Solieria* and *Eucheuma*, to a large central cell, or, as in *Rhabdonia*, to a large cellular placenta at the center of the cystocarp. Whether *Rhabdonia* should be united in a suborder with *Solieria* is perhaps doubtful. By some the genus is considered to be related to the *Rhodymenieæ*, and its affinity to *Rhodophyllis* and perhaps *Euthora* is not remote.

RHABDONIA, Harv.

(From ῥαβδος, a wand.)

Fronds deep red, cylindrical or nodose, branching, formed of an axis composed of slender, branching, longitudinal filaments surrounded by a layer of large roundish-angular cells and a cortical layer of smaller cells; tetraspores zonate, scattered, immersed in the cortex; cystocarps immersed in the frond, and projecting at one side, opening by a distinct carpostome, inclosing tufts of spores arranged in short, dense filaments, surrounding a globose, cellular, central placenta, connected by filamentous bands with a plexus of the axial filaments which surrounds the sporiferous mass.

A genus comprising from fifteen to twenty species, the greater part of which are confined to Australia, divided by Agardh into two subgenera, in one of which the frond is cylindrical and in the other constricted at intervals. Our species belongs to the first division, and the frond resembles closely that of *Cystoclonium purpurascens*, and the same is true of the tetraspores. The cystocarps are large, and project on one side. The genus is placed by Agardh near *Solieria*, but in that genus the spores are placed around a very large central carpogenic cell, while in *Rhabdonia* they are attached to a large, solid, central placenta formed of cells. The placenta is attached to the walls of the cystocarp by numerous bands of interwoven filaments, between which are the sporiferous masses, which consist at maturity of short filaments, whose cells are changed into spores, which are not held together by a gelatinous envelope as in *Champia*.

R. TENERA, Ag. (*Gigartina tenera*, J. Ag., Symb.—*Solieria chordalis*, Harv. (non Ag.), Ner. Am. Bor., Part II, p. 121, Pl. 23 *a.*—*Rhabdonia tenera*, J. Ag., Spec.—*R. Baileyi*, Harv. MSS., Am. Journ. Science, Vol. VI, p. 39.) **Pl. XIV, Fig. 2.**

Fronds deep red, from six inches to a foot and a half long, cylindrical, attached by a small disk, simple below, above densely branched, alternately decompound, branches long, virgate, erect, tapering at the base and apex, and furnished with numerous, linear, fusiform branchlets; tetraspores zonate, scattered in the cortex; cystocarps numerous, immersed, but projecting at one side.

In warm, quiet bays, in shallow water.

Common from Cape Cod southward; Goose Cove, Gloucester, Mass., *W. G. F.*

A characteristic species of Long Island Sound, and only known in one locality north of Cape Cod, but extending southward to the West Indies. It forms beautiful tufts often two feet long, in muddy places around wharves and in sheltered places, and is not likely to be mistaken for any other plant, except possibly for a large form of *Cystoclonium purpurascens*. The procarps consist of three cells, and from the innermost or that nearest the axis grows a long trichogyne, which curves round in a tortuous fashion, and makes its way to the surface, reminding one of the trichogynes of *Halymenia ligulata*, figured by Bornet. The section of the cystocarp given by Harvey in the Nereis does not pass through the center, and the cystocarp is not a closed cavity, as supposed by Harvey, but has a distinct carpostome; nor are the spores pyriform and attached to separate pedicels, but they are formed from the cells of short filaments.

SUBORDER SPONGIOCARPEÆ.

Fronds solid, cylindrical, branching; antheridia in spots on upper part of fronds; tetraspores cruciate, immersed in the cortical filaments; cystocarps in external wart-like protuberances, composed of parallel filaments, spores obovate, densely packed around the surface of a cellular mass which surrounds the tip of a short pedicel.

The present suborder was made by J. G. Agardh and Harvey to include a single species, *Polyides rotundus*, a species in several respects anomalous. The development of the cystocarps of that species was first made out by Thuret and Bornet, and a detailed account was published in the Études Phycologiques. In its development the cystocarp of *Polyides* resembles that of the genus *Dudresnaya.* There is produced from the cells at the base of the trichogyne a number of filaments which wind amongst the short filaments, of which the wart-like bodies near the tips of the fronds are formed. These filaments come in contact with certain cells of the protuberances, which then divide and produce the spores. Although this indirect fertilization of the carpogenic cells by means of winding filaments is the same as is found in *Dudresnaya*, the mature cystocarp is different in the two genera. In *Polyides* the ripe spores are arranged in a regular layer around a small placenta, which is borne on a short pedicel produced from the carpogenic cell. In *Dudresnaya coccinea* the spores are irregularly grouped around a placenta surrounding the carpogenic cell itself. In *D. purpurifera*, however, according to D. Bornet, the cystocarps more nearly resemble those of *Polyides*, and he thinks it not impossible to unite the two genera in one suborder.

POLYIDES, Ag.

(From πολυς, many, and ιδεα, form.)

Fronds cylindrical, dichotomous, composed of interlaced branching filaments, consisting of elongated cells and curving outwards at the surface so as to form a cortical layer of horizontal filaments; antheridia in patches on the upper part of frond, consisting of short, densely packed filaments bearing clusters of antherozoids; tetraspores cruciate, immersed in the cortical layer; cystocarps in wart-like protuberances on the upper part of the frond.

P. ROTUNDUS, Grev.; Phyc. Brit., Pl. 95.

Fronds blackish red, cylindrical, cartilaginous, three to six inches long, attached by a disk, with an undivided stipe, which becomes above repeatedly dichotomous, apices obtuse; warts flesh-colored, numerous on the upper divisions of the frond.

On stones in deep pools and in deep water.

Common from New York northward; Europe.

A species easily recognized by its regularly dichotomous, cylindrical frond, by its dark, almost black, color, and dense cartilaginous substance. When sterile it might be mistaken for *Furcellaria fastigiata*, a common species of Northern Europe, which may be expected to occur on our coast. In fruit, however, they are easily distinguished, since the cystocarps of *Polyides* are borne in external warts, while those of *Furcellaria* are in the somewhat swollen tips of the frond. The present species is usually found washed ashore from deep water, but on the northern coast is found also in deep tide-pools. When dried it becomes brittle and does not adhere to paper.

SUBORDER SPHÆROCOCCOIDEÆ.

Fronds cylindrical or membranaceous, substance often very delicate; antheridia forming superficial patches or occasionally contained in sunken cavities; tetraspores cruciate, zonate, or tripartite, often collected in spots (sori) on the surface; cystocarps external, hemispherical or flask-shaped, spores arranged in moniliform filaments, which radiate from a basal placenta, carpostome distinct.

The present suborder is by Agardh and some other writers divided into two, the *Sphærococcoideæ*, which include rather coarse cartilaginous algæ, which are cylindrical or somewhat compressed, but hardly membranaceous, and the *Delesserieæ*, which are rosy-red and of delicate texture and distinctly membranaceous. The fruit, however, is very similar in both groups. The spores are arranged in subdichotomous filaments, which radiate from a basal placenta, which in some genera, as *Gracilaria*, projects far into the cavity of the cystocarp. The suborder differs from the *Rhodymenieæ* in that the moniliform arrangement of the sporiferous filaments is preserved even at maturity, and the filaments are distinct from one another and not held together by a gelatinous envelope. It must, however, be admitted that there are genera which seem to indicate a close relation between the two suborders.

GRINNELLIA, Harv.

(Named in honor of *Mr. Henry Grinnell*, of New York.)

Fronds rosy-red, occasionally purple, delicately membranaceous, with a slender percurrent midrib, composed of a single layer, at the midrib of several layers, of large polygonal cells; antheridia in tufts on both sides of the frond; tetraspores tripartite, in swollen spots on the frond; cystocarps sessile on the frond, flask-shaped, spores in dichotomously branching filaments arising from a basal placenta.

A genus comprising a single species, which is found from Cape Cod to Norfolk, separated from *Delesseria* because the tetraspores are formed in incrassated spots on the frond. The genus is too near *Delesseria*, of which it should perhaps form a subgenus.

G. AMERICANA, Harv., Ner. Am. Bor., Part II, Pl. 21 *b*. (*Delesseria Americana*, Ag.—*Aglaiophyllum Americanum*, Mont.—*Cryptopleura Americana*, Kütz.) **Pl. XIII, Figs. 2–4.**

EXS.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 64.

Fronds diœcious, four inches to a foot and a half long, one to four inches wide, lanceolate, tapering at the extremities, occasionally bifid or proliferous, margin smooth or wavy; antheridia in small spots on both sides of the frond; tetraspores scattered over the frond in thickened spots; cystocarps scattered, sessile, flask-shaped.

On wharves, shells, stones, and sponges below low-water mark, and extending to several fathoms.

Cape Cod, southward.

This, with the exception perhaps of *Dasya elegans*, is the most beautiful alga of Long Island Sound. It is often found in tufts on wharves below low-water mark, and it flourishes in rather warm, shallow bays. It is met with at all seasons of the year; and, according to Miss Fisher, of Edgartown, the ladies of Martha's Vineyard collect it in winter, when it is found in considerable quantities on the ice. The male plant is smaller than the cystocarpic, and the antheridia may be detected by the naked eye in the form of small, whitish, glistening spots. The walls of the conceptacles are thinner than those of *Delesseria*. The swellings in which the tetraspores are borne can hardly be called warts, and the figure given by Harvey in the Nereis is somewhat exaggerated. The surface of the frond is raised, and becomes more or less convex, but there are no such irregular projections as represented in Harvey's figure.

DELESSERIA, Lam.x.

(In honor of *Baron Benjamin Delessert.*)

Fronds bright red, thin, membranaceous, laciniate or branched, costate, and often with lateral veins, composed of a single or a few layers of large polygonal cells; antheridia in spots on the frond; tetraspores tripartite, grouped in spots (sori) on the frond or on marginal leaflets; cystocarps external, sessile, with a basal placenta, from which radiate the numerous subdichotomous, sporiferous filaments.

A beautiful genus, comprising fifty or more species, distributed all over the globe. They are of delicate texture and rosy-red color, and are generally leaf-like in appearance, although some are narrowly linear. The genus is not likely to be mistaken for any other on our coast, unless it be *Grinnellia*, in which the tetraspores are borne in thickened portions of the frond. The fronds, when young, are more or less leaf-like and provided with a midrib, and generally also with lateral nerves; and, as they grow older, they become more or less stipitate by the wearing away of the blade of the leaf, which leaves the thickened midrib either naked or with a small winged margin. When still more advanced, owing to the growth of the laciniæ and the wearing away of the lateral nerves, the stipes appear to branch and to bear several leaf-like fronds. In some species the membranous portion of the fronds consists of a single layer of cells, which are rectangular when seen in section and polygonal seen from above. At the veins the cells form several layers, and in some species it is only at the tip that the fronds are formed of a single layer. When the cystocarps are formed, the cells are divided by numerous partitions parallel to the surface of the frond, and the wall of the conceptacle, when mature, consists of several layers of cells, all of about the same size and smaller than the cells of the frond.

D. SINUOSA, Lam.x.; Phyc. Brit., Pl. 259.

Fronds four to eight inches long and two to four broad, stipitate below, stipe often elongated and branched, with oblong or obovate, deeply sinuate or pinnatifid toothed leaves, midrib percurrent, lateral veins opposite, extending to the laciniæ; tetraspores tripartite, either borne in small lateral leaflets or in patches following the veins; cystocarps sessile, generally on the veins, hemispherical, with a distinct carpostome.

On algæ, generally in deep water.

From New Haven northward.

One of the more common *Florideæ* north of Cape Cod, and not rare in the colder waters of Long Island and Vineyard Sounds. It is found all the year, but especially in the autumn and winter. It is at once recognized by the presence of a midrib and lateral veins and by its general resemblance in outline to an oak-leaf.

D. ALATA, Lamx.; Phyc. Brit., Pl. 247.

Fronds two to four inches long, an eighth of an inch wide, stipitate below, above pinnately decompound, divisions linear, margin entire, costate, lateral veins scarcely visible; tetraspores tripartite, borne in the apices of the segments or in special leaflets; cystocarps hemispherical, on the upper veins.

Var. ANGUSTISSIMA, Harv., Phyc. Brit., Pl. 83.

Fronds very narrow, blade of the leaflets almost wanting.

From Boston northward, with the last; Europe.

A common species of Northern New England, but not yet found south of Cape Cod. Our form is uniformly narrower than the common European form, and there is scarcely a trace of lateral veins. *Hypoglossum Grayanum*, Reinsch, Contributiones ad Algologiam et Fungologiam, p. 55, Pl. 42, appears to be the same as *D. alata* of the New England coast.

D. LEPRIEURII, Mont.; Ner. Am. Bor., Part II, Pl. 22 *c.* (*Hypoglossum Leprieurii*, Kütz.—*Caloglossa Leprieurii*, J. Ag., Epicr.)

Fronds purple, one to two inches high, about a tenth of an inch wide, dichotomous, articulato-constricted, costate, proliferous from the costa, segments linear-lanceolate, attenuate, rhizoids and new leaflets formed at the constrictions; tetraspores tripartite, in oblique lines extending from the midrib to the margin; cystocarps sessile on the midrib.

West Point, *Bailey;* Fort Lee, N. Y., *Mr. Averill;* Harlem River, *C. H. Peck;* and common southward.

This small species inhabits tidal rivers where the water is warm, and is found on wood-work, stones, and water-plants. It is probably not rare near New York, and on our Southern Atlantic coast it is common. It extends to the West Indies, and is also found in the warmer waters of both hemispheres. It is distinguished at once from our other species by its small size, purple color, and very thin constricted fronds. The species was placed by Harvey in the subgenus *Caloglossa*, which is separated as a distinct genus by Agardh in his Epicrisis.

GRACILARIA, Grev.

(From *gracilis*, slender.)

Fronds filiform or compressed, carnoso-cartilaginous, dichotomous or irregularly decompound, composed of an inner layer of large angular cells, which become smaller outwards, and a cortical layer of small colored cells; antheridia in cavities sunk in the cortex or superficial; tetraspores cruciate, dispersed in the cortical layer; cystocarps external, sessile, spherical or conical, with a large cellular placenta at the base, from which radiate the sporiferous filaments, pericarp thick and connected with the placenta by slender filaments.

A genus containing not far from forty species, none of which really deserve the generic name, for they are usually coarse and often decidedly cartilaginous. The specific distinctions are principally derived from the branching, which in the present genus is very variable. Some of the species, as *G. lichenoides*, are used as food.

G. MULTIPARTITA, J. Ag.; Phyc. Brit., Pl. 15.

Fronds purplish red, four to twelve inches long, compressed or submembranaceous, deeply cleft vertically in an irregularly dichotomous or palmate manner, divisions linear wedge-shaped, acute; cystocarps large, conical, scattered over the frond.

Var. ANGUSTISSIMA, Harv.

Fronds narrow, nearly filiform below, compressed above, irregularly dichotomous, the apices frequently palmately divided.

On stones and on muddy bottoms below low-water mark.

Massachusetts Bay, *Harvey*, and common from Cape Cod southward; Europe; California.

A coarse and variable species, which is generally of a dingy purple color. The limits of the species are difficult to fix. Occasionally one finds with us specimens as broad as the common European form, but on the coast of California, and especially of Florida, one finds forms which look like large *Rhodymeniæ*. Most of our specimens are narrower than the type, and the var. *angustissima* of Harvey, it must be confessed, has more the habit of *G. compressa* than of *G. multipartita*. At Orient we have seen what we supposed was *G. confervoides*, but unfortunately our specimens were misplaced.

SUBORDER RHODOMELEÆ.

Fronds usually filiform and branching, sometimes membranaceous or (in exotic genera) reticulate; antheridia ovate or lanceolate in outline, formed by the transformation of monosiphonous branchlets, occasionally covering the surface of discoidal branches; tetraspores generally tripartite, borne either in localized portions of the fronds or in specially modified branches (stichidia); cystocarps external, with a distinct ovate or urceolate conceptacle or pericarp, spores pyriform, borne on short stalks given off from a basal placenta.

The largest suborder of the *Florideæ*, and one containing many of the most beautiful sea-weeds. The suborder is mainly characterized by the cystocarpic fruit, which is external, and has the spores borne separately on short stalks which arise from a placenta which surrounds the carpogenic cell at the base of the conceptacle. In the *Dasyæ*, however, the filaments which bear the spores branch and fill the larger portion of the conceptacle, but we have not thought it advisable to separate them as a suborder. The antheridia, except in the genus *Chondriopsis*, where they assume a peculiar shape, form ovate or siliculose tufts, generally developed from monosiphonous branchlets or rather hairs. The position of the tetraspores varies in the different genera. In some cases the branchlets become broadly ovate and the tetraspores are borne in parallel rows. Such collections of tetraspores are called stichidia. The fronds in the present suborder vary greatly. In the more beautiful genera of tropical regions they are in the form of complicated net-works or in membranes in which the cells are arranged in regular order, but in the majority of the genera the fronds are filiform and branching and generally beset, at least at some seasons, with delicate hairs. In most of the genera represented on our coast the fronds have a polysiphonous axis, that is, on cross-section there is seen to be a central cell surrounded by a circle of large cells, and in longitudinal sections there is a central filament composed of large cells, and on each side a lateral filament whose cells correspond in length to those of the central filament, the upper and lower walls of the three cells forming two parallel lines.

Fronds flattened .... *Odonthalia.*
Fronds filiform 1
1. Tetraspores borne in the smaller branches 2
   Tetraspores borne in stichidia 4
2. Superficial cells small, irregularly placed 3
   Superficial cells, at least in the younger branches, in transverse bands .... *Polysiphonia.*
3. Branches filiform throughout .... *Rhodomela.*
   Ultimate branches club-shaped, much attenuated at base. *Chondriopsis.*
4. Fronds beset with monosiphonous branchlets .... *Dasya.*
   Fronds without monosiphonous branchlets, superficial cells quadrate .... *Bostrychia.*

CHONDRIOPSIS, J. Ag.

(From χονδρος, cartilage, and οψις, an appearance.)

Fronds brownish red, terete or subcompressed, pinnately decompound, branches virgate, much constricted at the base, composed of a monosiphonous axis surrounded by a few (4–6) siphons and surrounded by secondary siphons, cortex of small polygonal cells; antheridia borne in short disk-like branchlets covering both surfaces except at the margin; tetraspores tripartite, in club-shaped branchlets; cystocarps sessile, ovate, with a distinct carpostome, spores pyriform, on short pedicels from a basal placenta.

A genus of which about twenty species have been described, which inhabit principally the warmer parts of the world, some being widely diffused. They are as a whole difficult to distinguish, the specific marks being principally the ramification and shape of the branchlets, points in which the different species vary very much. The antheridia are very peculiar. On the upper branches are borne flattened, more or less incurved, disk-shaped branches, whose margin is wavy. The antheridia cover both sides of these discoidal branches, except at the margin, which is composed of large hyaline cells. The fronds are intermediate between those of *Rhodomela* and *Laurencia*, and the branchlets are always much constricted at the base. Most of the species were formerly included by Lamouroux and others in the genus *Laurencia*. By C. A. Agardh they were, in the Species Algarum, placed in *Chondria*, a genus retained by Harvey in the Nereis. Since as originally defined the genus *Chondria* embraced algæ of rather remote relationship to one another, J. G. Agardh, in the third volume of his Species Algarum, separated the present group, under the name of *Chondriopsis*, the name *Chondria* being abandoned altogether. The habit of the species of the present genus is much like that of *Laurencia*, but the polysiphonous character of the fronds is more evident, the substance more delicate, and the branchlets more distinctly club-shaped than in that genus. As in *Laurencia*, the apices are all depressed, the growing point being sunk in a hollow concavity, from which, as well as from the younger part of the fronds, project numerous tufts of hyaline, dichotomous, monosiphonous filaments.

C. DASYPHILA, Ag. (*Laurencia dasyphila*, Phyc. Brit., Pl. 152.)

Fronds diœcious, four to eight inches high, broadly pyramidal in outline, cylindrical, robust, densely branched, generally with a percurrent axis and alternate, spreading, pinnately decompound branches, ultimate divisions short, club-shaped or top-shaped, very obtuse at apex and much constricted at base; cystocarps sessile on very short branchlets.

Var. SEDIFOLIA, Ag. (*Chondria sedifolia*, Ner. Am. Bor., Part II, Pl. 18 *g*.)

Branches fasciculate, approximate, branchlets obovate-oblong.

On rocks and stones at low-water mark, and on *Zostera*.

Common from New York to Cape Cod; Europe.

A rather coarse species which does not collapse when removed from the water, but which glistens on account of the water held by the tufts of hyaline filaments at the tips of the branches. The species is recognized by its coarseness and broadly pyramidal outline and by its club-shaped ultimate divisions. The variety has rather less obtuse tips and is not uncommon. In spite of its coarseness, the species quickly decays in fresh water.

C. TENUISSIMA, Ag. (*Laurencia tenuissima*, Phyc. Brit., Pl. 198.—*Chondria tenuissima*, Ner. Am. Bor., Part II, Pl. 18 *f*; Études Phycol., Pls. 43–48.)

Fronds diœcious, four to eight inches high, narrowly pyramidal in outline, cylindrical, slender, rather loosely branched, with a percurrent axis and long, suberect, alternate, virgate, pinnately decompound branches, ultimate branchlets narrowly fusiform, attenuated at both extremities.

Var. BAILEYANA. (*Laurencia Baileyana*, Mont., Ann. Sci. Nat., Ser. 3, Vol. II, p. 63.—*Chondria Baileyana*, Harv., Ner. Am. Bor., Vol. II, Pl. 18 *a*.—*Chondria striolata*, Farlow, List of Marine Algæ.)

Branches erect, subsimple, beset with slender curved branchlets, which are much attenuated at base and blunt at the apex.

On stones at low-water mark.

Squam, Mass., and common in Long Island Sound; Europe.

A variable species, distinguished from the last by its lighter yellowish color, less dense branching, and slender fusiform branchlets. The typical form is common with us, but not so common as variety *Baileyana*, which was considered by Agardh to be the same as *C. striolata* Ag. The species seems to us rather to be a form of *C. tenuis-*

sima, but it must be confessed approaching *C. dasyphylla*. Bailey was inclined to refer it to *C. dasyphylla*. He quotes Montagne, who first described the species, as *Laurencia dasyhhylla*, as follows: "Notwithstanding the close affinity of this alga, to *Laurencia tenuissima* and to *L. dasyphylla*, it cannot be confounded with either of them. The absence of ramification distinguishes it sufficiently from the first, and the form of the ramenta does not permit it to be referred to the second, from which it is in other respects quite distinct." Just what is meant by the "absence of ramification," by which *L. Baileyana* is to be distinguished from *L. tenuissima*, is not easy to see.

C. LITTORALIS, (Harv.) J. Ag. (*Chondria littoralis*, Ner. Am. Bor., Part II, p. 22.)

"Fronds robust, elongate, subdichotomous or irregularly much branched, branches flexuous, attenuated, with rounded axils, ramuli scattered or crowded, fusiform, attenuated at the base and apex, simple or pinnulated, acute." (Harvey, l. c.)

Wood's Holl, Mass., *W. G. F.*

The description taken from the Nereis applies pretty well to a specimen collected at Wood's Holl. We have seen several specimens of the species collected at Key West. It is dark colored and coarse, but has the branching and habit of *C. tenuissima*. The Key West specimens are reddish yellow, perhaps owing to exposure to the sun. Species of the present genus vary so much in appearance, according as they are more or less thoroughly "squashed" in pressing, that the determination of dried specimens frequently has but little value.

C. ATROPURPUREA, (Harv.) J. Ag. (*Chondria atropurpurea*, Harv., Ner. Am. Bor., Part II, Pl. 18 *e*.)

Fronds four to six inches high, robust, very densely branched; branches patent, secondary branches tapering at the base and apex, beset with scattered fusiform ramuli.

Var. FASCICULATA, Farlow.

Secondary branches borne in clusters; cystocarps broadly ovate, sessile on short lateral branchlets.

From Charleston, S. C., southward, *Harvey*. Var. *fasciculata*, Fort Hamilton, N. Y.

The characters of the present species are not well defined. Specimens from Charleston, determined by Harvey himself, are robust and have the ultimate branches scattered, but unfortunately they are without fruit. What has been supposed to be a variety of the same species occurs rather commonly on the coast of California, and was distributed in the Alg. Am. Bor., No. 57. It is, however, not beyond question whether the form distributed should not rather have been referred to *C. nidifica*, Harv., described in the Supplement to the Nereis The plant which is here described as var. *fasciculata* is less robust than specimens from California and Charleston, but resembles them in the dark color and secondary branches which taper at both extremities. It differs from Charleston specimens in having the branches in tufts, in which respect it resembles some Californian specimens. Whether the New York form should be considered a variety of *C. atropurpurea* rather than *C. nidifica* is perhaps doubtful.

ODONTHALIA, Lyngb.

(From *οδους*, a tooth, *αλς*, the sea.)

Fronds dark purple, plane, deeply distichously pinnatifid, with a rudimentary midrib, margin alternately toothed, formed of oblong internal cells and small irregularly shaped cortical cells; tetraspores tripartite, arranged in two rows in short, corymbose, stipitate, lanceolate branchlets (stichidia), which are marginal and generally axillary; cystocarps similarly placed, ovate, with a distinct carpostome and pyriform spores borne on a basal placenta.

A small genus of seven or eight species, which are confined mainly to the colder waters of the northern hemisphere. *O. dentata* occurs in the North Atlantic, extending as far south as Halifax. Several other species inhabit the North Pacific, especially the vicinity of Kamtschatka, one species occurring as for south as Japan and another in California. The species are dark and opaque, and the polysiphonous structure is scarcely visible in the older parts of the fronds, but is clearly seen in young shoots, especially in adventitious growths.

O. DENTATA, Lyngb.; Phyc. Brit., Pl. 34.

EXS.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 56.

Fronds four to twelve inches long, quarter of an inch broad, decompoundly pinnate, branches oblong, deeply pinnatifid or bipinnatifid, laciniæ alternate, linear, sharply inciso dentate toward the truncated extremities; tetrasporic and cystocarpic branchlets clustered, axillary.

Halifax, N. S., and several localities on the Saint Lawrence River.

This species has not yet been found within our limits, but may be expected on the Maine coast. It is easily recognized by its color and ramification, and does not adhere to paper in drying. As a rule, American forms of this species are narrower than the common British form, but they are not distinct, and at Halifax the common British form was dredged by Professor Hyatt in abundance. The *O. furcata* of Reinsch, Contributiones ad Algologiam et Fungologiam, p. 58, Pl. 42 *a*, is apparently the common narrow form of the present species.

RHODOMELA, J. Ag.

(From *ροδεος*, red, and *μελας*, black.)

Fronds dark red, filiform or subcompressed, pinnately decompound, branches filiform, not contracted at base, composed of a monosiphonous axis surrounded by several siphons and a thick cortex of small, irregularly placed, polygonal cells; tetraspores tripartite, borne in the ultimate branches; cystocarps sessile or pedicellate, spores pyriform, on short stalks from the basal placenta.

A small genus of dark-colored algæ, confined to rather high latitudes in both hemispheres. It is connected by the genus *Rytiphlœa* with *Polysiphonia*. The polysiphonous character of the frond is seen at the tip, and in most species cross-sections of the stem show a circle of large cells surrounding the axial cell and a thick cortical layer. When young the species are covered with dichotomous hairs. The genus is distinguished at sight from *Chondriopsis* by not having branchlets constricted at the base.

R. SUBFUSCA, Ag.; Phyc. Brit., Pl. 264.

Exs.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 55.

Fronds six inches to a foot and a half long, terete, pinnately decompound, branches virgate, lower branchlets patent, subulate, the upper fasciculato-corymbose; tetraspores prominent in subtorulose branchlets; cystocarps sessile, ovato-globose.

Var. GRACILIOR, J. Ag. (*Rhodomela gracilis*, Harv., Ner. Am. Bor., Part II, Pl. 13 *c*.)

Fronds slender; tetrasporic branches distinctly torulose.

In deep tide-pools and at a depth of several fathoms.

Throughout our whole limits; Europe.

A species which varies very much with the time of year and the place of growth. It is usually common in the spring months, when it is often washed ashore, and in the summer and autumn it is occasionally found, especially in dredging, in a denuded form, nothing remaining but the older branches, which are perennial and which give rise the following season to rather delicate new branches. As usually seen on Cape Ann the fronds are short, robust, and dark colored, even in early spring, while at Wood's Holl and in Long Island Sound the common spring form is much attenuated, delicate, and of a brighter red color, forming the *Rhodomela Rochei* of the Nereis. In spite of the difference in aspect, the extreme forms are connected by numerous transitional stages which make it impossible to admit a specific distinction. By Agardh *R. Rochei* is considered to be the spring form of the typical *R. subfusca*, but we are more inclined to regard it as the young of the var. *gracilior*, which is more common south of Cape Cod, the type occurring northward. The species does not adhere well to paper.

POLYSIPHONIA, Grev.

(From πολυς, many, and σιφων, a tube.)

Fronds filamentous or subcompressed, distichously or irregularly branching, formed of a monosiphonous axis and several (4–20) siphons, often with secondary siphons, and either naked or with a cortical layer of irregular cells, furnished with numerous tufts of hyaline, monosiphonous, dichotomous filaments; antheridia lanceolate in outline, borne on the dichotomous filaments; tetraspores tripartite, in one, rarely in two, rows, in the slightly altered upper branches; cystocarps ovato-globose or urceolate; spores pyriform, on short pedicels borne around a basal carpogenic cell.

The largest genus of *Florideæ*, of which more than two hundred species have been described, but not all of which can be considered valid. They abound in all parts of the world, especially in warm, shallow waters. Some are perennial, but the majority are annual and disappear during the winter. They are easily recognized at sight by the structure of the frond and the tetraspores, which are almost always in a single row in the upper branches, rarely in a double row, and not in swollen special branches or stichidia, as in *Bostrychia*, which is nearly related to *Polysiphonia*. The growth is from a single apical cell, from which is formed a monosiphonous axis. By tangential divisions of the upper cells there is formed a number of peripheral cells and a central cell. The peripheral cells are similar to one another and of the same length as the central cell, and, as the successive secondary cells lie exactly or nearly exactly over one another, the mature frond appears to be composed of a central filament or axis surrounded by a number of secondary filaments or siphons, as they are termed in speaking of the present genus and its allies. There is formed in some species a second set of cells alternating with the siphons, and also corticating, generally irregularly sinuous cells, which cover the surface. The tetraspores, according to Prof. E. P. Wright, are formed by out-growths from the axial cell. The antheridia are borne on the delicate, colorless filaments which form tufts on the younger parts of the frond. The filaments are dichotomous and the antheridia cover the lower cells of one of the forkings, the branch sometimes being prolonged beyond, when the antheridia are said to be mucronate. The cystocarps are terminal on short branches, and contain within a pericarp, whose cells are arranged in longitudinal series, pyriform spores on short stalks around a small basal placenta. Some of our species are not well defined, and a prolonged observation on the shore, especially during the spring months, is necessary before the limits of some species can be accurately fixed.

SECT. I. *Siphons four, cortications wanting.*

P. URCEOLATA, (Dillw.) Grev.; Phyc. Brit., Pl. 167.

Fronds deep red, becoming blackish, cæspitose, three to ten inches high, setaceous, branches subdichotomous, with short, alternate, patent or recurved, decompound branchlets, siphons four, cells below 4–5 times longer than broad, becoming shorter above; cystocarps on short lateral branches, urceolate, with a distinct neck; antheridia linear-oblong, mucronate.

Var. FORMOSA, Ag. (*Polysiphonia formosa*, Phyc. Brit.)

Filaments soft and flaccid, branches long, flexuous, branchlets somewhat attenuated, cells 5–10 times as long as broad.

Var. PATENS, Grev. (*P. subcontorta*, Peck, Twenty-third Report New York State Botanist.)

Branches numerous, recurved or revolute.

On wharves and rocks at low-water mark.

From New Jersey northward; Europe; California.

A common perennial species, most abundant in the spring, when it has a deep blood-red color. It is frequent on old wharves and wood-work and on the under surface of rocks near low-water mark, where it forms small turfs, in company with *Callithamnion Rothii.* The var. *formosa* is found only in the spring, and is softer, forms longer tufts, and has longer cells than the type. It is the only form of the species which adheres well to paper or which can lay claim to beauty. It is especially luxuriant in April at Wood's Holl and the region of New Bedford, and forms dense tufts sometimes a foot long. As usually seen in summer, the species is blackish and setaceous and covered with diatomes. The var. *patens*, which differs somewhat in general habit from the type, is not uncommon with us. Through the kindness of Mr. Peck, we have been able to examine a specimen of his *P. subcontorta*, which, judging from the description in the Twenty-third Report, seemed to be closely related to, if not a form of, *P. Harveyi.* An examination of the specimen, however, seems to us to show that it is var. *patens* of the present species, which it resembles in microscopic characters.

P. SUBTILISSIMA, Mont.

Filaments densely tufted, two to four inches long, purplish brown, rising from a creeping base, capillary, alternately decompound, branches multifid, attenuate, branchlets filiform, internodes once and a half as long as broad.

Var. WESTPOINTENSIS, Harv.

More slender and delicate.

Jackson Ferry, N. Y.; Newburyport, Mass., *Harvey;* Providence, R. I., *Mr. Olney;* Gloucester, Mass.? *W. G. F.* The variety at West Point.

The present species is with difficulty distinguished from *P. Olneyi*, which, in its turn, too closely approaches *P. Harveyi*. The two last-named species are attached by a small disk, and the filaments do not rise from a creeping base, as in the present species. The vertical filaments of *P. subtilissima* are of a purple color, and are fine and soft, and the cells are not much longer than broad. We have seen specimens collected by Mr. Olney near Providence which may with certainty be referred to the present, and have found floating in ditches at Gloucester tufts of a very dark, delicate species which may probably be referred to it. The specimens were apparently washed from some muddy shore, but the creeping basal filaments could not be seen. Gloucester collectors should search for the plant in muddy ditches towards Little Good Harbor.

P. OLNEYI, Harv., Ner. Am. Bor., Part II, Pl. 17 *b.—Dough Balls.*

Fronds brownish red, densely tufted, from two to five inches high, filaments capillary, much branched, branches patent or divaricate, decompound, attenuated above, with scattered slender branchlets, internodes three or four times as broad below, becoming shorter above; antheridia ellipsoidal, not mucronate; cystocarps broadly ovate, nearly sessile.

On *Zostera.*

From New York to Halifax, most common south of Cape Cod.

The present species passes by numerous forms into *P. Harveyi*, and in spite of the marked difference in the typical forms of the two species, the question remains to be settled whether *P. Olneyi* is not a slender variety of *P. Harveyi.* In its typical form *P. Olneyi* forms dense soft tufts, sometimes called dough-balls by the sea-shore population. The filaments are divaricately branched below, but the upper branches are slender and erect and beset with fine byssoid branchlets. When old, however, the lower branches become rigid, and the branchlets rather spine-like, as in the next species. Both *P. Olneyi* and *P. Harveyi* are very common from Cape Cod to New York, growing usually on *Zostera* in shallow, quiet bays. As they mature they fall from the *Zostera* and are blown into small coves, the bottoms of which are sometimes almost carpeted with the globose tufts of these two species, which lie loosely on the bottom. The typical forms of the present species collapse at once when removed from the water.

P. HARVEYI, Bail.; Ner. Am. Bor., Part II, Pl. 17 *a.—Nigger Hair.* **Pl. XV, Figs. 3, 4.**

Fronds blackish red, globosely tufted, filaments two to six inches high, setaceous, when young with a leading axis, becoming divaricately much branched, branches alternately decompound, patent, often angularly bent, beset with numerous short, simple or forked, spine-like branchlets, internodes all short, never more than twice as long as broad; antheridia ellipsoidal, not mucronate; cystocarps broadly ovate, on short pedicels.

On *Zostera* and other plants.

Common in Long Island Sound and found in several place in Massachusetts Bay; Goose Cove, Squam, Mass.

The typical form of the species is closely related to *P. spinulosa*, Grev., found in Scotland and in the Mediterranean and Adriatic Seas, where, however, it does not appear to be at all common. We once collected specimens at Antibes, France, and certainly at first sight it could not be distinguished from *P. Harveyi*. In the typical *P. Harveyi* the branches are rather rigid and the branchlets are spine-like and sometimes revolute. As the plant grows old the finer branchlets disappear, and there is left an irregular mass of coarse filaments beset with revolute branchlets, forming the *P. arietina* of Bailey, which is in the Nereis considered a variety of *P. Harveyi*. It is, however, rather an autumnal condition than a proper variety. The upper portion of the fronds of *P. Harveyi* are sometimes slender and byssoid, and as it is a well-known fact that the branchlets of *Polysiphoniæ* have the power of falling from their attachments and producing new plants, it may be, as has already been suggested, that *P. Olneyi* is the byssoid condition of *P. Harveyi*.

Polysiphonia Americana, Reinsch, Contrib. ad Algolog. et Fungolog., p. 50, Pl. 33 *a*, as far as can be judged by the plate, closely resembles some forms of *P. Harveyi*, except in the color, which as given by Reinsch is bright pink. It is said by Reinsch to resemble *P. arietina*, Bailey, in general appearance, but to differ in the erect, subdichotomous filaments, whose joints are bicellular.

SEC. II. *Siphons four, main branches corticated, ultimate branches without cortication.*

P. ELONGATA, Grev.; Phyc. Brit., Pls. 292, 293.—*Lobster Claws.*

Fronds dark red, six to twelve inches long, robust, cartilaginous, irregularly branched, lower branches naked, upper beset with closely set, alternately multifid branchlets, which taper at the base and apex, cortications covering all but the younger portions of frond, section of branches showing four large siphons, with secondary siphons and a rather thick cortex; cystocarps ovate.

Gloucester, Lynn Beach, Squam, Wood's Holl, Gay Head, Mass.

One of the largest but less common *Polysiphoniæ*, which is more abundant in the spring than at any other season. The species is perennial and in late summer and autumn the branchlets fall off, leaving the lower and coarser branches, which persist through the winter, and in the following spring produce at the apices tufts of delicate, deep-red branchlets. It is recognized by its long cartilaginous main branches, which are nearly naked, and which bear tufts of filaments at the apex. The popular name of lobster claws is tolerably appropriate.

P. FIBRILLOSA, Grev.; Phyc. Brit., Pl. 302.

Fronds brownish yellow, four to ten inches high, broadly pyramidal, rather robust below, becoming slender above, with an undivided axis or divided near the base into several long, main branches, secondary branches alternate, several times pinnate, fibrillose, with short, scattered, simple branchlets, ultimate divisions capillary, tufted; antheridia oblong, terminal; cystocarps ovate.

On stones and *Zostera* at low-water mark.

Lynn, Mass., *Harvey;* Wood's Holl, Noank, Orient Point, Newport, and several places in Long Island Sound; Europe.

Rather a common species in sheltered places south of Cape Cod, but only known northward from the reference of Harvey. It is smaller and more slender than the last species and the branches are not naked, but fibrillose. The present species is more nearly related to *P. violacea,* of which Harvey suggests that it may be a variety. The last-named species is more decidedly red in color, is a larger plant, and although the ultimate branches are in tufts, as in *P. fibrillosa,* the larger branches are destitute of the fibrillose branchlets characteristic of the latter species.

P. VIOLACEA, Grev.; Phyc. Brit, Pl. 209.

Fronds brownish red, six inches to two feet long, elongated, pyramidal, usually with an undivided main axis, which has several long, widely spreading branches near the base, main divisions robust, becoming capillary at the tops, branches rather naked below, bearing above numerous multifid branchlets, ultimate branchlets densely tufted; antheridia? cystocarps broadly ovate, sessile or shortly pedicelled.

Var. FLEXICAULIS, Harv.

Branches very long, slender, angularly bent, much divided, divisions patent and sometimes secund.

In deep tide-pools on exposed shores and on *Zostera* in deep water.

Common from New York northward. Var. *flexicaulis,* Cape Ann; Portland, *C. B. Fuller;* and northward.

One of the commonest species of the genus, frequenting cold, exposed tide-pools, where it has a dense habit and rarely exceeds a foot in length. When growing in deep water it is long and slender. In spring it has a pink color, but late in the season it becomes dark colored, almost blackish. Specimens of the present species are sometimes found in American herbaria bearing the name of *P. Brodiæi,* a species having six siphons, which has not as yet been detected with certainty on our coast. The *P. Brodiæi* of Bailey's List of United States Algæ is, according to Harvey, *P. fibrillosa.*

SECT. III. *Siphons more than four, corticating cells wanting.*

P. VARIEGATA, Ag.; Phyc. Brit., Pl. 155; Ann. Sci. Nat., Ser. 3, Vol. XVI, Pl. 6.

Fronds purplish brown, densely tufted, four to ten inches high, filaments setaceous and rigid below, capillary above, dichotomo-multifid, the lower axils patent, branches above somewhat zigzag, elongated, with alternately decompound, flaccid branchlets, siphons six in number, cortications wanting, internodes not much longer than broad; antheridia linear-oblong, mucronate; cystocarps ovate, short-stalked.

At the foot of wharves, on *Zostera,* &c.

Massachusetts Bay, *Harvey;* common from Cape Cod to the West Indies; Europe.

A beautiful summer species, forming large purple tufts on wood-work and various substances a short distance below low-water mark in warm, sheltered waters. The lower branches are rigid and widely spreading, but the tips are byssoid and collapse on being removed from the water. When mounted on paper small specimens have a slight resemblance to *P. Olneyi*, but the species is coarser, and the siphons are six instead of four in number.

P. PARASITICA, Grev.; Phyc. Brit., Pl. 147.

Fronds dark brownish red, one to three inches high, filaments compressed, decompound-pinnate, branches alternate, distichous, 2–3 pinnate, ultimate divisions erecto-patent, subulate, acute, internodes about as long as broad, siphons 8–9, cortications wanting; cystocarps ovate, on short stalks.

Providence, R. I., *Harvey;* Europe; California.

A small species, said to have been collected by Mr. Hooper on the authority of Harvey. It differs from our other species in the compressed frond and uniformly distichous arrangement of the branches. In aspect it looks more like a fine *Ptilota* than a *Polysiphonia*. In drying it does not adhere well to paper. In California the species is rather common, especially the large variety *dendroidea*.

P. ATRORUBESCENS; Grev.; Phyc. Brit., Pl. 172.

Fronds tufted, dark red, two to twelve inches long, filaments setaceous, rather rigid, branches long, erect, alternately decompound, with scattered, simple or virgately tufted branchlets, which taper at the base and apex, siphons usually 12, spirally twisted, articulations generally 2–3 times as long as broad; antheridia oval, terminal; cystocarps broadly ovate, sessile.

In deep water and washed ashore.

Gloucester, *Mrs. Davis;* Gay Head, Mass., *W. G. F.;* Fisher's Island, *Prof. Eaton;* Orient, L. I., *Miss Booth;* Noank, *W. G. F.;* Little Compton, R. I., and Long Branch, N. J., *Harvey;* Europe.

One of our less common species, recognized by the number of siphons, which are usually spirally twisted, and by the long branches, which bear small branchlets that taper at both extremities. Late in the season one finds denuded, rigid specimens, which bear little resemblance to the form found early in the season. It does not adhere well to paper in drying, and becomes quite black in the herbarium.

P. NIGRESCENS, Grev.

Fronds dark brown, three to twelve inches long, rigid below, becoming flaccid and much divided above, branches alternate, decompound-pinnate, ultimate branches subulate, siphons 12–16, articulations about $1\frac{1}{2}$–3 times as long as broad; antheridia lanceolate, mucronate; cystocarps ovate, subsessile.

Var. FUCOIDES, Ag.; Phyc. Brit., Pl. 277.

Fronds robust and naked below, upper branches pectinate or corymbose, articulations but slightly longer than broad.

Var. AFFINIS, Ag.; Phyc. Brit., Pl. 303.

Fronds elongated, diffusely branching, branches distant, undivided below, densely pinnate at the tip, articulations two or three times as long as broad.

In tide-pools and below low-water mark on stones and algæ.

Common along the whole coast.

One of our commonest and least beautiful species, which, although very variable, is generally easily recognized. In the Nereis, Harvey describes seven forms found on our eastern coast. Practically, the species as found with us is recognized under two principal forms. The first is rather robust, and has branches which are more or less pectinate or corymbose, and in the extreme forms, as var. *Durkeei*, Harv., l. c., Pl. 17 *c*, they are compressed, and the pinnæ are distichous and abbreviated. The second form of the species is represented by the *P. affinis* of the Phycologia Britannica, in which the main branches are much elongated and more delicate than in var. *fucoides*, and the ultimate divisions are arranged in pyramidal tufts. Between the two types described occur innumerable forms which hardly require a further description.

P. FASTIGIATA, Grev.; Phyc. Brit., Pl. 299.

Fronds dark brown, forming globose tufts one to three inches in diameter, filaments rigid, of nearly the same diameter throughout, repeatedly dichotomous, fastigiate, apices subulate, spreading, occasionally forcipate, siphons averaging about 20, articulations decidedly broader than long; antheridia oval, in dense terminal tufts; cystocarps ovate, taking the place of a terminal dichotomy.

On *Ascophyllum nodosum*.

Common from New York northward; Europe.

A very common species, at once recognized by its form and place of growth. It forms tufts on *Fucus* (*Ascophyllum*) *nodosus* and, according to Harvey, on *F. vesiculosus*. Its color is so dark that one at first sight would hardly suppose it to be one of the *Florideæ*. The filaments are rigid, and the plant does not collapse in the least when removed from the water, nor does it adhere to paper in drying. The antheridia are very abundant early in the season. The species, like most of the genus found on our coast, is diœcious, but occasionally one finds both sexes on the same individual. In this connection, it would be well to inquire if there is not a proterandrous condition among the *Florideæ*, as in the higher plants. It has seemed to us that such a condition may exist in *P. variegata*, and possibly in the present species. *P. fastigiata* is said to have been collected in California, but the locality is doubtful. It has been found also in Australia and New Zealand.

BOSTRYCHIA, Mont.

(From *βοστρυχιον*, a small curl.)

Fronds dark purple, compressed or filiform, distichously or irregularly branching, composed of several (4–11) cells (siphons) arranged around a central filament, the siphons either naked or corticated with subcubical cells, apices usually monosiphonous; tetraspores tripartite, in a double row in terminal fusiform branches (stichidia); cystocarps terminal on the branches, ovate, with a distinct carpostome, spores pyriform, attached to short filaments which are given off from a basal placenta.

A genus of about twenty species, characterized by their lurid purple color and by growing in places where the water is not very salt, some species, it is said, even growing in fresh water. They inhabit principally the tropics. The genus is intermediate between *Polysiphonia* and *Dasya*, and some species have been previously referred to *Rhodomela*. The tetraspores are in stichidia, as in *Dasya*, but the cystocarpic spores seem to us more nearly like those of *Polysiphonia*. The frond is originally monosiphonous, and soon becomes polysiphonous, the number of siphons not being as constant as in *Polysiphonia*. The corticating cells, when present, are regularly arranged in transverse bands. The development of the frond has been studied in detail by Dr. Ambronn in *B. scorpioides*.

B. RIVULARIS, Harv., Ner. Am. Bor., Part II, Pl. 14 *d*.

EXS.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 54.

Fronds an inch high, capillary, rising from a procumbent base, branches flexuous, bipinnate, pinnæ distichous, alternate, patent, loosely pinnulate, pinnules subulate, section of main branches showing about seven siphons; tetraspores cruciate, in two rows in oblong stichidia below the tips; cystocarps ovate, terminal on the shortened, naked, lower pinnæ.

On submerged logs in patches.

Hell Gate, N. Y., *Harvey;* Fort Lee, N. Y., *Mr. Averill;* College Point, Astoria, *C. H. Peck;* common southward; Australia.

A common species from Charleston, S. C., southward, but only occasionally found with us. The only certain localities are near New York City, and it is extremely doubtful whether it was ever found in the arctic waters of the Isle of Shoals, where it was reported by Captain Pike. The species is small and rather insignificant, but is easily recognized by its polysiphonous structure and ramification. There are no cortications, and the species belongs to the subgenus *Stictosiphonia*.

DASYA, Ag.

(From δασυς, hairy.)

Fronds bright red, filiform or compressed, distichously or irregularly branching, composed of a monosiphonous axis surrounded by several (4–12) siphons, often corticated with irregularly shaped cells, clothed in the upper part or throughout with colored, monosiphonous, dichotomous branchlets; antheridia in siliculose tufts on the branchlets; tetraspores tripartite, borne in regular rows in lanceolate or ovate-lanceolate enlargements of the branchlets; cystocarps ovate, acuminate, sessile or pedicellate, spores terminal on branching filaments arising from a basal placenta.

A large and beautiful genus, including about seventy species, of which the greater part are tropical, Australia being especially rich in species. The genus is divided into a number of subgenera, and is connected by *Bostrychia* and *Tænioma* with *Polysiphonia*. The tetraspores are in stichidia borne on the hair-like branchlets, while in *Bostrychia* they are in the polysiphonous branches, and in *Tænioma* the stichidia are formed from the flattened and scarcely altered branches. The cystocarps are borne on short lateral branches, which are usually slightly prolonged beyond the base of the cystocarp. The placenta of *Dasya* differs somewhat from that of *Polysiphonia* and our other genera of *Rhodomeleæ*. The spores are pyriform, but are borne on rather long branching filaments which surround the carpogenic cell at the base of the conceptacle, and which rise high up in its interior instead of being nearly sessile around the carpogenic cell, as in *Polysiphonia*. The development of the cystocarp has been studied in detail by Janczewski in *D. coccinea*. The fronds are either filamentous or more or less flattened, and, as in the case with most of the suborder, are formed from a monosiphonous axis, from the cells of which whorls of filaments are given off, which in the older parts of the frond become parallel to the axis and replace the siphons of *Polysiphonia*. In most of the genus there are also secondary siphons and corticating cells, and either at the tip or throughout the frond tufts of delicate, dichotomous, monosiphonous branchlets, which are colored and not hyaline, as in the hairs of some other genera.

D. ELEGANS, Ag., Sp. Alg. (*Rhodonema elegans*, Martens.—*Dasya pedicellata*, Ag., Syst.; Bailey, in Am. Journ. Sci., Vol. III, p. 84.)—*Chenille*. **Pl. XV, Fig. 1.**

EXS.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 51.

Fronds diœcious, villous, lake-red, six inches to three feet long, cylindrical, attached by a small disk, alternately 1–3 pinnate, with a percurrent axis, densely clothed throughout with tufts of purple, capillary, monosiphonous, dichotomous branchlets, sections of branches showing five cells around the axial cell; antheridia densely covering the lower cells of one of the divisions of the branchlets; tetraspores in two or three rows in linear-lanceolate or ovate pointed stichidia on the branchlets; cystocarps sessile on very short branches (pedicels) which are borne on the main branches.

On *Zostera*, wharves, &c., below low-water mark.

Common from Cape Cod southward; Adriatic Sea.

A beautiful species, known to lady collectors by the name of *chenille*, at once recognized by its long, cylindrical, branching fronds, densely fringed with fine lake-colored filaments. It is found throughout the year. In drying it adheres closely to paper. The antheridia are much like those of *Polysiphonia variegata*, but are longer. The species extends to the West Indies, but appears to be more common in Long Island Sound than elsewhere. There is in the collection of the Peabody Academy of Salem a very large specimen, said to have been collected at Ipswich Beach, Mass., but the locality must be regarded as doubtful. At any rate, the species is quite unknown elsewhere north of Cape Cod.

SUBORDER CORALLINEÆ, Decaisne.

Fronds rose-colored or purple, calcareous, horizontally expanded or erect and branching, crustaceous, foliaceous, or filiform, continuous or articulated; antheridia, carpospores, and tetraspores borne in distinct cavities (conceptacles), which are either external or immersed in the fronds; antherozoids spherical, attenuated at one end, or provided with two short projections borne on short filaments at the base of the male conceptacles; carpospores pyriform, terminating short filaments which surround a tuft of paraphyses at the base of the female conceptacles; tetraspores zonate, occasionally binate.

The present order includes all the calcareous *Florideæ* except a comparatively few species which belong to the *Nemalieæ* and *Squamarieæ*. Although classed by the earlier writers with the corals rather than plants, the species of *Corallineæ* are now placed at the head of the *Florideæ*, in consequence of their highly differentiated organs of fructification. Our knowledge of the fructification of the *Corallineæ* is derived principally from the Études Phycologiques of Thuret and Bornet and the Recherches Anatomiques sur les Melobésiées of Rosanoff. Thuret and Bornet describe three different forms of conceptacle, containing, respectively, the antheridia, the carpospores, and the tetraspores, the last only being mentioned by Harvey in the Nereis. The tetraspores, which are much more common than the carpospores, are usually zonate, although occasionally binate, and from the fact that they are borne in distinct conceptacles, which is not the case with the other *Florideæ*, it had erroneously been considered that the carpospores of the *Corallineæ* were four-parted. The cystocarpic spores, or carpospores, are always pyriform and undivided, and accompanied by paraphyses. The number of trichogynes is large, and they project in a tuft at the orifice of the conceptacle at the time of fertilization. The antherozoids differ from those of the other *Florideæ* in having appendages.

The *Corallineæ* abound in the tropics, and but few representatives are found in northern seas. Our own coast is especially poor in species. The study of the development of the plants of this order is difficult, owing to the calcareous deposit, and soaking in acid injures the more delicate parts. The species are nearly all fragile when dried, and it is not easy to preserve herbarium specimens in good condition. The suborder may be divided into two tribes. The *Corallineæ* proper have articulated fronds, which rise vertically from the substratum, as is seen in our common Coralline. The *Melobesieæ* are not articulated, but form irregular horizontal crusts, which sometimes rise in irregular erect branches.

Fronds erect, filiform, articulated.......................... *Corallina.*
Fronds horizontally expanded or vertical and inarticulate.
  Fronds horizontal .... *Melobesia.*
  Fronds rising in irregular protuberances from a horizontal base, *Lithothamnion.*

CORALLINA, Lam.x.

(From κοραλλιον, a coral.)

Monœcious or diœcious, fronds arising either from a calcareous disk or from interlaced filaments, erect, terete or compressed, articulated, branched, branches opposite, pinnate; conceptacles terminal, naked or occasionally with two horn-like appendages.

A genus comprising about thirty to thirty-five species, mostly tropical, *C. officinalis, C. squamata*, and a few others extending high northward. The fronds of *Corallina* are formed of a bundle of dichotomous parallel filaments, whose external branches grow obliquely outwards to form the cortical layer. The increase in the length of the frond arises from the elongation of the central bundle of filaments. The whole plant is covered by a dense cuticle. The conceptacles are formed from the terminal cells of the filaments just mentioned, which cease elongating and lose their calcareous incrustation, the cuticle also falling away. The peripheral filaments, at the same time, continue to elongate and project beyond the central bundle of filaments, thus forming the wall of the conceptacle.

C. OFFICINALIS, L.; Phyc. Brit., Pl. 222.—*Common Coralline.*

Diœcious, fronds two to six inches high, arising in dense tufts from a calcareous disk, decompound-pinnate, lower articulations cylindrical, twice as long as broad, upper articulations obconical or pyriform, slightly compressed, edges obtuse; conceptacles ovate, borne on the ends of the branches, or some of them hemispherical and sessile on the articulations.

Var. PROFUNDA, Farlow.

Fronds elongated, with few, irregular branches.

Common in tide-pools; the variety in deep water.

Europe; North Pacific?

The only species known on our coast, often lining the bottoms of pools, and when exposed to the sun becoming white and bleached. *C. squamata*, which is monœcious, and has a filamentous base, and whose upper articulations are compressed with sharp edges, especially on the upper side, is a common species of Northern Europe, and may be expected with us.

MELOBESIA, Aresch.

(Possibly from *μελιβοια* or *μηλοβοσις*, the daughter of *Oceanus.*)

Fronds calcareous, horizontally expanded, orbicular, becoming confluent and indefinite in outline, conceptacles external or immersed; antherozoids spherical, furnished with one or two short projections; tetraspores either two or four parted, borne sometimes in conceptacles having a single orifice, at other times in conceptacles having several orifices.

The limits of the three genera *Melobesia*, *Lithophyllum*, and *Lithothamnion* are not well defined. In *M. Thuretii*, Bornet, the plant consists merely of a few short filaments, which are buried in the substance of *Corallina squamata* and several species of *Jania*, upon whose surface the conceptacles of the *Melobesia* are alone visible. From this species, in which the frond may be said to be rudimentary, we pass through forms in which the frond is in the form of calcareous crusts or plates till we meet heavy, irregularly branching forms, which resemble corals much more than plants. In the present paper, *Melobesia*, including *Lithophyllum* of Rosanoff, comprehends all the smaller and thinner forms in which the frond does not rise in the form of irregular tubercles or branches, while in *Lithothamnion* are placed the branching and heavier species, referred by the older writers, as Linnæus, Ellis and Solander, Lamarck, and others, to *Millepora* or *Nullipora*, and by Kützing to *Spongites*. Our common species, *L. polymorphum*, which does not often branch, shows the insufficient basis on which the genera of this group rest. Although there is considerable diversity in the structure of the fronds, the organs of fructification, with some slight modifications of the antherozoids and tetraspores, are the same as in *Corallina* and *Jania*. The most detailed account of the frond in the Melobesioid group is that given by Rosanoff in his work already referred to. According to Bornet, however, the cystocarpic fruit of the *Melobesiæ* escaped the observation of Rosanoff, and what the latter called cystocarps were only a form of the non-sexual or tetrasporic fruit. The tetraspores are found in two different forms—either in hemispherical conceptacles, which have a single central orifice of good size, at whose base the spores are borne around a central tuft of paraphyses, or else in truncated conceptacles, whose flattened upper surface is perforated with numerous orifices, beneath each one of which is a tetraspore, separated from its fellows by a large, colorless cell.

The fronds of the smaller species of *Melobesia*, as *M. Lejolisii* and *M. farinosa*, consist of two portions, the basal and the cortical. The former consists of a single layer of cells, which arise from the division of the spore into four cells and subsequent marginal growth. The cortical layer in the smaller species is composed of small cells cut off by oblique partitions from the upper part of the basal cells. In the larger species of *Melobesia*, more particularly those placed in the subgenus *Lithophyllum*, the cortical layer is much more marked, and the cells of which it is composed seem to be arranged in lines which are curved at the base, but are straight above and at right angles to the direction of growth. In some of the small species of *Melobesia* certain of the basal cells elongate and swell at the summit, so that when seen from above they look larger than the neighboring cells. Rosanoff applied to such cells the name of heterocysts, a word badly chosen, since the heterocysts in the *Nostochineæ*, where the term was first employed, cannot well be compared with the heterocysts in *Melobesia*. The conceptacles in all our species of *Melobesia* are external. The form generally found is that which contains the tetraspores. Our species all occur in Europe, and it is very probable that the remaining Northern European forms not yet recorded with us will be found on further search.

a. Species small, growing on plants, basal stratum well marked, cortical layer imperfectly developed.

M. LEJOLISII, Rosanoff. (*M. membranacea*, Aresch., in Agardh's Spec. Alg.; Harvey, Phyc. Brit., Pl. 347, in part.—*M. farinosa*, Kütz., Spec. Alg.; Le Jolis's Liste des Algues.—*M. Lejolisii*, Rosanoff, l. c., p. 62, Pl. 1, Figs. 1–12.)

Fronds thin and brittle, at first orbicular but soon densely confluent, forming scaly patches of indefinite extent; heterocysts wanting, basal cells squarish, cortical cells few and indistinct; tetrasporic conceptacles very numerous, approximate, flattened-convex, orifice ciliated; tetraspores four-parted; antheridia and cystocarps ?

On leaves of *Zostera*.

Wood's Holl, Mass.; common from Nahant northward; Europe.

A species which is certainly common on eel-grass on the northern coast and probably equally abundant in Long Island Sound, although definite information on this point is wanting. This is the form which is found in American herbaria bearing the name usually of *M. farinosa* or *M. membranacea*. The orbicular character of the fronds soon disappears, as they are found in great numbers, and at an early stage become confluent. The conceptacles are so numerous that at times very little of the fronds themselves can be seen. The latter easily crumble and fall from the plant on which they are growing.

M. FARINOSA, Lam.x. (*M. farinosa*, Aresch., in Agardh's Spec. Alg., non Le Jolis's Liste des Algues.—*M. farinosa* and *M. verrucata ?* Harvey, in part.—*M. farinosa*, Lam.x., in Rosanoff, l. c., p. 69, Pl. 2, Figs. 2–13.)

Fronds thin, orbicular, becoming confluent, distinctly zonate; heterocysts present, basal cells elongated-rectangular, cortical cells semicircular or triangular seen from above; tetrasporic conceptacles small, hemispherical, orifice not plainly ciliate; tetraspores four-parted; antheridia and cystocarps?

On *Fucus vesiculosus.*

Wood's Holl, Mass; in all parts of the world.

Although only one locality is mentioned, the species probably occurs throughout our limits. It is distinguished from the last by the shape of the conceptacles and the absence of a circle of cilia around the orifice. The fronds are larger and more frequently orbicular, although scarcely thicker than in *M. Lejolisii.* In both species the calcareous incrustation is somewhat farinaceous as compared with the following, in which the incrustation is smoother and solid. *M. membranacea,* Lam.x. related to *M. farinosa,* but destitute of heterocysts and having tetrasporic conceptacles with several orifices, is to be expected on algæ of our coast.

M. PUSTULATA, Lam.x. (*M. pustulata,* Phyc. Brit., Pl. 347 *d*; Rosanoff, l. c., Pl. 4, Figs. 2–8.)

Fronds rather thick, circular, becoming reniform or orbicular, indistinctly zoned; heterocysts wanting, basal cells elongated vertically, cortical cells squarish; conceptacles large, hemispherical, orifice naked; tetraspores four-parted.

Probably common on the larger algæ along the whole coast, but being undistinguishable from the next species when sterile, one cannot be sure of the species unless it is in fruit. The tetraspores of *M. pustulata* are zonately four-parted, while those of *M. macrocarpa* are merely two-parted at maturity. In both species the fronds are rather thick and solid and do not crumble, as in the two preceding species, and the orbicular shape is preserved for a longer time.

M. MACROCARPA, Rosanoff. (*M. macrocarpa,* l. c., p. 74, Pl. 4, Figs. 2–8 and 11–20.)

Fronds as in *M. pustulata;* tetraspores large, two-parted.

On *Chondrus.*

Gloucester, Mass.; Europe.

b. Species rather large, growing on stones and shells, cortical stratum well developed.

M. LENORMANDI, Aresch. (*Lithophyllum Lenormandi,* Rosanoff, l. c., p. 85, Pl. V, Figs. 16, 17; Pl. VI, Figs. 1, 2, 3, 5.)

Fronds saxicolous, closely adherent to the substratum, suborbicular, becoming squamulose-imbricate, slightly zonate, margin crenate, lobed; tetraspores four-parted, in compressed, hemispherical conceptacles, with numerous orifices; antheridia and cystocarps?

On stones.

Gloucester, Mass.; Europe.

Apparently common in many places, but fruiting specimens were only collected at

Gloucester. The fronds form rose-colored crusts of considerable extent, and are so closely adherent that they can scarcely be removed. The tetrasporic conceptacles are large, but very much flattened.

LITHOTHAMNION, Phil.

(From λιθος, a stone, and ϑ μνιον, a bush.)

Fronds calcareous, thick, at first horizontally expanded, but afterwards producing erect knobs or coralloid branches; otherwise as in *Melobesia*.

A genus comprising probably not more than twenty or twenty-five good species, most of which are tropical. The larger and more solid forms inhabit deep water. In *Lithothamnion* the cortical portion is markedly developed, and it not rarely happens that new lobes are produced which overlap the older ones and form an imperforate layer over the older conceptacles, which are thus occluded before the spores are ripe. In such cases sections show conceptacles which are apparently buried in the central part of the frond.

L. POLYMORPHUM, (L.) Aresch. (*Millepora polymorpha*, L.; Sp. Alg.—*Millepora* (*Nullipora*) *informis*, Lamarck.—*Melobesia polymorpha*, Harvey, Phyc. Brit., Pl. 345.)

Fronds thick and stony, purplish, becoming whitish, forming incrustations of indefinite extent and occasionally rising in thick clumsy lobes, punctate throughout with the very numerous, small, immersed conceptacles; antherozoids spherical, with an appendage at one end (Bornet); tetraspores two-parted; cystocarps?

On rocks and stones in deep pools and below low-water mark.

Common from Nahant northward.

Not known with certainty south of Cape Cod, but very common northward, where it forms stony, purplish incrustations on rocks. As usually seen, it adheres closely to the rocks, covering patches of indefinite extent, and would be mistaken for a species of *Melobesia*. It is so hard and adherent that it is mistaken by persons on the shore for a part of the rock itself. Although the determination of the present species admits scarcely a doubt, the form usually found with us is smoother and less lobed than European specimens of the same species. In the description given above the tetraspores are said to be two-parted. This is true of all the American specimens examined, but it may be that what we have seen were immature spores, which, when ripe, are four-parted.

L. FASCICULATUM, (Lamarck) Aresch. (*Millepora fasciculata*, Lamarck.—*Melobesia fasciculata*, Harv., Phyc. Brit., Pl. 74.)

Fronds purple, stony, attached, afterwards becoming free, very irregular in outline, densely branching, branches fastigiate, subcylindrical, apices generally depressed; tetrasporic conceptacles densely covering the branches, flattened, hemispherical; tetraspores two-parted.

On stones or in free globose tufts at low-water mark and in deep water.

Eastport, Maine; Europe.

Rather common at Eastport, where it is often dredged. It is also found at low-water mark during the spring tides, especially on Clark's Ledge. Small forms of what may be the same species are occasionally washed ashore after storms as far south as Nahant. The species is at once distinguished from all our other forms by the very numerous, short, stout, cylindrical branches. The conceptacles are external and contain two-parted spores, which may possibly be later four-parted, although in the specimens we have examined they seemed to be quite mature. The conceptacles, as far as could be made out, had no distinct orifice, and were very much flattened externally.

ADDENDA.

To follow *Stilophora*, page 89:

ARTHROCLADIA, Duby.

Fronds olive-brown, filiform, branching, composed of a large central filament formed of cylindrical cells and a series of polygonal cortical cells, which become smaller towards the surface; plurilocular sporangia moniliform, borne on branching monosiphonous filaments which form tufts on the branches.

A small genus, consisting of a single species, which has been divided by Kützing into three, characterized by the tufts of monosiphonous filaments which bear the sporangia, and which are arranged in whorls, giving the fronds a nodose appearance. Harvey and Agardh place the genus in the *Sporochnaceæ*, while Le Jolis places it in a special suborder of *Phæosporeæ*.

A. VILLOSA, Doby. (*Sporochnus villosus*, Ag., Sp.—*Elaionema villosum*, Berk.)

Fronds six inches to three feet long, delicately filiform, with a percurrent axis and usually opposite, widely spreading, 1–2 oppositely pinnate branches; fructiferous filaments byssoid, in dense penicillate tufts which form irregular whorls; plurilocular sporangia moniliform, composed of numerous cells, about 15–20 in a row, generally secund on the branches of fructiferous filament; unilocular sporangia?

Washed ashore at Falmouth Heights, Mass., *Mr. F. T. Collins;* Cape Fear.

A rare species, only known on the New England coast from the specimens collected by Mr. Collins, which were rather smaller than European specimens. The species bears a more or less considerable resemblance to *Desmarestia viridis*, but the penicillate tufts are more regularly arranged in whorls, and bear the sporangia, which is not the case in the genus *Desmarestia*.

To follow *Lyngbya*, page 34:

SYMPLOCA, Kütz.

Filaments as in *Lyngbya*, but adhering to one another in fascicles.

Scarcely distinct from *Lyngbya* except in the existence of a mass of jelly, by means of which the filaments adhere to one another in meshes. In habit the species of the present genus resemble the species of *Calothrix* rather than *Lyngbya*, but the filaments are not prolonged in a hair-like extremity as in the first-named genus.

S. FASCICULATA, Kütz.

Filaments a quarter to half an inch high, united in tooth-like masses from a gelatinous base, .009–12^{mm} broad, sheaths thin, cells broader than long.

On rocks between tide-marks.

Newport, R. I.; Europe.

Table of comparative distribution of New England species.

	Number of New England genera.		Number of New England species.		Number of species north of Cape Cod.		Number of species south of Cape Cod.		Common to Northern Europe.		Common to Mediterranean and Adriatic.		Common to Pacific coast of United States.		Arctic.		Peculiar to New England.		Peculiar to coast north of Cape Cod.		Peculiar to coast south of Cape Cod.	
Cryptophyceæ	17		32		24		24		26		20								1		2	
Chroococcaceæ		5		6		5		4		5		3								1		
Nostochineæ		12		26		19		20		21		17										2
Zoosporeæ	36		88		71		65		77		34		15		33		3		2		3	
Chlorosporeæ		7		36		28		27		30	—	15		7		6		2		1		1
Bryopsideæ		2		2		1		2		2		2		1								
Botrydieæ		1		1		1				1												
Phæosporeæ		26		49		41		36		44		17		7		27		1		1		2
Oosporeæ	4		11		7		7		11		2		2		7							
Vaucherieæ		1		2		1		2		2		1										
Fucaceæ		3		9		6		5		9		1		2		7						
Florideæ	50		99		69		87		71		48		14		34		7		1		12	
Total	107		230		171		183		185		104		31		74		10		4		17	

Besides the genera and species, enumerated above, there are 4 genera and 10 species described, but not considered to be sufficiently well known. If these are counted, the total number of genera is 111, and 240 species. The comparison with Mediterranean and Adriatic species is imperfect, because there is no complete list of the algæ of those seas, and our Pacific coast has not as yet been sufficiently well explored to make it possible to give approximately the number of our species found there. In the table the species marked peculiar to New England are those which extend along our whole coast, those of more limited range being kept distinct. The table shows plainly the general fact that the total number of species increases as one goes southward, and that the increase is mainly due to the relative increase in number of the *Florideæ*. It also shows the close resemblance of our marine flora to that of Northern Europe, and although the number of species common to Arctic waters is not large, as far as the numbers themselves are concerned, yet, if we consider the absolutely small total of species found in Arctic regions, the number of species common to our coast is relatively very large. The general poverty of our flora may be seen in comparing the number of genera and species found in New England with the number of species and genera in Harvey's Phycologia Britannica and Le Jolis's Liste des Algues Marines de Cherbourg. The number given by Harvey is 110 genera and 388 species; that given by Le Jolis is 137 genera and 316 species. The Phycologia was published in 1846–'51, and Le Jolis's Liste in 1863. In both works, more especially in the Phycologia, a number of species which we have in the present article united were kept distinct; but as additional species have been discovered since the appearance of the two works above named, the total number of species is not probably much less, or may even be greater, than the figures given by Harvey and Le Jolis. In Phyceæ Scandinavicæ Marinæ, published in 1850, Areschoug describes 68 genera and 175 species. Since that date numerous additions have been made to the Scandinavian marine flora, and the total number of species is probably not far from that of the species of our own coast.

ARTIFICIAL KEY TO GENERA.

NOTE.—The following key is intended to enable persons who are not at all acquainted with our sea-weeds to ascertain with a partial degree of accuracy the genera to which specimens which they may collect are to be referred. For this purpose the characters used are, as far as possible, those which can be seen by the naked eye, but, as in many cases, the generic distinctions absolutely depend on microscopic characters, one must not expect to be able to recognize all of our forms without making a more or less careful microscopical examination, especially in the case of the *Cryptophyceæ* and *Phæosporeæ*. It should of course be understood that the key is entirely artificial, and does not represent the true botanical relations of our genera; since in many cases the characters refer only to species of our Atlantic coast and would mislead a student having a specimen from other waters.

1. Color bluish or purplish green,* algæ of small size, usually more or less gelatinous .... (*Crytophyceæ*) 5
2. Color grass green 18
3. Color from yellowish brown to olive green or nearly black 26
4. Color red or reddish purple, rarely blackish, in fading becoming at times greenish .... (*Florideæ*) 48
5. Cells arranged in filaments 9
   Cells in colonies, but not forming filaments 6
6. Cells grouped in twos or some multiple of two 7
   Cells solitary, not adherent in twos 8
7. Groups free, not united with one another by a gelatinous envelope. *Chroococcus.*
   Groups united by a gelatinous substance so as to form irregularly-shaped colonies .... *Glœocapsa.*
   Groups united by a gelatinous substance so as to form colonies of a dendritic shape .... *Entophysalis.*
8. Cells imbedded in a gelatinous substance, forming colonies of indefinite shape .... *Polycystis.*
   Cells imbedded in a gelatinous mass, which forms at first ovoidal and afterwards net-shaped colonies .... *Clathrocystis.*
9. Filaments ending in a hyaline hair 16
   Filaments not ending in a hair 10
10. Filaments provided with heterocysts † 11
    Filaments destitute of heterocysts 12
11. Filaments with a thin gelatinous sheath, spores not adjacent to the heterocysts .... *Nodularia.*

* Our marine species of *Clathrocystis* and the genus *Beggiatoa* are exceptions. The former is pinkish, and covers the mud and algæ between tide-marks with a very fine gelatinous film. The species of *Beggiatoa* are whitish to the naked eye, and form very delicate films over decaying algæ.

† Vid. page 11.

Filaments without a gelatinous sheath, spores next to the heterocysts .... *Sphærozyga.*

12. Filaments with a gelatinous sheath 15
Filaments without a gelatinous sheath 13
13. Filaments spirally twisted .... *Spirulina.*
Filaments not spirally twisted 14
14. Cells bluish or purplish green .... *Oscillaria.*
Cells colorless or containing opaque granules .... *Beggiatoa.*
15. Filaments free .... *Lyngbya.*
Filaments adherent in meshes .... *Symploca.*
Filaments united in bundles and surrounded by a general gelatinous sheath .... *Microcoleus.*
16. Filaments free .... *Calothrix.*
Filaments imbedded in a dense mass of jelly 17
17. Filaments nearly parallel, fronds forming a thin expansion... *Isactis.*
Filaments diverging from the base of the hemispherical or somewhat flattened fronds .... *Rivularia.*
Filaments simple at the surface and forking in the interior of the vesicular fronds .... *Hormactis.*

18. Fronds unicellular 19
Fronds multicellular 20
19. Cells small, ovoidal, prolonged into a long, root-like process at the base .... *Codiolum.*
Cells large, filamentous, pinnately branching .... *Bryopsis.*
Cells large, with few, erect, alternate branches, some of which swell at the end and bear numerous spores .... *Derbesia.*
Cells very long, cylindrical, with irregular or subdichotomous branches, spores large, solitary, in special lateral or terminal cells. *Vaucheria.*
20. Fronds membranaceous 21
Fronds filamentous 22
21. Fronds formed of a single layer of cells .... *Monostroma.*
Fronds composed of two layers of cells, which in some cases separate so as to form tubular fronds .... *Ulva.*
22. Filaments simple 23
Filaments branching 24
23. Small algæ, filaments soft and flaccid .... *Ulothrix.*
Rather coarse algæ, filaments more or less rigid, often twisted together .... *Chætomorpha.*
24. Some of the cells bearing long, hyaline hairs .... *Bulbocoleon.*
Hairs wanting 25
25 Branches small and root-like .... *Rhizoclonium.*
Branches distinct .... *Cladophora.*
26. Fronds irregularly globose, hollow, gelatinous .... *Leathesia.*
Fronds forming crusts or expanded pellicles 27

Fronds small, tufted, composed of a dense basal portion and an outer portion composed of free filaments 28
Fronds tubular, unbranched 29
Fronds filamentous 31
Fronds membranaceous, expanded 41

27. Fronds densely parenchymatous throughout, fruit in external spots .... *Ralfsia.*
Fronds minute, thin, formed of a basal horizontal layer of cells and short vertical filaments, between which the sporangia are borne. *Myrionema.*

28. Free filaments all alike .... *Myriactis.**
Free filaments of two kinds, one short and the other exserted. *Elochistea.*

29. Fronds simple, hollow throughout, substance thin 30
Fronds simple, cylindrical, somewhat cartilaginous, with numerous diaphragms .... *Chorda.*
Fronds branching, substance thin, sporangia large, arranged in transverse lines .... *Striaria.*

30. Sporangia densely covering the surface .... *Scytosiphon.*
Sporangia external in scattered spots .... *Asperococcus.*

31. Fronds capillary, branching, formed of single rows of cells (monosiphonous) .... *Ectocarpus.*
Fronds cylindrical, solid or occasionally becoming partially hollow with age 32

32. Fronds slimy, composed of an axial layer of elongated filaments and a distinct cortical layer of short, horizontal filaments 33
Fronds composed of elongated internal cells, which become smaller and polygonal at the surface 35
Fronds, at least in the younger portions, formed of cells of nearly uniform length, arranged in transverse bands, without any proper cortical layer 38

33. Fronds tough and dense .... *Chordaria.*
Fronds soft and flaccid 34

34. Outer cells of cortex producing plurilocular sporangia .. *Castagnea.*
Outer cells of cortex not producing plurilocular sporangia. *Mesogloia.*

35. Fronds traversed by a central filament formed of large cylindrical cells placed end to end 36
Fronds destitute of distinct axile filament 37

36. Sporangia in branching, monosiphonous filaments, which form tufted whorls on the branches .... *Arthrocladia.*
Sporangia inconspicuous, formed from the cortical cells. *Desmarestia.*

37. Sporangia globose, prominent in the cortical layer .... *Dictyosiphon.*

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* When reference is made in *Myriactis* and the following genera of *Phæosporeæ* to free external filaments, it should be understood that only filaments whose cells contain coloring matter are meant, and that no account is to be taken of the numerous hyaline hairs with which most of the species of *Phæosporeæ* are covered at certain seasons.

Sporangia at the base of filaments, which form scattered external tufts .... *Stilophora.*
38. Fronds minute, ending in a hyaline hair, monosiphonous below, densely beset above with very short branches, between which are the sporangia .... *Myriotrichia.*
Fronds ending in a large, single cell, the cells of the lower part giving off descending filaments, which become interwoven and form a false cortex 39
39. Rhizoidal filaments few and limited to the base of the plant, branching, irregularly pinnate .... *Sphacelaria.*
Rhizoidal filaments numerous 40
40. Branches distichously pinnate .... *Chætopteris.*
Branches whorled .... *Cladostephus.*
41. Fronds simple or occasionally proliferous 42
Fronds branching 47
42. Midrib present 43
Midrib wanting 44
43. Fronds stipitate, perforated with numerous holes .... *Agarum.*
Fronds entire, with a few separate leaflets on the stipe below the lamina .... *Alaria.*
44. Fronds thin, subsessile 45
Fronds thick and coriaceous, distinctly stipitate 46
45. Sporangia densely covering the surface of frond .... *Phyllitis.*
Sporangia external in scattered spots .... *Punctaria.*
46. Cryptostomata present, fronds attached by short, nearly simple rhizoids .... *Saccorhiza.*
Cryptostomata wanting, fronds attached by prominent, branching rhizoids .... *Laminaria.*
47. Fronds without distinction of midrib and lamina, fruit borne on short lateral branches .... *Ascophyllum.*
Blade distinct from the midrib, bladders borne in the laminæ, fruit terminal .... *Fucus.*
Bladders and fruit borne on special stalks .... *Sargassum.*

48. Fronds calcareous 49
Fronds not calcareous 50
49. Fronds erect, filiform, articulated .... *Corallina.*
Fronds thin, horizontally expanded .... *Melobesia.*
Fronds thick, horizontally expanded, but rising at intervals in irregular protuberances .... *Lithothamnion.*
50. Fronds horizontally expanded, crustaceous or membranaceous .. 51
Fronds erect or umbilicate 52
51. Fronds parenchymatous, spores in external warts .... *Peyssonnelia.*
Fronds parenchymatous, spores in cavities sunk in the frond .... *Hildenbrandtia.*

Fronds parenchymatous below, but above formed of loosely united filaments, tetraspores formed in the filaments .... *Petrocelis.*

52. Fronds tubular 53
Fronds filamentous 54
Fronds membranaceous 75

53. Fronds cartilaginous, hollow throughout, rigid, proliferous, tetraspores cruciate .... *Halosaccion.*
Fronds slender, much contracted at the joints, but without diaphragms, tetraspores tripartite in depressed cavities .. *Lomentaria.*
Fronds slender, nodose, with diaphragms at the nodes, tetraspores tripartite in the cortical layer .... *Champia.*

54. Fronds monosiphonous, without proper cortex 55
Fronds with distinct axial and cortical layers 62

55. Fronds monosiphonous throughout 56
Fronds at first monosiphonous, becoming polysiphonous above, spores formed by divisions of any of the cells, filaments simple, gelatinous, dark purple .... *Bangia.*
Fronds monosiphonous above, but below with a false cortex formed by descending filaments given off from the cells 60
Fronds formed of large cells placed end to end, with bands of smaller cells at the nodes, in some cases the nodal cells extending in a thin layer over the internodal cells 61

56. Spores (as far as known) formed directly from the contents of any of the cells 57
Spores on short pedicels, distinct, undivided .... *Trentepohlia* (?).
Tetraspores and cystocarps present 58

57. Filaments simple, forming a fine web over other algæ. *Erythrotrichia.*
Filaments dichotomously branching, minutely tufted .. *Goniotrichum.*

58. Fronds formed of prostrate filaments, from which arise erect pinnate filaments, cystocarps terminal, involucrate, spores irregularly grouped, not surrounded by a common gelatinous envelope when mature .... *Spermathamnion.*
Cystocarps terminal or lateral, spores irregularly grouped at maturity, covered by a general gelatinous envelope 59

59. Fronds dichotomous, formed of delicate vesicular cells, tetraspores in whorls at the joints, involucrate .... *Griffithsia.*
Fronds dichotomous or pinnate, tetraspores scattered on the branches, solitary or aggregated, cystocarps lateral, usually binate .... *Callithamnion*, in part.
Fronds with a monosiphonous axis, nearly concealed by the densely whorled branches, cystocarps terminal on short branches, tetraspores in whorls one above another on special branches .. *Halurus.*

60. Fronds capillary or bushy, densely branching, cortications confined to the larger branches, and evidently formed of vein-like descending filaments .... *Callithamnion*, in part.

Fronds compressed, ancipital, branches pectinate-pinnate, covered everywhere, except at the tips, by polygonal, arealated cells. *Ptilota.*

61. Fronds dichotomous, tips usually incurved .... *Ceramium.*
Fronds pinnate, main branches corticated throughout with cells arranged in transverse bands, secondary branches corticated only at the nodes .... *Spyridia.*

62. Fronds nearly black, substance dense 63
Fronds rose-colored or purple, gelatinous or rather succulent, sometimes capillary 64

63. Fronds dichotomous, cylindrical, cartilaginous, spores borne in external flesh-colored warts .... *Polyides.*
Fronds filiform, rigid, wiry, irregularly branching, forming dense, intricate bunches .... *Ahnfeldtia.*
Fronds small, compressed, pinnate, forming small turfs, spores borne on an axile placenta in the enlarged terminal branches .. *Gelidium.*

64. Cystocarps immersed in the fronds 65
Cystocarps external, ovate or urceolate 70

65. Fronds gelatinous, composed internally of a dense mass of slender longitudinal filaments, which give off short, corymbose, lateral branches, which form the cortex 66
Fronds succulent, consisting of an internal layer of slender longitudinal filaments and a cortex composed of roundish polygonal cells, which become smaller towards the surface 69

66. Spores arranged in regular radiating lines 67
Spores in an irregular mass 68

67. Cystocarps naked, cortical filaments free, often ending in hairs. *Nemalion.*
Cystocarps surrounded by a delicate membranous sack, cortical filaments ending in large hyaline cells, which are adherent to one another .... *Scinaia.*

68. Fronds dichotomous, subcompressed, central filaments fine and numerous .... *Nemastoma.*
Fronds filiform, pinnate, central filaments few, rather large. *Gloiosiphonia.*

69. Spores arranged in groups around a central placenta.... *Rhabdonia.*
Spores grouped in several irregular masses in the interior of the fronds .... *Cystoclonium.*

70. Fronds traversed by a distinct central filament or siphon 72
Fronds without a distinct central filament 71

71. Fronds succulent, brownish purple, cylindrical, beset with subulate branchlets, apices generally hooked, tetraspores zonate .. *Hypnea.*
Fronds red, somewhat rigid, filiform, tetraspores cruciate. *Cordylecladia.*

72. Branches much contracted at base .... *Chondriopsis.*
Branches not contracted at base 73

73. Fronds long, cylindrical, densely clothed with lake-red hairs.. *Dasya.*
Fronds purple or dark red, occasionally blackish, superficial cells either throughout or at least in the young branches arranged in transverse bands 74
Fronds dark red, much branched, rather robust, superficial cells small, irregularly placed .... *Rhodomela.*
74. Tetraspores borne in the younger branches .... *Polysiphonia.*
Tetraspores borne in swollen, pod-like branches (stichidia). *Bostrychia.*
75. Fronds cartilaginous, dense, spores immersed in the substance of frond 76
Fronds delicate or somewhat coriaceous 79
Fronds gelatinous, livid purple, composed of a single layer of cells, spores in marginal bands or spots .... *Porphyra.*
76. Fronds formed internally of numerous anastomosnig filaments which divide corymbosely at the surface 77
Fronds formed of roundish angular cells throughout 78
77. Fronds plane or slightly channelled .... *Chondrus.*
Fronds beset with small papillæ, in which the spores are borne. *Gigartina.*
78. Fronds with a prominent stipe, which passes into a proliferous lamina, cystocarps external, globose .... *Phyllophora.*
Fronds linear, regularly dichotomous, cystocarps immersed. *Gymnogongrus.*
79. Midrib present 80
Midrib wanting 82
80. Fronds rosy red, leaf-like 81
Fronds dark brownish purple, narrow, dentate, midrib scarcely distinct .... *Odonthalia.*
81. Tetraspores in spots on the fronds, lateral veins usually present. *Delesseria.*
Lateral veins wanting, tetraspores in thickened portions of the fronds .... *Grinnellia.*
82. Fronds narrow, much divided 84
Fronds palmately or dichotomously divided 83
83. Fronds deep red, broadly palmate, margins proliferous, tetraspores cruciate in patches .... *Rhodymenia.*
Fronds dark red, margins ciliate, tetraspores zonate.. *Rhodophyllis.*
Fronds dark purple, deeply divided, tetraspores scattered, cruciate. *Gracilaria.*
84. Branches alternately secund in threes or fours, the lowest undivided and spine-like, the rest pinnate .... *Plocamium.*
Fronds subflabellate, upper divisions divaricately toothed. *Euthora.*

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EXPLANATION OF PLATES.

PLATE I.

J. H. Blake and W. G. Farlow.

Fig. 1. *Glœocapsa crepidinum*, Thuret. 600 diam.
2. *Isactis plana*, Thuret. 600 diam.
3. *Sphærozyga Carmichaelii*, Harv.: *a*, heterocyst; *b*, *b*, spores. 600 diam.
4. *Lyngbya majuscula*, Harv. 400 diam.
5. *Oscillaria subuliformis*, Harv. 500 diam.
6. *Calothrix confervicola*, Ag.: *a*, *a*, hormogonia; *b*, *b*, heterocysts; *c*, cell of host-plant. 400 diam.

PLATE II.

J. H. Blake and W. G. Farlow.

Fig. 1. *Hormactis Quoyi*, (Ag.) Bornet: *a*, *a*, heterocysts. 600 diam.
2. *Rivularia atra*, Roth: *a*, *a*, heterocysts; the cross-lines represent the gelatinous matrix. 500 diam.
3. *Microcoleus chthonoplastes*, Thuret: *a*, free trichomata projecting beyond the ruptured sheath. 500 diam.
4. *Spirulina tenuissima*, Kütz. 900 diam.

PLATE III.

J. H. Blake and W. G. Farlow.

Fig. 1. *Ulva Lactuca*, (L.) Le Jolis: *a*, microzoospores which have escaped from marginal cells; *b*, cells in which zoospores are forming; *c*, cells from which zoospores have escaped. 500 diam.
2. *Rhizoclonium riparium*, Kütz. 20 diam.
3. *Cladophora lætevirens*, (Dillw.) Harv. 20 diam.

PLATE IV.

J. H. Blake and W. G. Farlow.

Fig. 1. *Bryopsis plumosa*, (Huds.) Ag.; portion of upper division of the unicellular frond. 10 diam.
2. *Vaucheria Thuretii*, Woronin: *a*, *a*, young antheridia; *a′*, antheridium which has discharged its antherozoids; *c*, *c*, oogonia with oospores. 100 diam.
3. *Phyllitis fascia*, Kütz; section of frond with plurilocular sporangia, *a*, covering the surface. 500 diam.
4. *Derbesia tenuissima*, (De Not.) Crouan: *a*, spores (zoosporangia?) nearly mature; *b*, *b′*, cross-partitions forming cell at base of sporangium. 100 diam.
5. *Punctaria plantaginea*, (Roth) Grev.; transverse section of frond: *a*, plurilocular sporangia with zoospores; *a′*, the same when old, after the zoospores have been discharged and the internal cell-walls obliterated.

PLATE V.

J. H. Blake and W. G. Farlow.

Fig. 1. *Leathesia difformis*, (L.) Aresch.; dissection showing a portion of cortical layer: *a*, *a*, unilocular sporangia; *b*, *b*, hairs. 400 diam.

2. *Chordaria flagelliformis*, Ag.; longitudinal section of outer part of frond showing cortical filaments with unilocular sporangia, *a*, and a few cells of internal layer. 500 diam.

3. *Asperococcus echinatus*, Grev.; transverse section of frond: *a*, unilocular sporangia; *b*, hairs. 150 diam.

4. *Stilophora rhizodes*, Ag.; longitudinal section of outer part of frond showing sorus with paraphyses and unilocular sporangia. 400 diam.

6. *Ralfsia verrucosa*, Aresch.; vertical section of frond with a sorus containing unilocular sporangia.

6. *Sphacelaria cirrhosa*, (Roth) Ag.; a portion of frond with propagulum. 200 diam.

PLATE VI.

J. H. Blake and W. G. Farlow.

Fig. 1. *Chorda filum*, L.; transverse section of portion of a frond showing paraphyses, *b*, and unilocular sporangia, *a*. 200 diam.

2. *Stilophora rhizodes*, Ag.; portion of sorus taken from Pl. V, Fig. 4, more highly magnified to show unilocular sporangia, *a*, *a'*, and paraphyses, *b*. 600 diam.

3. *Ectocarpus littoralis*, Lyngb., var. *robustus*, Farlow; plurilocular sporangia. 200 diam.

4. The same with unilocular sporangia.

5. *Myrionema Leclancherii*, (Chauv.) Harv.; vertical section showing plurilocular sporangia. 400 diam.

PLATE VII.

J. H. Blake and W. G. Farlow.

Fig. 1. *Castagnea virescens*, (Carm.) Thuret; unilocular sporangium and hair, *b*. 400 diam.

2. *Castagnea Zosteræ*, (Mohr.) Thuret; transverse section of outer portion of frond showing plurilocular sporangia, *a*, *a'*, and hair, *b*. 400 diam.

3. *Elachistea fucicola*, Fries; dissection of superficial part of frond, showing unilocular sporangia, *a*, *a'*, and colored exserted filaments, *b*. 300 diam.

PLATE VIII.

J. H. Blake and W. G. Farlow.

Fig. 1. *Fucus vesiculosus*, L.; fructifying tip of frond: *a*, air-bladder; *b*, conceptacles. Natural size.

2. *Laminaria longicruris*, De la Pyl.; section through fructiferous portion of frond showing unilocular sporangia, *a*, and paraphyses, *b*. 400 diam.

PLATE IX.

J. H. Blake and W. G. Farlow.

Fig. 1. *Fucus vesiculosus*, L.; section through a female conceptacle showing oospores and paraphyses. 200 diam.

2. The same; section through male conceptacle showing antheridia. 200 diam.

PLATE X.

J. H. Blake and W. G. Farlow.

Fig. 1. *Spyridia filamentosa*, Harv.; axis with branch bearing antheridia, *a*. 200 diam.
2. *Callithamnion corymbosum*, Lyngb.; branch with antheridia. 200 diam.
3. *Trentepohlia virgatula*, Harv.; showing the undivided spores, *a*, *a*. 200 diam.
4. *Griffithsia Bornetiana*, Farlow; tip of male plant with antheridia. 400 diam.
5. The same; portion of tetrasporic plant with tetraspores, *a*, and involucre, *b*. 200 diam.

PLATE XI.

J. H. Blake and W. G. Farlow.

Fig. 1. *Callithamnion Baileyi*, Harv.; plant with tetraspores: *a*, before separation from the mother-cell; *á*, free from the mother-cell. 200 diam.
2. The same; plant bearing binate cystocarp.
3. *Griffithsia Bornetiana*, Farlow; plant bearing cystocarp (favella). 200 diam.

PLATE XII.

J. H. Blake and W. G. Farlow.

Fig. 1. *Nemalion multifidum*, Ag.; dissection of outer part of the plant to show the cystocarp. 400 diam.
2. *Spyridia filamentosa*, Harv.; tip of female plant with a double cystocarp, the right-hand portion of figure representing the cystocarp and branch in section; the left-hand cystocarp being seen superficially. 400 diam.

PLATE XIII.

J. H. Blake and W. G. Farlow.

Fig. 1. *Polysiphonia Olneyi*, Harv.; branch with antheridium, *a*. 200 diam.
2, 3, and 4. *Grinnellia Americana*, Harv.: Figs. 3 and 4 represent the antheridia seen from above and in section, *a*; Fig. 2, section through a cystocarp. 400 diam.

PLATE XIV.

J. H. Blake and W. G. Farlow.

Fig. 1. *Petrocelis cruenta* J. Ag.; dissection of frond showing the tetraspores, *a*, *á*. 400 diam.
2. *Rhabdonia tenera*, J. Ag.; transverse section of frond showing cystocarp and carpostome. 200 diam.

PLATE XV.

J. H. Blake and W. G. Farlow.

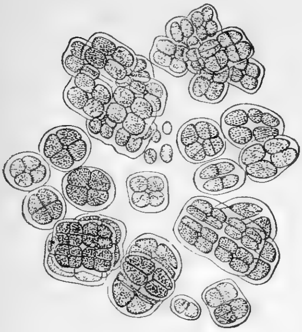
Fig. 1. *Dasya elegans*, Ag.; branch with stichidium bearing tetraspores. 300 diam.
2 and 5. *Champia parvula*, Harv.: Fig. 5, portion of frond bearing a cystocarp, *a*; slightly enlarged; Fig. 2, section through *a*, showing arrangement of spores, carpogenic cell, and carpostome. 400 diam.
3 and 4. *Polysiphonia Harveyi*, Bail.: Fig. 4, branch with cystocarp; Fig. 3, section through the same, showing spores and carpogenic cell. 400 diam.

INDEX OF GENERA AND SPECIES.

[The synonyms and species incidentally mentioned are in italics. The larger-sized figures indicate the page where the description is given.]

F.

G.



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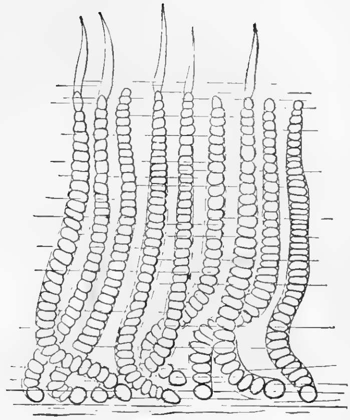

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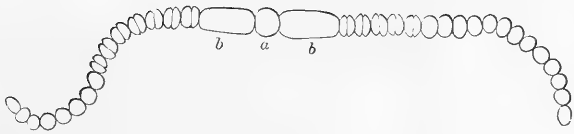

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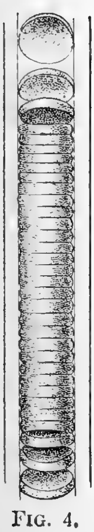

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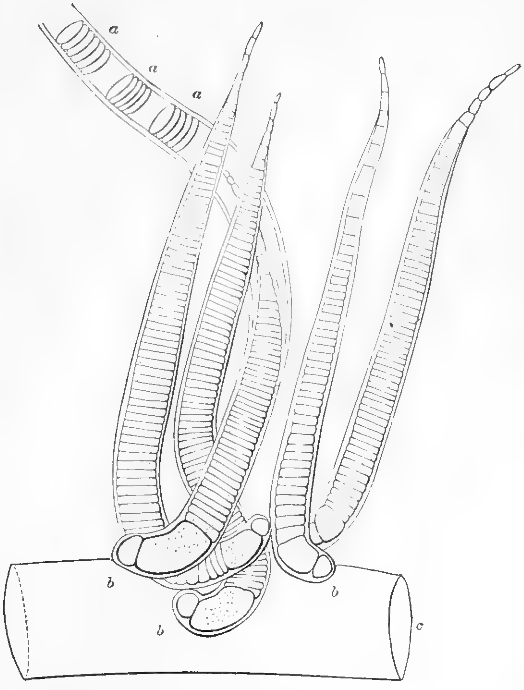

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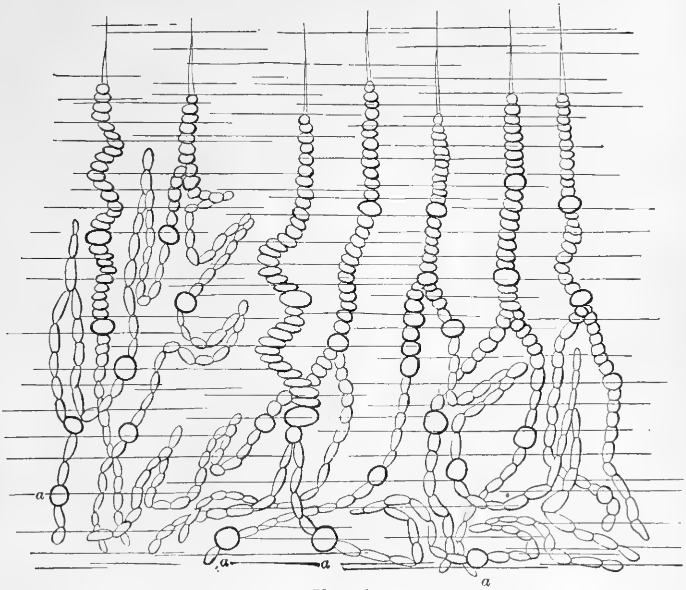

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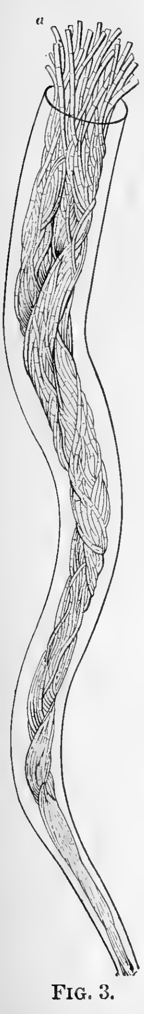

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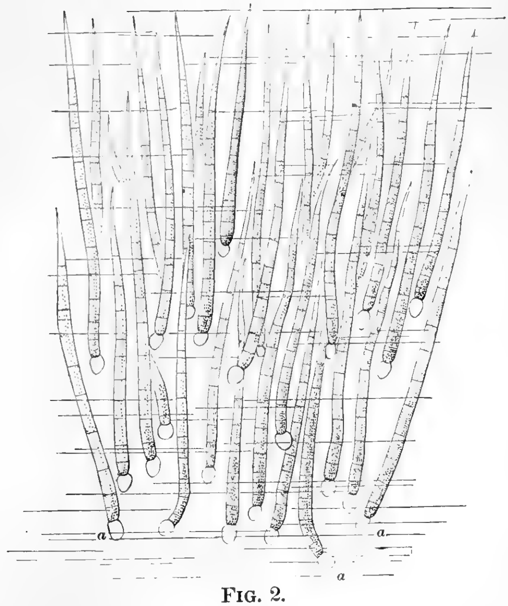

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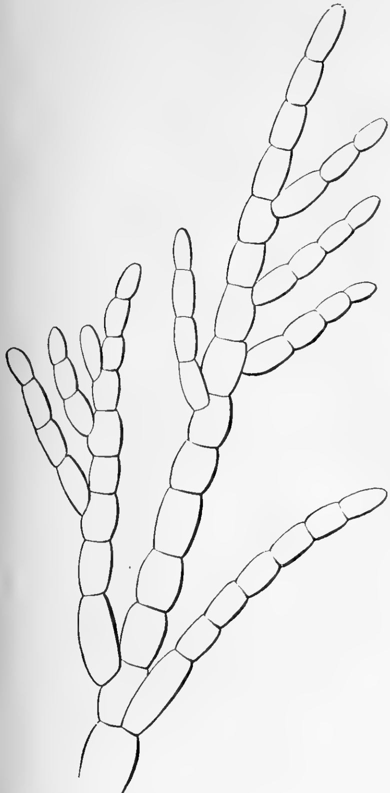

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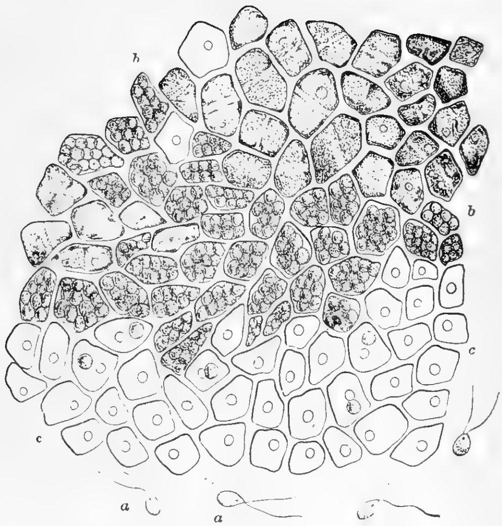

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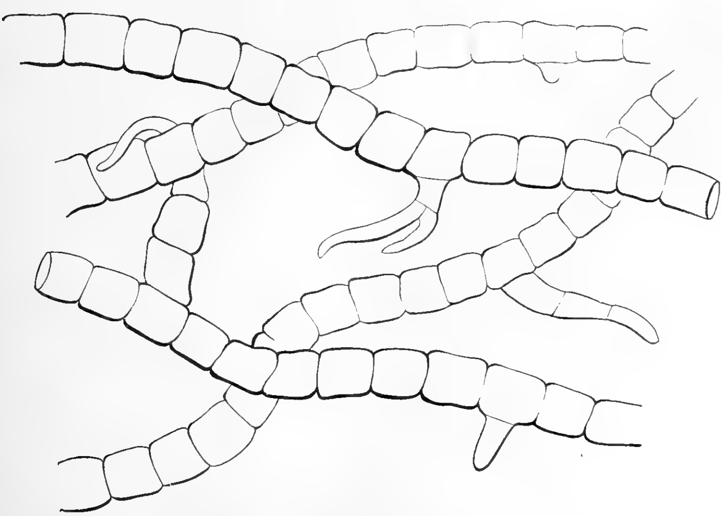

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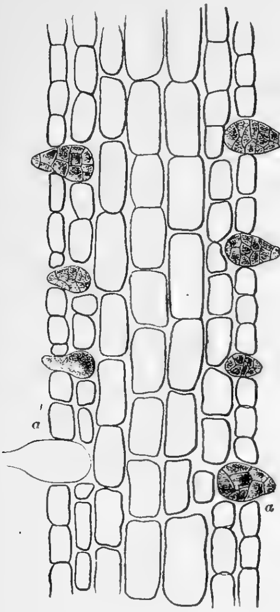
PLATE IV.



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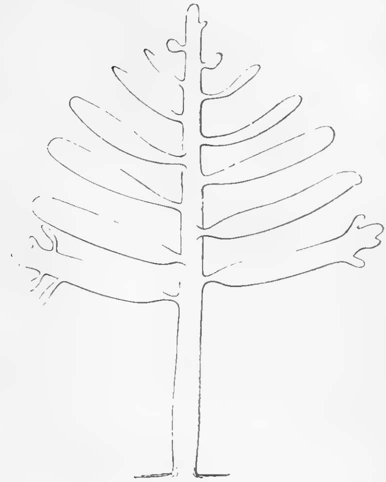

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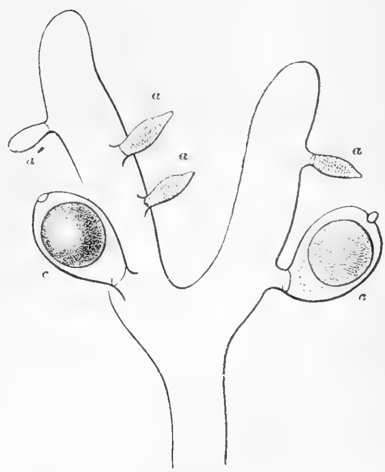

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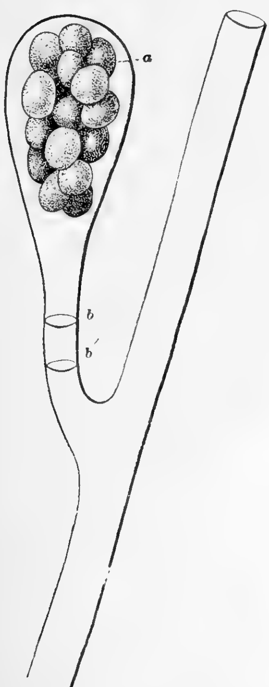

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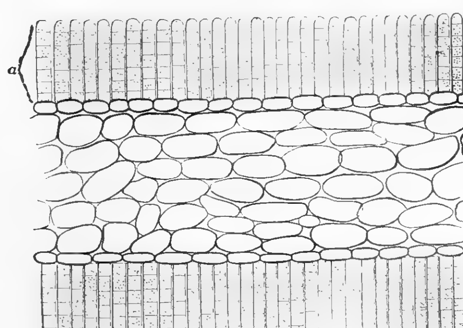

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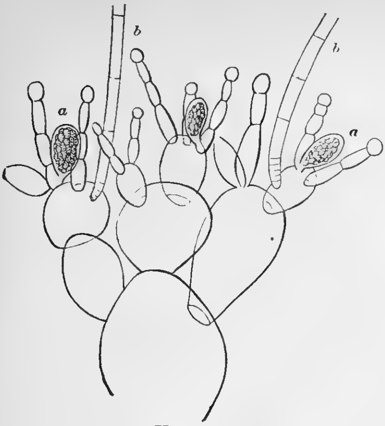

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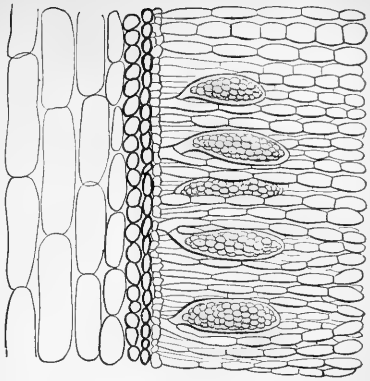

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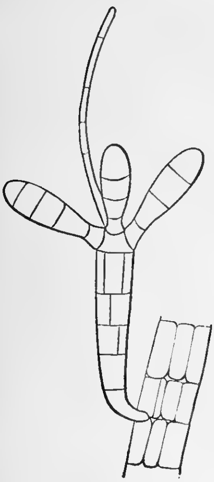

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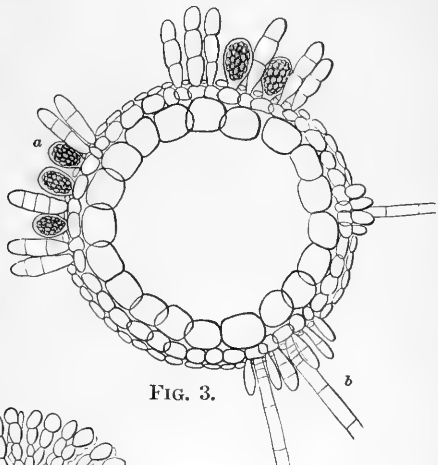

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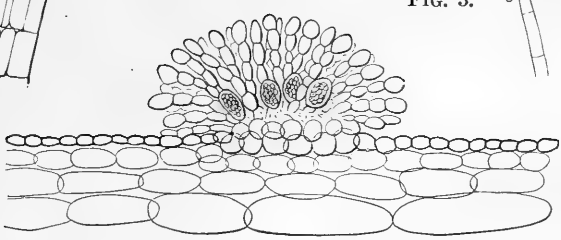

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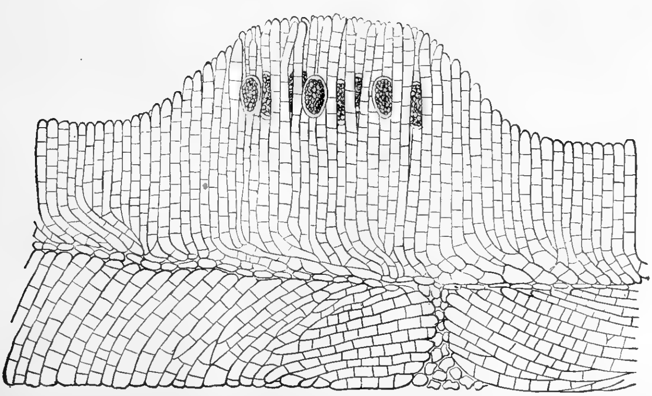

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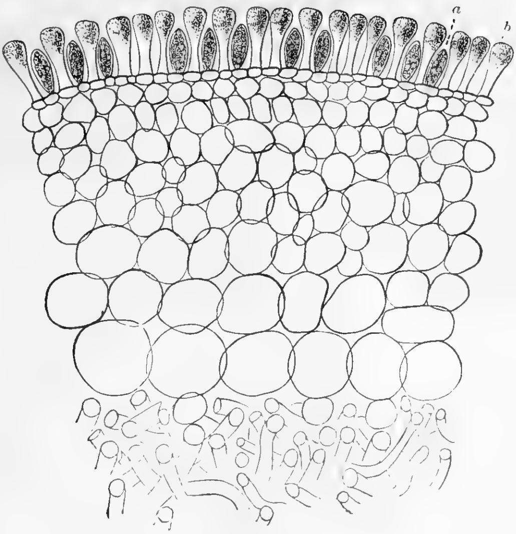

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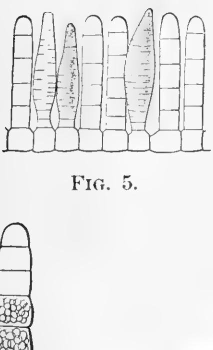

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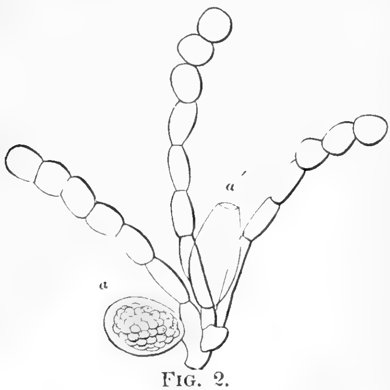

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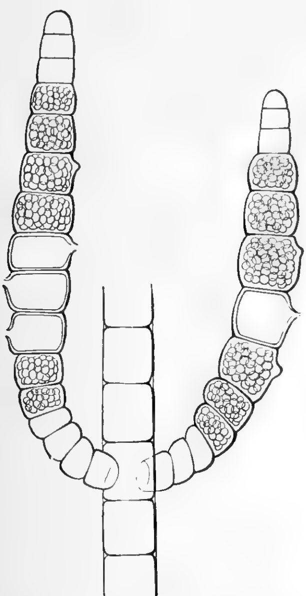

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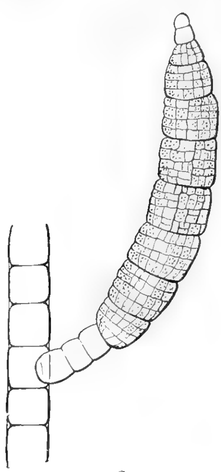

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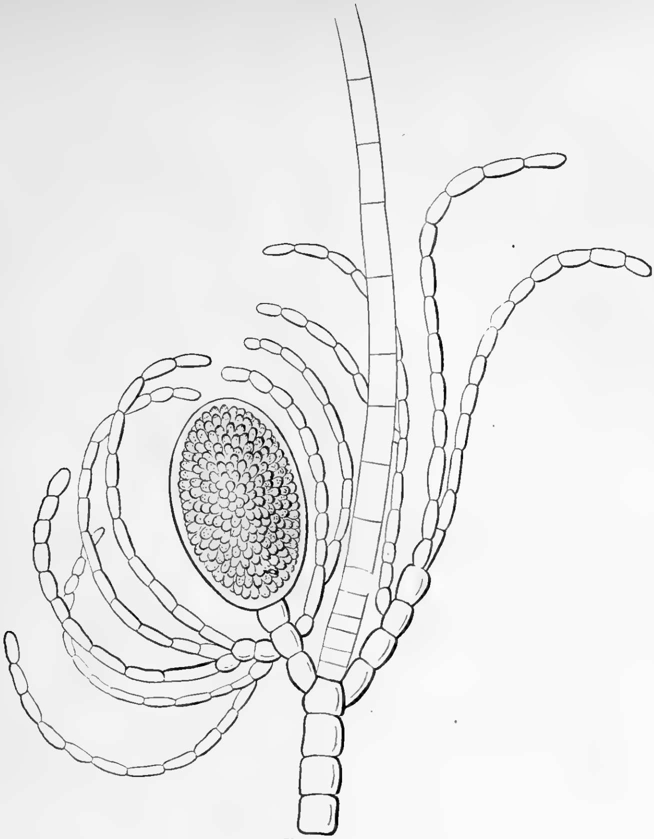

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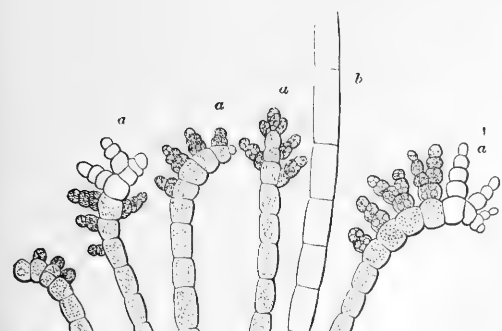

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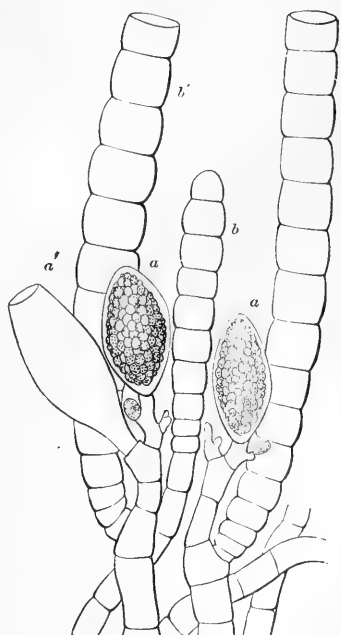

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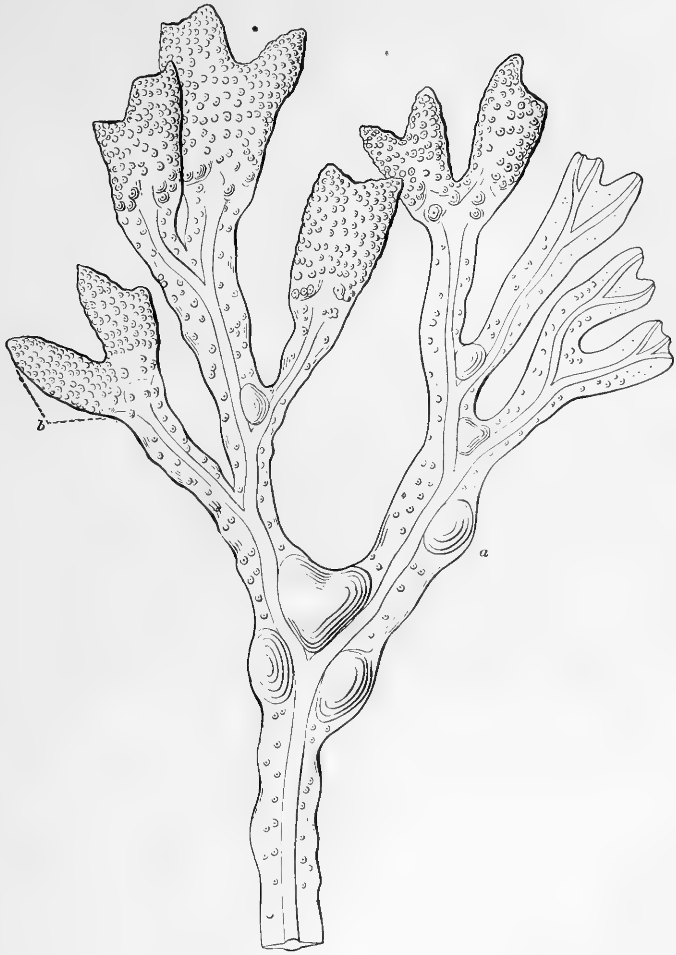

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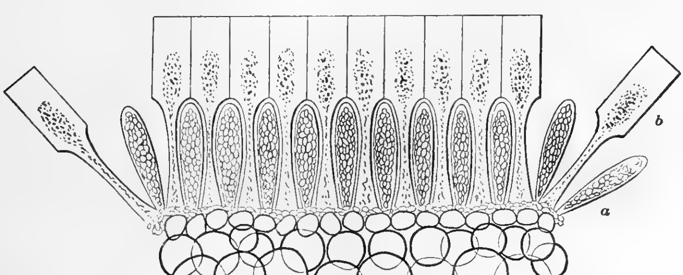

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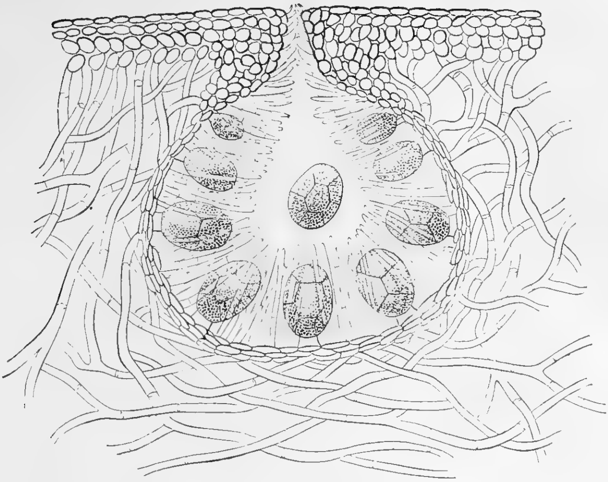

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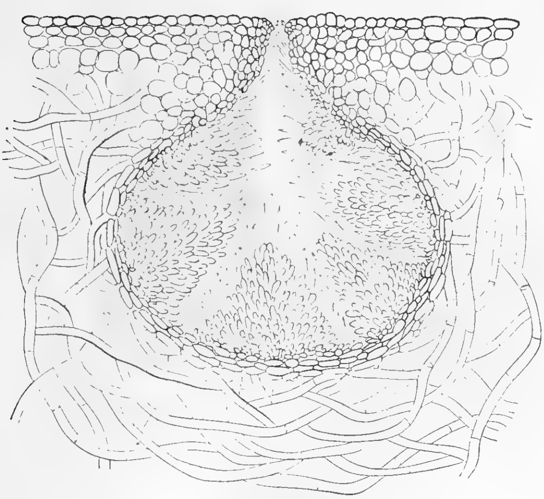

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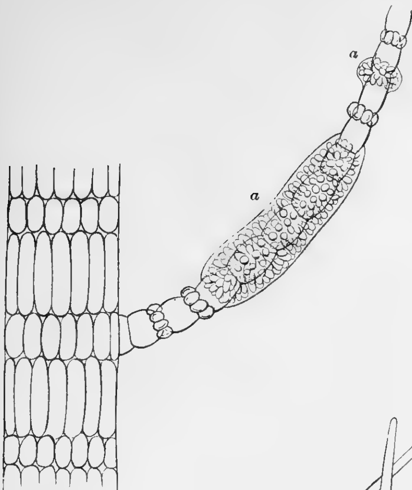

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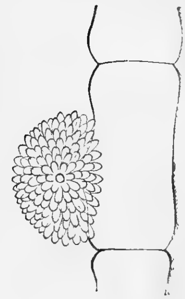

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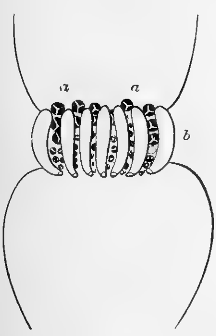

FIG. 5.

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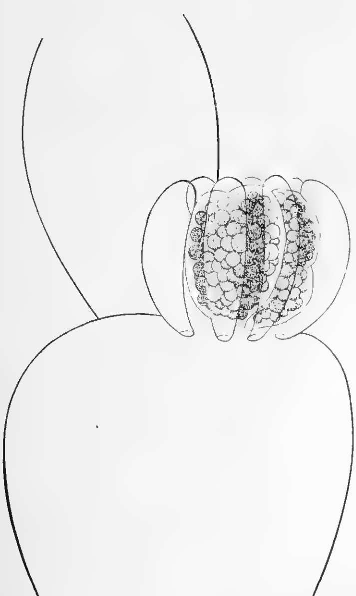

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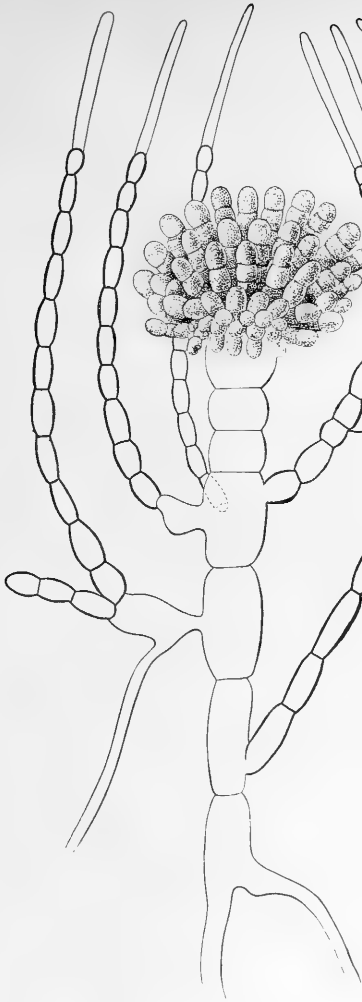

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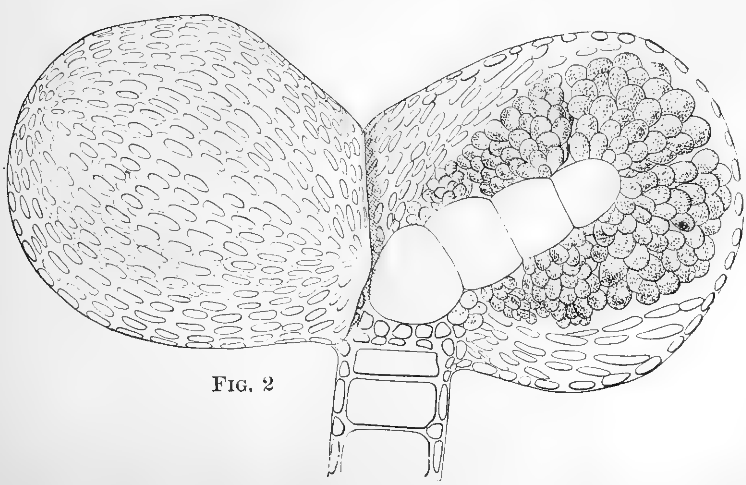

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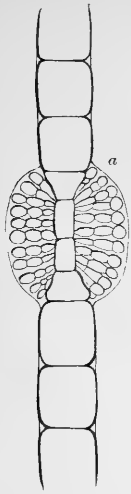

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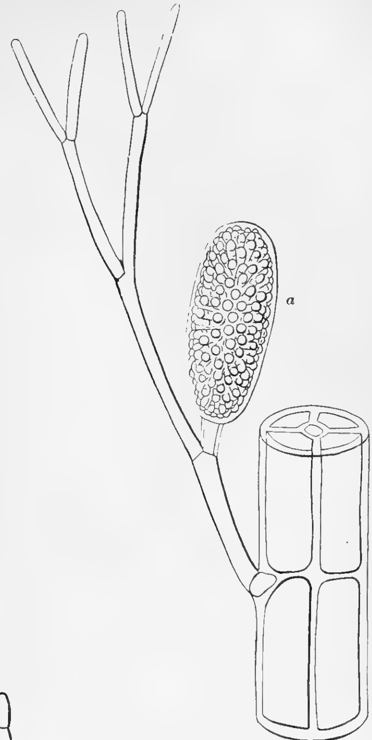

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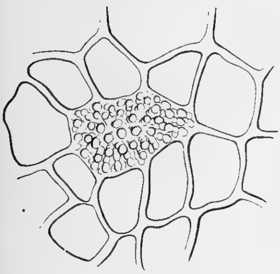

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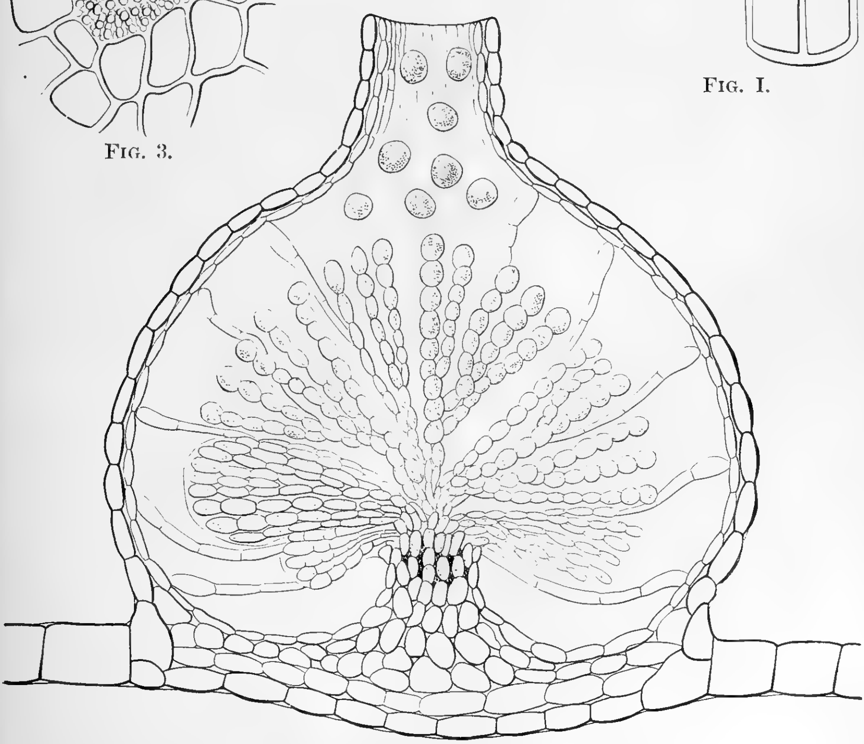

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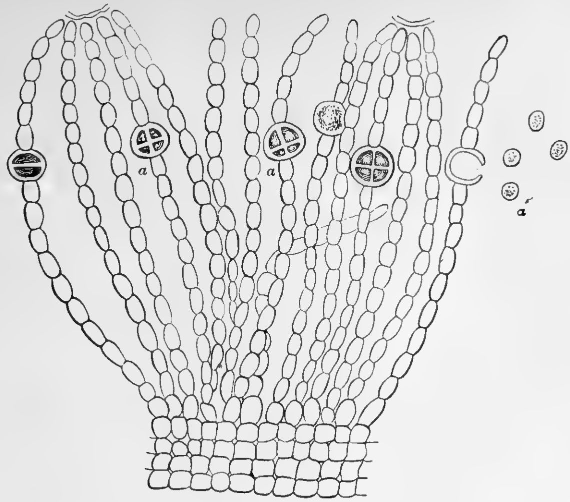

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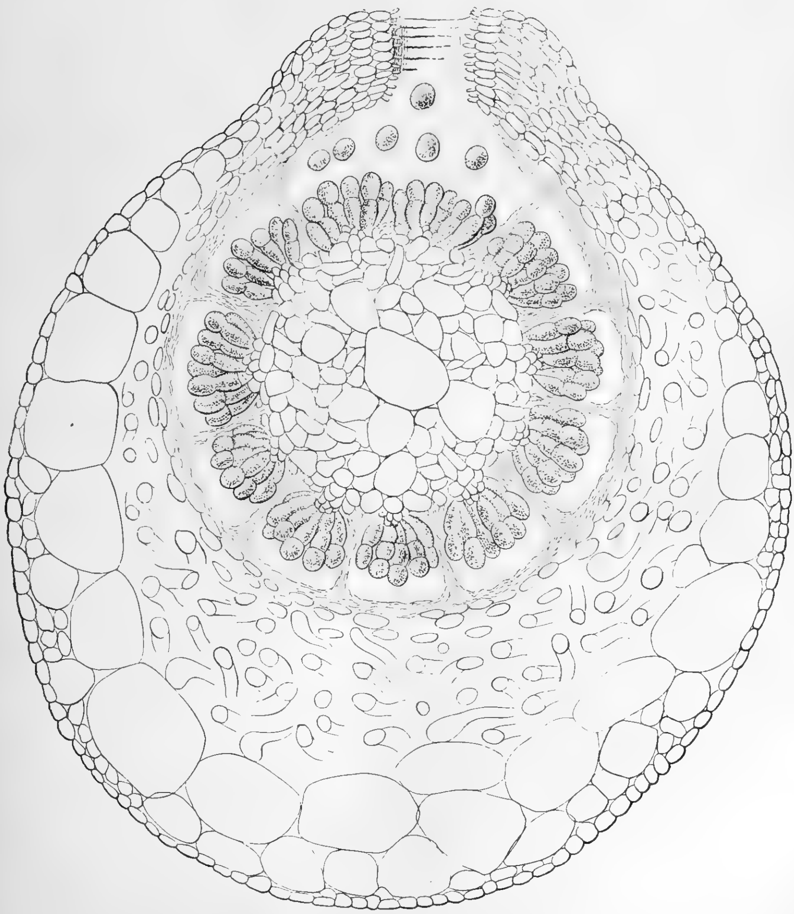

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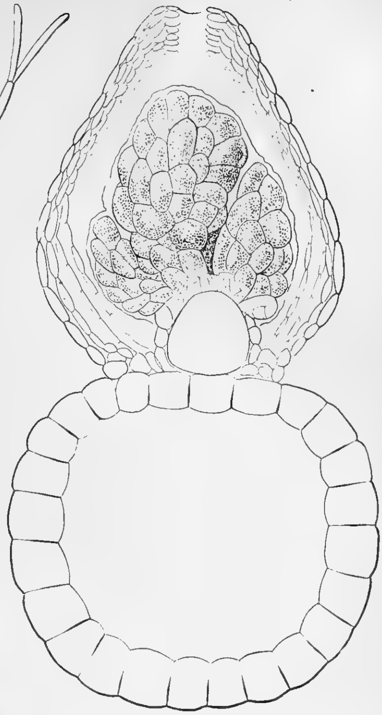

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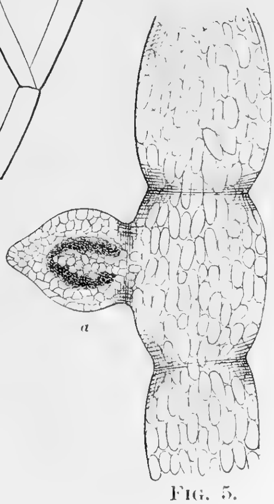

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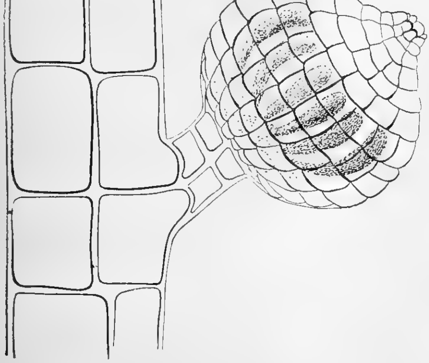

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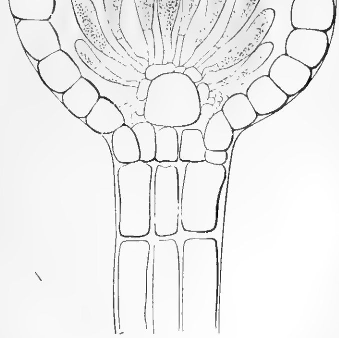

FIG. 3.

II.—REPORT ON THE CEPHALOPODS OF THE NORTHEASTERN COAST OF AMERICA.

By A. E. Verrill.

Part I.—The gigantic squids (*Architeuthis*) and their allies; with observations on similar large species from foreign localities.

The early literature of natural history has, from very remote times, contained allusions to huge species of Cephalopods, often accompanied by more or less fabulous and usually exaggerated descriptions of the creatures* In a few instances figures were attempted which were largely indebted to the imagination of their authors for their more striking peculiarities.

In recent times, many more accurate observers have confirmed the existence of such monsters, and several fragments have found their way into European museums.

To Professor Steenstrup and to Dr. Harting, however, belongs the credit of first describing and figuring, in a scientific manner, a number of fragments sufficient to give some idea of the real character and affinities of these colossal species. More particular accounts of the specimens described by these and other recent writers will be given farther on.

Special attention has only recently been called to the frequent occurrence of these "big squids," as our fishermen call them, in the waters of Newfoundland and the adjacent coasts. The cod-fishermen, who visit the Grand Banks, appear, from their statements, to have been

*The description of the "poulpe" or devil-fish, by Victor Hugo, in "The Toilers of the Sea," with which so many readers have recently become familiar, is quite as fabulous and unreal as any of the earlier accounts, and even more *bizarre*. His description represents no real animal whatever. He has attributed to the creature habits and anatomical structures that belong in part to the *polyps* and in part to the *poulpe* (*Octopus*), and which appear to have been derived largely from the several descriptions of these totally distinct groups of animals, contained in some cyclopedia. These he has confounded and hopelessly mixed up. As if to make this confusion worse confounded, he applied to his creation the name of "*Cephaloptera*," the designation of a gigantic genuine fish (a "ray") found on our southern coasts, and also called "devil-fish" by the fishermen. His account of the *general appearance* of the *Octopus*, however, is not so bad, and was evidently based on a very superficial personal examination of an ordinary specimen of *Octopus vulgaris*.

long familiar with them, and occasionally to have captured and used them for bait. The whalemen have also repeatedly stated that sperm-whales feed upon huge squid, and that, when wounded, they often vomit large fragments of them, in such a condition as to be recognizable.*

I have somewhere seen a statement to the effect that a huge squid of this kind was cast ashore, many years ago (in the last century, I believe), at the Island of St. Pierre, near Newfoundland, but have forgotten the authority for the statement.

The first reliable account, known to me, of specimens actually taken in American waters by our fishermen and whalemen was published by Dr. A. S. Packard, in 1873.† In that article Dr. Packard described a portion of a jaw from a large specimen (our No. 1) taken by the Gloucester fishermen on the Grand Banks, and a very large pair of jaws taken from the stomach of a sperm-whale (our No. 10). Soon after this, in 1873, a large living specimen (our No. 2) was encountered by Theophilus Picott and another fisherman, in Conception Bay, and one of the tentacular arms which they secured was preserved in the geological museum at Saint John's, Newfoundland, by the Rev. M. Harvey and Mr. Alexander Murray. Both these gentlemen wrote good and interesting accounts of this specimen, which were extensively copied in the magazines and newspapers, while a photograph of the arm itself was also secured and distributed.

This important addition to our knowledge of these creatures was followed, about two weeks later, by the capture of a nearly perfect specimen (our No. 5) of the same species, near Saint John's. Mr. Harvey and Mr. Murray likewise secured this specimen, and published detailed accounts of it, which gave a more accurate idea of the character of the genus and species than had any previous descriptions.

My own attention was specially directed to these large Cephalopods, at that time, on account of being so fortunate as to secure for study most of the preserved portions of all the specimens referred to above, with some additional ones, detailed below. For these very interesting specimens I am especially indebted to the zeal and kindness of the Rev. M. Harvey and to Prof. S. F. Baird. To Dr. A. S. Packard I am indebted for the use of the jaws of No. 10. Mr. Pourtalès, curator of the Museum of Comparative Zoology, has also kindly sent the specimens belonging to that museum, and Mr. W. H. Dall has contributed his specimens and drawings of a species from Alaska. Special acknowledgments to others will be found in connection with the descriptions of the specimens.

Although I have, in several former papers,‡ given details of the time

* See Maury's Sailing Directions. Also articles by N. S. Shaler, American Naturalist, vol. vii, p. 3, 1873; by Dr. Packard, op. cit., p. 90; and by Mr. W. H. Dall, op. cit., p. 484.

† American Naturalist, vol. vii, p. 91, February, 1873.

‡ American Jour. Science, vol. vii, p. 158, Feb., 1874; vol. ix, pp. 123, 177, Plates II–V, 1875; vol. x, p. 213, Sept., 1875; vol. xii, p. 236, 1876; vol. xiv, p. 425, Nov.,

and place of occurrence of many of the specimens enumerated below, it seems desirable to bring together, in this place, accounts of all these, in order that the various descriptions and measurements may be more readily compared, and also that errors in some of the former accounts may be corrected and new information added. To facilitate the comparison of the general accounts of more than twenty-five examples that I am now able to enumerate from our coast, I have given, by themselves, the statements of the time and place of their occurrence, with such general descriptions and measurements of each as are most available, reserving the more detailed special descriptions of the preserved specimens for the systematic part of this article.

This seemed the more desirable because the information concerning many of the specimens is so scanty as to render it impossible to refer them, with certainty, to either of the species now recognized or named. It is probable, however, that only three forms are indicated by the large Newfoundland specimens of *Architeuthis*, and two of these may be merely the males and females of one species. One of the principal differences usually indicated by the measurements is in respect to the size and length of the shorter arms, one form having them comparatively stout, often "thicker than a man's thigh," while the other form has them long and slender (usually 3 to 5 inches in diameter, with a length of 6 to 11 feet). In case these differences prove to be sexual, those with stout arms will probably be the females, judging from analogy with the small squids nearest related.* In the three specimens, of which I have seen the arms, they are long and slender, but in one the arms are much longer in proportion to the body than in the others; there are also differences in the denticulation of the suckers of the short arms. These differences appear, at present, to indicate two species.

A few words of explanation may be desirable here, in regard to the relative value of the measurements usually given, and also with reference to the parts most useful to preserve when, as will usually happen, the whole

1877. American Naturalist, vol. viii, p. 167, 1874; vol. ix, pp. 21, 78, Jan. and Feb., 1875 Annals and Magazine of Nat Hist., March, 1874. Transactions Connecticut Acad. Science, vol. v, p. 177, Plates XIII–XXV, 1879–'80.

*By examinations of very numerous specimens of our common squids, *Ommastrephes illecebrosus* and *Loligo Pealei*, I have satisfied myself that the adult females of both commonly differ from the males by having the head, the siphon, the arms, and the suckers relatively larger and stronger than in the males. In comparing specimens of the two sexes having the body and fins of the same length, this difference is often very evident. The large suckers of the tentacular arms often show an increased size in the female, in a very marked degree. The short arms show a greater increase in diameter than in length. In one of my former articles (Amer. Journ. Sci., ix, p. 179, 1875) the increase in size of these parts was erroneously, but inadvertently, said to be in the male, but this error has been corrected in my subsequent articles. Still, it is true that both sexes vary to a considerable extent in the size of the suckers, even in adult specimens of equal size, so that a male may easily be selected with suckers larger than those of some females of the same size. In these common squids I have found no great variation in the relative size and form of the caudal fins, when adult, and of the same sex. I have often found the males more common than the females.

cannot be saved. The measurements of the soft external parts of Cephalopods are, for the most part, only approximate, and they are not all of equal value, for some parts are more changeable in size and shape than others. The long, contractile tentacular arms, especially, are liable to great variation in length according to their state of contraction or extension, and therefore their relative length is of little or no value in discriminating species. Unfortunately, this, either by itself or combined with the length of the 'body' as total length, is often the principal one given. The circumference of the body varies, likewise, according to its state of contraction or relaxation, and the 'breadth' of the body, when such soft creatures are stranded on the shore, will depend much upon the extent to which it is collapsed and flattened from its proper cylindrical form, and is of less value than the circumference. Measurements of the length of the body, to the mantle-edge, and to the bases of the arms; length and circumference of the various pairs of short arms; of the length and circumference of the head; size of the eyes; length and breadth of the tail-fin; size of the largest suckers on the different arms; and size of the 'club' of the long arms, are all very useful and valuable. The shape of the tail-fin should be carefully noted, also the presence or absence of eyelids, and of a sinus or groove at the front edge of eyelids. The size and shape of the thin internal 'bone' or 'pen' is particularly desirable. All parts of Cephalopods contract to a very great extent, when preserved in strong alcohol for some time. Even the horny jaws and sucker-rings may decrease as much as 20 per cent. in size, and the soft parts much more. Usually it will not be possible to preserve the pen in any satisfactory shape by drying, for it cracks in pieces and curls up. It may be preserved packed in salt, in brine, or in alcohol. The same is true of the beak. The horny rims of the suckers can usually be dried, but are better by far in alcohol or brine. The parts most useful for preservation in alcohol or salt, in cases when only a portion can be saved, are the long tentacular arms, especially their terminal 'clubs,' with the suckers in place; the short arms, with their suckers; of these the left arm of the lower, or ventral, pair will probably be the most valuable, being usually the one that will show the sexual distinction, by the alteration of its suckers, toward the tip or in some other part; the lateral arms next to the ventral are next in importance; the caudal fin, and if possible the entire head, should be preserved; also the 'pen,' if possible. In cases where the head cannot be saved entire, even with the arms removed, the beak and tongue, and other fleshy parts in and behind the beak, should be carefully preserved, as nearly entire as possible, either in strong brine or in alcohol of not less than 80 per cent., which is generally the best strength for all kinds of Cephalopods.

General description of the several American specimens, and of their occurrence.

No. 1.—GRAND BANKS SPECIMEN, 1871. (*Architeuthis princeps.*)

Plate XI, figures 3, 3*a*.

This specimen was found dead and floating at the surface, on the Grand Banks of Newfoundland, in October, 1871, by Captain Campbell, of the schooner "B. D. Haskins," of Gloucester, Mass. It was taken on board and part of it used for bait.* Dr. A. S. Packard has given, in the American Naturalist, vol. vii, p. 91, February, 1873, a letter from Mr. James G. Tarr, of Gloucester, Mass., containing most of the facts that have been published in regard to the history of this individual. But its jaws were sent to the Smithsonian Institution by Mr. G. P. Whitman, and were sent to me by Professor Baird to be described and figured. The horny jaw or beak from this specimen is thick and strong, nearly black; it is acute at the apex, with a decided notch or angle on the inside, about .75 of an inch from the point, and beyond the notch is a large, prominent angular lobe. Mr. Tarr states that the mate of the vessel measured the body of this specimen with a rule, after it was hoisted on board, and that it measured 15 feet in length and 4 feet 8 inches in circumference. The arms were mutilated, but the portions remaining were estimated to be 9 or 10 feet long and 22 inches in circumference, two being shorter than the rest. It was estimated that it weighed 2,000 pounds, and would have filled eight or ten barrels.

No. 2.—CONCEPTION BAY SPECIMEN, 1873. (*Architeuthis Harveyi?*)

A large individual, seen resting at the surface, was approached and attacked by two men, who were in a small boat, near Portugal Cove, in Conception Bay, October 27, 1873. Full accounts of this adventure, written by Rev. M. Harvey, have been published in many of the magazines and newspapers.† Two of the arms, which it threw across the boat, were cut off with a hatchet and brought ashore. One of these was a short or sessile arm, the other was one of the long, slender tentacular

* I have been informed by many other fishermen that these "big squids," as they call them, are occasionally taken on the Grand Banks and used for bait. Others state that they have seen them in that region, without being able to capture them. Nearly all the specimens hitherto taken appear to have been more or less disabled when first observed, otherwise they probably would not appear at the surface in the day-time. From the fact that they have mostly come ashore in the night, I infer that they iinhabt chiefly the very deep and cold fiords of Newfoundland, and come up to the surface only in the night.

† See Amer. Jour. Science, vol. vii, p. 158, 1874; and Amer. Naturalist, vol viii, No. 2, p. 120, Feb., 1874, in a letter from Mr. Alexander Murray. Also, Proc. Zool. Soc. Lond., p. 178, 1874; Proc. Boston Soc. Nat. Hist., xvi, p. 161, 1873; The Maritime Monthly, iii, No. 3, March, 1874, p. 193; The New York World, Nov. 9, 1873; The Montreal Gazette, Nov. 26, 1873; The Boston Traveller, Nov., 1873.

arms. A portion of the latter, measuring 19 feet in length, was preserved by the Rev. M. Harvey and Mr. Alexander Murray for the museum at Saint John's, Newfoundland. It was photographed, and cuts copied from the photograph were published in some of the English magazines.* Before it was secured for preservation it had been considerably injured, many of the larger suckers having been torn off or mutilated. Owing to this fact they were originally described by Mr. Harvey as destitute of marginal denticulations, but he subsequently re-examined the specimen, at my request, and informed me that they were all originally denticulated. Of this specimen I have seen only the photograph and some of the smaller suckers. This fragment represents the distal half of one of the long tentacular arms, with its expanded terminal portion or 'club' originally covered with cup-shaped suckers, about 24 of which, forming two central rows, are very large, the largest being 1.25 inches in diameter; others, alternating with these along each margin, are smaller, with the edge supported by a serrated ring. The tip of the arm is covered with numerous smaller suckers, in four rows. The part of the arm preserved measured, when fresh, 19 feet in length and 3.5 inches in circumference, but wider, "like an oar," and 6 inches in circumference near the end, where the suckers are situated.

It is stated that 6 feet of this arm had been destroyed before it was preserved, and the captors estimated that they left from 6 to 10 feet attached to the creature, which would make the total length between 31 and 35 feet. According to Mr. Murray, the portion preserved measured but 17 feet in length when he examined it, October 31, 1873, after it had been a few days in strong brine. The other arm was destroyed and no description was made; but the portion secured was estimated by the Rev. Mr. Gabriel, who saw it, to have been 6 feet long and 10 inches in diameter; it was evidently one of the eight shorter sessile arms, and its size was probably overestimated. The fishermen, who were doubtless somewhat frightened, estimated the body of this individual to have been about 60 feet in length and 5 feet in diameter, according to Mr. Harvey; but if the proportions be about the same as in the specimens since captured (No. 5 and No. 14), as I believe, then the body could not have been more than about 10 feet long and 2.5 feet in diameter, and the long arms should have been about 32 feet in length.† Allowing 2 feet for the head, the total length, would, therefore, be about 44 feet.

The following extract is from a letter written by the Rev. M. Harvey to Dr. J. W. Dawson, and published in the Montreal Gazette, February 26, 1873: "Two fishermen were out in a small punt, on October 26, 1875, off Portugal Cove, Conception Bay, about nine miles from Saint John's.

* See Annals and Magazine of Natural History, IV, xiii, p. 68, Jan., 1874; and The Field, Dec. 13, 1873. The central line of this photograph is reduced four and a quarter times, while the front part is reduced about four times.

† Doubtless these long arms are very contractile, and changeable in length, like those of the ordinary squids.

Observing some object floating on the water at a short distance, they rowed towards it, supposing it to be a large sail or the *débris* of a wreck. On reaching it one of the men struck it with his 'gaff,' when immediately it showed signs of life, reared a parrot-like beak, which they declare was 'as big as a six-gallon keg,' with which it struck the bottom of the boat violently. It then shot out from about its head two huge livid arms and began to twine them round the boat. One of the men seized a small ax and severed both arms as they lay over the gunwale of the boat; whereupon the fish moved off and ejected an immense quantity of inky fluid, which darkened the water for two or three hundred yards. The men saw it for a short time afterwards, and observed its tail in the air, which they declare was 10 feet across. They estimate the body to have been 60 feet in length, 5 feet in diameter, of the same shape and color as the common squid, and they observed that it moved in the same way as the squid, both backwards and forwards.

"One of the arms which they brought ashore was unfortunately destroyed, as they were ignorant of its importance; but the clergyman of the village assures me it was 10 inches in diameter and 6 feet in length. The other arm was brought to Saint John's, but not before 6 feet of it were destroyed. Fortunately, I heard of it and took measures to have it preserved. Mr. Murray, of the geological survey, and I afterwards examined it carefully, had it photographed, and immersed in alcohol; it is now in our museum. It measured 19 feet, is of a pale, pink color, entirely cartilaginous, tough and pliant as leather, and very strong."

No. 3.—Coombs' Cove specimen, 1872. (*Architeuthis Harveyi* ♀ ?)

Another specimen (No. 3), probably considerably larger than the last, was captured at Coombs' Cove, Fortune Bay, Newfoundland. The following account has been taken from a newspaper article, of which I do not know the precise date,* forwarded to me by Professor Baird, together with a letter, dated June 15, 1873, from the Hon. T. R. Bennett, of English Harbor, Newfoundland, who states that he wrote the article, and that the measurements were made by him, and are perfectly reliable:†

"Three days ago there was quite a large squid run almost ashore at Coombs' Cove, and some of the inhabitants secured it. The body measured 10 feet in length and was nearly as large round as a hogshead. One arm was about the size of a man's wrist, and measured 42 feet in length; the other arms were only 6 feet in length, but about 9 inches in diameter, very stout and strong. The skin and flesh were 2.25 inches

* The exact date of this capture I do not know, but it was probably in the autumn or winter of 1872.

† Through Mr. Sanderson Smith, who visited Mr. Bennett after the publication of my first article, I learn that this specimen is the same as the one designated as No. 6 in my early papers, and that the measurements of No. 6, as given to me by Mr. Harvey, are incorrect, owing to his mistake in supposing that 42 feet was the *total length*, instead of the length of the longer tentacular arm.

thick, and reddish inside as well as out. The suction-cups were all clustered together, near the extremity of the long arm, and each cup was surrounded by a serrated edge, almost like the teeth of a hand-saw. I presume it made use of this arm for a cable, and the cups for anchors, when it wanted to come to, as well as to secure its prey, for this individual, finding a heavy sea was driving it ashore, tail first, seized hold of a rock and moored itself quite safely until the men pulled it on shore."

Mr. Bennett, in a memorandum subsequently given to Mr. Sanderson Smith, and communicated to me by him, states that both the tentacular arms were present, and that the shorter one was 41.5 feet in length. The large diameter of the short arms, compared with their length and with that of the long arms, and their shortness compared with the length of the body, are points in which this specimen apparently differed essentially from those that have been preserved and are better known. It was probably a female. The total length, as I understand the measurements, was 52 feet.

No. 4.—Bonavista Bay specimen. (*Architeuthis Harveyi ?*)

Plate III, figures 4, 4*a*. Plate IV, figures 1, 1*a*.

A pair of jaws and two of the suckers from the tentacular arms were forwarded to me by Professor Baird, of the Smithsonian Institution. These were received from Rev. A. Munn, who writes that they were taken from a specimen that came ashore at Bonavista Bay, Newfoundland; that it measured 32 feet in length (probably the entire length, including the tentacular arms) and about 6 feet in circumference. The jaws are large and broad, resembling those of No. 5 both in size and form, but much thinner than those of No. 1, and without the deep notch and angular lobe seen in that specimen. The suckers also agree with those of No. 5, but are a little smaller.

No. 5.—Logie Bay specimen, 1873. (*Architeuthis Harveyi*, type.)

Plate I. Plate II. Plate III. Plate IV, figures 4–11. Plate V, figures 1–5.

A complete specimen was captured in November, 1873, at Logie Bay, about four miles from Saint John's, Newfoundland. It became entangled in a herring-net, and made a desperate effort to escape. It was killed by the fishermen, with some difficulty, and only after a struggle, during which its head was badly mutilated and severed from the body, and the eyes, most of the siphon-tube, and part of the front edge of the mantle were destroyed. It is probable that this was a smaller specimen of the same species as No. 2. Fortunately, this specimen was secured by the Rev. M. Harvey, of Saint John's. After it had been photographed and measured, he attempted to preserve it entire in brine, but this was found to be ineffectual, and after decomposition had begun to destroy some of the most perishable parts, he took it from the brine and, dividing it into several portions, preserved such parts as were still undecomposed in strong alcohol. These various portions have all been examined by me, and part of them are now in my possession, and, with the photographs, have enabled me to present a restoration, believed to be tolerably accurate, of the entire creature (Plate II). In this figure the eyes, ears, siphon-tube, and front edge of the mantle have been restored from a small squid (*Ommastrephes*). The other parts have been drawn directly from the photographs and specimens.* There were two photographs of the specimen,† one showing the entire body, somewhat mutilated anteriorly, the other showing the head with the ten arms attached (Plate I, fig. 1). The photographs were made by Messrs. McKenny & Parsons, of Saint John's. The body or mantle of this specimen was about 7 feet long and between 5 and 6 feet in circumference; the relatively small caudal fin was arrow-shaped and 22 inches broad, but short, thick, and very pointed at the end; the two long tentacular arms were 24 feet in length and 2.5 inches in circumference, except at the broader part near the end; the largest suckers, which form two regular alternating rows, of twelve each, were 1.25 inches in diameter, with serrated edges. There is also an outer row of much smaller suckers, alternating with the large ones, on each margin; the terminal part is thickly covered with small serrated suckers; and numerous small suckers and tubercles are crowded on that portion of the arms where the enlargement begins, before the commencement of the rows of large suckers. The arrangement of the suckers is nearly the same as on the long arm of No. 2, but in the latter the terminal portion of the arm, beyond the large suckers, as shown in the photographs, is not so long, tapering, and acute, but this may be due to the different conditions of the two specimens. The eight short arms were each 6 feet long; the two largest were 10 inches in circumference at base; the others were 9, 8, and 7 inches. These short arms taper to slender, acute tips, and each bears more than 100 large, oblique suckers, with serrated margins, and over 200 smaller ones toward the tip.

* The figure was originally made, from the photographs only, by Mr. P. Rœtter, of the Museum of Comparative Zoology, but after the arrival of the specimens it had to be altered in many parts. These necessary changes were made by the writer, after a careful study of the parts preserved, in comparison with the photographs and original measurements. As published in my first paper (1875), the eyes and back of the head of the figure were restored as in *Loligo*. Subsequent studies and additional specimens showed that this genus is closely allied to *Ommastrephes*. Therefore, the head would have been more correctly shown had it been restored with reference to that genus, as has been done in this paper. The most obvious difference is in the eyes, which have distinct lids and an anterior sinus.

† Cuts made from these photographs have been published in several magazines and newspapers, but they have been engraved with too little attention to details to be of much use in the discrimination of specific differences. I have, therefore, prepared new figures from these photographs with the greatest care possible (Plate I). These figures are particularly valuable, as showing the arrangement of the suckers on the short arms.

The portions of the pen in my possession belong to the posterior part of the blade, with fragments from the middle; although neither the actual length nor the greatest breadth of this part can be given, we can yet judge very well what its general form and character must have been. It was a large, broad and thin structure, of a yellowish brown color, and translucent. Its posterior portion (Plate III, figure 3) resembles that of *Loligo*, but its anterior and lateral edges are entirely different, for instead of having a regular lanceolate form, tapering to both ends, as in *Loligo*, it expands and thins out toward the lateral and anterior borders, fading out insensibly, both at the edges and end, into soft membrane.* The posterior end, for about an inch and a half, rapidly narrows to a point, which was probably involute and hooded for a short distance; from this portion forward the width gradually increases from 1.2 inches to 5 inches, at a point 25 inches from the end, where our specimen is broken off; at this place the marginal strips are wanting, but the width is 5 inches between the lateral midribs (*d, d''*), which were, perhaps, far from the margin. Along the center of the shell there is a strong, raised, smooth, rounded midrib, which is very conspicuous in the middle and posterior sections, becoming angular near the end. On each side of the midrib is a lateral rib of smaller size. These at first diverge rapidly from the central one, and then run along nearly parallel with the outer margin and about .4 of an inch from it, but beyond 11 inches from the point the margins are torn off; the lateral ribs gradually fade out before reaching the anterior border; near the place where they finally disappear they are about 6 inches apart.†

No. 6 (of former articles)—Same as No. 3.

No. 7.—Labrador specimen.

Dr. D. Honeyman, geologist, of Halifax, Nova Scotia, has published, in a Halifax paper, a statement made to him by a gentleman who claims to have been present at the capture of another specimen (No. 7), in the Straits of Belle Isle, at West Saint Modent, on the Labrador side: "It was lying peacefully in the water when it was provoked by the push of an oar. It looked fierce and ejected much water from its funnel; it did not consider it necessary to discharge its sepia, as mollusca of this kind

* Probably there may have been a narrow prolongation or shaft beyond the portion preserved, but of this there is no fragment.

† Mr. Harvey published popular accounts of this specimen, and of the previously captured arm of the larger one (No. 2), in the Maritime Monthly Magazine of Saint John, New Brunswick, for March, 1874, and in several newspapers. Acknowledgments are also due to Mr. Alexander Murray, provincial geologist, who coöperated with Mr. Harvey in the examination and preservation of these specimens, and who has also written some of the accounts of them that have been published. See also the American Naturalist, vol. viii, p. 122, February, 1874; American Journal of Science, vol. vii, p. 460; Nature, vol. ix, p. 322, February 26, 1874; Appleton's Journal, January 31, 1874; Forest and Stream, p. 356 (with figure), January, 1874.

generally do in order to cover their escape. The men in the boat determined to secure it. After it had taken the boat in its arms, they tried to ship it with their oars. One of these broke, but another boat coming to aid in the capture, the squid was taken hold of by a grapnel and rolled into a seine-boat. The boats were engaged in the herring-fishing. This also appears to have been the squid's occupation about the time of its capture. The length of its longest arm was 37 feet; the length of the body 15 feet; whole length 52 feet. The bill was very large. The suckers of its arms or feet, by which it lays hold, about 2 inches in diameter. The monster was cut up, salted, and barreled for dog's meat."

In this account the length given for the "body" evidently includes the head also. This creature was probably disabled, and perhaps nearly dead, when discovered at the surface, and this seems to have been the case with most of the specimens hitherto seen living. Animals of this sort probably never float or lie quietly at the surface when in good health.

Nos. 8 and 9.—Lamaline specimens, 1870–'71.

Mr. Harvey refers to a statement made to him by a clergyman, Rev. A. E. Gabriel, of Portugal Cove, that two specimens (Nos. 8 and 9), measuring respectively 40 and 47 feet in total length, were cast ashore at Lamaline, on the southern coast of Newfoundland, in the winter of 1870–'71.

No. 10.—Sperm-whale specimen. (*Architeuthis princeps.*)

Plate XI, figures 1, 2.

This specimen, consisting of both jaws, was presented to the Peabody Academy of Science, at Salem, Mass., by Capt. N. E. Atwood, of Provincetown, Mass. It was taken from the stomach of a sperm-whale, but the precise date and locality are not known. It was probably from the North Atlantic. The upper jaw was imperfectly figured by Dr. Packard in his article on this subject.* It is one of the largest jaws yet known, and belonged to an apparently undescribed species, which I named *Architeuthis princeps*, and described in my former papers, with figures of both jaws.

No. 11.—Second Bonavista Bay specimen, 1872.

The Rev. M. Harvey, in a letter to me, stated that a specimen was cast ashore at Bonavista Bay, December, 1872, and that his informant told him that the long arms measured 32 feet in length, and the short arms about 10 feet in length, and were "thicker than a man's thigh." The body was not measured, but he thinks it was about 14 feet long and very stout, and that the largest suckers were 2.5 inches in diameter. The size of the suckers is probably exaggerated, and most likely the

*American Naturalist, vol. vii, p. 91, 1873.

length of the body also. It is even possible that this was the same specimen from which the beak and suckers described as No. 4, from Bonavista Bay, were derived, for the date of capture of that specimen is unknown to me. The latter, however, was much smaller than the above measurements, and it is, therefore, desirable to give a special number (11) to the present one.

No. 12.—Harbor Grace specimen, 1874–'75.

Another specimen, which we have designated as No. 12, was cast ashore, in the winter of 1874–'75, near Harbor Grace, but was destroyed before its value became known, and no measurements were given.

No. 13.—Fortune Bay specimen, 1874.

Plate IX, figure 11.

A specimen was cast ashore, December, 1874, at Grand Bank, Fortune Bay, Newfoundland. As in the case of several of the previous specimens, I was indebted to the Rev. M. Harvey for early information concerning this one, and also for the jaws and one of the large suckers of the tentacular arms, obtained through Mr. Simms, these being the only parts preserved. Although this specimen went ashore in December, Mr. Harvey did not hear of the event until March, owing to the unusual interruption of travel by the severity of the winter. He informed me that Mr. George Simms, magistrate of Grand Bank, had stated in a letter to him that he examined the creature a few hours after it went ashore, but not before it had been mutilated by the removal of the tail by the fishermen, who finally cut it up as food for their numerous dogs; and that the long tentacular arms were 26 feet long and 16 inches in circumference; the short arms were about one-third as long as the long ones; the "back of the head or neck was 36 inches in circumference" (evidently meaning the head behind the bases of the arms); the length of the body "from the junction to the tail" was 10 feet (apparently meaning from the base of the arms to the origin of the caudal fins). He thought that the tail, which had been removed, was about one-third as long as the body, but this was probably overestimated. In No. 14 the tail, from its origin or base, was about one-fifth as long as the balance of the body and head. Applying the same proportions to No. 13, the head and body together would have been 12 feet. In a letter to me, dated October 27, 1875, Mr. Simms confirmed the above measurements, but stated that the long arms had been detached, and that the bases of the arms measured as those of the tentacular arms (they had previously been cut off about a foot from the head), were triangular in outline, the sides being respectively 5, 6, 5 inches in breadth, the longest or outer side being convex and the two lateral sides straight. He, moreover, says that *all* the arms were covered with large suckers *from the base outward.* Hence, it is probable that he made a mistake as to these stumps, and that they really belonged to a pair of sessile arms. Probably the tentacular arms, when extended, had been cut off so close to their contractile bases that their stumps had afterwards become contracted within their basal pouches, and were therefore overlooked. He adds that the body was 3 feet broad (doubtless it was much flattened from its natural form), and that the measurements were made while the body lay upon uneven ground, so that its exact length could not be easily ascertained, and that the caudal fin had been cut off at its base. As the tail-fins of Nos. 5 and 14 were about one-fifth the length of the rest of the body and the head together, this specimen, if belonging to either of those species, should have been about 12 feet from the base of the arms to the tip of the tail.

The large sucker in my possession is 1 inch in diameter across the denticulated rim, and in form and structure agrees closely with those described and figured by me from the tentacular arms of Nos. 4, 5, and 14 (Plate IV, figures 1, 4, and Plate IX, figures 1, 1 *a*).

The jaws are still attached together, in their natural position, by the cartilages. They agree very closely in form with the large jaws of *Architeuthis princeps* V. (No. 10), figured on Plate XI, but they are about one-tenth smaller.

No. 14.—Catalina specimen, 1877. (*Architeuthis princeps.*)

Plates VIII–X.

A nearly perfect specimen of a large squid was found cast ashore, after a severe gale, at Catalina, Trinity Bay, Newfoundland, September 22, 1877. It was living when found. It was exhibited for two or three days at Saint John's, and subsequently was carried in brine to New York, where it was purchased by Reiche & Brother, for the New York Aquarium. There I had an opportunity to examine it very soon after its arrival.* I am also indebted to the proprietors of the aquarium for some of the loose suckers. Other suckers from this specimen were sent to me from Newfoundland, by the Rev. M. Harvey. Although somewhat mutilated, and not in a very good state of preservation when received, it is of great interest, being, without doubt, the largest and best specimen ever preserved. The Catalina specimen, when fresh,† was 9.5 feet from tip of tail to base of arms; circumference of body, 7 feet; circumference of head, 4 feet; length of tentacular arms, 30 feet; length of

* See American Journal of Science and Arts, vol. xiv, p. 425, November, 1877. When examined by me it was loose in a tank of alcohol. Dr. J. B. Holder gave me valuable assistance in making this examination, and also made one of the drawings of the caudal fin. It was afterwards "prepared" for exhibition by a taxidermist, who misplaced the arms, siphon, and other parts, and inserted two large, round, flat, red eyes close together on the top of the head! Continued soaking in strong alcohol had reduced its dimensions to about one-half their former measurements when examined by me two years later.

† Measurements of the freshly-caught specimen were made by the Rev. M. Harvey, at Saint John's, and communicated to me.

longest sessile arms (ventral ones?), 11 feet; circumference at base, 17 inches; circumference of tentacular arms, 5 inches; at their expanded portions, 8 inches; length of upper mandible, 5.25 inches; diameter of large suckers, 1 inch; diameter of eye-openings, 8 inches. The eyes were destroyed by the captors. It agrees in general appearance with *A. Harveyi* (No. 5), but the caudal fin is broader and somewhat less acutely pointed than in that species, as seen in No. 5; it was 2 feet and 9 inches broad, when fresh, and broadly sagittate in form. The dried rims of the large suckers are white, with very acutely serrate margins; the small smooth-rimmed suckers, with their accompanying tubercles, are distantly scattered along most of the inner face of the tentacular arms, the last ones noticed being 19 feet from the tips. The sessile arms present considerable disparity in length and size, the ventral ones being somewhat larger and longer than the others, which were, however, more or less mutilated when examined by me; the serrations are smaller on the inner edge than on the outer edge of the suckers. On the smaller suckers beyond the middle of the arms the inner edge is without serrations.

No. 15.—Hammer Cove specimen, 1876.

In a letter from Rev. M. Harvey, dated August 25, 1877, he states that a big squid was cast ashore November 20, 1876, at Hammer Cove, on the southwest arm of Green Bay, in Notre Dame Bay, Newfoundland. When first discovered by his informant it had already been partially devoured by foxes and sea-birds. Of the body, a portion 5 feet long remained, with about 2 feet of the basal part of the arms. The head was 18 inches broad; tail, 18 inches broad; eye-sockets, 7 by 9 inches; stump of one of the arms, 3.5 inches in diameter.

The only portion secured was a piece of the 'pen' about 16 inches long, which was given to Mr. Harvey.

No. 16.—Lance Cove specimen, 1877. (*Architeuthis princeps?* ♀.)

In a letter dated November 27, 1877, Mr. Harvey gives an account of another specimen which was stranded on the shore at Lance Cove, Smith's Sound, Trinity Bay, about twenty miles farther up the bay than the locality of the Catalina Bay specimen (No. 14). He received his information from Mr. John Duffet, a resident of the locality, who was one of the persons who found it and measured it. His account is as follows: "On November 21, 1877, early in the morning, a 'big squid' was seen on the beach at Lance Cove, still alive and struggling desperately to escape. It had been borne in by a 'spring tide' and a high inshore wind. In its struggles to get off it ploughed up a trench or furrow about 30 feet long and of considerable depth, by the stream of water that it ejected with great force from its siphon. When the tide receded it died. Mr. Duffet measured it carefully, and found that the body was nearly 11 feet long (probably including the head), the tentacular arms

33 feet long. He did not measure the short arms, but estimated them at 13 feet, and that they were much thicker than a man's thigh at their bases. The people cut the body open and it was left on the beach. It is an out-of-the-way place, and no one knew that it was of any value. Otherwise it could easily have been brought to Saint John's with only the eyes destroyed and the body opened." It was subsequently carried off by the tide, and no portion was secured.

This was considerably larger than the Catalina specimen.

The great thickness of the short arms of this specimen, and of some of the others, indicates a species distinct from *A. Harveyi*, unless the sexes of that species differ more than is usual in this respect among the smaller squids. The length of the sessile arms, if correctly stated, would indicate that this specimen belonged to *A. princeps*. In the female *Ommastrephes illecebrosus*, the common northern squid, the head is usually larger, the short arms are stouter, and the suckers are often larger than in the male, of the same length.

No. 17.—Trinity Bay specimen, 1877.

Mr. Harvey also states that he had been informed by Mr. Duffet that another very large 'big squid' was cast ashore in October, 1877, about five miles farther up Trinity Bay than the last. It was cut up and used for manure. No portions are known to have been preserved, and no measurements were given.

No. 18.—Thimble Tickle specimen, 1878.

The capture of this specimen has been graphically described by Mr. Harvey, in a letter to the Boston Traveller of January 30, 1879:

"On the 2d day of November last, Stephen Sherring, a fisherman residing in Thimble Tickle (Notre Dame Bay), not far from the locality where the other devil-fish (No. 19) was cast ashore, was out in a boat with two other men; not far from the shore they observed some bulky object, and, supposing it might be part of a wreck, they rowed toward it, and, to their horror, found themselves close to a huge fish, having large glassy eyes, which was making desperate efforts to escape, and churning the water into foam by the motion of its immense arms and tail. It was aground and the tide was ebbing. From the funnel at the back of its head it was ejecting large volumes of water, this being its method of moving backward, the force of the stream, by the reaction of the surrounding medium, driving it in the required direction. At times the water from the siphon was black as ink.

"Finding the monster partially disabled, the fishermen plucked up courage and ventured near enough to throw the grapnel of their boat, the sharp flukes of which, having barbed points, sunk into the soft body. To the grapnel they had attached a stout rope, which they had carried ashore and tied to a tree, so as to prevent the fish from going out with the tide. It was a happy thought, for the devil-fish found himself effectually moored to the shore. His struggles were terrific as he flung his ten arms about in dying agony. The fishermen took care to keep a respectful distance from the long tentacles, which ever and anon darted out like great tongues from the central mass. At length it became exhausted, and as the water receded it expired.

"The fishermen, alas! knowing no better, proceeded to convert it into dog's meat. It was a splendid specimen—the largest yet taken—the body measuring 20 feet from the beak to the extremity of the tail. It was thus exactly double the size of the New York specimen [No. 14], and 5 feet longer than the one taken by Budgell. The circumference of the body is not stated, but one of the arms measured 35 feet. This must have been a tentacle."

No. 19.—Three Arms specimen, 1878. (*Architeuthis princeps?*)

Mr. Harvey has also given an account of this specimen in the same letter to the Boston Traveller, referred to under No. 18. This one was found cast ashore, after a heavy gale of wind, December 2, 1878, by Mr. William Budgell, a fisherman, residing at a place called Three Arms, on the south arm of Notre Dame Bay. It was dead when found, and was cut up and used for dog-meat. Mr. Harvey's account is as follows:

"My informant, a very intelligent person, who was on a visit in that quarter on business, arrived at Budgell's house soon after he had brought it home in a mutilated state, and carefully measured some portions with his own hand. He found that the body measured 15 feet from the beak to the end of the tail, which is 5 feet longer than the New York specimen. The circumference of the body at its thickest part was 12 feet. He found only one of the short arms perfect, which was 16 feet in length, being 5 feet longer than a similar arm of the New York specimen, and he describes it as 'thicker than a man's thigh.'"

The statement that the sessile arms were longer than the head and body together, indicates that this was a specimen of *A. princeps*, like No. 14, but larger.

No. 20.—Banquereau specimen, 1879.

This consists of the terminal part of a tentacular arm, which was taken by Capt. J. W. Collins and crew of the schooner "Marion" from the stomach of a large and voracious fish (*Alepidosaurus ferox*), together with the first specimen discovered of the remarkable squid, *Histioteuthis Collinsii* V. The fish was taken on a halibut trawl-line, north latitude 42° 49′, west longitude 62° 57′, off Nova Scotia, January, 1879. This fragment, after preservation in strong alcohol, now measures 18 inches in length. It includes all the terminal club, and a portion of the naked arm below it. This club is narrow, measuring but .75 of an inch across its front side, while the naked arm is 1.25 broad, and rather flat, where cut off. From the commencement of the large suckers to the tip it measures 9.25 inches. It had lost most of its suckers, so that it cannot be identified with certainty. Part of the large suckers and some of the marginal ones still remain, though the horny rings are gone. Diameter of large suckers, .50 of an inch; of marginal ones, about .12 of an inch. The suckers have the same form and arrangement as in the larger specimens of *Architeuthis*. It may have belonged to a young *A. Harveyi*.

No. 21.—Cape Sable specimen. (*Sthenoteuthis megaptera* V.)

Plate XVI.

This specimen was found thrown on the shore, near Cape Sable, Nova Scotia, after the very severe gale in which the steamer "City of Boston" was lost several years ago. It is preserved in alcohol, entire and in good condition, in the Provincial Museum at Halifax, where it is well exhibited in a large glass jar. It is the type-specimen of *Architeuthis megaptera*, described by me, September, 1878.* It is a comparatively small species, its total length being but 43 inches; its head and body together, 19 inches; body alone, 14 inches; its tentacular arms, 22 and 24 inches; short arms, from 6.5 to 8.5 inches; tail-fin, 13.5 inches broad and 6 inches long.

This species differs widely from all the others in the relatively enormous size and breadth of its caudal fin, which is nearly as broad as the body is long, and more than twice as broad as long. It has been made the type of a new generic group.

No. 22.—Brigus specimen, 1879.

Mr. Harvey states that portions of another large squid were cast ashore near Brigus, Conception Bay, in October, 1879.

Two of the short arms, each measuring 8 feet in length, were found with other mutilated parts, after a storm.

No. 23.—James's Cove specimen, 1879.

From Mr. Harvey I have also very recently received an account of another specimen, which was captured entire, about the first of November 1879, at James's Cove, Bonavista Bay, Newfoundland. It seems to have been a fine and complete specimen, about the size of the Catalina Bay specimen (No. 14). Unfortunately, the fishermen, as usual, indulged immediately in their propensity to cut and destroy, and it is doubtful if any portion was preserved. The account referred to was published in the Morning Chronicle of Saint John's, Newfoundland, December 9, 1879, and was credited to the Harbor Grace Standard. The author of the article is not given. The following extract contains all that is essential: "A friend at Musgrave Town sends us the following particulars relative to the capture of a big squid at James's Cove, Goose Bay, about a month

*American Journal of Science, xvi, p. 207, 1878.

ago. Our correspondent says: 'Mr. Thomas Moores and several others saw something moving about in the water, not far from the stage. Getting into a punt they went alongside, when they were surprised to see a monstrous squid. One of the men struck at it with an oar, and it immediately struck for the shore, and went quite upon the beach. The men then succeeded in getting a rope around it, and hauled it quite ashore. It measured 38 feet altogether. The body was about 9 feet in length, and two of its tentacles or horns were 29 feet each. There were several other smaller horns, but they were not so long. The body was about 6 feet in circumference. When I saw it, it was in the water, and was very much disfigured, as one of the men had thoughtlessly cut off the two longest tentacles, and had ripped the body partly open, thereby completely spoiling the appearance of the creature. The foregoing particulars I obtained from Mr. Moores.'"

No. 24.—The Grand Banks specimen, 1880.

Plate V, figures 5–7. Plate VI.

This specimen, which I have designated as No. 24, was found, dead and mutilated, floating at the surface, at the Grand Banks of Newfoundland, April, 1880, by Capt. O. A. Whitten and crew of the schooner "Wm. H. Oakes," and by them it was well preserved and presented to the United States Commission of Fish and Fisheries. It is of great interest, because it furnishes the means of completing the description of parts that were lacking or badly preserved in the larger specimens, especially the sessile arms and the buccal membranes.

The specimen consists of a part of the head, with all the arms attached, and with the suckers in a good state of preservation on all the arms, though the tips of all the short arms, except the left of the second pair, are destroyed, and all of the arms are more or less injured on their outer surfaces. The jaws and buccal membranes, with the odontophore and œsophagus, are intact. Parts of the cartilaginous skull, with some of the ganglia and the collapsed eyes, are present, but the external surface of the head is gone and the eyelids are badly mutilated. No part of the body was preserved. The tentacular arms, with all the suckers, are in good preservation. Unfortunately, the distal portions of both the ventral arms had been destroyed, so that the sex could not be determined. The color of the head, so far as preserved, and of the external surfaces of the sessile arms, is much like that of the common squids.

Reproduction of lost parts.

This creature had been badly mutilated long before its death, as its healed wounds show, and to this fact many of the imperfections of the specimen are due. At the time of its death, or subsequently, the extremities of the ventral arms and of the third right arm appear to have been destroyed, besides other injuries. But both the dorsal arms and both the lateral arms of the left side had previously been truncated at 12 to 13 inches from their bases. The ends had not only healed up entirely, but each one had apparently commenced to reproduce the lost portion. The reproduced part consists, in each case, of an elongated, acute, soft papilla, arising from the otherwise obtuse end of the arm. At its base one or two small suckers have already been reproduced, and minute rudiments of others can be detected on some of them. Whether these arms would have been perfectly restored in course of time is, perhaps, doubtful,* but there can be no doubt that a partial restoration would, at least, have been effected. On the basal half of several of the arms some of the suckers had also been previously lost, and these were all in the process of restoration. The restored suckers were mostly less than one-half the diameter of those adjacent, and in some cases less than one-third. Among the restored suckers were some malformations. One has a double aperture, with a double horny rim. In one case two small suckers, with pedicels in close contact, occupy the place of a single sucker. In another instance a small pediceled sucker arises from the pedicel of a larger one, near its base.

Nos. 25, 26, &c.

Architeuthis abundant in 1875 *at the Grand Banks.*

From Capt. J. W. Collins, now of the United States Fish Commission, I learn that in October, 1875, an unusual number of giant squids were found floating at the surface on the Grand Banks, but mostly entirely dead and more or less mutilated by birds and fishes. In very few cases they were not quite dead, but entirely disabled. These were seen chiefly between north latitude 44° and 44° 30′, and between west longitude 49° 30′ and 49° 50′. He believes that between 25 and 30 specimens were secured by the fleet from Gloucester, Mass., and that as many more were probably obtained by the vessels from other places. They were cut up and used as bait for codfish. For this use they are of considerable value to the fishermen. Captain Collins was at that time in command of the schooner "Howard," which secured five of these giant squids. These were mostly from 10 to 15 feet long, not including the arms, and averaged about 18 inches in diameter. The arms were almost always mutilated. The portion that was left was usually 3 to 4 feet long, and at the base about as large as a man's thigh.

One specimen (No. 25), when cut up, was packed into a large hogshead-tub having a capacity of about 75 gallons, which it filled. This tub was known to hold 700 pounds of codfish. The gravity of the *Archiuthis* is probably about the same as that of the fish. This would indicate more nearly the actual weight of one of these creatures than any of the

*That mutilations of the arms in species of *Octopus* are regularly restored is well known, but it has been stated by Steenstrup that this does not occur in the ten-armed forms. I have repeatedly observed such restorations in *Loligo* and *Ommastrephes*.

mere estimates that have been made, which are usually much too great. Allowing for the parts of the arms that had been destroyed, this specimen would, probably, have weighed nearly 1,000 pounds.

Among the numerous other vessels that were fortunate in securing this kind of bait, Captain Collins mentions the following:

The schooner "Sarah P. Ayer," Captain Oakly, took one or two.

The "E. R. Nickerson," Captain McDonald, secured one that had its arms and was not entirely dead, so that it was harpooned. Its tentacular arms were 36 feet long (No. 26).

The schooner "Tragabigzanda," Captain Mallory, secured three in one afternoon. These were 8 to 12 feet long, not including the arms.

These statements are confirmed by other fishermen, some of whom state that the "big squids" were also common during the same season at the "Flemish Cap," a bank situated some distance northeast from the Grand Banks.

The cause of so great a mortality among these great Cephalopods can only be conjectured. It may have been due to some disease epidemic among them, or to an unusual prevalence of deadly parasites or other enemies. It is worth while, however, to recall the fact that these were observed at about the same time, in autumn, when most of the specimens have been found cast ashore at Newfoundland in different years. This time may, perhaps, be just subsequent to their season for reproduction, when they would be so much weakened as to be more easily overpowered by parasites, disease, or other unfavorable conditions.

Histioteuthis Collinsii Verrill.

In addition to the foregoing examples, all of which, except No. 21, are believed to be referable to the genus *Architeuthis*, I have, in former articles* described a very remarkable large squid, belonging to the genus *Histioteuthis*, in which a broad thin membrane or web unites the six upper arms together nearly to their tips, while the lower ones have a shorter web uniting them to the rest. Although small, when contrasted with the gigantic specimens of *Architeuthis*, it is considerably larger than any of the common small squids, and as it inhabits the same localities with *Architeuthis*, and has some points of resemblance to the latter genus, especially in having the smooth-rimmed suckers for uniting together the long tentacular arms, I have thought it best to mention it in this part of my article, in connection with the species of *Architeuthis*. The only specimen known was obtained (with No. 10) from the stomach of a large and voracious fish (*Alepidosaurus ferox*), having a formidable array of long, sharp teeth, eminently adapted for the capture of such prey. It was taken by Capt. J. W. Collins and crew, of the schooner "Marion," in deep water off the coast of Nova Scotia, and presented to the United States Fish Commission. This species (*H. Collinsii*) is figured on Plate XXIII, and will be described farther on.

*American Journal of Science, vol. xvii, p. 241, 1879; vol. xix, p. 29, pl. 14, 1880; Trans. Conn. Acad., vol. v, pp. 195, 234, pl. 22.

Moroteuthis robusta (Dall, sp.) Verrill.

In this connection I may also refer to a gigantic Pacific Ocean species, obtained by Mr. W. H. Dall, on the coast of Alaska, in 1872, which will be described as fully as possible in another part of this article, when discussing the foreign species of large Cephalopods (see Plates XIII and XIV). Three specimens were observed and measured by Mr. Dall. The largest one measured, from the base of the arms to the end of the body, 8.5 feet. The ends of all the arms had been destroyed in all the specimens. It was originally † briefly described by me under Mr. Dall's MSS. name, *Ommastrephes robustus*, but a more careful study of the parts preserved, especially the 'cone' of the 'pen' and the odontophore, convinced me that it belongs to the family *Teuthidæ*, characterized especially by having rows of sharp claws or hooks on the 'club' of the tentacular arms, instead of suckers. ‡ It was of special interest, to add another generic type to the list of gigantic species.

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† American Journal of Science, vol. xii, p. 236, 1876.

‡ Trans. Conn. Acad., vol. v., p. 246.

Comparative measurements of the specimens (in inches).

	Architeuthis Harveyi?										Architeuthis princeps?									
	No. 2.	No. 3.	No. 4.	No. 5, fresh.	No. 5, in alcohol.	No. 8.	No. 9.	No. 11.	No. 15.	No. 24.	No. 1.	No. 7.	No. 10.	No. 13.	No. 14.	No. 16.	No. 18.	No. 19.	No. 22.	No. 23.
Total length, to tip of tentacular arms		624	384	382		480	540					624		450?	480	528	660			456
Total length, to tip of short arms				166											246					
Base of arms to insertion of tail-fin				75										120	95					
Base of arms to tip of tail		120		92				168?			170?	180		140?	114	132	240	180		108
Head, length (base of arms to mantle)				10											14?					
Mantle edge to tip of tail, above				82											100?					
Circumference of body		90?	72	66							56?				84			144		72
Circumference of head														36	48					
Breadth of head, across eyes									18											
Breadth of eye-openings									7 × 9	3					8					
Length of tail-fin (tip to insertion)				18?	17									20?	19 p.					
Breadth of tail-fin				22	16				18						28 p.					
From outer angle to tip of tail-fin				27?	23										24.5 p.					
Outer angle of tail-fin to side of body					6.5										10 p.					
Length of tentacular arms	348?	504		288	161			384		67		444		312	360	396	420			348
Length of 'club' bearing rows of suckers	30			30	30					8.25					30.5 p.					
Part bearing largest suckers	18			15	14					4.25					19 p.					
Length of longest sessile arms		72		72				120		26.25	120 +			104?	132	156?		192	96	
Circumference of largest sessile arms (at base)		9		10	8				10.5		22			16?	17					
Breadth of largest sessile arms (at base)					3				3.5?	1.10					6					
Circumference of tentacular arms (middle)	4			2½–3	2.75										5					
Circumference of 'club' of same	6				4.5										6 p.					
Diameter of largest suckers of club	1.28		.92	1.25	1.15			2.25?		.35		2		1.10	1.15					
Diameter of largest suckers of short arms				1						.31					1					
Upper jaw, total length			3.55		3.85								5	4 +	5.25					
Upper jaw, breadth (front to back)			2.5+		2.50								3.50	3.24	3.88					
Lower jaw, total length					3								3.63	3.24	3.75					
Lower jaw, total breadth					2.65					1.20				3.08	3.88					
Lower jaw, tip of beak to notch			.62		.65					.32	.65		.80	.71	.87					

The measurements given from the preserved specimen of No. 14 are designated by p. affixed.

SPECIAL DESCRIPTIONS OF THE ATLANTIC COAST SPECIES.

Architeuthis Steenstrup.

Architeuthus Steenstrup, Oplysninger om Atlanter, Collossale Blæksprutter, Förhandlinger Skand. Naturf., 1856, vol. vii, p. 182, Christiana, 1857 (name proposed, but no generic characters given).

Architeuthis Harting, Verh. K. Akad., Weten., Natuurk., IX, 1860.

Megaloteuthis Kent, Proc. Zool. Soc., London, 1874, p. 178 (no generic characters given).

Size large. Body stout, nearly round, swollen in the middle. Caudal fin, in the typical species, relatively small, sagittate. Head large, short. Eyes very large, oblong-ovate, with well-developed lids and anterior sinus. Sessile arms stout, their suckers large, very oblique, with the edges of the horny rings strongly serrate, especially on the outer margin. The suckers of the basal half of all the arms, except the ventral ones, differ from the distal ones in being denticulated all around and less oblique. The margin has around it a free-edged membrane, which closely surrounds the denticles when the sucker is used, and allows a vacuum to be produced. Tentacular arms very long and slender, in extension, the proximal part of the club furnished with an irregular group of small, smooth-rimmed suckers, intermingled with rounded tubercles on each arm, the suckers on one arm corresponding with the tubercles of the other, so that by them the two arms may be firmly attached together without injury, and thus used in concert; other similar suckers and tubercles, doubtless for the same use, are distantly scattered along the slender part of these arms, one sucker and one tubercle occurring near together. A small cluster of smooth-edged suckers also occurs at the tips. The internal shell (imperfectly known in one species only) has a thin and very broad, lanceolate posterior blade, expanding forward from the end, with divergent ribs.

This genus is closely allied to *Ommastrephes*, from which it may be best distinguished by the presence of the peculiar connective suckers and tubercles for uniting the tentacular arms together.

Architeuthis Harveyi Verrill.—(Harvey's Giant Squid.)

Megaloteuthis Harveyi Kent, Proc. Zool. Soc. London, 1874, p. 178.

Architeuthis monachus Verrill, Amer. Journal Science, vol. ix, pp. 124, 177, pl. 2, 3, 4, 1875; vol. xii, p. 236, 1876. American Naturalist, vol. ix, pp. 22, 78, figs. 1–6, 10, 1875 (*? non* Steenstrup).

Ommastrephes Harveyi Kent, Proc. Zool. Soc. London, 1874, p. 492.

Ommastrephes (*Architeuthis*) *monachus* Tryon, Manual of Conchology, vol. i, p. 184, pl. 83, fig. 379, pl. 84, figs. 380–385, 1879. (Descriptions compiled and figures copied from the papers by A. E. V.)

Architeuthis Harveyi Verrill, Trans. Conn. Acad., vol. v, pp. 197, 259, pls. 13–16 a, 26, 1879–'80. Amer. Journal Science, vol. xix, pp. 284, 287, pl. 13, 1880.

Plates I—VI.

The diagnostic characters of this species, so far as determined, are as follows: Sessile arms unequal in size, nearly equal in length, decidedly shorter than the head and body together, and scarcely as long as the body alone, all bearing sharply serrated suckers; their tips slender and acute. Tentacular arms, in extension, about four times as long as the short ones; about three times as long as the head and body together. Caudal fin small, less than one-third the length of the mantle, sagittate in form, with the narrow lateral lobes extending forward beyond their insertions; the posterior end tapering to a long, acute tip. Jaws with a smaller notch and lobe than in *A. princeps*. Larger suckers, toward the base of the lateral and dorsal arms, with numerous acute teeth all around the circumference, all similar in shape, but those on the inner margin smaller than those on the outer. Remainder of the suckers on these arms, and all of those on the ventral arms, toothed on the outer margin only. Sexual characters are not yet determined.

Special description of the specimen No. 5.—The preserved parts of this specimen (see p. 8) examined by me are as follows: The anterior part of the head, with the bases of the arms, the beak, lingual ribbon, &c.; the eight shorter arms, but without the suckers, which dropped off in the brine, and are now represented only by a few of the detached marginal rings; the two long tentacular arms, which are well preserved, with all the suckers in place; the caudal fin; portions of the pen or internal shell; the ink-bag; and pieces of the body.

The general appearance and form of this species* are well shown by

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* Mr. W. Saville Kent, from the popular descriptions of this species, gave it new generic and specific names, viz, *Megaloteuthis Harveyi*, in a communication made to the Zoological Society of London, March 3, 1874 (Proceedings Zool. Soc., p. 178; see also Nature, vol. ix, p. 375, March 12, and p. 403, March 19). My former identification was based on a comparison of the jaws with the jaws of *A. monachus*, well figured and described by Steenstrup in proof-sheets of a paper which is still unpublished, though in part printed several years ago, and referred to by Harting. The agreement of the jaws is very close in nearly all respects, but the beak of the lower jaw is a little more divergent in Steenstrup's figure. His specimen was a little larger than the one here described, and was taken from a specimen cast ashore at Jutland in 1853. Mr. Kent was probably unacquainted with Steenstrup's notice of that specimen when he said (Nature, vol. ix, p. 403) that *A. monachus* "was instituted for the reception of two gigantic Cephalopods cast on the shores of Jutland in the years 1639 and 1790, and of which popular record alone remains." In his second communication to the Zoological Society of London, March 18, 1874 (Proc., p. 490), he states (on the authority of Crosse and Fischer) that a third specimen "was stranded on the coast of Jutland in 1854, and upon the pharynx and beak of this, the only parts preserved, the same authority founded his species *Architeuthis dux*." The specimen here referred to is evidently the same that Steenstrup named *A. monachus*, in 1856. The confusion in reference to these names is evidently due to this mistake.

The statement that *Architeuthis dux* Steenstrup is known from the beak alone is evidently erroneous. Steenstrup himself, Harting, and Dr. Packard, in their articles on this subject, all state that the suckers, parts of the arms, and the internal shell or pen were preserved, and they have been figured, but not published, by Professor Steen-

Plates I and II. The body was relatively stout. According to the statement of Mr. Harvey, it was, when fresh, about 213^{cm} (7 feet) long and 5½ feet in circumference. The 'tail' or caudal fin (Plate I, fig. 2, and Plate IV, fig. 11) is decidedly sagittate, and remarkably small in proportion to the body. It is said by Mr. Harvey to have been 55.9^{cm} (22 inches) across, but the preserved specimen is considerably smaller, owing, undoubtedly, to shrinkage in the brine and alcohol. The posterior termination is unusually acute, and the lateral lobes extend forward considerably beyond their insertion. In the preserved specimen the total length, from the anterior end of the lateral lobes to the tip of the tail, is 58.4^{cm} (23 inches); from the lateral insertions to the tip, 48.2^{cm} (19 inches); total breadth, about 38^{cm} (15 inches); width of lateral lobes, 15.2^{cm} (6 inches). The eight shorter arms, when fresh, were, according to Mr. Harvey's measurements, 182.9^{cm} (6 feet) long, and all of equal length,* but those of the different pairs were, respectively, 25.4^{cm}, 22.9^{cm}, 20.3^{cm}, and 17.8^{cm} (10, 9, 8, and 7 inches) in circumference.†

strup. Harting has also given a figure of the lower jaw, copied from a figure by Steenstrup. In the proof-sheets that I have seen this specimen is referred to as "*A. titan*," but Harting cites it as *A. dux* Steenstrup, which is the name given to it by Steenstrup in his first notice of it, in 1856. Therefore, two distinct species were confounded under this name by Kent. His rejection of the generic name, *Architeuthis*, might, perhaps, have been justified on the ground that Steenstrup had never published any definite description of it, and that he had mentioned no distinctive generic characters in his brief notice, had not Harting's article given, indirectly, sufficient information to justify us in adopting the genus. But Kent's genus rests on no better foundation than *Architeuthis*, for he gave to it no characters that can be considered generic. *Actual generic characters of Architeuthis* were first given in my articles in 1875, but those then given for the *pen* and *dentition* were erroneus. Previous to that time no characters had been published, either by Steenstrup, Harting, or Kent, sufficient to distinguish the genus from *Ommastrephes* and *Loligo*, much less from *Sthenoteuthis*, to which it is most closely allied.

I have more recently been led to consider our species distinct from the true *A. monachus* by correspondence with Professor Steenstrup, from whom I learn that the caudal fin in his species does not agree with that of the species here described, and that in his species the ventral arms differ from the others, both in form and in the character of the suckers. Certain differences in the arms can be detected in the photograph of our specimen (reproduced on Plate I), in which, fortunately, the ventral arms are well displayed. Unless these differences prove to be sexual characters, which is not likely, they would indicate a specific difference. Therefore, I have, for the present, adopted the specific name given by Kent to the Newfoundland specimens. The name was given as a well-merited compliment to the Rev. M. Harvey, who has done so much to bring these remarkable specimens into notice. Nevertheless, it is probable that when the original specimens of *A. monachus* shall have been fully described and figured, so as to make the species recognizable, one of our species may prove to be identical with it. At present I am unable to decide whether the affinities of *A. monachus* may not be with *A. princeps* rather than with *A. Harveyi*. Recently I have had an opportunity to study the suckers of a young specimen of our species (No. 21) in place. In this the suckers on the basal part of the ventral arms differ from the corresponding ones of the other arms in being denticulate only on the outer side.

*It is possible that they may have been originally somewhat unequal, and that mutilation of their tips made them appear more nearly equal than they were in life.

†In the original statement it is not mentioned to which pairs of arms these dimensions apply. After having been five years in alcohol, the ventral arms now measure

They are, except the ventral, compressed trapezoidal in form, and taper very gradually to slender, acute tips; their inner faces, along the proximal half of their length, are occupied by two alternating rows of large, obliquely campanulate suckers, with contracted apertures, surrounded by broad, oblique, thin, horny, marginal rings, much broader on the outer side than on the inner, and armed with strong, acute teeth around their entire circumference, but the teeth are largest and most oblique on the outside (Plate IV, figs. 5–8). The suckers gradually diminish in size to the tips of the arms, where they become very small; those toward the tips of the arms appear to have been denticulate on the outer side, and entire, or nearly so, on the inner margin. The ventral arms still have, as they show in the photograph, the inner face much broader than it is in the others, especially near the base, and they are more nearly square than any of the others. Their suckers are more numerous, farther apart transversely, and closer together in the longitudinal series, there being about 46 on the proximal half (36 inches) of each, while on each of the subventral arms there are only about 30 on the corresponding portion; the suckers also diminish rather abruptly in size at about 26 to 30 inches from the base, beyond which they are scarcely more than half as large as those on the second and third pairs of arms, at the same distance from the base; it is probable, judging from the small specimen (No. 24), that all the suckers of the ventral arms were denticulate only on the outer margin. The largest of these suckers are said by Mr. Harvey to have been about an inch in diameter when fresh. The largest of their marginal rings in my possession are 16^{mm} to 17^{mm} in diameter at the serrated edge, and 18^{mm} to 21^{mm} beneath.

The horny rings are yellowish horn-color, oblique, and more than twice as high on the back side as in front. A wide peripheral groove runs entirely around the circumference, just below the denticulated margin; it is narrower and deeper on the inner side. On the inner side of the largest kind (*c*, *d*, *e*, *g*) the edge is nearly vertical, and the denticles point upward or are but slightly incurved; but on the outer side the edge and denticles are bent obliquely inward; along the lateral sides the edge is more or less incurved, and the denticles are inclined more or less forward, toward the inner edge of the sucker (figs. 5, 6, 6*a*). The denticles are golden yellow, or when dry silvery white; those on the outer and lateral margins are largest, flat, lanceolate, with sharply beveled lateral edges and acuminate tips; those on the front margin are shorter, narrower, acutely triangular, and in contact at their bases. On the largest of these suckers there are forty-eight to fifty denticles. Some of the suckers (figs. 7, 7*a*, 8) of rather smaller size (*a*, *b*) are more oblique, with the outer side of the

7.5 inches in circumference, and one of the lateral ones (perhaps one of the third pair) 8 inches. The marginal membranes and crests had decayed, apparently, before the arms were preserved. The terminal portions of the arms are also gone, so that their real length cannot be given.

horny rings relatively wider and more incurved; the denticles of the outer margin are strongly incurved and decidedly narrower and more acute than the lateral ones, which are broad-triangular; the inner or front denticles are rather smaller, acute-triangular, and usually inclined somewhat inward. On these there are forty to forty-six denticles. The rings of the smaller suckers are still more oblique and more contracted at the aperture than those of the larger ones, with the teeth more inclined inward, those on the outer margin being largest.

Among the loose sucker-rims there are some which differ from the others in having the rim more oblique, and the inner edge with nearly obsolete teeth. These suckers of the second kind differ from the corresponding ones of *A. princeps* in having, on the outer margin, more numerous, more slender, and sharper teeth, which taper regularly from base to tip and are not so flattened. The larger of these sucker-rims (*i*) are 14.5^{mm} in diameter across the base; aperture, 9^{mm}; height at back, 7^{mm}; in front, 2^{mm}; number of large denticles on outer margin, ten to fourteen; the inner margin, except in the smaller ones, is either finely toothed or distinctly crenulated, and there are usually one or more irregular, broad, sharp lobes or imperfect teeth on the lateral margins. The teeth of the outer margin are regular, strongly incurved, tapering from the base to the very sharp tips, and sharply beveled on the edges. A smaller one (*j*), 11^{mm} across the base and 4.5^{mm} across the aperture, with height of back 6^{mm}, has five regular sharp teeth on the outer margin, two broad irregular ones on each side, while the front edge is nearly entire. These are supposed to come from the ventral arms. Others (*h*) are completely intermediate between the two principal forms, having very oblique rims, with a small aperture, but distinctly denticulate all around, the denticles on the inner margin being distinctly smaller than on the outer.

Measurements of sucker-rims from short arms (in millimeters).

	a. (alc.)	*b.* (alc.)	*c.* (alc.)	*d.* (dry.)	*e.*	*f.*	*g.*	*h.*	*i.*	*j.*
Diameter, outside, at base	17	17	20	18	21	19	20.5	16	14.5	11
Diameter of aperture	13	10	16	14	17	16	16.5	9.5	9	4.5
Height of horny ring, back side	7.5	9	8	7	8	7.5	7.5	9.5	7	6
Height of horny ring, front side	3	3	3.5	3	3	3	3	3	2	1.5
Number of distinct denticles	46	41	50	49	50	48	49	34	14	7

The two long tentacular arms are remarkable for their slenderness and great length when compared with the length of the body. Mr. Harvey states that they were each 731.5^{cm} (24 feet) long and 7^{cm} (2.75 inches) in circumference when fresh. In the brine and alcohol they have shrunk greatly, and now measure only 411.5^{cm} (13.5 feet) in length, while the circumference of the slender portion varies from 5.7^{cm} to 7.25^{cm} (2.25 to 3.25 inches). These arms were evidently highly contractile, like those of many small species, and consequently the length and diameter would vary greatly according to the state of contraction or relaxation. The length given (24 feet) probably represents the extreme length in an extended or flaccid condition, such as usually occurs in these animals soon after death. The slender portion is nearly three-cornered or triquetral in form, with the outer angle rounded, the sides slightly concave, the lateral angles prominent, and the inner face a little convex and generally smooth (Plate I, fig. 1, *e e*.)

The terminal portion, bearing the suckers, is 76.2^{cm} in length and expands gradually to the middle, where it is 11.4^{cm} to 12.7^{cm} in circumference (15.3^{cm} when fresh) and 3.9^{cm} to 4.1^{cm} across the face. The sucker-bearing portion may be divided into three parts. The first region (*i* to *i i*) occupies about 17.8^{cm} (7 inches); here the arm is rounded-triquetral, with margined lateral angles, and gradually increases up to the maximum size, the inner face being convex and bearing about forty irregularly scattered, small, flattened, saucer-shaped suckers, attached by very short pedicels, and so placed in depressions as to rise but little above the general surface. The larger ones are 5^{mm} to 6^{mm} in external diameter; 3^{mm} across aperture; 1.5^{mm} high. The smaller ones have a diameter of 4^{mm}; aperture, 2.5^{mm}; height, 1^{mm}. The horny ring (Plate IV, Figs. 9, 9*a*) is circular, thin, and of about uniform breadth all around; the edge is smooth and even, slightly everted; just below the edge there is a groove all around; below this a prominent, rounded ridge surrounds the periphery, below which the lower edge is somewhat contracted. A thick, soft membrane surrounds the edge. These suckers are at first distantly scattered, but become more crowded distally, forming six to eight irregular alternating rows, covering the whole width of the inner face, which becomes 4.1^{cm} broad. Scattered among these suckers are about an equal number of low, broad, conical, smooth, callous verrucæ, or wart-like prominences, rising above the general surface, their central elevation corresponding in form and size to the apertures of the adjacent suckers. These, without doubt, are intended to furnish secure points of adhesion for the corresponding suckers of the opposite arm, so that, as in some other genera, these two arms can be fastened together at this wrist-like portion, and thus may be used unitedly. By this means they must become far more efficient organs for capturing their prey than if used separately. The absence of denticulations prevents the laceration of the creature's own flesh, which the sharp teeth of the other suckers would produce under pressure, and the verrucæ prevent the lateral slipping, to which unarmed suckers applied to a smooth surface would be liable. Between these smooth suckers and the rows of large ones there is a cluster of about a dozen small suckers, with sharply serrate margins, from 5^{mm} to 8^{mm} in diameter, attached by slender pedicels. They are arranged somewhat irregularly in four rows, those of the outer rows more oblique, and corresponding in form with the larger marginal suckers.

The second division (ii to iii), 35.6^{cm} in length, succeeds the small suckers. Here the arm is flattened on the face, rounded on the back, and provided with a sharp dorsal carina, increasing in width toward the tip. It bears two alternating rows of about twelve very large, serrated suckers, and an outer row of smaller ones, on each side, alternating with the large ones. The upper edge is bordered by a rather broad, regularly scalloped, marginal membrane, the scallops corresponding to the large suckers, while prominent transverse ridges, midway between the large suckers, join the membrane and form its lobes. On the lower edge there is a narrower and thinner membrane, which runs all the way to the tip of the arm. In one (the lower) of the rows of large suckers there are eleven, and in the other ten, above 20^{mm} in diameter. The former row has one additional sucker at its proximal end, 15^{mm} in diameter, and three others at its distal end, respectively 16^{mm}, 12^{mm}, and 8^{mm} in diameter. The other row, of ten suckers, is continued by a proximal sucker 10^{mm} in diameter, and by two distal ones, respectively 15^{mm} and 13^{mm} in diameter. The number of large suckers in each row may, therefore, be counted as 12, 13, or 14, according to the fancy of the describer, there being no well-defined distinction between the larger and smaller ones in either row. The largest suckers, along the middle of the rows, are from 24^{mm} to 30^{mm} in diameter (Plate IV, fig. 4, *a*). They are attached by slender but strong pedicels, about 10^{mm} long and 6^{mm} to 7^{mm} in diameter. The outer or back side of these suckers is 16^{mm} to 18^{mm} high; the inner side 10^{mm} to 11^{mm}, so that the rim is about 24^{mm} to 28^{mm} above the surface of the arm. The horny rings are 7^{mm} to 8^{mm} high and have the aperture 20^{mm} to 23^{mm} in diameter. Each one is situated in the center of a pentagonal depressed area, about 25^{mm} across, bounded by ridges, which alternate regularly and interlock on the two sides, so as to form a zigzag line along the middle of the arm. These large suckers are broadly and obliquely campanulate, but much less oblique than those of the short arms; the marginal ring is strong, and sharply serrate all around; the denticles are acute-triangular and nearly equal. The rings are somewhat calcified and rather rigid when dried; a well-marked broad groove runs around the entire circumference, below the bases of the denticles.

The small marginal suckers (fig. 4, *b*) are similar in structure, but much more oblique, and mostly 9^{mm} to 11^{mm} in diameter; they are attached by much longer and more slender pedicels, and their marginal teeth are relatively longer, sharper, and more incurved, especially on the outer margin. The peripheral groove is broad and deep, but is interrupted on the outer side for about a third of the circumference; the outer third portion of the horny ring is somewhat flattened from the circular form.

The terminal division (iii to iv) of the arm is 22.8^{cm} long. It gradually becomes compressed laterally, and tapers regularly to the tip, which is flat, blunt, and slightly incurved. Just beyond the large suckers, where this region begins, the circumference is 9^{cm}. The face is narrow and bears a large number of small pediceled suckers (Plate IV, figs. 10, 10 *a*), arranged in four regular, alternating rows, gradually diminishing in size to near the tip of the arm, where the rows expand into a small cluster of about ten smooth-edged suckers. The suckers, except in the final group, are much like the marginal ones of the previous division, and at first are 5^{mm} to 7^{mm} in diameter, but decrease to about 2.5^{mm} near the tip of the arm. They have sharply serrate, oblique, marginal rings, higher on the outer side, with a peripheral groove on the inner and lateral sides only. In our preserved specimens the rings are gone from many of these small suckers, but those of the two rows next to the lower margin appear to have been larger than the others.

The suckers of the final group are close to the tip, which is slightly recurved over them. They are flat, attached to short pedicels, and provided with a narrow horny rim, which has the edge smooth, or nearly so, and surrounded by a thick membranous border. The diameter of these suckers is from $.5^{mm}$ to 2^{mm}. They are rather crowded, and the cluster is broader than long.

The color of the body and arms, where preserved, is pale reddish, with thickly scattered, small spots of brownish red.

The form of the jaws* of this specimen is well shown by Plate III, figs. 1, 2. When in place the tips of these jaws constitute a powerful beak, looking something like that of a parrot or hawk, except that the upper jaw shuts into the lower, instead of the reverse, as in birds. The color is dark brown, becoming almost black toward the tip, where its substance is thicker and firmer, and smoothly polished externally. The upper jaw (Plate III, fig. 1), in 1875, measured 79^{mm} in total length, 25^{mm} in transverse breadth, and 66^{mm} in breadth or height. The lower jaw (fig. 2) was 76^{mm} long, 70^{mm} transversely, and 67^{mm} broad, vertically. It was larger when first received, but has subsequently shrunk considerably more, in alcohol.

The upper mandible has the rostrum strong, convex, acute, and curved considerably forward, with concave cutting edges, and a slight notch at its base. The anterior edges of the alæ are irregular and uneven. The palatine lamina is broad and thin.

The lower mandible has the rostrum stouter and less curved, the tip acute, with a distinct notch just below the tip, the cutting edges nearly straight, and with a moderately deep and rather narrow notch at its base; a ridge runs backward from near the tip, in a curved line, cir-

*In order to explain the terms employed in describing the various parts of the jaws of Cephalopods, as used in this article, I have introduced figures of the jaws of one of our common small squids (*Loligo pallida* V.) from Long Island Sound. The nomenclature adopted is essentially that used by Professor Steenstrup.

1. 2.

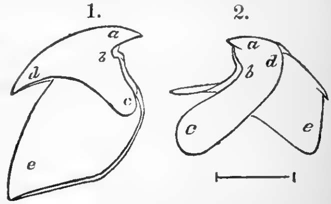

Fig. 1. Upper mandible: *a*, rostrum or tip of the beak; *b*, the notch; *c*, the inner end of ala; *d*, the frontal lamina; *e*, the palatine lamina; *ab*, the cutting edge of beak; *bc*, anterior or cutting edge of ala.

Fig. 2. Lower mandible: *a*, rostrum; *ab*, cutting edge; *bc*, anterior edge of ala; *d*, mentum or chin; *e*, gular lamina.

cumscribing a more flattened area, on which are grooves and ridges parallel with the notch. Beyond the notch, on the anterior edges of the alæ, there is, on each side, a broad, low, obtuse lobe or tooth, beyond which the edge is even and slightly concave to near the end of the alæ. The lamina of the mentum is short and strongly emarginate in the median line. Detailed measurements of the parts are given in the table of measurements on a subsequent page.

The roof of the mouth, or palate, between the anterior portions of the palatine laminæ, is lined with a rather firm, somewhat chitinous or parchment-like membrane, having its surface covered with strong, acute, recurved, yellowish teeth, apparently chitinous in nature, attached by broad, oval, or roundish flattened bases (Plate V, figs. 4, 5). These teeth are mostly curved, and very unequal in size and form, the various sizes being intermingled. They are arranged in irregular quincunx, in many indefinite rows. Many irregular, roundish, rough, white, stony granules are also attached to this membrane, among the teeth. Similar granules (Plate V, fig. 4*a*) occur in large numbers on the thinner extension of this membrane, which everywhere lines the mouth and pharynx.

The radula is about 64^{mm} in total length, with the dentigerous portion, where widest, about 11^{mm} in width. The teeth are in seven rows, with an exterior row of small, unarmed, thin, rhomboidal plates on each side, thus conforming to the arrangement in the other ten-armed Cephalopods. The teeth are deep amber-color to dark brown, and not unlike those of *Loligo* and *Ommastrephes* in form. Those of the median row have three fangs, the central one longest; those in the next row, on either side, have two fangs, while those of the two outer lateral rows, on each side, are acute and strongly curved; the outermost longest and simple, the next to the outer often having a small denticle on the outer side, near the base. (See Plate V, figs. 1, 2, 3.)

The membrane of the odontophore is broad, firm, and thick; the dentigerous portion occupies only about a third of its width, in the middle or broader portion, where it is bent abruptly back upon itself. The lower or ventral portion measures, from the anterior bend to the end, 20^{mm}; it narrows gradually to the broad, obtuse end, the width of the dentigerous portion decreasing from 9^{mm} to 5^{mm}, the naked lateral membrane decreasing from 8^{mm} to a very narrow border. The upper portion, from the bend to the end, measures 42^{mm} in length (in a straight line). The upper surface is deeply concave and infolded, at first, with the lateral membrane broad and recurved; farther back it becomes more flattened, with the dentigerous portion broader (11^{mm}), while the lateral membrane is abruptly narrowed and then extends to the end as a very narrow border. Toward the end the rows of teeth become more separated and the teeth smaller and paler, while the membrane becomes thinner and narrower.

The internal shell, or pen, was represented by numerous detached pieces, which, after much trouble, I succeeded in locating and matching, so as to restore the posterior end and some of the middle portions, giving some idea as to what its original structure must have been. The texture and structure of this part of the pen was somewhat like that of *Loligo*, but it was thinner, and had less definite outlines, and less of the peculiar quill-shape seen in the latter. The anterior end of the blade, instead of being even and regular in outline, appears to have been broadly rounded, or somewhat abrupt, with an indefinite outline, thinning out gradually on all sides into a soft, fibrous membrane, while the shaft, or or quill-portion, was not so distinctly differentiated from the broad, thin blade, which tapered to the posterior end, and was probably slightly hooded at the tip. The fragments in my possession belong to four more or less separated sections. The first section includes 11 inches of the posterior end, from close to the extreme tip forward; the second section includes about 9 inches, belonging to the posterior portion, and extends to about 25 inches from the posterior end, but lacks the extreme lateral margins outside the costæ (Plate III, fig. 3); the third section consists of about 7.5 inches, belonging to the middle region, but does not include the whole width on either side of the midrib; the fourth section is about 10 inches in length, and probably came from near the anterior end of the blade, apparently representing nearly the whole width on both sides.

From these fragments we can restore pretty accurately the last 25 inches and 12 inches or more of the middle portion, though the precise form of the indefinite anterior end of the blade must remain doubtful. The extreme posterior tip is broken off, but it was evidently pointed and thin as in *Ommastrephes*. At the mutilated end the breadth is now about a third of an inch. From this point the lateral edges diverge rapidly, with a slightly concave outline, for about 1.25 inches, where the breadth becomes 1.20 inches; beyond this the margins are nearly straight, and diverge gradually to the end of the first section, at 11 inches from the tip. At this place the breadth is 3.10 inches, the marginal portions outside of the lateral costæ being about .40 of an inch and the midrib about .25 of an inch broad. Beyond this point a section about 4.75 inches long is entirely wanting, and the succeeding section lacks the marginal portions, the lateral costæ forming the margins on both sides. At 19.50 inches from the tip the breadth between the lateral costæ is 3.75 inches; at 25 inches it is 5 inches broad. Whether the marginal portions originally extended to this point with a breadth as great as they have at 11 inches is uncertain, for their breadth decreases somewhat to that point, from a point about 4 inches from the tip, where their breadth is .60 of an inch. The midrib is strongly marked, being raised into a semi-cylindrical form, and of somewhat thicker material than the lateral portions; its breadth and hight steadily increases throughout both these sections and the following one, until it becomes nearly half an inch broad, but in the section from nearer the middle it is low and narrow, and decreases rapidly toward the end. The lateral costæ are well marked, considerably elevated, and well rounded; they run at first close to and nearly parallel with the midrib, but after the first 3 inches they diverge quite regularly to the point, at 25 inches from the end, beyond which we cannot trace them, until they reappear in the first part of the anterior section, where they are quite small and soon fade out entirely, at some distance from the extreme end. Near the posterior end, between the principal costæ and the margin, there are on each side two additional costæ, much less distinct, and many faint radiating lines. But these diverge more rapidly, and mostly run into the margin at 6 to 8 inches from the posterior end. The anterior portions and posterior portions are pale yellow or bluff, fading to whitish at the thin margins, and deepening into pale amber at the midrib. Their substance is flexible, translucent, and very thin—scarcely thicker than parchment, except at the midrib and costæ.

The third section evidently came from the middle region, where the shell was thickest and broadest. This piece is 7.50 inches long and 4.10 broad, with a strongly convex midrib, .30 to .35 of an inch broad, running through the center, but without any lateral costæ. In this portion the shell is much thicker and firmer than in the others, and of a decided brownish yellow or dull amber-color, but quite translucent; it is finely striated with close, nearly parallel lines. The breadth and form of this middle portion must remain undetermined for the present. The anterior section is quite incomplete, but is over 10 inches long, and shows an extreme width of about 6 inches, or 5.75 where the lateral costæ disappear. Some of the fragments extend forward 8 inches or more beyond that point, and gradually fade out, both at the ends and lateral margins, into a white, soft but tough, fibrous membrane. So far as this portion is preserved, it indicates a broadly rounded and ill-defined anterior margin.

To this species I refer, with some doubt, the tentacular arm of No. 2, preserved in the museum of Saint John's, Newfoundland. It agrees essentially in form and size, as will be seen from the description and measurements, with the corresponding arms of No. 5. Still, it must be remembered that, as yet, no reliable distinctions have been made out between the tentacular arms of *A. Harveyi* and *A. princeps*.

The total length of the tentacular arm of No. 2 was estimated at 30 to 35 feet. The portion saved measured, when fresh, 579.12^{cm} (19 feet). The circumference of the slender portion was 9^{cm} to 10^{cm}; of the enlarged sucker-bearing part, 15.24^{cm} (6 inches); length of the part bearing suckers, 76.2^{cm} (30 inches); diameter of the largest suckers, 3.17^{cm} (1.25 inches). Calculating from the photograph, the portion bearing the larger suckers was about 45.7^{cm} (18 inches) in length, and about 6.35^{cm} (2.5 inches) broad across the face; distance between attachments of large suckers, 4.27^{cm} (1.68 inches); outside diameter of larger suckers, 2.95^{cm} to 3.18^{cm} (1.16 to 1.25 inches); inside diameter, 1.86^{cm} to 2.54^{cm} (.74 to 1 inch); diameter of the small suckers of the outside rows, 1.02^{cm} to 1.22^{cm} (.40 to .48 of an inch). Mr. Harvey afterwards sent to me a full series of measurements of this arm, as then preserved. It had contracted excessively in the alcohol, and was only 13 feet 1 inch in length (instead of 19 feet, its original length), the enlarged sucker-bearing portion being 27 inches; the large suckers occupied 12 inches; the terminal part bearing small suckers, 9 inches; circumference of slender portion, 3.5 to 4.25 inches; of largest part, 6 inches; breadth of face, among large suckers, 2.5 inches; from face to back, 1.62 inches; diameter of largest suckers outside, .75 of an inch; aperture, .63 of an inch. It will be evident from these measurements, when compared with those made while fresh and from the photograph, that the shrinkage had been chiefly in length, the thickness remaining about the same, but the suckers (which had lost their horny rims, and therefore their size and form) were considerably smaller than the dimensions previously given. Comparing all these dimensions with those of the Logie Bay specimen, and calculating the proportions as nearly as possible, it follows that this specimen was very nearly one-third larger than the latter, but the large suckers appear to have been relatively smaller, for they were hardly one-twelfth larger than in the Logie Bay specimen. As the relative size of the large suckers is a variable sexual character in certain species of squids, it is possible that the difference may be a sexual one in this case.

A few of the horny rings from the small distal and lateral suckers (Plate IV, figs. 3, 3 *a*) were sent to me by Mr. Harvey. These agree well with the corresponding suckers of No. 5.

To this species I formerly referred the jaws and two large suckers from the 'club' of the tentacular arms of the Bonavista Bay specimen (No. 4, see p. 8). In form, size, and proportions the jaws resemble those of the specimen (No. 5) described above, so that the size of these two individuals must have been about the same. These jaws had been dried, and were very badly broken when received, so that only part of their dimensions could be ascertained at first, but I have recently partially repaired them, so as to study them more fully (see table under *A. princeps*). The total length of the upper mandible was about 105^{mm}; tip of beak to notch, 16^{mm}; notch to end of proper cutting edge of alæ, 75^{mm}. The lower mandible (Plate III, figs. 4, 4 *a*) shows both sides of the rostrum and alæ. The notch and tooth are well marked, and the tooth in front of it is narrower and much more elevated on one side than on the other. It is, therefore, quite possible that it belongs to *A. princeps*. The suckers (Plate IV, figs. 1, 1 *a*) had been dried, and have lost their true form, but the marginal rings are perfect, and only 23.4^{mm} (.92 of an inch) in diameter, but though somewhat smaller than in the specimen just described, they have the same kind of denticulation around the margin. Their smaller size may indicate that the specimen was a male, but they may not have been the largest of those on the tentacular arm.

To this species I also refer a young specimen (No. 24) which was found floating at the surface, at the Grand Bank of Newfoundland, April, 1880, by Capt. O. A. Whitten and crew of the schooner "Wm. H. Oakes," by whom it was presented to the United States Commission of Fish and Fisheries. It furnishes the means of completing the description of parts that were lacking or badly preserved in the larger specimens described above, and especially of the sessile arms and the buccal membranes (Plate VI).

The color of the head, so far as preserved, and of the external surfaces of the sessile arms, is a rather dark purplish brown, due to minute crowded specks of that color, thickly distributed, with a pinkish white ground-color between them. The outer buccal membrane is darker; the inner surfaces of the arms are whitish; the peduncular portions of the tentacular arms have fewer color specks, and are paler than the other arms.

This creature had been badly mutilated, as described on p. 18, long before its death, as its healed wounds show, and to this circumstance many of the imperfections of the specimen are due.

Sessile arms.

With the exception of the left arm of the second pair, none of the sessile arms have their tips perfect. Therefore, it is not possible to give their relative lengths.

The dorsal arms are the smallest at base, and the third pair largest. They are all provided with a rather narrow marginal membrane along each border of the front side. These membranes are scarcely wide enough to reach to the level of the rims of the suckers, though they may have done so in life. The front margin, bearing the suckers, is narrow on all the arms, but relatively wider on the ventrals than on any of the others. Each sucker-pedicel arises from a muscular cushion that is slightly raised and rounded on the inner side; these, alternating on the two sides, leave a zigzag depression along the middle of the arm; from each of these cushions two thickened muscular ridges run outward to the edge of the lateral membranes, one on each side of the pedicels of the suckers. These transverse muscular ridges give a scalloped outline to the margin of the membranes. These marginal membranes are narrowest and the suckers are smallest on the ventral arms. The dorsal and lateral arms are strongly compressed laterally, but slightly swollen or convex in the middle, and narrowed externally to a carina, which is most prominent along the middle of the arms, and most conspicuous on the third pair of arms. The dorsal arms are rather more slender than the second pair, and were probably somewhat shorter.

The left arm of the second pair has the tip preserved, with all its suckers present. On this arm there are 330 suckers in all. The total length of the arm is 26.25 inches. The first 50 suckers extend to 12.25 inches from the base; the next 50 occupy 4.5 inches; the next 50 cover 3.5 inches; the next 100 occupy 4.25 inches; the last 80 occupy 1.75 inches. This arm is .80 of an inch in transverse diameter near the base; 1.20

inches from front to back; breadth of its front or sucker-bearing surface (without the lateral membranes) is, where widest, near the base of the arm, .50 of an inch; the width gradually decreases to .18 of an inch at 20 inches from the base; beyond this the arm tapers to a very slender tip, with numerous small, crowded suckers in two regular rows. At the base (Plate VI, fig. 4) there is first one very small sucker; this is succeeded by two or three much larger ones, increasing a little in size; beyond these are the largest suckers, extending to about the 25th, beyond which they gradually change their form and regularly diminish in size to the tips. The larger proximal suckers, up to the 25th to 30th, are relatively broader than those beyond, and have a wider and more open aperture, and a more even and less oblique horny ring, which is sharply denticulate around the entire circumference, with the denticles rather smaller on the inner than on the outer margin, but similar in form. These are about .31 of an inch in external diameter. They show a gradual transition to those with more oblique rims and smaller apertures. Beyond the 30th the horny rims become decidedly more oblique and one-sided, with the denticles nearly or quite abortive on the inner side, and larger and more incurved on the outer margin, while the aperture becomes more contracted and oblique. At first there are eight to ten denticles on the outer margin, but these diminish in number as the suckers diminish in size, till at about 6 inches from the tip there are mostly but two or three, and the aperture is very contracted. Still nearer the tip there are but two blunt ones; then these become reduced to a single bilobed one; and finally only one, which is squarish, appears in the minute suckers of the last two inches of the tip. The first two or three suckers at the base of the arm are more feebly denticulated than those beyond, with smaller apertures.

On many of the suckers (Plate IV, fig. 2 *a*) there are still remaining, in more or less complete preservation, a circle of minute horny plates, arranged radially, or transversely on the edge of the membrane around the aperture, similar in arrangement to those described in another part of this article on the suckers of *Sthenoteuthis pteropus* (Plate XVII, fig. 9). They are less developed, however, than in that species, being thinner and more delicate, nor do their ends appear to turn up in the form of hooks. They seem to be generally very thin, oblong, scale-like structures, with rounded or blunt ends and slightly thickened margins. These structures will probably be found to vary with age, and perhaps with the season. They appear to be easily deciduous, and are often absent in preserved specimens.

On the dorsal and third pairs of arms the suckers have essentially the same arrangement, form, and structure, and on these three pairs of arms the larger suckers differ but slightly in size. The character and arrangement of the suckers on the distal portion of these arms is well shown on Plate VI, figs. 3, 3 *a*, which represent a portion of one of the third pair of arms, commencing at the 67th sucker.

The ventral arms are trapezoidal in section at base, and rather stout. Breadth of front surface, near the base, exclusive of membranes, .55 of an inch; transverse diameter, .95 of an inch; front to back, 1.25 inches. The sucker-bearing surface is, therefore, broader than in the other arms. The suckers are, however, distinctly smaller, and the proximal ones are different in form from the corresponding ones on the other arms. They are narrower and deeper, with more oblique and more contracted apertures, more oblique horny rims, which are denticulated on the outer margins only. On the larger ones there are 12 to 15 sharp, incurved denticles. In fact, the proximal suckers on the ventral arms agree better with the middle suckers, beyond the 30th, on the other arms, for there are none having wide-open apertures, surrounded by nearly even horny rims, denticulated all around. The suckers diminish regularly in size, and in the number of denticles, till at the 200th (where the arms are broken off) there are but three denticles.

Young A. Harveyi, No. 24.—Measurements of arms (in inches).

		Near base.	At 5 in.	At 10 in.	At 15 in.	At 20 in.
DORSAL PAIR.						
Breadth of front, excluding membranes		.35	.50	.30		
Breadth of lateral membranes		.20	.30	.20		
Diameter, transversely		.75	.60	.40		
Diameter from front to back		1.05	.90	.70		
SECOND PAIR.						
Total length	26.25					
Breadth of front		.40	.50	.35	.22	.18
Breadth of membranes		.25	.30	.15		
Diameter, transversely		.80	.65	.35	.30	.10
Diameter, front to back		1.20	1.20	.85	.60	.40
THIRD PAIR.						
Breadth of front		.50	.50	.40		
Breadth of membranes		.20	.25	.15		
Diameter, transversely		1.10	.70	.40		
Diameter, front to back		1.08	1.60	1.20		
FOURTH PAIR.						
Breadth of front		.40	.55	.30		
Breadth of membranes		.20	.25	.10		
Diameter, transversely		.98	.90			
Diameter, front to back		1.40	1.12			
TENTACULAR ARMS.						
Total length	67					
Base to expansion of club	58.75					
Diameter of slender portion	.46					
Length of club	8.25					
Length of part occupied by 24 largest suckers	4.25					
Length of part occupied by small distal suckers	2.60					
Greatest breadth of club	.70					
Diameter, front to back	.60					

Sessile arms, from base to particular suckers.

	To 25th.	To 50th.	To 100th.	To 150th.	To 200th.	To 250th.	To 300th.	To tip.
Dorsal pair, base to suckers	7.5	12.25						
Second pair, base to suckers	7.75	12.25	16.75	20.25	22.90	24.50	25.75	26.25
Third pair, base to suckers	7.25	12.25						
Fourth pair, base to suckers	6.25	10	16.50	20.75				

Measurements of suckers of sessile arms (in inches).

	15th.	30th.	50th.	100th.
On first pair of arms, external diameter	.31	.24	.16	....
On first pair of arms, aperture diameter	.25	.15	.10	....
On second pair of arms, external diameter	.31	.27	.20	.15
On second pair of arms, aperture diameter	.25	.18	.11	.08
On third pair of arms, external diameter	.31	.28	.22	....
On third pair of arms, aperture diameter	.22	.18	.12	....
On fourth pair of arms, external diameter	.25	.21	.16	.14
On fourth pair of arms, aperture diameter	.15	.11	.10	.07

Tentacular arms.—(Plate VI, fig. 2.)

The tentacular arms are both entire, with all the suckers well preserved. The total length is 65 and 67 inches respectively; length of the expanded portion or club, 8.25 inches; diameter of the peduncular portion varies from .40 to .70 of an inch; at the base, .90 inch; breadth of the proximal part of the club, where it is broadest, .70 inch; diameter, from front to back, 60 inch; external diameter of the largest suckers, .35 inch; height of their cups, .28 inch; of lateral suckers, .18 inch; of the largest marginal suckers on the distal portion, .14 inch.

The peduncular portion is somewhat thickened and rounded at the base, but through most of its length it is slender, varying in size, and nearly triangular in section, with the corners rounded, each side measuring, where largest, .60 of an inch in breadth. At about a foot from the base the small smooth-rimmed suckers and their opposing tubercles begin to appear on the inner surface. At first these are placed singly and at considerable intervals (2.5 to 3.5 inches), each sucker alternating with a tubercle on each arm; farther out they are nearer together, and toward the club they alternate, two by two, on each arm; near the commencement of the club they become more numerous, and are arranged somewhat in two rows; just at the commencement of the club they become more crowded, forming three and then four oblique transverse rows of suckers, with the same number of tubercles alongside of them; on the basal expansion of the club, which is its thickest portion, these suckers and tubercles become very numerous, covering nearly the whole inner surface, forming rather crowded and irregular oblique rows of six or more. These smooth-rimmed suckers are followed by an irregular group of about twenty, somewhat larger, denticulated suckers, occupying the entire breadth for a very short distance. Then follow the two median rows of large suckers, alternating with a row of marginal ones, of about half their size, on each side. The first three or four large suckers of each row gradually increase in size; then follow six to eight nearly equal ones of the largest size; these are followed by two to four distal ones, decreasing in size. In one of the rows there are fourteen that distinctly belong to the large series; in the other row there are twelve. The distal section of the club is occupied by four regular rows of small denticulated suckers, more strongly toothed on the outer margins, and similar in form to the marginal suckers of the middle region. Of these the two rows next the lower margin are decidedly larger than those of the two upper rows. Close to the tip there is a group of about a dozen minute suckers, with smooth even rims. The middle portion of the club is bordered on each side by a rather broad, thin, scalloped membrane. The distal section has a broad keel on the outer margin.

Suckers of tentacular arms (in inches).

Diameter of largest suckers	.35
Hight of largest	.28
Diameter of lateral	.18
Hight of lateral	.09
Diameter of smooth-rimmed ones	.10
Diameter of tubercles	.08
Of largest lateral suckers of distal section	.14
Of median lateral ones of distal section	.11

Buccal membranes and jaws.—(Plate VI, fig. 1.)

This specimen fortunately had the buccal membranes and other parts about the mouth perfectly preserved, which has not been the case in the larger specimens. The outer buccal membrane is broad and thin, rather deeply colored externally. Its margin extends into seven acute angles, one of which is opposite each of the lateral and ventral arms; but on the dorsal side there is only one, which corresponds to the interval between the two dorsal arms. From each of these angles a membrane runs to, and for a short distance along the side of, the opposite arm, except from the dorsal one, which sends off a membrane which divides, one part going to the inner lateral surface of each dorsal arm. The membranes from the upper lateral and ventral angles join the upper lateral sides of their corresponding arms; those from the lower lateral angles go to the lower lateral sides of the third pair of arms. The inner surface of the buccal membrane is whitish, and deeply and irregularly reticulated by conspicuous soft wrinkles and furrows, which become somewhat concentric toward the margin. Beneath this membrane are openings to the aquiferous cavities. The inner buccal membrane, immediately surrounding the beak, is whitish, thickened at the margin, and strongly irregularly wrinkled and puckered.

The jaws have sharp, dark brown tips, changing to clear brown backward, with the laminæ very thin, transparent, and whitish. The upper mandible has the rostrum regularly curved, with a distinct ridge, in continuation with its cutting edges, extending down the sides, and only a slight notch at its base.

The lower mandible has a notch close to the tip, with the rest of the inner edge nearly straight; at the base is a rather large and wide, V-shaped notch, the tooth beyond it being broad-triangular and rather large; beyond the tooth the alæ are white, soft, and cartilaginous.

Measurements of jaws (in inches).

Transverse diameter of buccal mass	1.50
Vertical diameter of buccal mass	1.70
Upper mandible:	
Tip to end of frontal lamina	1.25
Tip to notch	.57
Tip to lateral border of lamina	.77
Lower mandible:	
Tip to border of mentum	.45
Tip to lateral border of alæ	.70
Tip to inner end of alæ	1.02
Tip to bottom of notch	.32
Hight of tooth	.06
Notch to inner end of alæ	.80
Mentum to inner end of alæ	1.20

The portion of the œsophagus preserved is 14.75 inches long and about .15 of an inch broad, in its flattened condition.

The radula (Plate V, figs. 5–7) is amber-colored, .18 of an inch broad. The tridentate median teeth have moderately long but not very acute points, of which the middle one is a little the longest. The inner lateral teeth are bidentate, and somewhat broader and longer than the median ones; their outer denticle is well developed, but considerably shorter than the inner one. The next to the outer lateral teeth are larger at base and much longer, simple, broad, tapering, flattened, slightly curved, acute at tip. They appear not to have the small lateral denticle observed on the corresponding teeth of the adult *Architeuthis* (see Plate V, figs. 1, 2). The outer lateral teeth are similar to the preceding, but rather longer and not quite so broad at base. The marginal plates are well-developed, thin, somewhat rhomboidal.

The internal cavity of the ears is somewhat irregularly three-lobed, with several rounded papillæ projecting inward from its sides, very much as in those of *Ommastrephes*. Each ear contained two irregular-shaped otoliths, one of which (Plate V, fig. 8) was much larger than the other, in each ear.

The eyes were both burst, and most of their internal structure was destroyed. So far as preserved they closely agree with those of *Ommastrephes*. The eyeballs were large and somewhat oblong in form, and appear to have been nearly 2 inches broad and 3 long. The eyelids are badly mutilated, but the anterior sinus can be imperfectly made out. It seems to have been broad and rounded. The aquiferous cavities appear to have been like those of *Ommastrephes*. The form and structure of the cartilaginous 'brain-box' also appear to be essentially the same as in the genus last named.

Architeuthis princeps Verrill.—(King of Giant Squids.)

Architeuthis princeps Verrill, Amer. Jour. Science, vol. ix, pp. 124, 181, pl. 5, 1875. American Naturalist, vol. ix, pp. 22, 79, figs. 25–27, 1877. Trans. Conn. Acad., vol. v, p. 210, pl. 17–20, 1879–'80. Amer. Jour. Science, vol. xix, p. 288, pl. 12, April, 1880.

Ommastrephes (*Architeuthis*) *princeps* Tyron, Manual of Conchology, p. 185, pl. 85, 1879. (Figures copied and description compiled from papers by A. E. V.)

Plates VII–XI.

This species is distinguished by the length and inequality of the short arms, of which the longest (ventral or subventral) exceed the combined length of the head and body by about one-sixth; by the denticulation of the suckers of the short arms, of which there are two principal forms, some having very oblique horny rings, with the outer edge very strongly toothed and the inner edge slightly or imperfectly denticulated; the others having less oblique rings, with the denticles similar in form all round, though smaller on the inner margin; by the stronger jaws, which have a deeper notch and a more elevated tooth on the anterior edge; and by the caudal fin, which is short-sagittate in form, with the posterior end less acuminate than in the preceding species.*

This species was originally based on the lower jaw mentioned as No. 1, and on the upper and lower jaws designated as No. 10, in the first part of this article. The jaws of No. 10 were obtained from the stomach of a sperm-whale taken in the North Atlantic, and were presented to the Essex Institute by Capt. N. E. Atwood, of Provincetown, Mass., but the date and precise locality of the capture are unknown. The size and form of these jaws are well shown in Plate XI, figs. 1, 2. The total length of the upper jaw (fig. 1) is 127^{mm} (5 inches); greatest transverse breadth, 37^{mm} (1.45 inches); front to back, 89^{mm} (3.5 inches); width of palatine lamina, 58.9^{mm} (2.32 inches). The frontal portion is considerably broken, but the dorsal portion remaining appears to extend nearly, but not quite, to the actual posterior end, the length from the point of the beak to the posterior edge being 86.4^{mm} (3.4 inches). The texture is firmer and the laminæ are relatively thicker than in *A. Harveyi*. The rostrum and most of the frontal regions are black and polished, gradually becoming orange-brown and translucent toward the posterior border, and marked with faint striæ radiating from the tip of the beak, and by faint ridges or lines of growth parallel with the posterior margin; a slight but sharp ridge extends backward from the notch at the base of the cutting edge, and other less marked ones from the anterior border of the alæ. The tip of the beak is quite strongly curved forward and acute, with a slight shallow groove, commencing just below the tip, on each side, and extending backward only a short distance and gradually fading out. The front or cutting edge is nearly smooth and well curved, the curvature being greatest toward the tip; at its base there is a broad, angular notch, deepest externally. The inner face of the rostrum is con-

* The possibility that this and *A. Harveyi* may be only the sexual forms of one species is fully recognized by the author.

vex in the middle and concave or excavated toward the margins, which are, therefore, rather sharp. The anterior borders of the alæ are convex, or rise into a broad but low lobe or tooth beyond the notch, but beyond this they are nearly straight, but with slight, irregular lobes, which do not correspond on the two sides. The anterior edges of the alæ make nearly a right angle with the cutting edges of the rostrum. The palatine lamina is broad, thin, and dark brown, becoming reddish brown and translucent posteriorly, with a thin whitish border. The surface is marked with unequal divergent striæ and ridges, some of which, especially near the dorsal part, are quite prominent and irregular; the posterior border has a broad emargination in the middle, but the two sides do not exactly correspond.

The lower jaw (Plate XI, fig. 2) was badly broken, and many of the pieces, especially of the alæ, are lost, but all that remain have been fitted together. The extreme length is 92^{mm} (3.63 inches); the total breadth and the distance from front to back cannot be ascertained, owing to the absence of the more prominent parts of the alæ; from tip of beak to posterior ventral border of mentum, 42.6^{mm} (1.68 inches); from tip of beak to posterior lateral border of alæ, 55.9^{mm} (2.20 inches); from tip of beak to posterior ventral border of gular lamina, 60^{mm} (2.37 inches); from tip of beak to bottom of notch at its base, 20^{mm} (.80 inch); tip of beak to inner angle of gular lamina, 47^{mm} (1.85 inches); height of tooth from bottom of notch, 6.25^{mm} (.25 inch); breadth between teeth of opposite sides, 15^{mm} (.60 inch); breadth of gular lamina, in middle, 44.5^{mm} (1.75 inches). The beak is black, with faint radiating striæ, and with slight undulations parallel with the posterior border; the rostrum is acute, slightly incurved, with a notch near the tip, from which a very evident groove runs back for a short distance, while a well-marked angular ridge starts from just below the notch and descends in a curve to the ala, opposite the large tooth, defining a roughened or slightly corrugated and decidedly excavated area between it and the cutting edges; the cutting edge below this ridge is nearly straight, or slightly convex; the notch at its base is rounded and deep and strongly excavated at bottom; the tooth is broad, stout, obtusely rounded at summit, sloping abruptly on the side of the notch, and gradually to the alar edge. The anterior edge of the ala, beyond the tooth, is rounded and strongly striated obliquely; it makes, with the cutting edge, an angle of about 110°. The inner surfaces of the two sides of the internal plate of the rostrum form an angle of about 45°.

The lower jaw of No. 1 (Plate XI, figs. 3, 3 *a*) is represented only by its anterior part, the alæ and gular laminæ having been cut away by the person who removed it.* It agrees very well in form and color with the corresponding parts of the one just described, but is somewhat smaller. The lateral ridges of the rostrum are rather more prominent, and the

* The specimen was given to the Smithsonian Institution by Mr. G. P. Whitman, of Rockport, Mass., in 1872. (No. 2524.)

area within it is narrower and more deeply excavated, especially at the base of the notch, where the excavation goes considerably lower than the inner margin. The notch is narrower and not so much rounded at its bottom. The tooth is about the same in size as that of No. 10, and appears to be even more prominent, because the anterior edge of the ala is more concave at its outer base; it is also more compressed and less regularly rounded at summit. This jaw measures 32.5^{mm} (1.30 inches) from the tip to the posterior ventral border of mentum; 17^{mm} from the tip to the bottom of the notch; 4^{mm} from bottom of notch to the tip of the tooth.

Both these lower jaws agree in having a very prominent tooth on the alar edge, with a large and deeply excavated notch between it and the cutting edge of the beak, and in this respect differ from the lower jaw of *A. Harveyi*, for in the latter the tooth or lobe is broad and less prominent, while the notch is narrower and shallower. This seems to be the best character for distinguishing the jaws of the two species. But they also differ in the angle between the alar edge and the cutting edge of the rostrum, especially of the lower jaw, for while in *A. Harveyi* this is hardly more than a right angle, in *A. princeps* it is about 110°. Moreover, the darker color and firmer texture of the jaws of the latter seem to be characteristic.

To this species I have referred the Catalina specimen (No. 14, p. 13), preserved in the New York Aquarium. The jaws of the latter, which were examined and carefully measured by me, agree very closely, both in form and size, with those of No. 10, the type of the species, but are a trifle larger. The total length of the upper mandible is 133^{mm}; greatest breadth, 99^{mm}; from inner angle of anterior edge to the dorsal end of frontal lamina, 95^{mm}; tip of rostrum, or beak, to the dorsal end of frontal lamina, 92^{mm}; tip of rostrum to bottom of notch, 19^{mm}; notch to inner end of anterior edge, 38^{mm}; transverse breadth between anterior edges, 17^{mm}.

The total length of the lower mandible is 95^{mm}; breadth from gular lamina to inner end of alæ, 99^{mm}; front edge of jaw to posterior end of gular lamina, 83^{mm}; breadth of alæ, 41^{mm}; posterior edge of alæ to end of gular lamina, 44.5^{mm}; tip of beak to bottom of notch, 22^{mm}; notch to inner angle of alæ, 70^{mm}; depth of notch, 3.5^{mm}.

The general form of this species is very well shown on Plate VIII. This figure has been made from the sketches and measurements made by me soon after the specimen was received in New York and before it had been "mounted" (see p. 13). The head was, however, so badly injured that it could not be accurately figured, and this part is, therefore, to be regarded as a restoration, as nearly correct as could be made under the circumstances. It may require considerable corrections, both as to size and form. The caudal fin is remarkable for its small size, as in *A. Harveyi*. Its breadth is scarcely more than that of the greatest diameter of the body. It is short-sagittate in form, with strongly divergent side lobes, which extend forward beyond their lateral insertions, and end in a rounded or blunt angle. The posterior end is somewhat prolonged and acute, but less so than in that of *A. Harveyi*, which it otherwise resembles. One of the figures (Plate X, fig. 2), was made by me several weeks after it had been placed in strong alcohol, and had shrunk considerably; the other (fig. 1) was made by Dr. J. B. Holder after it had been in alcohol only a few days.

When fresh, the caudal fin was 84^{cm} in breadth, but when sketched by Dr. J. B. Holder its breadth was 71^{cm}; its length, from posterior tip to lateral insertions, 48.3^{cm}; from tip to end of lateral lobes, 61^{cm}.

The length of the body and head together, when fresh, was about 289^{cm} (9.5 feet), but when measured by me it was about 218^{cm}.

The sessile arms were unequal in size and length, the longer ones considerably longer than the head and body together. Mr. Harvey found that the longest arms, said to be the ventral ones, were 335^{cm} (11 feet) long and 43.2^{cm} (17 inches) in circumference at base. When first examined by me the ventral arms measured 10.5 feet, and were longer than any of the others, but all the rest were more or less mutilated at the tips, and several had thus lost a considerable portion of their length, so that it is quite probable that originally the subventral arms (or third pair) were actually longer than the ventral ones. The circumference of the third pair of arms, when measured by me, was considerably greater than that of the ventral ones, the former being 11.25 inches, the latter 10 inches. Hence, I have inferred that the greatest circumference (17 inches), measured by Mr. Harvey, applies to the third pair of arms.

The ventral arms have both outer angles bordered by a strong, thick marginal membrane about an inch wide. The arms are all more or less trapezoidal in form, and taper to very slender tips. When examined by me they had already lost nearly all their suckers. A few remained near the base of one of the arms of the third pair. These were 25^{mm} (1 inch) in diameter, with the aperture 15.5^{mm} (.62 inch) across; the denticles on the outer border of the marginal ring were broad-triangular, acute, and strongly incurved, much larger than those on the inner margin.

Of the detached suckers, I have been able to study with care 18 specimens from the sessile arms. Part of these are represented only by the horny marginal rings. The three largest differ from the rest in having the denticles less incurved and more nearly alike all around the margin, those on the inner edge being only somewhat smaller and more slender than those on the outer margin, while the rings themselves are less oblique and eccentric. These probably came from the basal half of the lateral arms. The other suckers all belong to one type, like those seen upon the third pair of arms, described above. They differ, however, very much in size, in the number of denticles, and in the presence or absence of more or less perfect denticles on the inner margin, this, in the smaller ones, often being without any distinct denticles whatever; the horny rings are very oblique and the aperture eccentric. Suckers of this kind probably originally occupied the entire length of the ventral arms and the distal half of the other arms. The diameters vary from 8mm to 24mm externally; the apertures from 3.5mm to 20mm.

One of the most perfect of these suckers (*b*) is preserved in alcohol, with the soft parts (Plate IX, figs. 5, 6), and was sent to me from Newfoundland by Mr. Harvey. This has the greatest external diameter 22mm; diameter of aperture, 10mm; height of cup (outside), 16mm; height at center, 15mm; height near inner margin, at attachment of pedicel, 6mm; length of pedicel, 14mm; diameter of pedicel, 1.5mm. In a side-view the sucker is oblique and gibbous; the lower surface is convex centrally, but has a deep notch or pit near the front margin, in the bottom of which the slender but strong pedicel is attached, and the horny ring has a corresponding notch; the outer or back portion is much swollen and produced downward and backward, and here the horny ring is correspondingly high. The aperture is nearly circular, but is rather shorter from front to back than transversely. In this and some of the other suckers of similar size the entire circumference of the margin is furnished with rather large, sharp denticles, which are strongly inclined inward and considerably larger on the outer than on the inner margin. There are about thirteen of the large teeth, occupying rather more than half the circumference; these are broad at base, beveled off to an acute edge on the sides, and somewhat acuminate, with sharp tips. Those on the middle of the outer border point inward to the center of the sucker, but those along the sides point rather obliquely to the front margin. The front margin is occupied by about seventeen smaller, unequal, acute denticles, those in its center the smallest and most regular; these are acute-triangular and their points are directed more upward than those of the opposite edge. The horny rings are light yellow (when dried they are white and osseous), their denticles yellowish white, and often silvery white and lustrous at tip and along their edges, especially when dried. The large suckers of this form I refer to the basal half of the lateral and dorsal arms. The suckers smaller than the above have fewer of the larger outer teeth, and usually fewer and less perfectly formed teeth along the front margin. Those that have the aperture 7mm or less in diameter usually have the front margin of the ring only irregularly fissured, with the intervals minutely denticulate or crenulate, while the outer half of the margin may bear nine or ten large and well-developed denticles, with broad, stout bases and sharp edges and tips; the edges of these teeth along the middle are usually convex, and then the outline is incurved to the acute point. One of the smaller suckers examined has the aperture about 4.5mm in diameter, with the same form as the larger ones; this has about six large, sharp denticles, like those above described, on the outer half of the margin of the rings, while the front margin is nearly entire and smooth. The smallest one (*j*) is similar, with but four distinct large denticles, with another imperfect, lobe-like one on one side, and with a smooth front margin. These probably came from the distal half of the various arms.

The three largest suckers (Plate IX, fig. 9), supposed to be from near the base of the lateral arms, have about 45 marginal denticles, of nearly uniform size, and less incurved than in those above described. In these the back side of the horny ring is less expanded, and therefore the suckers were less oblique than in the smaller ones. The largest of these (*a*) had the aperture 20^{mm} in diameter.

Measurements of suckers of short arms (in millimeters).

	a.	*b.*	*c.*	*d.*	*e.*	*f.*	*g.*	*h.*	*i.*	*j.*
Transverse diameter, outside	24	21	20	20	17	16	16	10	9.5	8
Diameter of aperture, inside	20	10.5	9	9	8.5	8	7	5	4.5	3.5
Hight of horny ring, back side	10	......	11	12	11	11	11	......	7	5
Hight of horny ring, front side	5	......	3.5	3	3	2.5	3	......	2	1.5
Number of large denticles	23	13	12	12	9	12	10	7	6	4
Number of small denticles	22	17	10	17	12	15	......	......	......	......

The long tentacular arms agree very closely with those of *A. Harveyi* (No. 5) in form and in the arrangement of the suckers on the 'club.' When fresh they measured 914.4^{cm} (30 feet) in length, with a circumference of about 12.7^{cm} (5 inches), except at the enlarged club, which was 20.32^{cm} (8 inches) in the middle. But when first examined by me they had shrunk to 731.5^{cm} (24 feet) in length, and the circumference of the slender portion was 9^{cm} to 10^{cm}; that of the club was 15.24^{cm} (6 inches). At that time the club was 77.47^{cm} (30.5 inches) long; that portion bearing the larger suckers was 48.26^{cm} (19 inches); the wrist or portion bearing the smaller and partly smooth-rimmed suckers and tubercles was 15.24^{cm} (6 inches) long; the terminal portion, bearing small denticulated suckers, was 22.86^{cm} (9 inches); the breadth of the front of the club was 7.62^{cm} (3 inches). The terminal portion had a strong carina-like membrane or crest along the back, and was here 5^{cm} (2 inches) wide from front to back.

The large suckers (Plate IX, figs. 1, 1 *a*) of the tentacular arms are nearly circular in outline, and are broad, depressed, little oblique, constricted just below the upper margin, and then swelled out below the constriction to the base. The calcareous ring is strong, white, and so ossified as to be somewhat rigid and bone-like. The margin is surrounded by numerous (about 45 to 50) nearly equal, acute-triangular teeth, sometimes separated by spaces equal to their breadth, at other times nearly in contact at their bases; their edges are so beveled as to be sharp, while there is a triangular thickening in the middle of each at base. A wide, deep, and concave groove extends entirely around the rim a short distance below the margin; below this the lower part of the rim is somewhat expanded and irregularly plicated, varying in width. The largest ring examined by me measures 31^{mm} in its greatest diameter externally; the aperture is 26^{mm} and 23^{mm} across its longer and shorter diameters;* greatest hight or breadth of rim, 11^{mm}; least hight, 8^{mm}; breadth of groove, 1.5^{mm} to 2^{mm}.

*This specimen is somewhat warped by drying, so that the aperture is not so circular as when fresh.

The marginal suckers (Plate IX, fig. 10), alternating with the large ones on the club, are very oblique, with the rings strong and very one-sided, the height of the back being more than twice that of the front margin. The aperture is not circular, the outer portion of the margin being incurved or straight. The groove below the margin is narrow and deep, especially on the sides, but only extends around the front and sides, being entirely absent on the outer third of the circumference. The denticles are about 22 to 24, slender, acute, not crowded, the most of them being separated by spaces greater than their breadth at base. The outer ones are strongly incurved; those along the sides are curved forward obliquely toward the front margin, while those on the front margin point upward and sometimes rather outward. The denticles are of nearly equal length, but those of the front margin are both more slender and more acute; they all have sharp, beveled edges and a thickened median ridge or tubercle. The largest ring examined was 14^{mm} in diameter; height or breadth of back side of rim, 8^{mm}; of front side, 3.5^{mm}.

The small suckers, covering the last division of the club, are very similar to the marginal ones last described, except that they are much smaller and more delicate, with a narrower and less oblique rim. The denticles of the inner margin are very acute, and point obliquely outward and upward. Greatest diameter of the one described, 6^{mm}; hight of back side of rim, 4^{mm}; of front side, 1.5^{mm}.

The small terminal group of smooth rimmed suckers, seen in No. 5, were not noticed, but they were not looked for specially.

To this species I have also referred the specimen (No. 13) from Grand Bank, Fortune Bay (see p. 12, where the general measurements are given). Fortunately, Mr. Simms was able to obtain the jaws in pretty good condition, and also one of the largest suckers of the tentacular arms. These specimens were forwarded to me by the Rev. M. Harvey. They had been dried, and the jaws, which were still attached together by the ligaments, had cracked somewhat, but all parts were present except the posterior end of the palatine lamina, which had been cut or broken off. Although these jaws had undoubtedly shrunken considerably, even when first received, they were afterwards put into alcohol and have since continued to shrink, far more than would have been anticipated, so that, at present, the decrease in some of the dimensions amounts to 20 per cent., while even the harder portions have decreased from 5 to 10 per cent. from the measurements taken when first received by me.* When first received, in 1875, the upper mandible measured

* There is no reason to suppose that the shrinkage has been any more in this case than in the others, but I have not had an opportunity for making comparative measurements from the same specimens when recently preserved, and again after long preservation in alcohol, except in one other instance (No. 5), in which a similar shrinkage was evident. (See table of measurements, p 22.)

111^{mm} in total hight or breadth; 88^{mm} from tip of beak to anterior end of palatine lamina; 20^{mm} from tip of beak to the bottom of the notch. The lower mandible measured 96^{mm} in total length; 80^{mm} from tip of beak to inner end of alæ; 19^{mm} from tip to bottom of notch.

At the present time (January, 1880), the breadth of the upper mandible is about 90^{mm}; from tip of beak to anterior end of palatine lamina (at junction with anterior edge of alæ), 89^{mm}; tip of beak to bottom of notch, 19^{mm}; breadth of palatine lamina, 58^{mm}; beak to posterior end of frontal lamina, 90^{mm}; beak to posterior lateral edge of alæ, 43^{mm}; notch to end of anterior edge of alæ, 33^{mm}; notch to end of hardened or black portion of same (proper cutting edge), 17^{mm}; transverse breadth at notches, 16^{mm}. The lower mandible measures, in length, 82^{mm}; beak to inner end of alæ, 67^{mm}; to bottom of notch, 18^{mm}; breadth, alæ to mentum, 78^{mm}; end of alæ to outer side of gular lamina, 84^{mm}; inner side of gular to mentum, 50^{mm}; breadth of gular, 44^{mm}; breadth of alæ, anterior to posterior edge, laterally, 29^{mm}; tip of beak to posterior ventral end of mentum, 33^{mm}; tip to posterior lateral border of alæ, in line with cutting edge of rostrum, 45^{mm}; posterior lateral border of alæ to end of gular, 40^{mm}; depth of notch, 3^{mm}; breadth of tooth, 8^{mm}; notch to end of cutting or hardened edge of alæ, 20^{mm}; to inner end of alæ, 55^{mm}; breadth transversely, across teeth, 16^{mm}. (See also the following table of measurements of jaws).

The beak of the upper mandible is sharp, strongly and regularly curved, most so near the tip; a radial ridge runs from the notch to the lateral borders of the alæ; the anterior or cutting edges of the alæ are somewhat convex and irregularly crenulate. The lower mandible has a sharp beak, with a slight notch close to the tip; the cutting edges of the rostrum are otherwise nearly straight; the notches at the base are deep and narrow V-shaped. The teeth are rather prominent, obtuse, slightly bilobed at the summit; the one on the right side of the mandible is more prominent than the other, owing to the fact that the edge of the ala, beyond it, is more concave in outline. There is also a broad and slightly prominent lobe in the middle of the anterior edges of the alæ. The sides of the rostrum are strongly excavated toward the base and around the notches, and radially striated. The jaws are dark brown, becoming blackish toward the tips.

*Comparative measurements of jaws (in inches).**

	A. Harveyi.			A. princeps.				
	No. 4.	No. 5, when received.	No. 5, later.	No. 1.	No. 10.	No. 13, fresh.	No. 13, preserved.	No. 14.
UPPER MANDIBLE.								
Length, beak to end of palatine	3.55		3.85		5		3.75 +	5.25
Greatest breadth, palatine to frontal	2.49 +	2.84	2.60		3.50 +	4.50	3.54 +	3.88
Greatest transverse diameter			1		1.45		1.15	
Inner end of alæ to dorsal end of frontal			2.50		3 +		2.95 +	3.75
Tip of beak to same	2.37 +		2.55		3.40 +		3.17	3.62
Tip to anterior end of palatine lamina		2.06				3.57		
Tip to bottom of notch	.63	.69	.61		.75	.81	.75	.75
Notch to end of anterior edge of alæ			1.10		1.15		1.30	1.50
Transverse breadth at notch	.60						.63	
Transverse breadth between edges of alæ							1	.69
Breadth of palatine lamina			1.70		2.32		2.30	
End of palatine to edge of frontal lamina			2.20		3.15			3.50
Beak to posterior edge of alæ, laterally			1.40		1.95 +		1.70	
LOWER MANDIBLE.								
Total length, beak to end of gular		3.44	3		3.63	3.89	3.24	3.75
Mentum to inner end of alæ	2.60 +		2.55				3.08	
Total breadth, gular lamina to end of alæ			2.65				3.32	3.88
Breadth of gular lamina			1.50		1.75		1.74	
Anterior edge of alæ to end of gular lamina			2.45		3.15		2.68	3.25
Tip of beak to end of mentum, medially			.85	1.30 +	1.68		1.31	
Tip to end of gular lamina, medially			1.85		2.37		2.40	
Breadth of alæ, laterally	1.18		.93 +		1.50		1.15	1.62
End of gular lamina to alæ, laterally			1.50		1.60		1.58	1.75
Tip of beak to bottom of notch	.62	.69	.60	.67	.80	.77	.71	.87
Tip to posterior edge of alæ, laterally	1.67		1.50 +		2.20		1.78	
Tip to inner end of alæ	2.33	2.63	2.10 +			3.45	2.67	
Tip to inner angle of gular lamina	1.20		1.18		1.85		1.28	
Notch to inner angle of alæ	1.92		1.77				2.17	2.75
Depth of notch	.12		.12	.15	.15		.12	.13
Breadth of tooth in front of notch	.30			.35	.32		.32	.38
Spread of jaws between teeth					.60		.64	

* Nos. 1 and 10 had been dried for many years. All the others had been preserved in alcohol—Nos. 4 and 13 for several years; No. 5 about one year; No. 14 for only a few days. The amount of shrinkage is considerable in those preserved long in alcohol or dried.

Comparative measurements of Architeuthis Harveyi and A. princeps (in inches).

	No. 5. A. Harveyi.		No. 2. A. Harveyi.		No. 14. A. princeps.	
	Fresh.	Preserved.	Fresh.	Preserved.	Fresh.	Preserved.
Total length, to tips of short arms	166?				246	212
Total length, to tips of tentacular arms	382?				480	372
From base of arms to tip of tail	92?				114	86
From base of arms to origin of fins	75?				95	67
Head, from base of arms to mantle (above)	10?				14?	12
Body, edge of mantle to tip of tail (above)	82				100?	74
Tip of tail to insertion of fin	18?	17				19
Breadth of caudal fin	22	16			33	28
From end of body to outer angle of fin	27?	23				24.5
Front edge of fin, outer angle to side of body	2	6.5				10
Circumference of body	66				84	66
Circumference of head					48	
Length of tentacular arms	88	161	348?		360	289
Length of sucker-bearing portion	30	30	30	27	36	30.5
Length of dorsal arms (first pair)	72?					81 +
Length of lateral arms (second pair)	72?					100 +
Length of lateral arms (third pair)	72?					76 +
Length of ventral arms (fourth pair)	72				132	126
Circumference of first pair of arms, at base	7					9
Circumference of second pair of arms, at base	8					9.50
Circumference of second pair, 3 feet from base						7.50

Comparative measurements, &c.—Continued.

	No. 5. A. Harveyi.		No. 2. A. Harveyi.		No. 14. A. princeps.	
	Fresh.	Preserved.	Fresh.	Preserved.	Fresh.	Preserved.
Circumference of third pair, at base	10	8			17	11.25
Circumference of third pair, 3 feet from base						9
Circumference of fourth pair, at base	9	7.5				10
Circumference of fourth pair, 4 feet from base						8.5
Circumference of tentacular arms	3.75	2.75	4	3½–4¼	5	4
Circumference of terminal club of same		4.5	6	6	8	6
Diameter of largest sucker of tentacular arms		1.15	1.28	1.25	1.25	1
Diameter of largest sucker of sessile arms	1	.84			1	1
Aperture of latter		.68			.80	.80
DETAILS OF TENTACULAR ARMS.						
Length of 'club' or expanded portion	31	30	30	27		30.5
Of part of club bearing 24 largest suckers	15	14	18	14		19
Of 'wrist' or part with group of small suckers	7	7				6
Of terminal part, with small suckers	9	9		9		9
Breadth of club in middle		1.5	2.5	2.5		3
Breadth of wrist		1.6	2.6	1.5		3
Breadth of slender middle portion		1.15				1.5
Breadth of tip, from front to back		1.75		1.5		2
Circumference of club		4.5		5.5		6
Circumference of wrist		5		6		6
Circumference of middle portions of arm	2¼–3½	2¼–3¼		3½–4¼		3½–4
Distance between pedicels of large suckers		1.15	1.68	1.44		
Distance between pedicels diagonally		1	1.32	1.31		
DETAILS OF SUCKERS OF CLUB.						
Largest suckers, diameter in middle	1.25	1.15	1.28	1.24	1.25	
Largest suckers, diameter of horny ring		.92			1.15	1.15
Diameter of facets around suckers		1		1.40		1.25
Largest suckers, hight from attachment		1				.75
Largest suckers, length of pedicels		.40				.50
Largest suckers, hight of ring		.32				.42
Secondary suckers, next to wrist, diameter		.24				.44
Marginal suckers, diameter of rings		.40		.48		.60
Marginal suckers, hight of rings, outer side		.28				.35
Sessile suckers of wrist, diameter		.12		.28		
Suckers of terminal section, diameter		¼–1/16				

The dried sucker from the tentacular arm appears to have been one of the largest (Plate IX, fig. 11). At the present time the transverse diameter of the ring, outside, is 28^{mm}; diameters of the edge, 24^{mm} and 22^{mm}; greatest hight of the ring, including denticles, 9.5^{mm}; least hight on inner side, 6.5^{mm}. There are forty-eight marginal denticles, which are nearly the same in size and form all around. They are narrow, triangular, acute, with the edges beveled, sharp, and with a central, thickened, triangular ridge on the outside. The ring is white, hard, smooth, and osseous in appearance.

Of the other specimens enumerated in the first part of this paper, it is probable, judging from the proportions given, that Nos. 16, 18, and 19 also belonged to *A. princeps*. Nos. 18 and 19 appear to have been much larger than any of the examples of which portions have been preserved, and it was very unfortunate that the persons who secured them did not know their value, for they were both found within a few miles of the settlement at Little Bay Copper Mine, on the south arm of Notre Dame Bay, and could easily have been taken to Saint John's.

Observations on the specimens described from foreign localities.

A.—ATLANTIC OCEAN SPECIES.

We are largely indebted to Professor Steenstrup and to Dr. Harting for our earliest knowledge of the specimens preserved in European museums, or cast ashore on the European coasts. Professor Steenstrup* has given accounts, compiled from contemporary documents, of a specimen taken at Malmö, Sweden, about 1546 or 1549, and of two specimens of huge Cephalopods cast ashore at Iceland, in 1639, and November or December, 1790.

The specimen of 1790, described in the MSS. of Svend Paulsen, 1792, had tentacles 3 fathoms long; the body (with head) was 3½ fathoms long. That of 1639, described in Olafsens og Povelsens Reise til Island, ii, p. 716, was 4 to 5 fathoms long.

In the article published in 1857, he also briefly mentioned a specimen cast ashore at Jutland, December, 1853, of which the jaws were preserved, and on which he then based the species *Architeuthis monachus;* and another specimen, which he named *Architeuthis dux*, taken by Capt. Vilh. Hygom in the Western Atlantic. He has also since described and figured† the jaws of the specimen of *Architeuthis monachus* obtained at Jutland in December, 1853.

In the same memoir, of which I have seen only the first few pages, there are references to a description and figures of "*A. Titan*," obtained in 1855 by Captain Hygom in north latitude 31°, west longitude 76°. The latter specimen appears to be the same as that referred to in 1856 as *A. dux*, and the same that Harting‡ mentioned, under the name "*Architeuthis dux* Steenstrup," as collected at the same time and place, and of which he published an outline figure (see our Plate XII, fig. 4) of the lower jaw, copied from a drawing furnished to him by Steenstrup.

Harting states that the pen or 'gladius' of this specimen is 6 feet long. Many important parts of this specimen were secured, and I regret that I have been unable to see the figures and description of it, referred to by Harting as forming part of Professor Steenstrup's unpublished memoir. But to judge by the outline figure given by Harting, it is a species quite distinct from those described by me. The lower jaw

*Meddelelse om tvende Kiæmpestore Blæksprutter, opdrevne 1639 og 1790 ved Islands Kyst, og om nogle andre nordiske Dyr. Förhandlinger Skandinaviske Naturforskeres, v, pp. 950–957, 1847, Copenhagen, 1849.

Oplysninger om Atlanter colossale Blæksprutter, Förhandlinger, Skand. Naturf., 1856, vii, p. 182, Christiania, 1857.

†In a paper, of which I have seen some proof-sheets, given by him to Dr. Packard, entitled "Spolia Atlantica." This memoir has not been published. The plate (1) that I have seen is marked "Vid. Selsk. Skrifter, V. Række, naturv. og mathem. Afd. iv Bind;" and there are references to three other plates, illustrating "*A. Titan*," &c.

‡Description de quelques fragments de deux Céphalopodes gigantesques. Publiées par l'Académie Royale des Sciences à Amsterdam. 1860. 4to, with three plates. (Verh. K. Akad. Weten., ix, 1861.) The figures have been partly copied in Tryon's Manual of Conchology, i, plates 60 and 86.

resembles that of *A. Harveyi* more than *A. princeps*, and is a little larger than that of our No. 5. The beak is more rounded dorsally, less acute, and scarcely incurved; the notch is narrow, and the alar tooth is not prominent.

M. Paul Gervais, in the Journal de Zoologie, ix, p. 90, 1875, gives a short description of this species, based apparently on the proof-sheets and unpublished plates (not seen by me) of Steenstrup's article referred to above. He describes it as follows: A large species, of which a fragment of an arm preserved in the Museum of Copenhagan is nearly as large as the arm of a man. The sucker-bearing surface of the arm is extended bilaterally into a membrane exceeding, on each side, the arm itself. Diameter of the opening of the suckers 0.020^{m}; of the suckers themselves 0.030^{m}. Length of the dorsal bone (pen) 2^{m}; breadth [longueur, by error], measured in the middle of its length [longueur], 0.17^{m}. He refers to Steenstrup's Plates III and IV.

In a letter to the writer, dated September 4, 1875, Professor Steenstrup states that, in addition to the specimens above mentioned, there are, in the museum of the University of Copenhagen, two complete specimens of *Architeuthis*, preserved in alcohol. Both are of comparatively small size. One, from the northern coast of Iceland,* he refers to *A. monachus*. It has tentacular arms 10 feet long, and sessile arms 4 feet long. The other is a still smaller one, from the warmer parts of the Atlantic, possibly the young of *A. dux*.

It is evident, therefore, that at no distant day most of the remaining doubtful points in respect to the structure and relationship of the species of this genus can be cleared up by Professor Steenstrup, even if additional specimens should not be obtained.

The publication of Professor Steenstrup's detailed memoir upon this genus would give great pleasure and satisfaction to all students of this class of animals. His thorough knowledge of the group, and his numerous and important investigations of the Cephalopods, published during many years, will give special value to his conclusions.

Harting, in the important memoir referred to, describes specimens of two species, both of which are apparently distinct from all the Newfoundland specimens enumerated by me.

The first of these (his Plate I) is represented by the jaws and buccal mass, with the lingual dentition and some detached suckers, preserved in the museum of the University of Utrecht, but from an unknown locality. These parts are well figured and described, and were referred to *Architeuthis dux* by Harting. The form of the lower jaw (see Plate XII, fig. 1) is unlike that of *A. dux*, for the beak is very acute, the cutting edge is concave, the notch shallow and broad, and the alar tooth is somewhat prominent. The size is about the same as our No. 5. The suckers (Plate XII, fig. 2 *a*, 2 *b*) are from the sessile arms, and agree pretty nearly with those of *A. Harveyi*. The edge is strengthened by

*This one is referred to by Dr. Packard, Amer. Naturalist, vol. vii, p. 94, 1873.

an oblique, strongly denticulated ring, which, in all the suckers figured, including both larger and smaller ones from the short arms, has regular, acute, subequal denticles all around the circumference, in this respect agreeing with *A. Harveyi.* The internal diameter of the largest of these suckers is .75 of an inch; the external 1.05 inches. They were furnished with slender pedicels, attached obliquely on one side. The lingual teeth (see Plate XII, fig. 1*c*, copied from Harting) are in seven regular rows, and resemble closely those of *Loligo.* On that account mainly, in a former paper, I proposed to designate it by the name of *Loligo Hartingii.* But since that time I have been able to study the dentition of the species of *Architeuthis* and *Sthenoteuthis*, and now refer Harting's species to *Architeuthis*, without hesitation, although the dentition is poorly figured. Professor Steenstrup, in a letter to me subsequent to the publication of my former papers, also expressed the opinion that Harting's specimen belongs to *A. monachus.* If distinct, however, as is possible, it may be called *Architeuthis Hartingii.*

The other species described by Harting was from the Indian Ocean, and belongs to the genus *Enoploteuthis* (Plate XII, fig. 4, jaws).

In this genus there are large, sharp, curved claws (see Plate XV, figs. 5, *a*, *b*), both on the club of the tentacular arms and on the sessile arms, in place of the suckers of ordinary squids. The teeth of the odontophore, in Harting's species, are remarkably small and simple (see fig. 5, *c*, *d*, after Harting). As this species does not appear to have had a special name, I propose to call it *Enoploteuthis Hartingii.*

D'Orbigny* gave the name *Enoploteuthis Molinæ* to a large species, of which the body was estimated to be about 4 feet long, found floating and mutilated in the South Pacific, south latitude 30° 44′, west longitude 110° 33′, by Banks and Solander, in 1769, on Captain Cook's second voyage. Of this, fragments are preserved in the Museum of the College of Surgeons, London.†

A similar species, perhaps based on the same specimen, was recorded by Molina, from off the coast of Chili, as *Seppia unguiculata.*

Lieutenant Bouyer, of the French steamer "Alecton," encountered a huge Cephalopod, in November, 1860, between Madeira and Teneriffe. Its body was estimated to be between 15 and 18 feet in length. A long and laborious attempt was made to capture it, and a slip-noose was passed around the body, but on attempting to hoist it on board, the rope cut through the soft flesh and the tail alone was secured. A sketch of the animal was made by one of the officers.

The original account of this occurrence, given in the Comptes-Rendus of the French Academy of Science for 1861, is as follows:

M. Flourens read the following report made to the minister of the marine by M. Bouyer, lieutenant commanding the "Alecton."‡

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* Histoire Nat. des Céphalopodes Acétabulifères, p. 339, 1845.

† See also Todd's Cyclopedia of Anatomy and Physiology, i, p. 529.

‡ Comptes-Rendus Acad. of Sciences, vol. liii, p. 1263. For the following translations I am indebted to Mr. Sanderson Smith.

"SAINTE CROIX DE TÉNÉRIFFE,
"'*Alecton*,' *December* 2, 1861.

"Monsieur le MINISTRE: I have the honor to inform your excellency that I anchored at Téneriffe the 1st of December, at eight o'clock in the morning.

"From Cadiz to Téneriffe, that is to say, from the 27th of November to 1st of December, I have encountered the most favorable weather; thus, making use of my sails, setting the safety-valve at 0.30—in a word, economizing fuel as much as possible, I have been sometimes able to reduce the consumption to 6 tons a day, going to 7 or 8 knots, with a moderate breeze from the northeast.

"A singular incident has marked my voyage. On the 30th of November, 40 leagues from Téneriffe, at two o'clock in the afternoon, I encountered a monstrous animal which I recognized for the gigantic cuttle-fish [*poulpe géant*], the contested existence of which seems to have been consigned to the realm of fable.

"Finding myself in the presence of one of these strange beings that the ocean sometimes produces from its depths as if to offer defiance to science, I resolved to study nearer by, and try to gain possession of it.

"Unfortunately, a heavy swell, taking us on the side, caused the 'Alecton' to roll irregularly, and interfered with the evolutions, whilst the animal itself, though almost always at the surface of the water, moved itself with a kind of intelligence, and seemed to wish to avoid the vessel.

"After several encounters, which permitted only of its being struck by several balls, I succeeded in approaching near enough to place a harpoon in it, as well as to get a running noose around it. We were preparing to multiply the fastenings when a violent movement of the animal caused the harpoon to come out; the part of the tail where the cord was fastened broke off, and we brought on board only a fragment, weighing 20 kilograms [about 44 pounds].

"We had seen the monster near enough to make an exact painting of it. It is the giant squid [*encornet*], but the form of the tail seems to make of it an undescribed variety. It seemed to measure 15–18 feet to the head, shaped like a parrot's beak, and enveloped by 8 arms, from 5 to 6 feet long. Its appearance was frightful, its color a brick-red, and this half-formed being [*être ébauché*], this colossal and slimy embryo, has a repulsive and terrible appearance.

"Both officers and men begged me to have a boat lowered and to go and seize again upon the animal and bring it alongside. They would, perhaps, have succeeded, but I feared that in this hand to hand encounter the monster might throw his long arms, furnished with suckers, over the sides of the boat, upset it, and perhaps strangle some sailors with his formidable scourges, charged with electrical effluvia.

"I thought that I ought not to expose the lives of my men to satisfy a sentiment of curiosity, even though this curiosity had science for its basis, and, notwithstanding the fever of excitement which accompanies such a chase, I was obliged to abandon the mutilated animal, which, by a sort of instinct, seemed to carefully avoid the vessel, dived, and passed from one side to another when we again approached it."

The following is a translation of a letter addressed to M. Moquin Tandon by M. Sabin Bertholet, consul of France, which was also read before the Academy. It contains some additional particulars:

"SAINTE-CROIX DE TÉNÉRIFFE, *December 12th*, 1861.

"On the 2d of November last the steam dispatch-boat 'Alecton,' commanded by M. Bouyer, lieutenant commanding, anchored in our harbor on its way to Cayenne. This dispatch-boat had encountered in the sea, between Madeira and Ténériffe, a monstrous cuttle-fish [*Poulpe*], which was swimming at the surface of the water.

"This animal measured from 5 to 6 meters in length, without counting its eight formidable arms, covered with suckers, which crown its head. Its color was brick-red. Its eyes, not rising above the surface of the head, had a prodigious development and frightful fixity. Its mouth, shaped like a parrot's beak, might have measured [*offrir*] about half a meter. Its body, spindle-shaped, but very much swollen towards the center, presented an enormous mass of which the weight has been estimated at more than 2,000 kilograms [4,400 pounds]. Its fins, situated at the posterior extremity, were rounded into two fleshy lobes of very great size. It was on the 30th of November, about half-past twelve, that the crew of the 'Alecton' perceived this terrible Cephalopod swimming alongside. The commander immediately stopped the vessel, and notwithstanding the dimensions of the animal he maneuvered to obtain possession of it. A running noose was arranged in order to catch it, guns were loaded, and harpoons prepared in all haste. But at the first balls which were fired at it the monster dived, passing under the vessel, and speedily reappeared on the other side; again attacked with harpoons, and after having received several shots, it disappeared two or three times, each time showing itself some minutes afterwards at the surface of the water, agitating its long arms. But the vessel followed it continually, or slackened its speed according to the movements of the animal. This chase lasted more than three hours. The commander of the 'Alecton' desired, at any cost, to dispose of this enemy of a new kind; still, he did not dare to risk the lives of his sailors by lowering a boat, which this monster might upset by seizing it with a single one of his formidable arms. The harpoons, which were thrown at it, penetrated into the soft flesh and came out without success; several balls had traversed it uselessly. However, it received one which seemed to wound it grievously, for it immediately vomited a great quantity of foam and blood mixed, with glutinous substances which had a strong odor of musk. It was at this instant that they succeeded in seizing it with the running noose; but the rope slipped along the elastic body of the mollusk, and stopped only near the extremity where the two fins originate. They tried to hoist it on board. Already the greater part of the body was out of water, when the enormous weight of this mass caused the running noose to penetrate the flesh and separated the posterior part from the rest of the animal. Then the monster, released from this noose, fell back into the sea and disappeared. They showed me, on board the 'Alecton,' this posterior part. I send you a sufficiently exact drawing of this colossal poulpe, made on board by one of the officers of the 'Alecton.*

"I ought to add I have myself questioned old fishermen of the Canaries, who have assured me that they have several times seen, in the open sea, great reddish calamaries, 2 meters or more long, which they did not dare to capture."

Messrs. Crosse and Fischer have, from the figure and this narrative of the officers,† proposed to establish for this specimen a species, which they named *Loligo Bouyeri*. The figure is imperfect, but evidently represents a ten-armed cuttle-fish, though only eight arms are shown, and the tail is represented as truncated.‡ In fact, these figures and the description are not sufficient to indicate specific or exact *generic* characters. The eight short arms, shown in the figure, are stout, tapered, and less than half the length of the head and body together. It was most probably a species of *Architeuthis*, to judge from the caudal fin, described as consisting of two lobes of small size. It may be designated provisionally as *Architeuthis Bouyeri*.

In a popular work entitled "Les Monstres Marins," by Armand Landrin, Paris, 1867, there is also a detailed account of this encounter, which, while agreeing in most points with those already quoted, contains some additional particulars. Although it is put in quotation-marks, and is stated to be by M. Bouyer himself, the original place of publication is not given, and I have not been able to ascertain its origin. In this account the eyes are said to have been "flat, glaucous, and as large as saucers [*assiettes*]." "The part of the tail that we had on board weighed 14 kilograms; it was of a soft substance, exhaling a strong odor of musk. The part which corresponds to the backbone [pen] began to attain a sort of relative hardness. It broke easily, with an alabaster-white fracture. The entire animal, according to my estimate, weighed two or three tons [4,000 to 6,000 *livres*]. It blowed [*soufflait*] energetically, but I did not observe that it ejected the blackish substance by means of which the small calamaries of Newfoundland destroy the transparency of the water in order to escape from their enemies. The sailors told me that they had seen to the south of Good Hope poulpes similar to this, although of less size."

The description in this work is accompanied by a cut representing

* This colored drawing was shown to the academy.

† Journal de Conchyliologie, 3d ser., vol. ii, p. 138, 1862. See, also, Tryon's Manua of Conchology, vol. i, p. 87, pl. 59, 1879 (figure copied from "The Universe").

‡ One of the published figures, as explained above, shows ten arms and all the other essential characters of *Architeuthis*.

the creature swimming just beneath the surface of the sea. This is unlike either of the other two illustrations that I have seen, but the origin of this figure is not given. In the popular work "The Ocean World," by Louis Figuier (London edition, 1869, p. 462), there is also an account of this encounter, which is for the most part a translation from the original accounts given above, accompanied by a figure which, as the author states, "is copied from M. Berthelot's colored representation of this scene." This is a very fair representation of a genuine *Architeuthis*, and is of especial interest, if we recollect that when this figure was made there was no figure extant, nor any authentic description of the form and structure of *Architeuthis*. The head is undoubtedly represented too large, but the form and proportion of the, body caudal fin, arms, and tentacles are very much like those of the Newfoundland examples.

Popular accounts of this, as well as of other large Cephalopods of earlier occurrence, are contained in many other general works besides those referred to above.*

In "Les Monstres Marins" (p. 44), referred to above, there is the following account, inclosed in quotation marks, but without any statement of the source from which it was taken:

"An American captain, whom I knew very well, in New York," says B. H. Révoil, "told me that in 1836, when he was in the neighborhood of Lucayes Islands, his ship had been attacked by a cuttle-fish, which, stretching out its gigantic arms, had reached and dragged into the sea two men of his crew. With a blow of his hatchet, the chief steersman cut off one of its arms. This monstrous appendage measured 3½ meters (11½ feet) in length, and its thickness was that of a man. I have seen this curious specimen of natural history in the museum of Mr. Barnum, in New York, where it is preserved, shriveled and folded on itself, in an enormous jar full of alcohol."

Some of our older readers may, perhaps, have seen such a specimen in Barnum's Museum, which, however, has not been regarded in this country as a very reliable source of scientific information on such subjects. Possibly this specimen, as well as the story, may have been an ingenious invention.

According to Jeffreys (British Conchology, vol. v, p. 124), a huge Cephalopod was stranded in 1860 or 1861, between Hillswick and Scalloway, on the west of Shetland. "From a communication received by Professor Allman it appears that the tentacles were 16 feet long, the pedal arms about half that length, and the mantle-sac 7 feet; the mantle was terminated by fins; one of the suckers examined by Professor Allman was ¾ inch in diameter."

Mr. Kent, in the articles† already referred to, mentions a sessile arm

* Among these popular works, of permanent value, containing such accounts should be cited "The World of the Sea," translated and edited by the Rev. H. Martyn Hart, London, Cassell, Petter & Galpin, from "Le Monde de la Mer," by M. Moquin Tandon.

† Proceedings Zoological Society of London for 1874, pp. 178 and 493.

of a giant Cephalopod which has been long preserved in the British Museum, but of which the origin is unknown. He states, in the first article, that it is just 9 feet long and 11 inches in circumference at the base, tapering off to a fine point. There are about 150 suckers in each of the two alternating rows, those at the base being .75 of an inch in diameter.

In his second article he refers this arm doubtfully to *Ommastrephes todarus*, and gives the following description:

"The length of this arm, from one extremity to the other, is just 9 feet; the circumference at the base 11 inches; and from this it gradually decreases, terminating in a fine point. The suckers are arranged in two rows throughout the extent of the arm, numbering, approximately, 150 to each row, or a total of 300 to the whole organ. Forty-three suckers only are stationed on each side in the first or proximal half of the arm; one hundred on each side occupy the whole length, with the exception of 14 inches, this smaller length including the remaining fifty on each side, which are very minute and crowded together. The comparative distances between the suckers throughout the whole length in each row are as follows: Between the first and second sucker, $1\frac{1}{2}$ inches; half way up the arm, 1 inch; at three-quarters of the entire length, $\frac{1}{2}$ inch; and within 6 inches of the distal extremity, $\frac{1}{4}$ inch. The relative diameters of the suckers at similar distances are: At the base, extreme outside measurement, $\frac{3}{4}$ inch; inside measurement of corneous ring, $\frac{1}{2}$ inch; and, those suckers a little past the first few being the largest, half way down, $\frac{1}{2}$ inch outside and $\frac{1}{2}$ inch inside measurement; at three-quarters length, $\frac{1}{4}$ inch; and at 6 inches from the extreme point, $\frac{1}{8}$ inch outside measurement, gradually diminishing from here to the size of a pin's head.

"The shape and structure of the suckers upon this British Museum specimen agree with those of *Ommastrephes todarus*, as given by D'Orbigny, corresponding also with those figured by Harting, referred by him to the same species, and anticipated by the same authority to be also identical with Professor Steenstrup's *Architeuthis dux*. More minutely they may be described as hemispherical in shape, the stalk or peduncle being attached laterally at the base of the hemisphere, the point of insertion of the same in the cup being marked by a conspicuous pit-like depression. The horny ring is obliquely set, and much deeper at the side opposite the insertion of the stalk; the inner margin is serrated; and in most examples the serratures bordering the deeper side are considerably larger than in the other portions of the circumference; in some instances the serratures, except at the particular point mentioned, are altogether aborted, having the inner margin of the ring quite smooth; in other examples, and more especially among the larger suckers, the teeth or serratures are equal or subequal. The average number of the teeth of the largest rings is twenty."

Mr. Kent, unfortunately, does not state to which pair this arm belongs. But from his description of the two forms of suckers, it is probably one of the lateral arms, if it is in this respect like our young *A. Harveyi* (No. 24). It evidently belongs to an *Architeuthis*, and is very near to our *A. princeps*.

In the Zoologist, London, 2d series, No. 118, p. 4526, July, 1875, there is an article entitled "Notice of a gigantic Cephalopod (*Dinoteuthis proboscideus*), which was stranded at Dingle, in Kerry, two hundred years ago. By A. G. More, F. L. S." The article is chiefly a reprint of the rude but interesting popular accounts written at the time of the capture, and upon these Mr. More proposed to found a new genus and species. The character which he mainly relied upon, as of generic value, is the power of projecting the beak in the form of a proboscis. But this is habitually done by the various common species of *Ommastrephes*, *Loligo*, &c., and perhaps by all ten-armed Cephalopods. There is not sufficient evidence, from the published accounts, that this specimen differed in any way from the *Architeuthis monachus*. It was described as 19 feet in total length; the long arms having been mutilated, the part remaining was 11 feet long, and as thick as a man's arm; the short arms varied from 6 to 8 feet in length, and were as thick as a man's leg, and had two rows of large serrated suckers; the proboscis (buccal mass with beak) was the size of a man's fist; the beak was "somewhat like to an Eagle's Bill, but broader." The whole animal was said to have been as large as a large horse. The length of the head and body together was 8 feet.

Mr. More has kindly sent me a tracing from the original figure. This shows a broad, oval, flat body, and a small caudal fin. The body or mantle had evidently been split open and spread out flat.

This fact is also evident from the original descriptions, reprinted by Mr. More, in which the sides of the mantle are described as follows: "Over this Monster's back was a mantle of a bright Red Color, with a fringe round it; it hung down on both sides like a Carpet on a table, falling back on each side, and faced with white." The liver, according to the descriptions, had been removed: "When it was dead and opened the liver wayed 30 pound." The proboscis had also been removed before it was exhibited, and it is therefore very probable that the figure and descriptions represent it as more extended than was natural.

The measurements given indicate a specimen smaller than several of the American examples, and but little if any larger than our No. 5, from Logie Bay.

The more important of these ancient letters are here reproduced:

"*Letter No. 2, from Thomas Hooke (Dublin) to Mr. John Wickins (London) December* 23, 1673.

"LOVING FRIEND: I send you this onely pursuant to my former of the Fish, which I now confirm to be as I gave you the first Account with this addition of certainty, that knowing the man by name James Steward, and hearing two or three nights since of his being at a Printers neer our house to get the Lord Lieutenants Order Printed, which he gave him for exposing what he hath of the fish to view, I sent, desiring to speak with him, and he came, having then the Picture with him of the Fish, and he gave me himself the full account of it, viz.

"That in the month of October last, I think about the 15th day he was alone riding by the sea-side, at Dingle-I-cosh and saw a great thing in the Sea, which drew his eye towards it, and it came just to him; when he discerned the horns it began to look frightfully, he said he was sometimes afraid to look on it, and when he durst look on it, it was the most splendid sight that ever he saw; The Horns were so bespangled with those Crowns, as he calls them; they shewed he saith like Pearls or precious Stones; the Horns it could move and weild about the Head as a Snail doth, all the ten; the two long ones it mostly bore forwards, the other eight mov'd too and fro every way; When it came to shore its fore parts rested on the shore, and there lay; He got help after awhile, and when he saw it stirred not to fright them, he got ropes and put them about the hinder parts, and began to draw it on shore, and saw it stir'd not to hurt them, they grew bold, and went to pull with their hands on the Horns, but these Crowns so bit them, that they were forced to quit their hold; the crowns had teeth under every one of them, and had a power to fasten on anything that touched them; they moved the Horns with handspikes, and so being evening they left it on the shore, and came in the morning and found it dead. The two long Horns are about one 11 foot, the other 9; the other 8 Horns, about 6 and 8 foot long a peice, and as thick as a man's arm every one of them. He hath brought up to Dublin but two short Horns of the Crowned ones, and the little Head, being not able to bring the rest the way is so long.

"The certainty is attested by many at the place, and is no doubt a very certain truth, the mantle was all red on the out-side, which for the colour sake he kept a peice of it, it was five inches thick, and white under; when they cut the Fish it had not a drop of blood, nor scale, nor fin, my man took a draught of the Picture which I have here enclosed, he said it was as big as any horse as ever he saw, it had no leggs.

"Your loving friend,

"THOMAS HOOKE."

"*Letter No.* 3, *from Thomas Clear to his son, dated Drangon, neer Clonmell, December* 19, 1673.

"DEAR SON: I did the last week write to you, which I hope you have received, to which I refer you. This inclosed paper is a form of a strange and monstrous Fish, that was cast on shore in the County of Kerry in Ireland, about a month since by a storm, you need not doubt the truth of it, for I have myself seen part of it, and have one of the Crowns by me to produce, I refer you to the paper for a relation of it; remember your duty both to God and man; be carefull in both, and the

Lord direct you with all our Dear loves to you and all friends, concludes him that is your very affectionate loving Father.

"THOMAS CLEAR."

"*The Monster Described.*

"This Monster was taken at Dingle-I-cosh in the county of Kerry, being driven up by a great storm in the Month of October last 1673; having two heads, one great head (out of which sprung a little head two foot, or a yard from the great head) with two great eyes, each as big as a pewter dish, the length of it being about nineteen foot, bigger in the body than any horse, of the shape represented by this figure, having upon the great head ten horns, some of six some of eight or ten, one of eleven foot long, the biggest horns as big as a man's Leg, the least as his wrist, which horns it threw from it on both sides; And to it again to defend it self having two of the ten horns plain, and smooth that were the biggest and middle horns, the other eight had one hundred Crowns a peece, placed by two and two on each of them, in all 800 crowns, each Crown having teeth, that tore any thing that touched them, by shutting together the sharp teeth, being like the wheels of a watch, The Crowns were as big as a man's thumb or something bigger, that a man might put his finger in the hollow part of them, and had in them something like a pearl or eye in the middle; over this Monster's back was a mantle of a bright Red Colour, with a fringe round it, it hung down on both sides like a Carpet on a table, falling back on each side, and faced with white; the crowns and mantle were glorious to behold: This monster had not one bone about him, nor fins nor scales, or feet, but had a smooth skin like a man's belly. It swoom by the lappits of the mantle; The little head it could dart forth a yard from the great, and draw it in again at plesure, being like a hawk's beak and having in the little head two tongues by which it is thought it received all its nourishment; when it was dead and opened the liver wayed 30 pounds. The man that took it came to Clonmel the 4th of this instant December, with two of the horns in a long box with the little head, and the figure of the fish drawn on a painted-cloth, which was the full proportion of it, and he went up to Dublin, with an intent to shew it to the Lord Lieutenant."

"*Letter No. 4, manuscript.*

"In a Letter from a very Sober person in Dublin dated 27th of December 1673.

"Yesterday I went to See part of the Sea Monster, which was taken at Dingle, viz. the two Bigg Hornes and the little head, the Hornes are neare foure foot long, and about six inches thick towards the Root, and full of little Coronetts about the Compass of a groat, and teeth in every one of them, they were fixt to the Horne, with a string like a Veine, by which I conceive they received Nourishment, rather then that the nourishment should be conveyed through them downe the Hornes to the Beast. The head was not soe bigg as my fist, the mouth and two hard shells upon it very black and shap'd somewhat like to an Eagles Bill, but broader; In the mouth there was two tongues, and (as the Man declared that tooke this monster) the Beast had naturall power to draw this head in or putt it out of the Body as necessity required."

In the Zoologist, June, 1875, p. 4502, and August, p. 4569, and in the August number of the Annals and Magazine of Natural History, vol. xvi, p. 123, Mr. More also gave an account of the capture, and briefly described the beak, odontophore, and portions of the tentacles and arms of another specimen, taken off Boffin Island, on the west coast of Ireland, April, 1875. The tentacular arms are said to have been 30 feet long; the expanded portion, 2 feet 9 inches; the large central suckers, nearly 1 inch in diameter; those of the outer rows, .5 of an inch; one short arm is said to have been 8 feet long and 15 inches in circumference at the base when fresh. It had small suckers without teeth on the horny rings, on the 'wrist' of the 'club' and scattered along the tentacular arms, as do our specimens. The rounded tubercles that always accompany these smooth-rimmed suckers are not mentioned, but doubtless they were also present. The beak was 5.25 inches long and 3.5 inches broad, dark reddish brown, "with a large tooth in both margins of the inner mandible and a much smaller notch on each side of the outer mandible."

Mr. More believed this to be distinct from the Newfoundland species, and referred it to *A. dux*, but his description agrees closely with the corresponding parts of *A. Harveyi* (No. 5) described by me, except in the relatively somewhat greater size of the sessile arms at base. In this respect, however, it is equaled or surpassed by our No. 14, and by others of the Newfoundland examples. This may also be only a peculiarity of the female. The measurements indicate a specimen intermediate in size between our Nos. 5 and 14, but the description is not sufficient to indicate with certainty to which of our species it was nearest related. A more detailed description, with figures of the suckers and odontophore, would probably settle this point. Mr. More supposed that the lateral suckers of the tentacular club were larger in his example than in *A. Harveyi*, but that is not the case.

Prof. G. O. Sars, in his recent work (Mollusca Reg. Arct. Norvegiæ, p. 377), also mentions a specimen of *Architeuthis* (12 feet long) cast ashore on the Norwegian coast, at Foldenfjord, in 1874. He refers it doubtfully to "*A dux* Steenstrup" (from the Kattegat), by which we should understand *A. monachus*, without doubt.

In "Nature," vol. xxii, No. 25, October 21, 1880, p. 585, under the caption "An Octopus," there is an account of the stranding of a large Cephalopod, early in October, at Kilkee, County Clare, Ireland, from a letter of the Rev. R. J. Gabbett. The description, though very imperfect, is sufficient to show that it was not an *Octopus*, but probably an

Architeuthis, which had lost its tentacular arms, as is often the case with stranded specimens. The length of the head is given as about 3 feet, and its diameter is given as 1½ inches—probably a mistake for 1½ feet. The more important points are as follows: "Its arms had been partially broken; there were eight of them, each as thick as a strong man's upper arm, and beneath each were two rows of suckers like cupping-glasses, more than a shilling size in circuit. When perfect, each of these arms must have been from 12 to 15 feet long, and from the point of one arm to that of its opposite was a length of nearly 30 feet. The animal's length, from the insertion of its suckers to the end of its body, must have been nearly 20 feet—perhaps more. Its mouth, like a parrot's beak, was as large as two joined hands of a large man, with the fingers outstretched. It weighed about 4 cwt."

Examples from the Indian Ocean and New Zealand.

In the Journal de Zoologie, vol. iv, No. 2, p. 88, 1875, M. Paul Gervais has given a partial summary of the gigantic Cephalopods previously known, and has mentioned an additional species (*Architeuthis Mouchezi* Vélain), of which portions were brought to Paris by M. Vélain, from the Island of Saint Paul, Indian Ocean, where it was cast ashore in November. He also quotes the brief notice of the animal by M. Vélain (in Comptes-Rendus, t. lxxx, p. 1002, Séance du Avril 19, 1875). It is stated that this example belongs to the same group with *Ommastrephes*. A description and a rude figure of it, made from a photograph taken in the position in which it lay upon the shore, has also been published by M. Vélain in the Arch. de Zool. Exper., vol. vi, p. 83, 1877. The figure has been copied in Tryon's Manual of Conchology, vol. i, pl. 82. According to this figure, the tentacular arms were very long and the short arms were truncated, probably owing to mutilation. One of the tentacular arms was saved, and, with the beak, was preserved in Paris. The caudal fin was narrow and lanceolate, adhering to the sides of the body by its entire length. In the latter feature this is very different from any of the northern species.

In the Archives de Zool. Experimentale, vol. vi, 1877, M. Vélain has proposed a new genus (*Mouchezia*) for this specimen. The peculiarity of the pen appears to be the only character of any special importance referred to by him.

Mr. T. W. Kirk, in the Transactions of the Wellington Philosophical Society, for October, 1879, p. 310, has published accounts of the occurrence of five specimens of "giant cuttle-fish" on the coast of New Zealand:

No. 1. The first of these was cast ashore at Waimarama, east coast, in September, 1870. Of this the beak was preserved and sent to Mr. Kirk by Mr. Meinertzhagen, whose account of the occurrence, with a rather crude description and some measurements made by an eye-witness, Mr. Kirk has printed. He gives no description of the beak, unfortunately. The dimensions given are as follows: Length from tip of tail to root of arms, 10 feet 5 inches; circumference, 6 feet; length of arms, 5 feet 6 inches. "The beast had eight tentacles, as thick as a man's leg at the root; horrid suckers on the inside of them, from the size of an ounce bullet to that of a pea at the tip; two horrid goggle eyes; and a powerful beak between the roots of the arms. His head appeared to slip in and out of a sheath. Altogether he was a most repulsive looking brute."

It is probable that this specimen had lost its two tentacular arms before death, and that it was actually of the same species as the other specimens recorded by Mr. Kirk. Mr. Kirk, however, seems to think that the above description refers to an Octopod.

No. 2. "The beak of number 2 was deposited in the Colonial Museum by Mr. A. Hamilton. The animal was captured at Cape Campbell by Mr. C. H. Robson, a member of this society, who very kindly furnished me with the following information. Writing on the 19th June, 1879, he says:

"'In reply to yours of the 12th about the cuttle-fish, I may state that while stationed at Cape Campbell I found several specimens of large size, all, however, more or less mutilated, except one, the beak of which I gave to Mr. Hamilton. It was alive and quite perfect, the body being 7 feet long, eight sessile arms 8 feet long, and two tentacular arms 12 feet. I am, however, only writing from memory. Mr. Hamilton has the exact measurements, and I remember distinctly that the total length was close on 20 feet.'

"I am sorry to say that Mr. Hamilton has mislaid the notes and measurements, but those given above cannot be far out."

No. 3. The third specimen was examined and measured by Mr. Kirk, personally, where it lay on the beach. He also made a drawing of it, but it has not yet been published to my knowledge. It was found on the beach at Lyall Bay, May 23, 1879, by three boys. Mr. Kirk states that it had been somewhat mutilated by the natives before he saw it, and the pen or bone had been cut across; but he preserved all the pieces of the pen, the beak, tongue, and some of the suckers. Most of the suckers had been torn off.

"The length of body from tip of tail to anterior margin of the mantle was 9 feet 2 inches, and 7 feet 3 inches in circumference; the head from anterior margin of mantle to roots of arms, 1 foot 11 inches; making the total length of the body 11 feet 1 inch. The head measured 4 feet in circumference. The sessile arms measured 4 feet 3 inches in length, and 11 inches in circumference. Each of these arms bore thirty-six suckers, arranged in two equal rows (as shown by the scars), and measuring from $\frac{13}{16}$ to $\frac{1}{4}$ of an inch in diameter. Every sucker was strengthened by a bony ring armed with from forty to sixty sharp incurved teeth. The tentacular arms had been torn off at the length of 6 feet 2 inches, which was probably less than half their original length.

"The fins were posterior, and were mere lateral expansions of the mantle. They did not extend over the back, as in the case with *Onychoteuthis*, &c. Each measured 24 inches in length and 13 inches in width.

"The cuttle-bone, when first extracted, measured 6 feet 3 inches in length and 11 inches in width, but has since shrunk considerably. It was broadly lanceolate, with a hollow conical apex 1⅛ inches deep."

No. 4. "Another specimen, measuring 8 feet in length, was lately caught by a fishing party near the Boulder Bank, at Nelson, concerning which I have only seen a newspaper cutting, and have not been able to obtain particulars."

No. 5. "A fifth was found by Mr. Moore, near Flat Point, east coast. A description was sent to Mr. Beetham, M. H. R., who, I believe, intends communicating it to this society."

From the above descriptions it is not possible to decide with certainty whether these specimens belong to the *Architeuthis*-group or whether they are more nearly allied to the *Onychoteuthis*-group, like *Moroteuthis*, for the armature of the tentacular arms is not known. The broad-lanceolate form of the pen, with a small conical hood at the end, would seem to indicate affinities with *Architeuthis*, and the presence of true suckers on the sessile arms, and small size of the fins, are favorable for that view. Altogether, the descriptions indicate that this New Zealand species is related to, and perhaps identical with, the one discovered at the Island of Saint Paul, and first named by M. Vélain *Architeuthis Mouchezi*. It is to be hoped that Mr. Kirk will soon give detailed descriptions and figures of the portions in his possession.

C.—*Examples from the North Pacific.*

The following species, although the specimens when found had lost some of their most characteristic parts, appears to be nearly related to *Onychoteuthis*, a genus having sharp claws instead of suckers on the 'club' of the tentacular arms, and a cluster of small tubercles and smooth suckers on its 'wrist,' to unite the arms together. It probably is nearly related to the group *Lestoteuthis*, characterized below.

Moroteuthis robusta (Dall, sp.) Verrill, 1881.

Ommastrephes robustus (Dall, MSS.) Verrill, Amer. Journ. Sci., vol. xii, p. 236, 1876.

Onychoteuthis (*Lestoteuthis*) *robusta* Verrill, Trans. Conn. Acad., vol. v, pp. 195, 246, 252, pls. 23, 24, 1880.

Plate XIII. Plate XIV.

This large and very interesting species* was discovered by Mr. W. H. Dall, near Iliuliuk, Unalashka Island, off the coast of Alaska.† He

* This is the species referred to as perhaps *Onychoteuthis Bergi* by Mr. Dall in his note upon large Cephalopods, in the American Naturalist, vol. vii, p. 484, 1873.

† The first specimen was found by Mr. M. W. Harrington, of Mr. Dall's party, on the west shore of Amaknak Island, Captain's Harbor, Unalashka, April 26.

found three specimens thrown upon the beach, April 26 and May 8, 1872. He made descriptions, measurements, and some very valuable drawings of them, while fresh. The specimens had all been more or less mutilated by the ravens before they were discovered. He preserved the pharynx, beak, and odontophore of No. 1, part of the 'bone,' a piece of the caudal fin, and the basal part of one of the ventral arms, with five of the suckers adhering, from one of the other specimens (No. 2), and has generously placed them in my hands for examination, together with his drawings, measurements, and notes.

The parts remaining of the largest specimen (No. 3) when found had a total length of 427^{cm} (14 feet), but the ends of the tentacular arms had been destroyed; length from tail to base of tentacular arms, 559^{cm} (8 feet, 6 inches); to front edge of mantle, 232.4^{cm} (7 feet, 7½ inches); width across fins, 107^{cm} (42 inches); diameter of body, 45.7^{cm} (18 inches); slender basal portion remaining of tentacular arms, 155^{cm} (61 inches); their diameter, 6.3^{cm} (2.5 inches); short arms (ends gone), 76^{cm} to 102 ^{cm} (30 to 40 inches); length of pen, 226^{cm} (7 feet, 5 inches).

According to Mr. Dall's note the color was reddish, in fine red dots on a whitish ground, with a darker stripe on the outer median line of the arms. The eyes were bluish black, furnished with lids, and with a small sinus in front; diameter of the opening, 2.5^{cm} (1 inch).

The mandibles retracted into a short, yellow, puckered muzzle, which was included in a longer, plain, proboscis-like tube, extending an inch or two beyond. Siphon, short and thick.* Region of the eye somewhat raised. The nuchal collar is well marked, and slightly above it, on each side, is a raised epidermal ridge, from which three wavy raised crests or frills, attached at their inner edge, pass obliquely backward, on each side. No cranial cartilage was observed. Mantle firm and dense. The neck has one median dorsal and two ventral facets, long, oval-shaped, with a median depressed line, but otherwise smooth and white; the dorsal moves on a smooth part of the inside of the mantle; the ventrals move on similar raised facets of the mantle beneath. The caudal fin was rather broad, lanceolate or spear-shaped, acute at tip. Gills yellowish olive, with obliquely transverse laminæ. Gizzard yellowish, the muscles laid like a coil of spun-yarn, in layers transverse to one another.

The pen (Plate XIII, figs. 4, 5) was gone from the first specimen (No. 1) and broken in the others. It was found unattached in the dorsal cavity. It had a thickened median rib, but becomes very thin at the sides, and is divided by sharp, stiff ribs or folds into three longitudinal areas on each side (Plate XIII, fig. 6). The posterior end is one-sided, funnel-shaped close to the tip, which is inserted into a long, round, thick, firm, cartilaginous cone, which tapers to a point posteri-

* No valve is shown in Mr. Dall's sketches.

orly. The portion of the pen (of No. 2) preserved* and forwarded to me includes all the cone and a part of the posterior end of the quill-portion, attached within the concavity of the cone (Plate XIV, fig. 7). The anterior end of the cone is concave and very obliquely terminated, the dorsal side extending forward some distance along the dorsal side of the quill. The whole length of the preserved cone (doubtless much shrunken by the alcohol) is 44.5^{cm} (17.5 inches); of the oblique anterior termination 15.25^{cm} (6 inches); greatest diameter 4^{cm} (1.6 inches). The cone is nearly round, firm, translucent, brownish or deep amber-color, and composed of numerous distinct concentric layers. The concavity of the anterior end firmly embraces the remnant of the funnel of the quill, which has numerous small costæ converging to the apex; two of the dorsal costæ are much stronger than the rest, forming a strong ridge each side of the smaller median costa, which lies in a deep median depression or furrow.

The tentacular arms had lost their clubs; but the part remaining was cylindrical, 2.5 inches in diameter. The other arms were somewhat thicker. The few suckers remaining on them were attached by slender pedicels, and arranged in two alternating rows; they were furnished with horny rims having the edge entire, except where irregularly broken away; those of the distal part of the arms were gone.

The portion of the arm of the second specimen preserved in alcohol and sent to me came from the base of the left ventral arm. It is 65^{mm} in length; diameter from inner to outer surface, not including marginal membrane, 45^{mm}; including membrane, 64^{mm}. It is well rounded on the inner face, but more flattened on the upper side, while the outer surface is broadly rounded; the outer angle has a strong, thick marginal membrane, 19^{mm} wide (see section of this arm, Plate XIV, fig. 8, *c*). The sucker-bearing surface is broad, with a slight marginal membrane along each margin (b, b^1), rising into broad, flat, somewhat thickened, blunt lobes alternating with the suckers. Two alternating rows of firm, smooth, rather irregular-shaped tubercles run along the median region, between the rows of suckers, with which they alternate, on each side.

This segment of the arm still bears five suckers, which appear to represent the first, second, and fourth pairs, though there may possibly have been others before the first of these. They are all similar, rather small in proportion to the arm, round, but little oblique, decidedly convex beneath, and with a rather long, slender pedicel (fig. 8, *a*). The horny marginal rings are dark brown, yellowish at the thin edge, which is entire and nearly smooth, except where broken. The largest of these remaining suckers are 8.5^{mm} in diameter outside; aperture, 5^{mm}; height of cup, 7^{mm}; length of pedicel, 3^{mm}.

* Mr. Dall states that he attempted to dry the rest of this pen, and that of No. 3, but they turned brown, and then black, effloresced, and decomposed. He also states that the pen, when fresh, was translucent whitish, and that it changed to brownish yellow in the alcohol.

The exposed parts of the jaws are black and polished; their internal laminæ are reddish brown, becoming translucent yellowish toward the margins.

The upper mandible (Plate XIV, fig. 5) has an elongated, tapered, considerably incurved, and sharp rostrum; the notch is rather narrow and deep, and a well-developed, triangular, lateral groove runs down from the notch for some distance, its upper border being in line with the cutting edge of the rostrum. The anterior edge of the alæ, so far as normally exposed, is nearly straight, but slightly undulated.

The lower mandible (Plate XIV, fig. 6) has the cutting edges of the rostrum slightly concave, with a slight notch close to the tip, which is small and incurved; the notch at the base is broad and shallow, bordered externally by a slight, angulated ridge; the exposed anterior edges of the alæ have each two slight lobes, but are otherwise nearly straight; the alæ are broader toward the inner end, which is obtusely rounded.

The lower mandible now measures, from the tip of the rostrum to the posterior dorsal border of the mentum, 13^{mm}; tip to the extreme posterior end of the gular lamina, 50^{mm}; to the dorsal angle of the same, 33^{mm}; tip to the inner end of the alæ, 46^{mm}; to the bottom of the notch, 13^{mm}; breadth of alæ, 24^{mm}; transverse breadth at notches, 12^{mm}.

The upper mandible, from the tip of the beak to the end of the palatine lamina, is 71^{mm} long; from tip of beak to end of frontal lamina, 53^{mm}; to bottom of notch, 11^{mm}; length of exposed (dark) portion of anterior edge of alæ, 14^{mm}.

The odontophore (Plate XIV, figs. 1–4) has a very broad, thin, marginal membrane, yellowish white in color, becoming brown and thickened toward the dentigerous portion, where there is a row of very small, thin plates, bordering the outer row of teeth; the ventral portion of the dentigerous band is dark brown, regularly convex, and narrowed gradually to the obtuse end; the dorsal portion is considerably longer, abruptly bent backward, with the borders incurved, gradually decreasing to the posterior end; on this part the teeth become much smaller and paler.

The outer lateral teeth, on the anterior portion, are long, slender, sharp, and strongly curved; the median ones are much shorter, with a sharp, strongly curved central point, and a very small, almost rudimentary denticle on each side; the inner laterals are a little longer than the median, with a stout incurved point; on the outer side of its base there is a small denticle; the teeth of the two outer rows, on each side, are simple.

Length of odontophore, from anterior bend to posterior tip of dorsal end, 22^{mm}; to tip of ventral end, 14^{mm}; breadth of lateral membrane, in middle, 11^{mm}; of dentigerous belt, anteriorly, 3^{mm}.

The following measurements were made by Mr. Dall from the fresh specimens:

Table of measurements (in inches).

	No. 1.	No. 2.	No. 3.
Total length (to mutilated ends of tentacles)	80 +	110 +	167 +
Base of arms to tip of tail (head and body)	51	67	102
Base of arms to edge of mantle (head)	5	6	10.5
Edge of mantle to tip of tail (body)	46	61	91.5
Length of tail-fins (insertion to tip)	....	33.75	48
Breadth of tail-fins	13.5 +	25.5	42
Length of 'pen'	....	60	89
Breadth of pen, in middle	....	....	12.25
Length of tentacular arms (ends gone)	30 +	43 +	61 +
Length of longest sessile arms (ends gone)	30 +	23.5 +	40 +
Diameter of body	7.5	....	18
Breadth between insertions of fins	....	3.5	5
Diameter of eye	....	1	1.25

The generic affinities of this species must be regarded as still somewhat doubtful, owing to the absence of the tentacular clubs, and most of the suckers of the sessile arms. The characters of the 'pen;' of the dentition, especially of the median teeth; of the nuchal frills; of the siphon; and of the cartilaginous facets, constituting the mantle fastenings, all indicate that it belongs in the family *Teuthidæ*, near *Onychoteuthis*. But in this family there is a great diversity as to the arrangement of the hooks and suckers constituting the armature of the arms. Some of these combinations are as follows:

TEUTHIDÆ.

Sessile arms with suckers only.

Onychia.—Tentacular club with two central rows of hooks, rows of small suckers along each margin, and a cluster of suckers and tubercles on the 'wrist.' Sessile arms with smooth suckers. (*Teleoteuthis* V.)

Onychoteuthis (typical).—Tentacular club with two rows of hooks, with an apical cluster of suckers, and with a cluster of suckers and tubercles on the wrist. (Plate XV, figs. 6, *a–c*.) Sessile arms with suckers in two rows.

Ancistroteuthis (typical).—Two central rows of hooks, with proximal and apical suckers on the club, as in the last. Pen narrow, widest anteriorly, with a long, terminal, hollow cone.

Gonatus.—Tentacular club with one or two central median hooks, and with numerous, multiserial, small suckers, distally and laterally. Sessile arms with four rows of suckers, those of the two central rows larger, all serrate.

Sessile arms with both suckers and hooks.

Abralia.—Tentacular club with two rows of alternating hooks and suckers in the middle, and with a cluster of suckers on the wrist and two rows at the tip. Sessile arms with hooks on the basal portion, and two rows of small suckers toward the tips. Pen dilated in the middle, hooded at the tip. Buccal membrane with suckers.

Lestoteuthis (gen. nov.).—Tentacular club with numerous suckers, and few large central hooks. Sessile arms dissimilar; lower ones with four rows of suckers; upper, with two central rows of hooks, alternating with marginal suckers on each side. Pen narrow, with a short, hollow, terminal cone. (Type, *L. Kamtschatica* Middendorff, sp.)

Sessile arms with hooks only.

Verania.—Tentacular club with hooks; sessile arms with hooks in two rows. Fins large and broad. Pen lanceolate.

Acanthoteuthis.—Tentacular and sessile arms with hooks. (Fossil.)

Ancistrochirus.—Tentacular and sessile arms with hooks in two rows. Pen lanceolate. Fins extending forward to edge of mantle.

Enoploteuthis (typical).—Tentacular club with two rows of hooks, and with a cluster of small connective suckers and tubercles on the wrist. Sessile arms all with hooks, in two rows, extending to the tips. Fins short. Pen lanceolate.

The position of *Moroteuthis* among the genera enumerated above must remain uncertain, for the present, because the armature of the tentacular club is unknown. But as it has smooth-ringed suckers on the ventral arms, at least at the base, it is probable that the genus is more nearly allied to the genera in the first group. But it differs very decidedly from all those named, in the form of the pen, and in having a long, solid cartilaginous cone, shaped like a large *Belemnites*, appended to its posterior end. In respect to this feature of the pen, this genus differs from all existing genera, and seems to have affinities with some of the mesozoic fossil genera.

In *Onychoteuthis* and *Teleoteuthis** the pen has a more or less lanceolate form, with a small posterior hood or hollow cone, without a solid appendix. *Gonatus* and *Lestoteuthis* not only differ from *Moroteuthis* in the pen, but have four rows of serrated suckers on the ventral arms.

The genus *Ancistroteuthis* (type *A. Lichtensteinii*) agrees somewhat better in the form of the pen, which is widest near the anterior end, from whence it tapers back to a long and oblique, compressed, posterior, hollow cone, but without a solid appendix at the end. It has numerous longitudinal nuchal crests, like *Onychoteuthis.*

It is not improbable that it may become necessary to establish a distinct family for *Moroteuthis*, when its armature becomes known. In that case the family should be called *Moroteuthidæ.*

LESTOTEUTHIS Verrill, 1880.

The characters of *Lestoteuthis Kamtschatica*, which I proposed to take as the type of this generic group, are not yet fully known. The peculiari-

*This name is proposed as a substitute for *Onychia* Lesueur, 1821 (*non* Hubner, 1816). The type-species is *T. carribæa* (Les., sp.). *T. platyptera* D'Orb. and *T. Krohnii* Verany appear to be additional species.

ties in the armature, both of the sessile and tentacular arms, as given above (p. 70), are quite sufficient, however, to warrant its separation from all the other genera. Its pen, as figured, also differs from all others hitherto described. It is narrowest anteriorly, gradually and slightly expanding backward to the one-sided, conical hood or cone, which is not inserted into a solid terminal cone, as in *Moroteuthis robusta*, and the blade is relatively larger. The caudal fin is large, rhomboidal, and acute posteriorly, as in the latter. The tentacular club bears two large, abruptly curved, claw-like hooks in the middle, with numerous small suckers around them and on the proximal part. The length of the head and body of the original example was about 28^{cm} (11 inches).

This genus is, in the character of its armature, very much like *Gonatus* Sars; the structure of its pen appears to be similar.

Mr. Dall has described a small species (probably young) from the coast of California, which may possibly belong to the same group. He referred it doubtfully to *Onychoteuthis* (*O. lobipennis* Dall).

A large Cephalopod, referred doubtfully to *Ommastrephes*, has been recorded from Japan and described by Dr. F. Hilgendorf.* It was taken on the east coast of Japan, north latitude 35° to 36°. It had been split open, salted, and partly dried, and the viscera had been removed. The ends or clubs of the tentacles were also gone. In this condition it was on exhibition in Yeddo. The following are the measurements given: Tip of tail to front edge of mantle, 186^{cm} (6 feet, 1 inch); mantle to mouth, about 41^{cm} (1 foot, 5 inches); longer sessile arms, 197^{cm} (6.5 feet); from tip of tail to tip of sessile arms, 414^{cm}; total expanse across outstretched tentacles, 600^{cm}; circumference of mantle (breadth as cut open), 130^{cm}; length of caudal fin, 60^{cm}; breadth of caudal fin in middle, 45^{cm}; breadth of forward end of caudal fin, 28^{cm}; diameter of posterior tip, 1^{cm}; tongue of funnel, 10^{cm} broad, 6^{cm} long; eye-opening, which was oblong-oval, without an obvious sinus, 19^{cm}; distance between eyes, 26^{cm}; diameter of oval skin of lip, 12^{cm} by 8^{cm}; breadth of sessile arms, 11^{cm}; of tentacles, 2^{cm} to 3^{cm}; diameter of horny rings of suckers on base, 1.5^{cm}; height, 0.7^{mm}; number of denticles, 37.

The great size, and especially the length, of the caudal fin in proportion to that of the mantle ($\frac{1}{3}$) render it probable that this was not a species of *Architeuthis*. The form of the fin, its length exceeding its breadth, is unlike the usual proportions in *Ommastrephes* and *Sthenoteuthis*. It is more probable that this specimen belonged to *Moroteuthis robusta*, or to some related form not yet characterized.

D.—*Note on large species of Octopus.*

Although this article relates specially to the gigantic species of ten-armed Cephalopods, it may not be amiss to add a few lines in respect to species of *Octopus* that attain large dimensions. It is certain, however,

*Mittheilungen der deutschen Gesellschaft für Natur und Välkerkunde Ostasiens. Herausgegeben von dem Vorstande, 1st Heft, p. 21, May, 1873, Yokohama, Japan. See also American Journal of Science, vi, p. 237, September, 1873.

that none of the latter that have hitherto been examined by naturalists reach dimensions to be compared with those of the species of *Architeuthis*, *Moroteuthis robusta*, and their allies.

The common *Octopus* of the west coast of North America (*O. punctatus* Gabb) is one of the largest of its tribe hitherto studied. According to Mr. W. H. Dall,* it occurs abundantly at Sitka, and there "reaches a length of 16 feet, or a radial spread of nearly 28 feet, but the whole mass is much smaller than that of the decapodous Cephalopods of lesser length. In the *Octopus* above mentioned the body would not exceed 6 inches in diameter and a foot in length, and the arms attain an extreme tenuity toward their tips." Dr. W. O. Ayres tells me that he has often seen this species exposed for sale in the markets of San Francisco (where it is eaten chiefly by the French), and that specimens with the arms 6 or 7 feet long are common. A smaller specimen, presented to the museum of Yale College, was over 4 feet long and weighed 14½ pounds.

Prof. W. H. Brewer states that he has seen specimens in the San Francisco markets which spread 14 feet across the outstretched arms.

The common *Octopus vulgaris* ("poulpe" or "devil-fish") of the Mediterranean, Bermuda, and West Indies sometimes grows to a somewhat formidable size. According to Verany, the largest one seen by him was 9 feet long and weighed 25 kilograms (Tryon). This one was captured by a fisherman with his hands only.

A large species, perhaps the same, occurs in the West Indies. According to Prof. B. G. Wilder,† a correspondent, Mr. J. S. George, of Nassau, New Providence, mentions in a letter the occurrence there of an *Octopus* "10 feet long, each arm measuring 5 feet; the weight was estimated at between two hundred and three hundred pounds." It was found dead on the beach. This estimate of the weight is altogether out of proportion to the measurements given, which would correspond to a weight of not more than thirty or forty pounds at the utmost.

Specimens of similar size have been recorded from other parts of the world, while more or less fabulous accounts of more gigantic forms are numerous, especially among the early writers. Fragments of huge species of *Octopus* are said by many writers to have been vomited by wounded sperm-whales, but no scientific examination of any of these has been made. At present it seems most probable that all the large fragments recorded as being vomited by sperm-whales belong to species allied to *Architeuthis*.

There is no satisfactory evidence that any of these species of *Octopus* ever intentionally attack man, or that any one has ever been seriously injured by them. They are rather sluggish and timid creatures, seeking shelter in holes and crevices among rocks. They feed mainly upon bivalve mollusks and crustacea, but will also eat fish, and may, perhaps, like lobsters and crabs, devour the bodies of persons who have been drowned. There

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* American Naturalist, vol. vii, p. 485, 1873.

† American Naturalist, vol. vi, p. 772, 1872

is good reason to believe that most of the supposed cases of *Octopus* attacking and drowning persons (like that of an Indian girl of the Oregon coast, often cited), are merely instances of accidental drowning, or suicides, and that the presence of an *Octopus* is a post-mortem circumtance. Their power and ferocity, as well as their size, have often been excessively exaggerated.

PART II.—MONOGRAPHIC REVISION OF THE CEPHALOPODS OF THE ATLANTIC COAST, FROM CAPE HATTERAS TO NEWFOUNDLAND.

The number and variety of Cephalopods known to inhabit this coast have been very much increased within a few years, principally through the investigation of the marine fauna carried on by the United States Fish Commission during the past ten years. Many of the newly discovered species have been captured from time to time by the dredging parties of the Fish Commission. Several very interesting new forms have been presented to the Fish Commission by the enterprising and intelligent fishermen of Gloucester, Mass., many of whom have, during the past three years, saved and brought home at all seasons large collections of marine animals of all kinds, including a very large number of new and strange species, of the greatest interest.* Mr. A. Agassiz, while dredging in deep water off the coast, on the Coast-Survey steamer "Blake," last season, obtained three additional new forms, which are also included in this revision. Descriptions of most of these new species have already been published by the writer in various articles in the American Journal of Science, Bulletin of the Museum of Comparative Zoology (vol. viii), Transactions of the Connecticut Academy (vol. v), and Proceedings of the National Museum (vol. iii), but many additional details and some new figures have here been added.

In this revision thirty-two species are included; of these, two are probably extralimital. Of the thirty species of Cephalopods that we now know to belong to this fauna, twenty-five have been added to it within the past ten years; of these, eighteen species have been described as new by the writer; among these were six new genera.

SUBCLASS DIBRANCHIATA, OR ACETABULIFERA.

Cryptodibranchiata Blainville, Dict. Sci. Nat., vol. xxxii, p. 172, 1824.
Acétabulifères Férus. & D'Orb., 1835; Céphal. Acétab., pp. v, xxxv, 1. D'Orbigny, Hist. Cuba, Moll., p. 5, 1853.
Dibranchiata Owen, Trans. Zool. Soc. London, vol. ii, p. 103, 1838.
Antepedia Gray, Catal. Brit. Mus., Moll., vol. i, p. 3, 1849.

Branchial cavity large, containing a single pair of large, highly specialized gills, each having a muscular branchial heart at its base. Siphon used in locomotion, with or without an internal valve, completely tubu-

* The number of separate lots thus brought in and presented to the Fish Commission amounts to over 900. Besides the invertebrates, many new and remarkable fishes are included in these donations.

lar. The interior lateral or basal lobes of the siphon are flexible, and capable of acting as valves to close the opening of the branchial sac by pressing against the inside of the mantle when it contracts. The jet ot water thus forced through the siphon by its reaction propels the animal backward or forward, or in any direction opposite to that in which its flexible extremity may be turned.

Body varying in form from subspherical to long-conical. Sides often with fins. Mantle destitute of an external shell. The internal shell, when present, is dorsal,* and may be either horny or calcareous. Sessile arms in four pairs, around the head, provided on the inner surface with suckers or with hooks (modified suckers). Eyes highly developed. Jaws in the form of a sharp, horny beak, the upper jaw shutting into the lower one; jaws hollow and supported by strong internal cartilages. Odontophore usually with seven (rarely five) rows of sharp teeth. An ink-sac opening near the end of the intestine, at the base of the siphon.

The exposed surfaces of the body, fins, head, and arms contain within the skin small sacs or vesicles filled with bright-colored fluids of different colors, but most commonly various shades of purple, brown, red, and yellow. These vesicles are known as chromatophores. They are under the control of muscular fibers, which are so attached to them that, by contracting, they cause the chromatophores to expand into larger, flat, and more or less round spots of color. By the flattening and enlargement of the chromatophores the colored fluids are spread out into thin layers, making them appear of lighter tints. Sometimes the chromatophores overlap each other in several strata when expanded. When their muscular fibers relax the vesicles contract into minute spherical specks, and then appear much darker in color, but are more widely separated, so that the general color is paler. By this means all these animals are able to effect rapid changes in their colors for purposes of concealment, or in accordance with varying conditions of nervous activity. The muscular fibers of the chromatophores are controlled by the nerves of the mantle, and contract by reflex action, and also, apparently, in accordance with the will of the creature. Their contractility often persists for some time after the death of the animal. When freshly-caught specimens are put into alcohol the chromatophores expand.

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* In this article, the terms used in describing the form and relations of parts are those in most common use among systematic writers on this group of animals. No attempt is here made to decide the still unsettled questions in regard to the homologies of the arms and siphon with the foot or other parts of Gastropods, nor to apply the later views of Huxley and others as to the general axial relations of the body. For my present purposes I have thought it best to call the oral region the anterior end and the opposite extremity the posterior end; when the animal is in its normal horizontal position, the side which is uppermost is called the dorsal side and the lower surface is called the ventral. The prehensile organs are called sessile arms and tentacular arms, and the locomotive tube is called the siphon, without reference to the homologies of these organs.

This subclass includes two very natural divisions:

Decacera.—Having inside the circle of eight sessile arms, two long tentacular arms, with suckers or hooks on the distal portion. Suckers pediceled, and with horny rims. Body elongated, always with lateral fins.

Octopoda.—Having only the eight sessile arms. Suckers not pediceled, and destitute of horny rings. Body rounded, rarely finned.

ORDER I—DECACERA, OR DECAPODA.

Decapoda Leach, Zool. Miscel., vol. iii (t. Gray) 1817 (*non* Latr., 1806).
H. & A. Adams, Genera, vol. i, p. 25.
D'Orbigny, Tabl. Méth. des Céphal., p. 57, 1826; Hist. Cuba, Moll., p. 30, 1853.
Decacera Blainville, Dict. Sci. Nat., vol. xxii, 1824; Man. Mal., p. 366, 1825.
Sephinia Gray, Catal. Brit. Mus., Moll., vol. i, p. 35, 1849.

Body generally elongated, often acute posteriorly. Head furnished with ten prehensile arms, bearing pediceled suckers or hooks. Four pairs of arms are shorter, tapering from the base, and covered with rows of suckers along the whole length of the inner face; the fifth pair of arms, known as tentacles or tentacular arms, differing from the rest, and arising from a pair of pits or pouches, are situated between and inside the bases of the third and fourth pairs of sessile arms, and have a long and more or less slender and contractile peduncular portion and a terminal, usually enlarged, sucker-bearing portion. Beak at the end of a protractile pharynx, surrounded with a loose outer buccal membrane, which is usually seven-angled and united to the arms by bridles. Siphon usually with an internal valve. Eyes movable in the sockets, with or without lids. Ears behind the eyes. Head united to the mantle either by a dorsal and two lateral, free, connective cartilages or by three muscular commissures. Mantle cylindrical or conical, supported by an internal dorsal, horny 'pen,' or by a calcareous internal dorsal shell or 'bone;' always with muscular fins along each side, which are usually united posteriorly. Male with one or more of the arms hectocotylized.

This group has been divided by D'Orbigny into the following two tribes, which are, perhaps, more convenient than natural:

Oigopsidæ.—Eyes naked in front, furnished with free lids, with or without an anterior sinus; pupils circular.

Myopsidæ.—Eyes covered by transparent skin, sometimes with a thickened fold, forming a lower lid; pupils crescent-shaped.

OIGOPSIDÆ.

FAMILY TEUTHIDÆ Owen (restricted).

Teuthidæ (*pars*) Owen, Trans. Zool. Soc. London, vol. ii, 1838.
Teuthidæ (*pars*) D'Orbigny, Céphal. Acétab., p. xxxvii (Introduction), p. 328, 1835-'48.
Onychoteuthidæ (*pars*) Gray, Catal. Brit. Mus., Moll., vol. i, p. 45, 1849.
H. & A. Adams, Genera, vol. i, p. 30.

Tentacular arms furnished with sharp horny claws or hooks, which correspond with peculiarly and highly modified sucker-rings; true denticulated suckers may or may not accompany the hooks; tip of arm with a cluster of small, smooth-rimmed suckers; proximal part of club with a mixed group of connective tubercles and smooth-ringed suckers, by which the arms can be fastened together and used in concert. Sessile arms with hooks, with suckers, or with both. Eyes with free lids and a sinus. Mantle united to neck by three simple, movable, connective cartilages. Siphon with a valve and with dorsal bridles. Nuchal or alfactory crests well developed; sometimes several longitudinal crests exist on each side. Pen thin, lanceolate, usually with a posterior hooded portion, and sometimes terminated by a solid cartilaginous cone. Odontophore in *Cheloteuthis* and *Gonatus* with only five rows of teeth, in others with seven rows.

For a synopsis of the hitherto-described existing genera of this family, see pp. 69, 70.

Owen's family *Teuthidæ* included nearly all the *Decacera* having horny internal shells. As adopted by D'Orbigny, it included *Ommastrephidæ* and *Teuthidæ*.

CHELOTEUTHIS Verrill.

Trans. Conn. Acad., vol. v, p. 234, Jan., 1881; Bulletin Mus. Comp. Zool., vol. viii, p. 109, 1881.

Allied to *Enoploteuthis*, *Lestoteuthis*, and *Abralia*, but with a more complicated armature than either of these genera. Ventral arms with denticulated suckers, arranged in four rows; other arms have two median rows of sharp incurved claws, (distal portions have lost their armature). Tentacular arms long, with broad clubs, strongly keeled externally, and with series of connective suckers and tubercles extending for some distance along the inner surface of the arms. Tentacular club provided with a marginal row of connective suckers, alternating with tubercles, along one margin; with a central row of unequal hooks, some of them very large; with submedian groups of small, slender-pediceled suckers (or hooks); with marginal series of small suckers; and with several rows of small suckers covering the prolonged distal portion of the face. Connective cartilages on the base of the siphon simple, long-ovate; the corresponding processes of the mantle are simple longitudinal ridges. Odontophore with five rows of teeth.

The caudal fin, pen, and many other parts are destroyed.

Cheloteuthis rapax Verrill.

Cheloteuthis rapax Verrill, Trans. Conn. Acad., vol. v, p. 234, pl. 49, figs. 1–1*f*, Jan., 1881; Bulletin Mus. Comp. Zool., vol. viii, p. 110, Cephalopoda, pl. 2, figs. 1–1*f*, 1881.

Plate XV, figures 3–3*f*, 4.

The body was rather short and thick, tapering rapidly backward. The caudal fin appears to have been short-rhomboidal, but this is uncertain. The siphon is large, with an internal valve. The connective cartilages (fig. 3 *e*) on the sides of the base of the siphon are long-ovate, with the posterior end widest and rounded. The corresponding cartilages on the inside of the mantle are simple longitudinal ridges.

Head large, with very large eyes; pupils round. The arms are long and taper to slender tips; the dorsal ones are smaller and shorter than the others; the lateral and ventral pairs are nearly equal in length, and about as long as the mantle; the ventral arms are somewhat more slender than the lateral ones. All the arms appear to have borne slender-pediceled claws or hooks, with strongly incurved horny points, but only the fleshy parts of these are left, in most cases, and the tips of the arms are bare. On the ventral arms these hooks were smaller, and in four rows; the fleshy portion of these consists of a small rounded head with lateral lobes, running up, on one side, into an incurved beak, so that the shape is somewhat like a bird's head. On the other arms the claws were in two rows only, but they were much larger; in a few cases, on the lateral arms, the horny claws are left. These are strongly compressed and deeply imbedded in the muscular sheath, only the sharp incurved point projecting (figs. 3 *c*, 3 *d*).

The tentacular arms (fig. 3) are long and strong, their length being more than twice that of the sessile arms. The club is rather stout, long, decidedly expanded, and has an elevated, crest-like keel on the distal half of its dorsal surface; this keel rises abruptly at its origin, and is colored on the outer side, but white on the face next to the inner surface of the club. The club is broadest near its base, the distal third is narrow and the tip rounded. The armature is remarkable: in the middle line there is a row of six medium-sized hooks (fig. 3, *a''*), followed by two much larger ones (*a*, *a'*), situated near the middle; these have lost their horny claws; series of minute, slender-pediceled suckers run along the club, either side of the median line, and beyond the large hooks these rows unite and entirely cover the face of the distal third of the club (fig. 3, *d*), there forming about eight rows; at the tip there is a circular group of minute suckers (*d'*); toward the base of the club the lower side is expanded and bears a row of five peculiar suckers (fig. 3, *e*), having a marginal series of slender, minute, incurved spinules; these suckers have very thick basal processes, which are appressed and directed toward the central line of the club, bearing the suckers on their inner ends, attached by short pedicels; round connective tubercles alternate with these suckers, in the same row; beyond these there is a triangular marginal group of slender-pediceled suckers (*c*), of about the same size; other rows of minute pediceled suckers (or hooks) occupied the submedian area between the marginal ones and the central line, which is indicated by a strong white cord. The opposite margin of the club appears to have borne several rows of small suckers, but this part is badly injured. A band of minute papillæ (*e'*), apparently the remnants of suckers and alternating connective tubercles, extends downward for more than half the length of the tentacular arm; at first this band is like a continuation of the connective suckers and tubercles on the margin of the club, and the papillæ are apparently in a single row, while the surface near them is crossed by fine transverse grooves or furrows; but farther down the arms there may have been two or more rows of suckers which have been destroyed.

The beak (fig. 3 *f*) is somewhat compressed, with very acute mandibles. The upper mandible has the point long and regularly incurved, with the cutting edge regularly arched, without a basal notch, and forming, with the anterior edge, an obtuse angle. Lower mandible with a strongly incurved tip and regularly concave cutting edge, having no basal notch and only a slight tooth on the anterior border, which forms a very obtuse angle with the cutting edge. The radula has but five rows of teeth (Pl. XV, fig. 4), the inner lateral rows being absent.

Color mostly gone, but where still remaining, as on the back of the tentacular club, it consists of minute purple chromatophores; inner surface of sessile arms purplish brown.

Measurements (in millimeters).

Length of body	78
Length of dorsal arms	58
Length of second pair of arms	86
Length of third pair of arms	87
Length of ventral arms	85
Length of tentacular arms	225
Length of club	29
Breadth of club	7
Breadth of tentacular arms	5
Breadth of lateral arms at base	6
Breadth of dorsal arms	5
Diameter of eyeball	19
Length of connective cartilages on siphon	14
Breadth of the same	4

A specimen of this remarkable squid, in very bad condition, was taken from the stomach of a fish trawled at station 893, in 372 fathoms, about 100 miles south of Newport, R. I. It was accompanied by a specimen of *Ommastrephes illecebrosus*, in a similar condition. It had lost its pen, its epidermis, and most of the horny hooks and sucker-rings; the head was detached from the body and the caudal fin was nearly destroyed; the eyelids were gone, but the eyeballs remained. The description must, therefore, remain imperfect till other specimens can be obtained.

Several loose horny hooks of a Cephalopod belonging to this family were also dredged in the same region. They resemble the hooks of *Onychoteuthis Banksii* (Plate XV, fig. 4), but may have belonged to *C. rapax*. A larger one, from station 892, is bent nearly into a half circle.

GONATUS Steenstrup (? *non* Gray).

?*Gonatus* Gray, Catalogue Mollusca Brit. Mus., vol. i, Cephal. Antep., p. 67, 1849 (characters inaccurate).
?H. & A. Adams, Genera, vol. i, p. 36.

Body slender, tapering; caudal fins short, broad, united posteriorly. Pen narrow anteriorly, thin and lanceolate posteriorly, with a terminal, hood-like expansion. Ventral arms with four rows of small, pedicellated suckers; others with two larger median rows, with a horny ring, having a single large hooked claw on the outer edge; outer suckers with longer pedicels, the horny ring with several small denticles. All the suckers have a circle of minute scales or plates around the aperture. Tentacles long and slender, the terminal part dilated into a narrow club, with a membranous keel; the club is covered with minute denticulated suckers, like the outer ones of the sessile arms; smaller suckers extend for some distance along the arm; center of the club with one or two larger claws, resembling the median ones of the lateral arms, their horny rings having a small aperture, and bearing, on the outside, a large claw-like hook. Odontophore with only five rows of teeth.

By Dr. J. E. Gray the free eyelids of this species were overlooked, and on that account he referred it to the family *Loligidæ*. H. and A. Adams have made the same mistake. Their statement that the siphon has no valve is equally erroneous.

Gonatus Fabricii Steenstrup.

Sepia loligo Fabricius, Fauna Grœnlandica, p. 358, 1780 (good description).
Onychoteuthis Fabricii Lichtenstein, Isis, vol. xix, 1818.
Möller, Kröyer's Tidss., vol. iv, p. 76, 1842.
Loligo Fabricii Blainville, Dict. Sci. Nat., vol. xxvii, p. 138, 1823.
Onychoteuthis? amœna Möller, Ind. Moll. Grönl., Kröyer's Tidss., vol. iv, p. 76, 1842 (young?).
Gonatus amœna Gray, Catal. Moll. Brit. Mus., vol. i, Cephal. Antep., p. 68, 1849?
H. & A. Adams, Genera, vol. i, p. 36, pl. 4, fig. 2?).
Gonatus amœnus G. O. Sars, Moll. Reg. Arct. Norvegiæ, p. 336, pl. 31, figs. 1–15 (excellent), pl. xvii, fig. 2 (dentition), 1878.
Tryon, Man. Conch., vol. i, p. 168, pl. 73, fig. 290 (descr. from Gray, fig. from H. & A. Adams, Genera?).
Verrill, Proc. Nat. Mus., vol. iii, p. 362, 1880; Trans. Conn. Acad., vol. v, p. 237, pl. 45, figs. 1–1 *b*, 2–2 *d*, Jan., 1881.

Plate XV, figures 1–1*c*, 2–2*d*.

Body small, elongated, rather slender, tapering backward; front dorsal edge of mantle extending forward in a blunt lobe or angle. Caudal fin very short, but broad, nearly twice as broad as long, the front edges extending forward beyond the insertion as rounded lobes; lateral angles subacute; posterior angle obtuse. Arms stout and rather long, the dorsal and ventral pairs stouter than the lateral. Ventral arms bear four rows of small suckers; on the others the median rows (2 *c*, 2 *d*) are larger than the outer ones, with shorter pedicels, and the very oblique horny ring, having a small opening, is developed into a single, large, hooked tooth on the outer side; around the inner side of the aperture there is a partial circle of small flat scales, in several rows. The suckers of the outer rows (2 *a*, 2 *b*) are about two-thirds as large, with longer and more slender pedicels and with lateral apertures; the horny ring has about five acute-triangular teeth on the outer margin, and there are several rows of small scales forming a broad circle entirely around the aperture. The tentacular arms are long and slender, with broader clubs, which bear a large number of minute suckers, much like the outer ones of the arms, arranged in many crowded rows, some of which extend beyond the club along the arm; in the middle (fig. 1 *b*) there are usually one or two larger suckers (absent in our specimen), in which the horny ring has a small aperture, and is developed into a large hook-shaped claw on one side, and a complete circle of small plates surrounds the horny ring.

Pen thin and delicate, narrow anteriorly, with slender lateral ribs; posteriorly, for more than half the whole length, expanded into a thin lanceolate form; posterior tip laterally dilated, with the edges involute (fig. 1).

A young specimen of this species, in nearly perfect preservation, was recently presented to the United States Fish Commission by Capt. William Demsey and crew of the schooner "Clara F. Friend." It was taken from the stomach of a cod, off Seal Island, Nova Scotia.

Greenland (Fabricius, Möller). Porsangerfjord, northern coast of Norway (G. O. Sars). Coast of Finmark, in stomach of "coal-fish," abundant (G. O. Sars, Norwegian Exp. of 1878).

D'Orbigny, Gray, and other writers have erroneously referred the *Onychoteuthis Fabricii* (based on the *Sepia loligo* of Fabricius) to *O. Banksii.* The detailed Latin description given by Fabricius applies perfectly to the present species, and not at all to *O. Banksii.* He describes the four rows of suckers on the short arms, the small suckers and two large central hooks on the tentacles, the short caudal fin, etc.

FAMILY OMMASTREPHIDÆ.

Teuthidæ (pars) D'Orbig., Céphal. Acétab., pp. xxxvii, 328.
Onychoteuthidæ (pars) Gray, Catal. Brit. Mus., Moll., vol. i, p. 45, 1849.
Ommastrephidæ Gill, Arrangement Fam. Mollusks, p. 1, 1871.
Tryon, Man. Conch., vol. i, p. 107, 1879.

Body elongated, tapering to a point posteriorly, shorter and less acute in the female, often very large (*Architeuthis*). Sessile and tentacular arms without hooks, but provided with suckers, having denticulated horny rings; tentacular arms with an expanded club, having four rows of suckers on its middle portion, those in the two central rows larger; proximal portion with or without smooth-ringed connective suckers and tubercles; tip with a cluster of smooth-ringed suckers. Siphon in a deep groove, attached by four bridles and strengthened by a median longitudinal dorsal band, free in the middle; an internal valve. Eyes with a round pupil; lids free, with a distinct anterior sinus. Nuchal or auditory crests consist of three longitudinal membranes on each side, united by a transverse one in front. Connective cartilages of the mantle three; the lateral ones in the form of a longitudinal ridge, with a smaller transverse one across its posterior end; corresponding cartilages on the siphon long-triangular, with a longitudinal and a transverse groove. Two oviducts. Hectocotylized arm of the male either the right or left ventral.

Pen usually very narrow along the middle portion, and with three ribs; anterior and posterior portions expanded, the latter with the edges involute, and forming a terminal hood or hollow cone.

OMMASTREPHES D'Orbigny (restricted).

Ommastrephes (*pars*) D'Orbigny, Voy. Am. Mérid., 1835; Céphal. Acétab., p. 341.
Illex and *Todarodes* Steenstrup, Oversigt K. Danske Vidensk. Selsk. Forhandl., 1880, p. 90.

Body elongated, pointed posteriorly. Caudal fin broad, transversely rhomboidal. Pen narrowed behind the middle, with a strong median rib and large marginal ribs on each side; near the posterior end thin and concave, expanded into a lanceolate form; at the tip involute and slightly hooded. Head large. Eyes with lids, having a distinct sinus in front.

Arms stout, the third pair usually stoutest, with a dorsal keel; all the arms have marginal membranes, strengthened by transverse muscular ridges, exterior to the suckers. Suckers of the arms deep and oblique, with horny rims, which are strongly denticulate on the outer margin, the median tooth usually largest. Tentacular arms rather long and contractile, stout, with a moderately wide terminal club, which has along its middle region two rows of large central suckers, and a row of smaller marginal ones alternating with them on each side; proximal part of club with small denticulated suckers only; distal part of club with four to eight rows of small denticulated suckers.

Siphon-tube placed in a groove on the under side of the head, and attached to the head by a lateral bridle on each side behind the eyes, and by a pair of bridles on its dorsal surface, at the bottom of the depression in which it is lodged. Terminal orifice transversely elliptical, furnished with an internal valve. The depression back of the siphon is smooth in our species, in some other species longitudinally furrowed.

Mantle-fastenings ("apparatus of resistance"), situated on the basal extension of the siphon, consist of two large triangular bosses, each with an elongated and somewhat ear-shaped longitudinal fosse, and a shallower transverse one. On each side of the inner surface of the mantle is a corresponding T-shaped cartilage, consisting of a short, raised, longitudinal ridge, swollen posteriorly, and a lower transverse ridge, which fit closely into the fosses on the siphon. The dorsal side of the head has a median longitudinal facet, that fits upon its counterpart on the mantle, over the anterior part of the pen, which gives it support.

The nuchal crests are formed by a transverse tegumentary fold behind the eyes, from which run backward, on each side, three longitudinal lamellæ, which are delicate, and have a sensory (perhaps olfactory) function.

Buccal membrane seven-angled, thin, corrugated on the inner surface, destitute of suckers.

Branchial auricles and gills large. Liver massive, stomach and cœcal appendage voluminous.

The male has one of the ventral arms (which may be either right or left in our species) hectocotylized near the tip, by an enlargement and flattening of the bases of the sucker-stalks, while their cups become small or abortive.

The female has oviducts developed on both sides, but they are small and simple, opening below the bases of the gills. Two symmetrical nidamental glands, which are comparatively small and simple in our species, are situated behind the heart.

Professor Steenstrup, in the paper last quoted in the above synonymy, has given a revision of the Ommastrephes group. He divides the old genus *Ommastrephes* into three genera, viz: I. ILLEX, which includes *O. illecebrosus*, with *O. Coindetii*, the closely allied Mediterranean form; II. TODARODES, which includes only the well-known *Ommastrephes todarus* of the Mediterranean, to which he restores the name *sagittatus* Lamarck, which has been otherwise employed by other authors during half a century past; III. OMMATOSTREPHES (restricted), which corresponds exactly with *Sthenoteuthis*, established by me in a paper published several months earlier. (Trans. Conn. Acad., v, p. 222, February, 1880.) In another part of his article he refers to my paper, which had been promptly sent to him, but he makes no reference whatever to the genus *Sthenoteuthis*, nor to the species *S. megaptera*, which, as a species, had been described by me still earlier (1878) and in far greater detail than most of the other species which he mentions, and which should, under his system of classification, bear the name of *Ommastrephes megaptera*. Nor does he point out any new characters for distinguishing this generic group other than those first given by me, viz, the presence of connective suckers and tubercles on the tentacular arms, proximal to the club, and the great development of the membranes on the lateral arms. Under the ordinary rule of nomenclature, by which the first correct subdivision made in an older genus shall be entitled to priority, while the original name shall be retained for the remaining group, the name *Sthenoteuthis* ought to be maintained for the division first established by me, while *Ommastrephes* (restricted) should be retained for a part or all of the remaining species.

While I very much regret this confusion of names, I perceive no way to remedy it except by the application of the usual rules of priority. I can certainly see no necessity for the imposition of new names when others equally good were already provided. As for the distinction between *Illex* and *Todarodes*, it seems to me very slight and scarcely of generic importance. *Illex* is characterized by having eight rows of small suckers on the distal part of the club and a smooth siphonal groove. *Todarodes* is characterized by having four rows of distal suckers and some small grooves or furrows at the anterior end of the siphonal groove.

But I have a species (which I refer to *O. Sloanei* Gray) from Tasmania which agrees with *Illex* in having a smooth siphonal groove, but with *Todarodes* in having only four rows of distal tentacular suckers, and in the sharp denticulation of its large suckers. According to Steenstrup's system this would have to be made still another genus, or else his generic characters would have to be entirely changed in order to admit it into either of his groups. The existence of eight rows of suckers in *Illex* seems to be due merely to the crowding together of the ordinary four rows; nor can we attach much importance to the superficial furrows in the siphon-groove. Therefore, my own opinion is that *Illex* and *Todarodes* should be reunited and should retain the name *Ommastrephes** in a restricted sense. The absence of connective suckers and tubercles on the tentacular arms will be the most important diagnostic character to distinguish it from *Sthenoteuthis* and *Architeuthis*. *Dosidicus* is, perhaps, only an abnormal *Sthenoteuthis* with partially reproduced arms.

Ommastrephes illecebrosus Verrill.—(Short-finned Squid.)

Loligo illecebrosa Lesueur, Journ. Phil. Acad. Nat. Sci., vol. ii, p. 95, plate not numbered, 1821 (figures incorrect).
Blainville, Dict. des Sci. Nat., vol. xxvii, p. 142, 1823.
Gould, Invert. Mass., ed. 1, p. 318, 1841 (habits).
Loligo piscatorum La Pylaie, Ann. des Sci. Nat., vol. iv, p. 319, 1825, pl. 16 (habits as observed at Saint Pierre).
Ommastrephes sagittatus (*pars*) D'Orbig., Céphal. Acétab., p. 345, pl. 7, figs. 1–3 (after Lesueur).
Gray (*pars*), Catalogue Moll. British Mus., part i, Cephal. Antep., p. 58, 1849.
Binney, in Gould's Invert. Mass., ed. 2, p. 510, 1870 (excl. syn.), pl. 26, figs. 341–344 [341 is imperfect]* (*not* pl. 24, fig. 339.)
Tryon (*pars*), Man. Conch., vol. i, p. 177, pl. 78, fig. 342 (very poor, after Lesueur), pl. 79, fig. 343, 1879 (*not* pl. 78, figs. 341, 345).
Ommastrephes illecebrosa Verrill, Amer. Journ. Sci., vol. iii, p. 281, 1872 (synonomy); Report on Invert. Viney. Sd., &c., 1873, pp. 441 (habits), 634 (descr.); Amer. Journ. Sci., vol. xix, p. 289, April, 1880; (*illecebrosus*) Trans. Conn. Acad., vol. v, p. 268, pls. 27, 29, figs. 5, 5 *a*, pl. 37, fig. 8, pl. 38, fig. 2, pl. 39, figs. 2, 3 *a* 3 *b*, 1880–'81.
Illex illecebrosus Steenstrup, Oversigt K. Danske Vidensk. Selsk. Forhandl., 1880, p. 90 (author's separate copy, received August, p. 20).

Plates XVIII–XX.

Body, in the younger specimens, long and slender; in the adults, especially when the stomach is distended with food, and in the breeding season, rather stout; most so in the large females; in preserved specimens the apparent stoutness of the body depends very much upon

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* I can see no necessity for the proposed reformation of the original spelling of this word by changing it to *Ommatostrephes*, for usage justifies the elision of a syllable in so long a name. The original spelling has been unchallenged for over forty years.

* This species is not well figured in the last edition of Gould's Invertebrates. Plate 25, fig. 339, which Mr. Binney refers to it, really represents a *Loligo*. Plate 26, figs. 341–344 (erroneously referred to *Loligopsis pavo*), was doubtless made from a specimen of this species, but, if so, the long arms were incorrectly drawn, and confused with the short arms.

whether the mantle was in a contracted or expanded state when the animal died. Caudal fin transversely rhomboidal, or broad spear-shape, about one-third wider than long, its breadth usually less than half the length of the mantle; the posterior borders are nearly straight and form nearly a right angle at the posterior end; the anterior margins are somewhat convexly rounded, and the front margin extends, at the sides of the body, considerably forward beyond the insertion of the fin. Ratio of fin-length to mantle-length 1:2.48 to 1:3 (the latter in the young ones). Average proportions, in eight adult specimens, of fin-length (from insertion) to length of dorsal side of mantle, about 1:2.55; breadth of fin to length of mantle, average, 1:1.90; length of head (dorsal edge of mantle to base of arms) to mantle-length, average, 1:7.15.

The head is large, well rounded; the exposed portion is shorter than broad, its breadth about equals that of the body, in ordinary contraction; its sides, in the region of the eyes, are somewhat swollen; the under surface is flattened, and has a deep, nearly smooth excavation, semicircular, or rather semielliptical, in outline, to receive the dorsal half of the siphon-tube, which fits into it closely.

The sides of the head, back of the eyes, have a rather prominent, transverse ridge, back of which the head suddenly narrows to the neck. The transverse ridges curve backward slightly and meet on the dorsal side of the head, where they are less prominent. Three thin, lamelliform, erect folds of the skin extend backward from the transverse ridge, on each side of the head; of these the middle or lateral one is about in line with the lower eyelid; the upper one is, at its origin, about midway between the latter and the median dorsal line, but its posterior edge bends downward and joins that of the one below; the lowest of the three is shorter and curves upward, and finally joins the middle one at its posterior edge. These folds form, therefore, in connection with the transverse ridge, two well-defined lateral areas or facets, of delicate and evidently very sensitive integument, placed just in front of the mantle-opening, on each side, where they must be bathed by the inflowing currents of water. A pair of large special nerves extends directly from the cephalic ganglion to these organs. It seems probable to me, therefore, that they are the seat of a special sense, analogous to, if not identical with, that of smell. They are, also, closely connected with the organs of hearing, and the crests may be of some service in concentrating sound vibrations. A small auditory pore is situated within the lower facet.

The pupils are round and the eyes are large, though the opening between the lids is usually rather small, especially in alcoholic specimens. In these the aperture is usually contracted to a small, obliquely-transverse, irregular-triangular form, or even to a narrow oblique slit; when more open, the aperture is still usually somewhat angular; the anterior sinus is narrow and extends downward and forward.

The eyelids form, when nearly expanded, an irregular oval, the longest diameter placed transversely and somewhat obliquely, while the narrow and deep sinus extends forward and somewhat downward. When partly closed (Plate XIX, fig. 4) the opening between the lids generally becomes more oblong, and sometimes approaches a triangular form.

The mantle is thick and very muscular; its anterior margin has a concave outline beneath, forming a slightly prominent angle on each side; from these angles it advances somewhat to the slight median dorsal angle, which projects forward but little, and does not form a distinct lobe, and sometimes it is hardly noticeable, even as an angle, the transverse outline of the edge on the dorsal side being, in that case, nearly straight, or advancing a very little in the middle.

The sessile arms are rather stout, tapering to acute tips. The dorsal arms are a little smaller and shorter than the others; the second and third pairs are nearly equal in size and length, the second often a trifle the longer; those of the fourth pair are usually intermediate in length between the first and second pairs.

All the sessile arms are stout and armed with similar suckers. Along their inner angles, outside the suckers, they are all similarly provided with marginal membranes, which rise to about the same height as the suckers, on each side. Just proximal to each sucker, on the inner face of the arm, arises a thickened, transverse, muscular fold, that extends to the edge of the lateral membrane, which often recedes between their extremities, so as to have a scalloped outline.

The dorsal arms are a little shorter and decidedly smaller than the others. The two lateral pairs of arms are stoutest and longest, and nearly equal, sometimes one pair and sometimes the other being longest. The ventral arms are a little longer than the dorsal and shorter than the lateral ones. The dorsal and upper lateral arms are trapezoidal in section, with the inner face rather broad. The dorsal arms have a slightly elevated, median dorsal crest, commencing near the base and running to the tip. Those of the second pair have a broader, membranous fold on the lower outer angle, along the whole length. Those of the third pair are stouter than the others, and much compressed laterally, with the outer surface rounded, close to the base, but becoming compressed and keeled farther out, and having a high median ridge or crest along its middle region, becoming narrow toward the tip. The ventral arms are trapezoidal in section, with a narrow fold along the outer angle, which is acute, while the inner ventral angle is rounded.

The tentacular arms (Plate XVIII, figs. 1 *a*, 2) are long; when extended, in fresh specimens, they reach back beyond the base of the caudal fin. They are rather stout, rounded-trapezoidal along the peduncular portion; along the upper-outer angle a thin fold runs from the base to the tip, becoming on the back side of the club a wide carina, which often folds down obliquely toward the upper margin of the club; two less marked folds run along the inner angles, defining a narrow inner face along the whole length, but on this face there are no suckers, except close to where it begins to expand into the broader face of the club; along the sides of the club the marginal membranes become much wider, rising to a level with the suckers, and have transverse muscular ridges opposite the marginal suckers, producing scalloped edges.

In the male of our species one of the ventral arms (Plate XVIII, figs. 3, 3 *a*) is strongly hectocotylized, somewhat as in *Loligo*. But in this species it is the right arm about as often as the left that is modified. Toward the tip of the arm, for some distance, the pedicels of the suckers, especially of the outer row, become shorter, and the bases of the sucker-stalks become larger, broader, and transversely compressed, while the cups of the suckers themselves decrease rapidly, till they become very minute, and on a number of the most flattened and largest stalks they are entirely abortive, in the case of the medium-sized males, but very close to the tip they may again become normal. The inner row of suckers is more or less modified in a similar manner; but fewer of the sucker-stalks are affected, and these are usually not so extensively altered, though in the larger males many of them are commonly destitute of cups and have the same flattened form as those of the outer row, with which they are usually united along the median line of the arm, forming a zigzag ridge. In a very large male (J), with the right ventral arm modified, the alteration of the sucker-stalks becomes obvious at about the 45th sucker, and there are, beyond this, about 80 modified suckers, extending to the very tip; of these, about 30, in the outer row, are represented only by the flat, lamelliform bases of the sucker-stalks, without cups; on the inner row the small cups extend for about ten suckers farther than on the outer. The lamelliform processes are united medially in a zigzag line along the entire tip. The modified part is about an inch in length. This arm is as long as its mate (though in other specimens it is often shorter); but it is broader, stouter, and more blunt at tip, both the inner face and lateral membrane being increased in width. The younger males, 4 to 6 inches long, have the corresponding suckers less extensively modified, and the cups, though very much reduced in size, are usually present on all or nearly all the stalks.

The portion of the tentacles which bears suckers is always less than half the whole length. The relative size of the suckers varies greatly in both sexes, perhaps in connection with a renewal of their horny rings. But in some extreme cases the loss of the sucker, or of the entire club, and the regeneration of a new one will best explain this variation.

The club is long and moderately broad, gradually widening from the peduncular part of the arm, and tapering at the end to a rather blunt, flattened, and curved tip, which is strongly carinated on the outer side by a thin lamina. The suckers commence a short distance in advance of the expansion of the club. They are at first small, deep cup-shaped, and somewhat scattered, in two alternate rows, but all of these small ones have oblique rims, strongly denticulated on the outer margin with four or five long incurved teeth, while the inner edge is smooth. Of the small ones, before the commencement of the two median rows of large suckers, there are from ten to fifteen.

The middle region of the club is occupied by two rows of large suckers (fig. 2) and by a row of small marginal ones, on each side, alternating with the large ones. The uppermost of the two rows of large suckers contains one or two more suckers than the lower, and they are also larger. The number in the upper row is seven to nine, in the lower five to seven, the largest specimens having the greater number. Of these, the three to five middle ones in each row are decidedly the largest, and have the edge of the marginal ring nearly smooth and even; at each end of each row the suckers diminish in size and the edge becomes denticulated, at first by the formation of narrow incisions, which leave broad, stout, blunt denticles; but as the suckers diminish in size these become longer, narrower, and more acute; their inner margins remain smooth. The large suckers are broad and moderately deep, somewhat swollen below, and a little oblique. The marginal suckers are much smaller, shallower, more oblique, and have the entire rim finely and sharply denticulated, the denticles being longer and strongly incurved on the outer margin. Beyond the rows of large suckers there is, at first, a small group of sharply denticulated suckers, in four rows, resembling the marginal ones in form and size; but these rapidly decrease in size and become more crowded, till they appear to form eight crowded rows of very small suckers, with minute apertures, which occupy the entire face of the terminal section of the club to the tip; at the extreme tip there is a cluster of small smooth-rimmed suckers, as usual.

The suckers of the sessile arms are largest on the two lateral pairs, on which they are nearly equal, and the largest are about the same in size as those on the tentacular club, the latter being often the smaller in the males, but usually the larger in the females; those of the ventral arms are smallest; those of the dorsal arms are intermediate in size between those of the lateral and ventral arms. The first few suckers (three to five), at the base of each arm, are smaller than those beyond, but increase regularly in size; they have the edge of the rim nearly entire, or with only a few blunt teeth on the outer margin; then follow about twelve suckers, of the largest size. These large suckers (Plate XIX, figs. 5, 5 *a*) are deep, oblique cup-shaped, somewhat swollen in the middle, with oblique horny rims, which are entire on the inner margin, but on the outer have a large, strongly incurved, acute median tooth, on each side of which there are usually four or five shorter, flat, blunt teeth; but toward the base of the arms these are fewer and shorter, while distally they become more numerous, longer, and more acute, and often the edge is more or less denticulate nearly all around. The larger suckers are followed by a regularly decreasing series of thirty to forty smaller secondary ones (figs. 6, 6 *a*), not counting the numerous very small ones, within one-third of an inch of the tip. These secondary suckers grade gradually into the large or primary ones, both in size and form; they are, however, armed with four or five very sharp incurved teeth on the outer margin, of which the median one is longest, while the inner margin is usually entire. They are very oblique and one-sided in form. The membrane around the rim of all the suckers is thickened, but most so on the basal ones; it usually recedes behind the large median tooth, leaving there an emargination.

The outer buccal membrane is not very large; its inner surface is closely covered with lamelliform folds and wrinkles; its border is prolonged into seven acute angles, from which membranes extend to the opposite arms, going to the upper sides of the second and fourth pairs of arms, and to the lower side of the third pair; but the seventh angle is in the median dorsal line, and the membrane from it bifurcates, one-half going to the inner side of each dorsal arm. Immediately around the jaws there is a circular, thickened, rugose oral membrane, with a strongly lobed edge, while its inner surface is radially wrinkled and covered with scattered rounded verrucæ. A plain fold intervenes between this and the outer buccal membranes. The beak and pharynx can be protruded its whole length, when in use. At such times the oral membranes are partially unfolded.

The jaws are sharp and incurved at tip, reddish brown to brownish black in color, with the posterior borders of the laminæ whitish and translucent. The upper mandible has a much incurved tip, with the cutting edges regularly curved, and with a shallow notch at their bases, beyond which the anterior edges rise into a broad, obtuse lobe or low tooth, by which the hardened and dark-colored part, as seen by transmitted light, has the form of a sharp angular tooth, but its actual projection anteriorly is but slight, because the translucent edge beyond it rises to about the same level. The lateral-posterior borders of the frontal laminæ are sinuous and incurved in the middle; the palatine lamina is broad, with the posterior lateral edges incurved and sinuous.

The lower mandible has the extreme tip strongly incurved, forming a slight notch close to the tip, below which the edges are slightly incurved or nearly straight, with a decided V-shaped notch at the base; the anterior edges, beyond the notch, form a triangular tooth of the inner laminæ, but this is obscured, unless viewed by transmitted light, by the outer alar lamina, which rises at its anterior edge, where it is translucent, nearly to a level with the tooth; the inner ends of the alæ are wider than the middle, and broadly rounded; the gular laminæ are short, narrowed posteriorly, with their inner edges incurved, and with a thickened, prominent ventral carina.

The jaws of a large specimen measure as follows: Upper mandible, tip to posterior end of palatine lamina, 22^{mm}; to dorsal end of frontal lamina, 16^{mm}; to posterior lateral edge of same, 9^{mm}; to base of cutting edge, 5^{mm}; inner edge of palatine lamina to dorsal end of frontal lamina, 17^{mm}; lower mandible, tip to inner end of alæ, 13^{mm}; to ventral notch of alæ, 4^{mm};

to ventral notch of gular laminæ, 9mm; to posterior end of same, 16mm; to base of cutting edges, 5mm.

The buccal mass has, on the outer surface of the dorsal and lateral sides, a broad, thin, brown horny plate, with a notch posteriorly, in the median line.

The odontophore (Plate XIX, fig. 3) is remarkable for the length and sharpness of the teeth, especially of the central and outer rows. The median teeth (*a*) have a long and very acute median denticle, with much shorter lateral ones. The inner lateral teeth (*b*) have broad bases and a long and very sharp central denticle, with a much shorter lateral one on the outside. The next to the outer lateral teeth (*c*) are simple, slender, and sharp. The outer lateral teeth (*d*) are much longer, strongly curved, and very acute.

The pen (Plate XVIII, fig. 4) is long and slender, with a slender mid rib and strong marginal ribs; the anterior end is thin, broad pen-shaped, subacute; from very near the anterior end it tapers gradually backward to about the posterior fourth, where it becomes very narrow, apparently consisting only of the consolidated lateral ribs and midrib, the former showing on the ventral side a thin groove between them, the latter appearing as a slender ridge on the dorsal side. The posterior portion is narrow-lanceolate in form, with thin edges and a strong midrib, composed of the united marginal ribs of the anterior portion; the thin edges are incurved, so as to give a canoe-shaped form to this portion, and near the tip the edges unite beneath into a short, hood-like tip. Anteriorly the lateral ribs show two grooves on the ventral side, and appear to be composed of three united ribs.

The ground-color of a specimen taken by me in 1870 at Eastport, Me., when first caught, was pale bluish white, with green, blue, and yellow iridescence on the sides and lower surface; the whole body, head, and outer surfaces of arms and fins were more or less thickly covered with small, unequal, circular, orange-brown and dark brown spots, having crenulate margins; these spots were continually changing in size, from mere points, when they were nearly black, to spots 1mm to 1.5mm in diameter, when they were pale orange-brown, becoming lighter colored as they expanded. On the lower side of body, head, and siphon the spots were more scattered, but the intervals were generally less than the diameter of the spots. On the upper side the spots were much crowded and in different planes, with the edges often overlapping, thus increasing the variety of the tints. Along the middle of the back the ground-color was pale flesh-color, with a distinct median dorsal band, along which the spots were more crowded and tinged with green in fine specks. Above each eye there was a broad lunate spot of light purplish red, with smaller and much crowded brown spots. The upper surface of the head was deeply colored by the brown spots, which were here larger, darker, and more crowded than elsewhere, and situated in several strata. The under sides of the arms and fins were colored like the body, except that the spots were smaller and much less numerous. The suckers were pure white. The eyes were dark, blue-black, surrounded by an iridescent border.

The colors change constantly, when living or recently dead, by means of the continual contraction and dilation of the chromatophores. The different tints pass over the surface like blushes.

In specimens recently preserved in alcohol the same pattern of coloration is usually visible. The dark dorsal band on the body and head, and the dark patches above the eyes, as well as smaller dark patches in front of the eyes, can be plainly seen. In these darker parts the chromatophores are much crowded, and have a purplish brown color, varying to chocolate-brown in specimens longer preserved. On other parts of the body the chromatophores are more scattered and usually reddish brown in color, with a circular or elliptical outline; when expanded, the larger ones are about 1^{mm} in diameter. The under surfaces of the fins, siphon, head, and arms have fewer and smaller spots, and are, therefore, lighter colored, and appear nearly white when these spots are contracted.

A fresh specimen, caught in Casco Bay, in 1873, had the following proportions: Length of head and body, not including the arms, 221^{mm}; length of caudal fin, 86^{mm}; breadth of fin, 90^{mm}; diameter of body, 35^{mm}; length of upper arms, 80^{mm}; of second pair, 100^{mm}; of third pair, 100^{mm}; of the ventral pair, 90^{mm}; of tentacular arms, 182^{mm}.

Of our species I have measured large numbers of specimens preserved in different ways, and also fresh, and have found no great variation in the form and relative length of the caudal fin, among specimens of similar size and in similar states of preservation, nor do the sexes differ much in this respect. The young, however, differ very decidedly from the large specimens in these proportions. The modes of preservation also cause much of the variation in the proportions of fins and arms to the mantle. The two sexes are probably equally numerous, but in our collections the females usually predominate, and the largest specimens are usually females, though equally large males occur. In 31 measured specimens, in alcohol, from various localities and of both sexes, the average length, from tip of tail to dorsal edge of the mantle, was 176^{mm} (6.96 inches); from tip of tail to insertion of fin, 66^{mm} (2.60 inches). Average proportion of fin to mantle-length, 1:2.68. Among these the proportions varied from as low as 1:2.48, in some of the larger ones (with mantle above 8 inches), up to 1:3 in the smaller ones (with the mantle less than 3 inches long).

The following tables are intended to illustrate the natural variations in the proportion, due mainly to age, and the accidental variations caused by differences in the modes of preservation and strength of the alcohol. The effect of strong alcohol is to shrink the fins relatively more in breadth than in length, and to reduce the diameter of the body and arms out of proportion to their length.

The specimens from Eastport, Me., designated G, H, I, R, were collected at one time, in midsummer, and preserved in the same way, in alcohol of moderate strength, repeatedly changed; at the present time the strength of the alcohol is about 80 per cent. They are in good condition, moderately firm and not badly contracted. Those designated as D, E, F, N, O, P were also collected at one time, in August, and preserved together. They are in fair condition, but not so well preserved as the former lot. Those numbered ii to xiv were preserved together about the last of July. They were placed in strong alcohol, and are hard and badly contracted. J, K, and L were preserved together, but were originally found dead on the beach and in a relaxed state. They are only moderately contracted by the alcohol.

Measurements of Ommastrephes illecebrosus (in inches).

	O♀	P♀	D♀	E♀	J♂	I♂	R♂	W♂	Fresh.
Tail to tip of dorsal arms	13.40	13.00	12.75	10.50	13.50	10.50	10.50	8.25	12.04
Tail to tip of second pair arms	14.20	13.70	......	......	14.30	10.80	11.10	......	12.84
Tail to tip of third pair arms	14.20	13.70	13.25	11.00	14.20	11.00	11.20	......	12.84
Tail to tip of fourth pair arms	13.10	13.60	......	......	13.40	10.60	11.00	......	12.44
Tail to tip of tentacular arms	16.50	17.50	15.5	12.00	15.50	12.20	12.50	......	16.12
Tail to base of dorsal arms	10.00	9.40	9.00	7.90	10.00	8.30	8.20	6.50	8.84
Tail to center of eye	9.30	8.90	8.25	7.35	9.50	7.75	7.70	......	......
Tail to edge of mantle, above	8.60	8.00	7.75	7.10	8.70	7.50	7.20	5.70	......
Tail to edge of mantle, below	8.20	7.50	7.30	......	8.10	7.15	6.65	5.38	......
Tail to insertion of fin	3.30	3.20	3.10	2.75	3.50	2.90	2.80	2.10	3.44?
Breadth of fin	4.20	4.30	4.25	3.78	5.15	3.80	3.90	2.65	3.60
Between lateral insertions	......	......	.50	.40	.65	.45	......	......	......
Front edge, outer angle to insertion	2.20	2.20	2.00	1.90	2.50	2.80	2.10	1.45	......
Outer angle to tip of tail	3.30	3.25	3.15	2.90	3.50	3.00	2.90	2.00	......
Circumference of body	4.80	4.80	......	......	6.50	4.30	4.00	......	......
Breadth of body	1.70	1.60	......	......	2.15	1.30	1.40	1.10	1.40
Breadth of head at eyes	1.60	1.50	1.35	1.15	1.65	1.20	1.30	1.00	......
Breadth of eye-opening	.40	.45	.35	......	.36	.20	.23	.25	......
Breadth of siphon at bridle	.75	.70	.65	.55	.78	.60	.55	......	......
Length of head, mantle to base of dorsal arms	1.40	1.40	1.25	.80	1.30	.80	1.00	.80	......
Length of dorsal arms	3.75	3.60	3.25	2.70	2.65	2.20	2.43	1.75	3.20
Length of 2d pair	4.30	4.20	4.00	3.15	4.40	2.70	3.12	2.25	4.00
Length of 3d pair	4.10	4.25	4.00	3.00	4.55	2.67	3.15	2.25	4.00
Length of 4th pair	3.60	3.80	3.50	2.80	3.80	2.43	2.75	2.00	3.60
Length of tentacular arms	6.80	8.00	6.50	4.00	5.80	4.00	4.10	4.50	7.28
Length of club	3.30	3.50	2.75	1.85	2.55	1.75	1.90	1.30	......
Breadth of dorsal arms	.35	.36	.28	.25	.35	.30	......	.20	......
Breadth of 2d pair	.45	.44	.35	.30	.45	.35	......	.25	......
Breadth of 3d pair	.45	.44	.35	.28	.50	.35	......	.25	......
Breadth of 4th pair	.44	.42	.32	.30	.45	.35	......	.25	......
Breadth of tentacular arms	.25	.28	.30	.30	.28	.20	......	.17	......
Breadth of club	.30	.30	.22	.18	.25	.22	......	......	......
Front to back of 3d pair	.65	.60	.50	.40	.65	.45	......	......	......
DIAMETER OF SUCKERS.									
Largest on tentacular arms	.18	.17	.15	.11	.17	.11	.13	......	......
Largest on 3d pair	.18	.16	.14	.11	.20	.14	.14	......	......
Largest on ventral arms	.11	.11	.10	.09	.11	.09	.07	......	......
PROPORTIONS.									
Fin-length to mantle-length, 1:	2.60	2.50	2.50	2.58	2.48	2.58	2.57	2.71	......
Fin-breadth to mantle-length, 1:	2.04	1.86	1.82	1.87	1.69	1.97	1.84	2.15	......
Length* to breadth of fin, 1:	1.27	1.34	1.37	1.37	1.46	1.30	1.39	1.26	......
Length of head to mantle, 1:	6.14	5.70	6.20	8.87	6.70	9.30	7.20	7.12	......
Length of dorsal arm to mantle, 1:	2.29	2.22	2.38	2.62	3.28	3.40	2.96	3.25	......
Tentacular suckers to mantle, 1:	47.77	47,05	51.66	64.54	51.20	68.18	55.38	......	......

* The length of the fin, in these tables, means the distance from the lateral insertions to the tip of the tail, which is somewhat less than the extreme length.

Some specimens, included both in this and the following tables, show small differences in their measurements (made at different times), due partly to the different degrees of extension employed in measuring them, and partly to the fact that the alcohol had been changed and its strength altered.

Measurements of Ommastrephes illecebrosus, females (in inches).

	Vineyard Sound.	Newfoundland.	Halifax.	Eastport.	Eastport.	Eastport.	Eastport.	Eastport.	Eastport.	Casco Bay.	Eastport.	Casco Bay.	Cape Cod.	Maine.	Cape Cod.	Cape Cod.	Cape Cod.	Cape Cod.
Sex and designation	♀ K	♀ Q	♀ 10028	♀ O	♀ N	♀ G	♀ P	♀ D	♀ F	♀ U	♀ E	♀ T	♀ x	♀ X	♀ iii	♀ xiii	♀ xiv	♀ ii
End of body to edge of mantle, above	9.50	8.80	8.70	8.70	8.70	8.60	8.10	7.80	7.80	7.45	7.15	6.85	6.25	5.55	4.40	4.15	4.10	4.00
End of body to same, beneath	8.70	8.40	7.90	8.30	8.05	8.10	7.60	7.30	7.20	6.85	7.00	6.50	6.10	5.30	4.00	3.90	3.85	3.70
End of body to origin of fin	3.70	3.50	3.60	3.40	3.50	3.40	3.20	3.10	3.10	3.00	2.80	2.85	2.40	2.15	1.60	1.50	1.40	1.45
End of body to center of eye	10.00	9.60	9.70	9.10	9.00	9.30	9.10	8.25	8.30	7.98	7.60	7.30	6.70	5.80	4.70	4.30	4.20	4.35
End of body to base of dorsal arms	10.50	10.50	10.50	9.90	9.70	10.00	9.85	9.00	8.70	8.20	8.00	7.80	7.20	6.20	5.00	4.60	4.55	4.50
Eye to tip of dorsal arms	4.80	4.70	5.60	4.30	4.45	4.20	4.20	4.00	3.30	3.00	3.50	2.30	2.65	......	1.65	1.40	1.40	1.35
Eye to tip of 2d pair arms	5.60	5.10	6.30	4.75	4.95	4.40	4.70	4.55	3.90	3.50	8.70	3.25	2.65	2.55	1.85	1.65	1.50	1.45
Eye to tip of 3d pair arms	5.40	5.15	6.20	4.75	4.65	4.30	4.75	4.50	3.65	3.45	3.60	3.30	2.80	2.50	1.80	1.70	1.55	1.50
Eye to tip of 4th pair arms	5.40	5.00	6.15	3.80	4.40	4.20	4.75	4.30	3.60	3.20	3.20	3.20	2.70	......	1.70	1.60	1.30	1.40
Eye to tip of tentacular arms	8.10	7.00	10.50	7.00	6.00	5.50	8.00	7.00	6.10	4.80	4.60	4.95	3.70	3.40	2.40	2.30	2.00	1.90
Breadth of head across eyes	1.30	1.90	1.50	1.60	1.50	1.55	1.30	1.35	1.20	1.35	1.15	1.10	1.05	1.00	.80	.70	.70	.70
Breadth of head in front of eyes	1.45	1.65	......	1.40	1.50	1.50	1.30	......	1.10	1.25	......	1.00	1.00	......	.70	.70	.60	.60
Breadth of body	1.72	2.35	......	1.60	1.90	1.85	1.00	......	1.20	1.50	......	1.25	1.20	......	.80	.80	.70	.80
Breadth of caudal fins	5.50	5.50	5.30	4.15	4.85	5.00	4.30	4.25	4.00	4.05	3.85	3.70	3.10	2.85	2.20	2.05	1.90	1.95
Circumference of body	5.65	6.80	......	4.70	5.25	5.80	4.75	......	3.90	4.40	......	3.70	3.50	......	2.20	2.25	2.20	2.10
Length of tentacular club	2.85	2.70	4.20	3.20	2.75	2.60	8.15	2.75	2.00	2.00	1.85	1.90	1.55	1.55	1.10	.90	.95	.90
Diameter of largest suckers of club	.16	.17	.19	.18	.18	.20	.17	.15	.12	......	.11	......	......	......	......	......	......	......
Diameter of largest suckers of 3d pair arms	.16	.18	.20	.18	.20	.19	.16	.14	.13	......	.11	......	......	......	......	......	......	......
PROPORTIONS.																		
Ratio of fin to length of mantle, 1:	2.56	2.51	2.41	2.56	2.46	2.52	2.53	2.51	2.51	2.48	2.55	2.40	2.60	2.58	2.75	2.76	2.85	2.75
Breadth of fin to length of mantle, 1:	1.72	1.60	1.64	2.09	1.80	1.72	1.88	1.85	1.95	1.83	1.85	1.85	2.01	1.95	2.00	2.02	2.16	2.05

Measurements of Ommastrephes illecebrosus, males (in inches).

	Vineyard Sound.	Vineyard Sound.	Eastport.	Eastport.	Eastport.	Vineyard Sound.	Cape Cod.	Cape Cod.	Massachusetts Bay.	Cape Cod.	Cape Cod.	Cape Cod.	Cape Cod.	Cape Cod.	Cape Cod.	Newport.
Sex and designation	♂ J	♂ L	♂ H	♂ I	♂ R	♂ M	♂ ix	♂ vii	♂ W	♂ xii	♂ xi	♂ viii	♂ iv	♂ vi	♂ v	10280
End of body to edge of mantle, above	8.70	8.50	7.80	7.45	7.10	6.80	6.70	6.70	6.15	5.80	5.60	5.55	5.25	4.15	4.05	2.70
End of body to same, beneath	8.10	8.00	7.30	7.10	6.70	6.35	6.15	6.30	6.00	5.70	5.40	5.25	4.80	4.00	3.90	2.60
End of body to origin of fin	3.50	3.30	3.00	2.90	2.80	2.70	2.60	2.60	2.30	2.20	2.20	2.10	2.00	1.50	1.45	.90
End of body to center of eye	9.50	9.30	8.20	7.80	7.50	7.10	6.90	7.10	6.80	6.25	5.90	5.90	5.45	4.40	4.10	3.00
End of body to base of dorsal arms	10.00	10.30	9.00	8.20	8.20	7.80	7.70	7.70	7.10	6.60	6.50	6.30	5.75	4.80	4.50	3.15
Eye to tip of dorsal arms	4.50	4.15	3.05	2.60	2.95	3.30	3.00	2.90	2.70	2.35	2.50	2.10	2.05	1.50	1.35	1.20
Eye to tip of 2d pair of arms	4.90	4.80	3.50	2.95	3.20	3.60	3.30	3.10	3.00	2.65	2.80	2.35	2.30	1.70	1.50	1.65
Eye to tip of 3d pair of arms	4.95	4.90	3.30	2.95	3.40	3.80	3.10	3.00	2.95	2.40	2.60	2.35	2.20	1.70	1.45	1.55
Eye to tip of 4th pair of arms	4.50	4.10	3.10	2.90	3.20	3.35	2.95	2.90	2.70	2.25	2.50	2.00	2.20	1.50	1.35	1.25
Eye to tip of tentacular arms	6.50	5.70	4.40	4.00	4.20	4.85	5.40	4.20	3.70	3.10	3.60	3.30	2.75	2.20	2.15	2.25
Breadth of head across eyes	1.60	1.30	1.40	1.15	1.30	1.00	1.10	1.20	1.20	.90	1.00	1.00	.90	.80	.75	.58
Breadth of head in front of eyes	1.60	1.30	1.25	1.05	1.20	1.00	1.00	1.05	1.00	.85	.90	.90	.80	.65	.70	.46
Breadth of body	2.10	1.75	1.55	1.40	1.35	1.20	1.15	1.10	1.05	1.00	1.15	.95	.90	.70	.80	.60
Breadth of caudal fins	5.15	4.35	4.30	3.60	3.75	3.70	3.40	3.30	3.00	2.70	2.75	2.70	2.60	2.05	1.90	1.35
Circumference of body	6.30	5.60	4.80	4.30	4.05	3.90	3.80	3.20	3.10	3.15	3.30	2.90	2.95	2.40	2.40	......
Length of tentacular club	2.55	2.50	1.89	1.60	1.85	2.30	2.10	1.65	1.60	1.40	1.50	1.40	1.20	1.00	.95	1.15
Diameter of largest suckers of club	.17	.14	.12	.11	.13	......	......	......	......	......	......	......	......	......	......	.01
Diameter of largest suckers on 3d pair arms	.20	.16	.15	.14	.14	......	......	......	......	......	......	......	......	......	......	......
PROPORTIONS.																
Ratio of fin to length of mantle, 1:	2.48	2.57	2.60	2.57	2.53	2.51	2.58	2.58	2.67	2.63	2.54	2.64	2.62	2.76	2.80	3.00
Breadth of fin to length of mantle, 1:	1.69	1.95	1.81	2.10	1.90	1.83	1.97	2.03	2.05	2.15	2.03	2.05	2.02	2.02	2.15	2.00

Off the coast of Rhode Island to Cumberland Gulf. Abundant from Cape Cod to Newfoundland. About 100 miles south of Newport, R. I., in 65 to 372 fathoms (U. S. Fish Com.). Vineyard Sound, Massachusetts, rare, large in winter, small in May (V. N. Edwards).

Recent explorations have extended the range of this species much farther southward, in the deep water near the edge of the Gulf Stream. Although we cannot be certain that specimens caught in the trawl were living at the bottom, owing to the possibility of their entering it during its ascent, it is very probable that they do actually inhabit those depths. This is rendered more certain by the fact that we found adult specimens in the stomachs of fishes (*Lophius*) taken at stations 865 and 893. The most southern specimens known were taken by Mr. A. Agassiz, on the "Blake," off Cape Hatteras, in 263 fathoms.

Ommastrephes illecebrosus.—Specimens examined.

Number.	Locality.	When collected.	Received from—	Specimens. No., sex.
10280	Newport, R. I	1872	United States Fish Commission.	1 young.
10027, J	Vineyard Sound	Nov. 2, 1876	V. N. Edwards	1 ♂, left hand.
10027, K	do	do	do	1 ♀.
10027, L	do	do	do	1 ♀.
M	do	May, 1876	do	1 ♂, right hand.
W	Provincetown, Mass	July, 1879	United States Fish Commission.	1♂, figured.
	do	do	do	9 ♂.
	do	do	do	5 ♀.
	do	do	do	3 young.
	do	do	do	28 +, duplicates.
	Salem, Mass	Oct. 25, 1873	J. H. Emerton	1 ♀.
	Gloucester, Mass., loc. 233	1878	United States Fish Commission.	1 young.
S. T. U	Casco Bay, Me	1873	do	3 ♀.
X	Off Seguin Island, Me. (50 fathoms).	1879	(Lot. 517) United States Fish Commission.	1 ♀ young.
	Mount Desert, Me	1860	A. E. Verrill	50 +, large.
	Off Cashe's Ledge	1873 (loc. 21)	United States Fish Commission.	1 mutilated.
9693, G	Eastport, Me	1870	A. E. Verrill	1 ♀, large.
9693, H, I	do	do	do	2 ♂, left hand.
9693, R	do	do	do	1 ♂, right hand.
D. E. F	do	1872	United States Fish Commission.	3 ♀, large.
N. O. P	do	do	do	3 ♀.
	do	do	do	1 young.
	Halifax, N. S	J. R. Willis	Smithsonian	Do.
10028	do	J. M. Jones	J. M. Jones	1 ♀, large.
10278, Q	Newfoundland	do	do	Do.
	Cumberland Gulf	L. Kumlein	National Museum	1 mutilated.
865	North latitude 40° 05′; west longitude 70° 23′ (65 fathoms).	1880	United States Fish Commission.	1 adult.
893	North latitude 39° 52′ 20″; west longitude 70° 58′ (372 fathoms).	do	do	Do.
CCCXXXII	North latitude 35° 45′ 30″; west longitude 74° 48′ (263 fathoms).	do	"Blake" expedition.	3 ♀, adult.

Several of the smaller specimens included in this list are so young that it is impossible to determine their sex with certainty without dissection. The hectocotylization of the ventral arm in the male is scarcely recognizable in those with the mantle less than 4 inches long.

The Mediterranean form (*Ommastrephes Coindetii* Verany), usually identified with the *var. b* of *Loligo sagittata* Lamarck, 1799,* is closely

* It seems more probable, however, that Lamarck's description applied rather to *O. Bartramii* (Les. sp.) of the Gulf Stream region. Blainville and others have thus applied it, correctly, as I believe.

related to our species, but if the published figures and descriptions can be relied upon, it can hardly be identical, as D'Orbigny and other writers have considered it. The American form has a more elongated body, with a differently-shaped caudal fin, which is relatively shorter than the best authors attribute to *O. sagittatus*. The figure given by Verany is, however, an exception in this respect, for in it the body is represented about as long as in some of our larger specimens.† It should be remarked, however, that Lesueur's figure of *O. illecebrosus* shows the body too small and too short in proportion to the size of the fin, and the fin wrong in shape and occupying more than half the length of the mantle; the proportions of the arms are also erroneous. But Lesueur explains these defects by his statement that the figures were hasty sketches made for the sake of preserving the colors, and that he saved a specimen by which to correct, afterwards, his drawings and description, but the specimen saved turned out to be *Taonius pavo*, so that the original sketches were published without correction. Tryon's fig. 342 is a poor copy of one of Lesueur's, published without credit to him.

If the European form be really identical with the American, the distribution is very anomalous, for while the former is a Southern European form, inhabiting the Mediterranean and scarcely extending north of the southern waters of Great Britain, where it appears to be rare, our species is a strictly northern, cold-water form, rarely found south of Cape Cod, even in winter, unless in deep water. Its range extends quite to the Arctic Ocean.

Notes on habits.

When living, this is a very beautiful creature, owing to the brilliancy of its eyes and its bright and quickly-changing colors. It is also very quick and graceful in its movements. This is the most common "squid" north of Cape Cod, and extends as far south as Newport, R. I., and in deep water to the region off Cape Hatteras. It is very abundant in Massachusetts Bay, the Bay of Fundy, and northward to Newfoundland. It is taken on the coast of Newfoundland in immense numbers, and used as bait for codfish. It occurs in vast schools when it visits the coast, but whether it seeks those shores for the purpose of spawning or in search of food is not known. I have been unable to learn anything personally in regard to its breeding habits, nor have I been able to ascertain that any one has any information in regard either to the time, manner, or place of spawning. At Eastport, Me., I have several times observed them in large numbers in midsummer. But at that time they

†According to Jeffreys (Brit. Conch., vol. v, p. 229, pl. 5), the English *O. sagittatus* has the fin "from $\frac{2}{5}$ to nearly $\frac{1}{2}$ the length of the mantle;" and the form of the pen, especially of the posterior end, as figured by him, is different from that of our species,

Professor Steenstrup, in a recent article (Oversigt K. Danske Vidensk. Selsk. Forhandl., 1880), separates the Mediterranean from the American form. He restores, in the same article, the name *sagittatus* to *var. a* of Lamarck (= *O. todarus* of most modern authors), which he now calls *Todarodes sagittatus*.

seemed to be wholly engaged in the pursuit of food, following the schools of herring, which were then in pursuit of shrimp (*Thysanopoda Norvegica*), which occur in the Bay of Fundy, at times, in great quantities, swimming at the surface. The stomachs of the squids taken on these occasions were distended with fragments of *Thysanopoda*, or with the flesh of the herring, or with a mixture of the two, but their reproductive organs were not in an active condition. The same is true of all the specimens that I have taken at other localities in summer. From the fact that the oviducts are small and simple, and the nidamental glands little developed, I believe that it will eventually prove that this species discharges its eggs free in the ocean, and that they will be found floating at the surface, either singly or in gelatinous masses or bands, not having any complicated capsules to inclose them. Nothing is known as to the length of time required by this species to attain its full size. It probably lives several years.

This squid is an exceedingly active creature, darting with great velocity backward, or in any other direction, by means of the reaction of the jet of water which is ejected with great force from the siphon, and which may be directed forward or backward, or to the right or left, by bending the siphon. Even when confined in a limited space, as in a fish-pound, it is not an easy matter to capture them with a dip-net, so quick will they dart away to the right and left. When darting rapidly the lobes of the caudal fin are closely wrapped around the body* and the arms are held tightly together, forming an acute bundle in front, so that the animal, in this condition, is sharp at both ends, and passes through the water with the least possible resistance. Its caudal fin is used as an accessory organ of locomotion when it slowly swims about or balances itself for some time nearly in one position in the water.

The best observations of the modes of capturing its prey are by Messrs. S. I. Smith and Oscar Harger, who observed it at Provincetown, Mass., among the wharves, in large numbers, July 28, 1872, engaged in capturing and devouring the young mackerel, which were swimming about in "schools," and at that time were about four or five inches long. In attacking the mackerel they would suddenly dart backward among the fish with the velocity of an arrow, and as suddenly turn obliquely to the right or left and seize a fish, which was almost instantly killed by a bite in the back of the neck with their sharp beaks. The bite was always made in the same place, cutting out a triangular piece of flesh, and was deep enough to penetrate to the spinal cord. The attacks were not always successful, and were some-

* This position of the fins is very well shown in Plate 26, fig. 341, of Binney's edition of Gould's Invertebrata of Massachusetts. This figure was probably drawn by Mr. Burkhardt from living specimens formerly kept in Cutting's Aquarium, in Boston, about 1860 to 1862. This figure is very good, in most respects, except that the clubs of the tentacles have been confounded with the ventral pair of the sessile arms, and thus the suckers are represented as if they extended along the whole length of the tentacles.

times repeated a dozen times before one of these active and wary fishes could be caught. Sometimes, after making several unsuccessful attempts, one of the squids would suddenly drop to the bottom, and, resting upon the sand, would change its color to that of the sand so perfectly as to be almost invisible. In this position it would wait until the fishes came back, and when they were swimming close to or over the ambuscade, the squid, by a sudden dart, would be pretty sure to secure a fish. Ordinarily, when swimming, they were thickly spotted with red and brown, but when darting among the mackerel they appeared translucent and pale. The mackerel, however, seemed to have learned that the shallow water was the safest for them, and would hug the shore as closely as possible, so that in pursuing them many of the squids became stranded and perished by hundreds, for when they once touch the shore they begin to pump water from their siphons with great energy, and this usually forces them farther and farther up the beach. At such times they often discharge their ink in large quantities. The attacks on the young mackerel were observed mostly at or near high-water, for at other times the mackerel were seldom seen, though the squids were seen swimming about at all hours, and these attacks were observed both in the day and evening.

It is probable, from various observations, that this and other species of squids are mainly nocturnal in their habits, or at least are much more active in the night than in the day. Those that are caught in the pounds and weirs mostly enter in the night, evidently while swimming along the shores in "schools." They often get aground on the sand-flats at Provincetown, Mass., in the night. On the islands in the Bay of Fundy, even where there are no flats, I have often found them in the morning, stranded on the beaches in immense numbers, especially when there is a full moon, and it is thought by many of the fishermen that this is because, like many other nocturnal animals, they have the habit of turning toward and gazing at a bright light, and since they swim backwards, they get ashore on the beaches opposite the position of the moon. This habit is also sometimes taken advantage of by the fishermen, who capture them for bait for codfish. They go out in dark nights with torches in their boats, and by advancing slowly toward a beach, drive them ashore. They are taken in large quantities in nets and pounds, and also by means of "jigs" or groups of hooks, which are moved up and down in the water, and to which the squids cling, and are then quickly pulled out of the water. They are also sometimes caught by fish-hooks, or adhering to the bait used for fishes.

Their habit of discharging an inky fluid through the siphon, when irritated or alarmed, is well known. The ink is said to have caustic and irritating properties.

This squid, like the *Loligo*, is eagerly pursued by the cod and many other voracious fishes, even when adult. Among its enemies while young are the full-grown mackerel, who thus retaliate for the massacre of their own young by the squids. The specimens observed catching young mackerel were mostly 8 to 10 inches long, and some of them were still larger.

This species, like the common *Loligo*, has the instincts and habits of a cannibal, for small squids of its own species form one of the most common articles of its diet. From an adult female of ordinary size (G, of our tables), caught at Eastport, Me., I took a great mass of fragments of small squids, with which the stomach was greatly distended. These fragments completely filled a vial having a capacity of four fluid ounces.

From the rapidity with which the squids devour the fish that they capture, it is evident that the jaws are the principal organs used, and that the odontophore plays only a subordinate part in feeding. This is confirmed by the condition of the food ordinarily found in the stomach, for both the fishes and the shrimp are usually in fragments and shreds of some size, and smaller creatures, like Amphipods, are often found entire, or nearly so; even the vertebræ and other bones of herring are often present. On the other hand, in some specimens, the contents of the stomach are finely divided, as if the odontophore had been used for that purpose.

Notes on the visceral anatomy.

Plate XIX, figure 1. Plate XX, figure 1.

This species, in common with others of the same genus, is very different from *Loligo Pealei* in the form and structure of many of its internal organs. The branchial cavity is larger and the gills (*g*, *g*) originate farther back and are much larger than in *Loligo*, their length being about two-fifths the entire length of the body; they originate back nearly at the middle of the body. The liver (*l*, *l*) is much larger and more conspicuous, consisting of two large, oblong, lateral lobes or masses, closely united together in the median plane, with a groove along the dorsal side, in which lies the œsophagus. The ink-bag (*i*) is elongated-pyriform, with a silvery luster externally, but blackish when filled with the ink. The size and form of the stomach and its cœcal lobe (*s*, *s′*) vary greatly according to their degree of distention with food. When well filled they are very large, saccular, and more or less pyriform, the cœcal lobe extending back nearly to the end of the body. The walls of the stomach are in part thick, muscular, and longitudinally plicated within. The intestine (*h*) has two spatulate papillæ, one on each side of the anal orifice.

The heart (*H*) is large, somewhat irregular and unsymmetrical, with four points, the two lateral continuous with the afferent vessels (*bo*) of the gills; the anterior passing into the anterior aorta (*ao*); the posterior median one, continuous with the posterior aorta, gives off first a small ventral branch, which supplies the reproductive organs, and then, later, a median ventral artery (*o*), going to the mantle; while much farther back it divides into two branches (*o′*, *o′*), which supply the sides of the mantle and caudal fin. The branchial auricles (*au*) are large and ovate, with a small, round capsule at the posterior end.

The anterior urinary organs or 'kidneys' (*r*, *r*) are voluminous, deeply lobulated organs, intimately united together and connected with the venæ cavæ, and mostly situated below and in front of the heart, but there are two more compact glandular portions (r') extending, as usual, backward along each of the posterior venæ cavæ (vc'') in the form of a long pyriform gland. Just in front of the bases of the gills, on each side, there is a circular opening (u) through the peritoneal membrane, which probably gives exit to the urinary excretions.

The reproductive organs of the female, however, present the greatest divergence from *Loligo* and allied forms. Instead of having a single large oviduct on the left side only, and opening far forward, we find in this genus two small oviducts (od), symmetrically placed and opening much farther back. The ends are free, near the bases of the gills, but behind them, instead of passing over the dorsal sides of the bases of the gills, as in *Loligo* and other genera. The apertures of the oviducts are simple elongated slits. Moreover, instead of the large and very conspicuous, nidamental glands, situated in front of the heart, as in *Loligo*, we find in *Ommastrephes* much smaller and simpler glands (xx), situated much farther back, side by side, near the median line, behind the heart.

The ovary (ov) is a long, pyriform, lobulated organ; its anterior end is attached to the posterior end of the stomach, and is divided into several short lobes, which clasp the end of the stomach; its small posterior end extends backward into the concavity of the hooded portion of the pen (p'').

The spermary or testicle of the male (Plate XIX, fig. 1, t) occupies the same position as the ovary; it is a more compact organ, with a smoother surface, and the anterior lobes are longer and narrower and extend farther forward along the sides of the stomach. The prostate gland and other male organs resemble those of *Loligo* (see Plate XXIX, figs. 1, 2).

It must be borne in mind, however, that none of the specimens examined were in their breeding season. Consequently, the reproductive organs were all much smaller and less conspicuous than they would have been in breeding individuals. This is particularly the case with the ovaries and oviducts, but the same remark would also apply to the nidamental glands, which might assume a different form, as well as much greater volume, at the breeding season.

The specimens dissected had all been preserved in alcohol, which would cause these organs to appear smaller than is natural.

STHENOTEUTHIS Verrill.

Ommastrephes (*pars*) D'Orbigny, Voy. Amér. Mérid., Moll. (1835?); Céphal. Acétab., 1839–'48.

Sthenoteuthis Verrill, Trans. Conn. Acad., vol. v, p. 222, Feb., 1880; Amer. Journ. Sci., vol. xix, p. 289, April, 1880.

Ommatostrephes Steenstrup, Oversigt K. Danske Vidensk. Selsk. Forhandl., 1880, p. 89, (sep. copy, p. 19, received Aug., 1880).

This group was instituted to include certain species of squids remarkable for the connective suckers on the tentacular arms, for the large size and high development of their organs of locomotion, especially of the caudal fin and siphon, and for the presence of a broad, thin web along the lower side of the lateral arms, outside the suckers.

The tentacular arms are, like those of *Architeuthis*, very long, slender, and provided at the base of the club with smooth-rimmed connective suckers, alternating with rounded tubercles, for the mutual adhesion of the two arms; the central part of the club is, as in *Architeuthis*, provided with two central rows of large serrated suckers, and a row of smaller marginal ones on each side, of different form, alternating with them. The lateral arms have a well-developed median crest (most developed on the third pair) along the outer side; on the lower inner angle there is a thin, membranous web, often more than twice as wide as the arm, along the whole length, much more highly developed than in typical *Ommastrephes*, in which a narrow marginal membrane occurs. On the ventral arms the inner face is broader than on the others, and the two rows of suckers are farther apart. The suckers on all the sessile arms are strongly denticulated on the outer side of the rim, with smaller or obsolete teeth on the inner side.

Caudal fin very large, rhomboidal. Internal bone or pen similar to that of *Ommastrephes*, decidedly hooded at the posterior end.

Odontophore with seven rows of teeth; median tooth with three large denticles; inner lateral teeth with two unequal points; two outer laterals simple, slender. Eyes as in *Ommastrephes*.

This group is related on one side to *Architeuthis*, on the other to *Ommastrephes*. The armature of the tentacular arms will distinguish it from the latter, and the large caudal fin and broad membrane of the sessile arms from former.* The dentition of the type is peculiar, so far as known. In addition to the typical species, this genus will doubtless include several species with marginal webs that have hitherto been referred to *Ommastrephes*, but they are often too indefinitely described and figured to show the special characters referred to.

Among those that belong, without much doubt, to this genus, in addition to those described below, are *S. Oualaniensis* (Lesson), and *S. pelagicus* (Bosc), and possibly *O. gigas* D'Orb., though the latter does not have the wide lateral membrane on the arms.

Sthenoteuthis megaptera Verrill.—(Large Broad-finned Squid.)

Architeuthis megaptera Verrill, Amer. Journ. Sci., vol. xvi, p. 207, 1878.
Tryon, Manual of Conchology, vol. i, p. 187 (description copied from preceding paper).
Sthenoteuthis megaptera Verrill, Trans. Conn. Acad., vol. v, pp. 223, 286, pl. 21, figs. 1-9, pl. 27, fig. 6, pl. 45, figs. 5, 5 *a*, 1880-'81; Amer. Journ. Sci., vol. xix, p. 288, 1880.

Plate XVI, figs. 1-10.

Although very much larger and stouter than any of the ordinary squids, this species is much smaller than the species of *Architeuthis*, the

*According to the statement of Gervais, *Architeuthis dux* has similar membranes.

total length of the body and head being but 19 inches. Body relatively short and thick. The caudal fin is remarkably large and broad; it is more than twice as broad as long, and the length is about half that of the body. Its form is nearly rhombic, with the lateral angles produced and rounded and the posterior angle very obtuse, the posterior edge, as preserved, being slightly concave.

The ventral anterior edge of the mantle is concave centrally, with a slight angle on either side, about .75 inch from the center. From these angles it is again concave to the sides. On the dorsal side the edge advances farther forward than beneath, terminating in a slightly prominent obtuse angle in the middle of the dorsal edge. The nuchal crests around the ear consist of a slightly elevated transverse ridge, with three thicker and much more elevated laminæ, which extend forward, on the head, one in the median line of the eye, with one above and one below it, the lower one longest and least elevated, curving downward beneath the head. The two upper ones are broadly rounded at top. Behind the transverse fold there is a deep, irregularly crescent-shaped fosse. The eye-sockets are large, oblong, and furnished with distinct lid-like margins. The eyes are large, prominent, oblong, and naked; the anterior portion is swollen laterally on both sides. The short arms are trapezoidal, the dorsal ones somewhat (about 1.25 inches) shorter, and smaller than the others, which are nearly equal in length, the second pair being stouter than the rest and a little longer. The dorsal arms have a slightly prominent membrane along the outer angles; the subdorsal or upper lateral arms are narrowed to an acute edge or crest on the outer angle, but on the inner angle have a broad, thin, marginal membrane outside the suckers. The lower lateral arms are similar in size and form, and also have a very broad, lateral, marginal membrane next to the suckers, on the lower side. The ventral arms are more slender and a trifle longer, and have narrower marginal membranes. The tentacular arms are slender, elongated, expanded toward the tip, and have suckers arranged much as in the gigantic species, even to the smooth-edged suckers and opposing tubercles proximal to the large suckers, as I have described them in *Architeuthis Harveyi*. The sucker-bearing portion is margined by a scalloped membrane on each side.

The small proximal suckers of the tentacular arms occupy about 44.5^{mm} (1.75 inches) at the commencement of the terminal club; they are about 1.5^{mm} in diameter, circular, regularly cup-shaped, with a nearly even, smooth rim; they are raised on slender pedicels. Alternating with these are smooth, rounded tubercles, which are also on pedicels and slightly larger than the intervening suckers. There are four suckers and four tubercles in the row along the inner margin; along the outer margin there are fewer, smaller suckers, but without horny rings; if they originally had such rings they were probably smaller than the others. The large suckers (Plate XVI, fig. 9) forming the two central rows on the terminal club are furnished with a somewhat oblique dark brown ring, very strongly and sharply toothed around the outer portion of the edge, and usually with one tooth larger and longer than the rest on the middle of the outer margin; inner margin with much smaller, very acute teeth, of unequal size. The teeth are gold-colored at tip.

Larger suckers of the sessile arms are very oblique, with the rim strong, dark brown, bearing large, strong, sharp, much incurved, unequal teeth on the outer side of the rim; the inner margin is entire. The ventral arms bear about 44 similar suckers, exclusive of the minute ones close to the end; the largest ones are situated beyond the middle of the arm. The lateral arms bear about the same number of large suckers, with numerous minute ones at the tip. The dorsal arms bear, each, about 30 suckers, exclusive of the small terminal ones.

The 22d sucker of the left ventral arm (Plate XVI, figs. 8, 8*a*) has a strong, somewhat elliptical rim, with seven strong and very acute incurved teeth on the outer side, and with the opposite margin on the inner side smooth for more than a third of the circumference. The median tooth on the outer margin is decidedly larger and longer than the others, and abruptly bent inward above its base. It is elongated and gradually tapered to the very acute tip, but thick and channeled externally at its base. To the right and left of this are three similar, but smaller, unequal teeth, all strongly curved inward toward the inner margin, but not convergent to the center. Of these, the second from the central tooth, on each side, is the largest, and the third is the smallest. Between the latter and the smooth inner edge there is a small rounded lobe, or blunt tooth. Peduncle broad toward the rim, tapering rapidly to the slender base. Outer sides of rim much higher than inner. Greater diameter, 10^{mm}; lesser, 7^{mm}; greater interior diameter, 7^{mm}; total height, 13^{mm}; longest tooth, 2.5^{mm}.

The exposed portion of the upper mandible is black; the point is strongly curved, acute, with a smooth cutting edge, separated from the inner lobe by a deep, acute notch; inner lobe or edge of alæ thin, broadly rounded, with a slightly rounded, uneven edge. Length of mandible, 29^{mm}; distance from bottom of notch to tip, 10^{mm}; internal breadth between lobes, 8^{mm}.

The lining membrane of the palate (Plate XVI, fig. 2) is pale, translucent, covered with rather large, whitish, translucent teeth, variable in form and size, but mostly rather broad at base and tapering to an obtuse tip; some are more slender and acute. No granules were detected on the membrane.

The odontophore (Plate XVI, figs. 3–7) was too much injured to show its general form, but it appeared to resemble that of *A. Harveyi*. The lateral membrane was broad in the middle, translucent, white. No plates outside the lateral teeth could be detected. The teeth all have slender, acute tips. The median teeth have three points of nearly equal length; the inner lateral ones have two points, the outer one somewhat shorter and smaller than the other; the two outer lateral teeth are simple, long, acute, the outermost rather narrower at base and somewhat longer.

Total length, 109cm (43 inches); length of body and head, 48.2cm (19 inches); length of body from dorsal edge of mantle, 35.56cm (14 inches); from ventral edge, 33.16cm (13 inches); of head from edge of mantle to

Measurements of Sthenoteuthis megaptera and S. pteropus (in inches).

	S. megaptera, Nova Scotia.	S. pteropus, Bermuda.	S. megaptera? Sable Island Bank.
Length, tip of tail to end of dorsal arms	25.5	27.5	....
Length, tip of tail to end of third pair	....	29.5	....
Length to end of tentacular arms	43	....	....
Length to base of arms	19	20.5	....
From base of arms to mantle	5	6.25	....
Tip of tail to edge of mantle (above)	14	14.75	....
Tip of tail to edge of mantle (below)	13	14.5	....
Tip of tail to center of eye	....	18.5	....
Length of caudal fin (tip to insertion)	6	6.75	....
Breadth of caudal fin	13.5	11.25	....
Breadth between lateral insertions	2.33	2	....
End of body to outer angle of fin	7	7.25	....
Front edge of fin, from outer angle to insertion	6.5	5.5	....
Circumference of body	12.5	11.5	....
Breadth of body	5	4.75	....
Breadth of head	4	3 +	....
Diameter of eye-opening (longitudinal)	1.25	1.75	....
Diameter of eye-opening (transverse)	.75	1.25	....
Length of tentacular arms	24	....	....
Length of dorsal arms (first pair)	6.5	7.25	....
Length of subdorsal arms (second pair)	8	8.75	....
Length of subventral arms (third pair)	8.5	9.25	....
Length of ventral arms (fourth pair)	8	9.25	....
Breadth of first pair of arms at base	.75	.75	....
Breadth of second pair of arms	1.12	.80	....
Breadth of third pair of arms	1.00	.90	....
Breadth of fourth pair of arms	1.00	.90	....
Breadth of tentacular arms	.33-.50	.40-.75	....
Breadth of terminal club of same	.75	....	....
Length of siphon in middle	....	2.5	....
Breadth of siphon at base	....	.2	....
Breadth of aperture of siphon	....	.1	....
DETAILS OF TENTACULAR ARMS.			
Length of 'club,' or expanded part	6.5	....	....
Length of part bearing large suckers	3.25	....	....
Length of 'wrist,' bearing smaller suckers	1.25	....	....
Length of tip, with small suckers	1.50	....	....
Breadth of 'club' in middle	.75	....	....
Breadth of middle of arm	.50	....	....
DETAILS OF SUCKERS.			
Diameter of largest suckers of tentacular arms	.40	....	....
Diameter of rims of same	.32	....	....
Diameter of largest suckers of dorsal arms	....	.28	....
Diameter of rims of same	....	.20	....
Diameter of largest suckers of second pair	....	.40	....
Diameter of rims of same	....	.28	....
Diameter of largest suckers of third pair	....	.32	....
Diameter of rims of same	....	.24	....
Diameter of largest suckers on ventral arms	.40	.30	....
Diameter of rims of same	.32	.23	....
JAWS.			
Upper mandible, total length	1.16	1.68	1.25
Upper mandible, tip of beak to bottom of notch	.40	.40	.34
Upper mandible, tip to dorsal edge of frontal lamina	....	1.32	.98
Upper mandible, breadth between anterior lobes of alæ	.32	.32	.25
Upper mandible, breadth of palatine	....	.84	.70
Lower mandible, total length	....	1.16	.91
Lower mandible, depth, end of alæ to mentum	....	1.12	.87
Lower mandible, beak to notch	....	.44	.31

base of arms, 12.7^{cm} (5 inches); length of long tentacular arms, 55.8^{cm} and 60.9^{cm} (22 and 24 inches) respectively; of first (dorsal) pair of arms, 16.5^{cm} (6.5 inches); of second pair, 20.3^{cm} (8 inches); of third pair, 21.6^{cm} (8.5 inches); of fourth pair, 20.3^{cm} (8 inches); length of caudal fin, 15.24^{cm} (6 inches); breadth, 34.3^{cm} (13.5 inches); transverse distance between insertions of caudal fins, 5.9^{cm} (2.33 inches); breadth across body in middle, 12.7^{cm} (5 inches); circumference of body, 31.7^{cm} (12.5 inches); length of eye-opening, 3.2^{cm}; its breadth, 1.9^{cm}; length of sucker-bearing portion of tentacular arms, 16.5^{cm} (6.5 inches); of portion bearing large suckers, 8.25^{cm} (3.25 inches); breadth, 1.9^{cm} (.75 inch); length of terminal portion, 3.8^{cm} (1.5 inches); diameter of naked or peduncular portion, .8^{cm} to 1.25^{cm}; breadth of dorsal arms at base, 1.9^{cm}; of second pair, 2.57^{cm}; of third pair, 2.54^{cm}; of fourth pair, 2.54^{cm}; diameter of largest tentacular suckers, 9^{mm} to 10^{mm}; of their rims, 7^{mm} to 8^{mm}; diameter of largest suckers of ventral arms, 10^{mm} (.40 inch); of their rims, 7^{mm} to 8^{mm}.

Color, in alcohol, reddish or purplish brown, specked with darker brown on the dorsal surface of the body; upper side of head and outer sides of arms thickly covered with specks of purplish brown; inner surfaces paler, much as in the common small squids; sides yellowish brown; under surfaces yellowish brown, tinged with purplish.

The original specimen was cast ashore during a severe gale near Cape Sable, Nova Scotia, several years ago, and was secured for the Provincial Museum at Halifax, by J. Matthew Jones, esq. It is preserved entire in alcohol and is still in good condition.

I also refer to this species an entire beak with the odontophore, presented by Capt. George A. Johnson and crew of the schooner "A. H. Johnson." It was taken at Sable Island Bank, Nova Scotia, in 280–300 fathoms, September, 1878. This beak (Plate XVII, fig. 2) has the exposed parts black, the internal laminæ reddish brown. The upper mandible is sharp and strongly incurved, with a small narrow notch at its base, from which runs a raised lateral line; beyond the notch the anterior edge of the ala is convex and slightly uneven. The lower mandible has a small notch below the incurved tip; below this the cutting edge is slightly concave to the basal notch, which is narrow on the right side, but broader and V-shaped on the left; beyond the notch the alar tooth is narrow, prominent, and truncate on the right, but broader and blunt on the left. Opposite the notch and tooth the side of the beak is strongly excavated. Total length of upper mandible, 31^{mm}; hight, palatine to frontal, 24^{mm}; tip to bottom of notch, 8.5^{mm}; tip to dorsal edge of frontal laminæ, 24.5^{mm}; breadth between anterior lobes of alæ, 6.2^{mm}; breadth of palatine, 17.5^{mm}. Total length of lower mandible, 23^{mm}; hight, mentum to inner end of alæ, 22^{mm}; tip to notch, 7.8^{mm}; tip to end of mentum, 8.2^{mm}; tip to dorsal end of gular, 16^{mm}; transverse breadth at alar teeth, 7^{mm}.

The odontophore is similar to that of the typical *S. megaptera*, but the lateral denticles of the median and inner lateral teeth are relatively shorter, and these, with some other differences, render it doubtful whether this beak actually belongs to that species. The odontophore is 4^{mm} broad; the teeth are all sharp, rather slender, pointed, and pale amber-color. A slight, smoothish, marginal ridge borders the dentigerous zone on each side, but is scarcely divided into distinct plates. The median teeth have three sharp, rather slender denticles, the median about a third longer than the lateral; the inner lateral teeth have a long point, with the acute outer denticle much shorter; the teeth of both outer rows are long, considerably incurved, acute, the outer ones the more slender.

Several additional specimens of this species have recently been received. The most important of these consists of the tentacular club and the pharynx, with the jaws and odontophore complete (Plate XVII, fig. 1). These are from a specimen of which the head and arms were found in the mouth of a codfish on the eastern part of George's Bank, by Manuel D. Mitchel, and were by him presented to the United States Fish Commission. The portions of the specimen not saved were used as bait for cod. The arms were described as 18 inches long.

The part of the tentacular club in my possession, which does not include the proximal portion, is 175^{mm} long, 17^{mm} broad in the middle; the distal portion, beyond the large suckers, is 62^{mm} long; breadth of its sucker-bearing face, 8^{mm}; from front to back, including width of dorsal keel, but not the suckers, 18^{mm}; diameter of largest suckers, 12^{mm}; of horny rings, 11^{mm}; of aperture, 8^{mm}; hight of horny ring, outer side, including teeth, 6.5^{mm}; length of pedicels, 5^{mm}; distance between pedicels, 15^{mm}. The large suckers agree very well with those described and figured from the type-specimen (Plate XVI, fig. 9); this portion of the club had nine of these large suckers in each row; their pedicels arise from the middle of deep squarish depressions, between which run thick transverse ridges, which bear the smaller marginal suckers toward their outer ends, and then support the marginal membrane. A part of the large suckers have retained their horny rings, but all the marginal and small distal suckers have lost them. The horny rings of the large suckers (fig. 10) are oblique, much higher on the outer than on the inner side; the edge bears about 28 sharp, incurved, well-separated, unequal teeth; of these the largest is at the middle of the outer edge; another smaller one, but larger than its fellows, is at the middle of the inner edge; two others, in size similar to the last, occupy the middle of the lateral edges; thus the edge is divided into four equal parts by the four larger teeth, between which there are five or six smaller, very acute teeth, separated by spaces greater than their breadth. The horny rings are amber-brown, the teeth are golden yellow at tip. The distal portion of the club is compressed, with the face narrow and tapering, but with an elevated dorsal keel; it bears four crowded rows of small, pediceled suckers, the two rows on one side of the median line being composed of very much smaller suckers than the other two. At the very tip of the club there is a round cluster of small, smooth suckers, as in *Architeuthis*. The buccal mass is 52mm in length and 42mm in diameter. A thick buccal membrane, covered with low, irregular verrucæ, surrounds the jaws. The jaws are sharp and strong; their exposed portions are black, the alæ reddish brown. The beak of the upper jaw is long, strongly incurved, acute, its cutting edge regularly curved, with a deep notch at its base, from which a well-defined groove runs downward. The lower jaw is sharp, its cutting edge is most concave near the tip, below which it is nearly straight; sides covered with fine radiating lines; basal notch broad, shallow, angular; beyond the notch there is a broad, low, angular tooth. The surface of the fleshy palate is covered with low, rounded verrucæ. The odontophore is broad, with sharp, pale amber-colored teeth, which agree well with those of the original specimen (Plate XVI, figs. 3–7); outside of the lateral teeth there is a narrow, raised, chitinous ridge, apparently not divisible into plates.

Another specimen, consisting of the buccal mass and jaws, but without the odontophore, was presented to the United States Fish Commission (lot 797) by Capt. Charles Anderson and crew of the schooner "Alice G. Wunson," of Gloucester, Mass.

The jaws of this were slightly larger than in the one just described. They agree well in nearly every respect, but the notch at the base of the lower mandible is narrower and the tooth beyond it broad and rounded.

Measurements of jaws (in millimeters).

Number of lot.	810.	797.
Upper jaw, tip to bottom of notch	12	13
Transverse breadth, at notches	9	10
Tip to end of frontal lamina	38	41
Lower jaw, tip to bottom of notch	11	13
Tip to notch of mentum	11	14
Tip to ventral end of gular lamina	....	25
Mentum to inner end of lateral alæ	31	36
Breadth of lateral alæ	15	15
Breadth of odontophore, across face	5.5	....

The fifth specimen, received in lot 879, October, 1880, consists of two of the sessile arms, but the suckers have lost their horny rings, so that the identification cannot be very positive. The largest arm, which is not quite entire, is 255mm long, and 23mm in diameter at the larger end. It was taken from the stomach of a cod, on the Grand Banks, and presented to the United States Fish Commission by the captain and crew of the schooner "Otis P. Lord."

Specimens examined.

Lot.	Locality.	Fathoms.	When received.	Name of vessel.	Received from.	Specimens.
	Cape Sable, N. S.	Beach	....	....	Halifax Mus'm	1, entire.
	Sable Island Bank	280–300	Sept., 1878	A. H. Johnson	U. S. Fish Com.	1, jaws, &c.
810	George's Bank	Cod stomach	Aug., 1880	Sultana	....do	1, jaws and arm.
797	East slope G.'s B.	....do	Aug., 1880	Al. G. Wunson	....do	1, jaws.
879	Grand Banks	....do	Oct., 1880	Otis P. Lord	....do	1, arms.

Sthenoteuthis pteropus Verrill.

Ommastrephes pteropus? Steenstrup (MSS., 1858).
Tryon, Man. Conch., i, p. 179 (no description).
Sthenoteuthis pteropus Verrill, Trans. Conn. Acad., vol. v, p. 228, pl. 27, fig. 7, 7 *a*, pl. 36, figs. 5–9, Feb., 1880; Amer. Journ. Sci., vol. xix, p. 289, Apr., 1880.
Ommatostrephes pteropus Steenstrup, Oversigt K. Danske Vidensk. Selsk. Forhandl., 1880 (received Aug.), pp. 76–81, fig. 7, p. 79, fig. 2, p. 81 (details).

Plate VII, figure 2. Plate XVII, figures 3–9.

A large squid, 74.8^{cm} (29.5 inches) long from tail to tip of longest sessile arms, similar in size and form to the preceding, and closely allied to it, has been sent to me by Mr. G. Brown Goode, who obtained it at Bermuda. It is probably the *Ommatostrephes pteropus* of Steenstrup.

The body is stout, acuminate posteriorly; the anterior border of the mantle, beneath, is even, and not distinctly emarginate in the middle.

The caudal fin is large, broad, transversely rhomboidal, but neither so broad nor so large proportionally as in *S. megaptera*. The siphon is very large and broad (63^{mm} long by 50^{mm} broad), with a large aperture, 25^{mm} wide. The eyeballs are very large, elongated, measuring, although somewhat collapsed, about 42^{mm} long by 31^{mm} broad. The eye-openings, as distended, are large, oblong, elliptical, with a broad sinus and slightly thickened edges.

The arms are stout and rather long, the third and ventral pairs being nearly equal in length; those of the second pair are about 12.5^{mm} shorter than those of the third; the dorsal ones about 63^{mm} shorter than those of the second; the dorsal arms are 18.4^{cm} long, trapezoidal in form, the outer face convex and about 1.9^{cm} broad; the lateral and inner faces, 1.2^{cm}; along the inner angles there is a narrow membrane, outside the suckers (fig. 7, *a*). Those of the second pair are 24.7^{cm} in length; their transverse breadth is about 2^{cm}; from inner face to outer angle, 1.9^{cm}; along the outer angle, in these, is a thick, acute-edged crest, widest in the middle of the arm; along the lower inner angle, outside the suckers, there is a broad and very thin membrane, 2.5^{cm} or more in width (fig. 7, *b*); along the upper inner angle is a similar membrane, about .6^{cm} wide.

The arms of the third pair are 26^{cm} long (31^{cm} from center of eye to tip of arms); they are compressed, 2.25^{cm} broad at base; on the outer angle, along the middle, there is a very prominent crest (fig. 7, *c*), so that, in this part, the distance from inner face to outer angle is 4^{cm}; along the lower inner angle there is a very broad, thin, delicate web, where widest at least 5^{cm} to 7^{cm} (2 to 2.75 inches) wide; it is considerably torn and may have been still wider; it is widest beyond the middle of the arm; on the upper inner angle the corresponding membrane is about 0.6^{cm} wide (fig. 7, *c*). Transverse, thick, fleshy ridges run out from between the suckers a short distance on these membranes, and then fade out. The ventral arms are 2.25^{cm} broad at base and trapezoidal;

they have a smaller crest along the outer angle, and a narrow membrane along each inner angle.

All the sessile arms bear similar suckers (Plate XVII, figs. 8, *a–c*), all of which are provided with 7 to 13 large, very acute, incurved teeth on the outer margin of the very oblique horny rings, and with much smaller, sometimes rudimentary ones on the inner margin, much as in *S. megaptera*. The largest of all the suckers are near the middle of the second pair of lateral arms, from the sixth to the sixteenth, and especially from the ninth to the fourteenth; the diameter of the ninth is 10^{mm}, the edge of its rim 8^{mm}. On the dorsal arms the eighth to the thirteenth are the largest; the diameter of the ninth is 7^{mm}; edge of horny rim, 5^{mm}. On the third pair the eighth to the fourteenth are largest; the diameter of the tenth is 8^{mm}, its rim 6^{mm}. On the ventral arms the fourteenth to the twentieth are largest; the diameter of the fifteenth is 7.5^{mm}, its rim 5.5^{mm}. On the ventral arms the rows of suckers are more separated than on the other arms, their inner faces being wider. On the lateral arms, toward the base, the two rows are nearer together, while the suckers of each row are distant, so that they almost form one irregular row at first. The suckers are all very oblique, with the horny rims very low or narrow in front, and very high on the outer side; these rings are dark brown, but the teeth have a golden luster.

The thick fleshy margin (fig. 9), outside the denticulated edge of the horny ring, is completely covered all around by a series of thin, bracket-shaped, horny plates, light brown in color, arranged radially and movable with the membrane to which they are attached for the most of their length; both the outer and the inner ends are free and turned upward, like a small tooth or denticle; those of the inner end are mostly acute, and form a circle of minute movable denticles, nearly in line with the large teeth of the horny ring, five to ten occupying the intervals between the large teeth of the largest suckers; those plates that stand opposite the teeth of the horny ring are shorter than the others, and often broader, and have no denticle on the flat or upcurved inner ends, which fit to the form of the base of the tooth in front of them; the outer ends are abruptly bent upward and often inward, forming a denticle or flattened hood, usually rounded at the end. These marginal plates vary greatly in width and form, even on the same sucker, according to position, and small, imperfectly developed, wedge-shaped ones are interpolated between the larger ones, around the periphery.

One of the largest suckers, the twelfth of the second pair of arms (fig. 8, *b*, *b′*), has 22 teeth on the horny ring; of these five are small, but sharp, on the middle of the inner border; nine, on the outer border, are largest; and four, on each side, are intermediate in size. The median tooth on the outer margin is largest, and the one next to it, on each side, is a little smaller than the second one from it. The thirteenth sucker of the ventral arms has, on its ring, eighteen denticles; of these nine are very large, with the median more decidedly the largest, and the one on each side of it is shorter as compared with the next; six, on the inner margin, are minute, and these are connected with the larger series by one or two somewhat larger ones at each end of the inner border.

The stumps of the tentacular arms are flattened, oval, and smooth, measuring about 10^{mm} by 18^{mm} near the base; their length is about 28^{cm} (11 inches), which is doubtless less than half their original length.

According to Steenstrup (op. ult. cit., p. 81, fig. 2), there are, in his example, a few connective suckers and tubercles on the proximal part of the club.

The siphon is very large and lodged in a broad groove in the lower side of the head; the anterior part of this groove, which is separated from the rest by a transverse fold of the skin, is covered by about twelve narrow, longitudinal ridges, separated by strong longitudinal furrows; an additional outer ridge, on each side, is separated from the others by a wider interval; several of these ridges and furrows extend backward beyond the transverse fold. The dorsal side of the siphon is strengthened by a thick, longitudinal, muscular band, which becomes free from the siphon farther back, and is united to the head by a small median connective strap; either side of this are the two broad connective bridles, and at the sides of the siphon, near the ears, on each side, is a broad lateral connection between the mantle and head, with a large aquiferous opening beneath it.

The exposed parts of the jaws (Plate XVII, figs. 3, *a*, *b*) are black and polished; the laminæ are reddish brown, with broad, thin, yellowish-white margins. The upper mandible has a long, sharp rostrum, with regularly curved cutting edges, and a small, well-defined, V-shaped notch, from which a short groove runs backward, beyond which there is a slight ridge; anterior edge of alæ, beyond the notch, forming no distinct lobe or tooth, but slightly convex and irregularly crenulate; posterior lateral borders of alæ with a broad sinus in the middle; palatine lamina long and thin, with sinuous posterior margins; frontal lamina broad, extending well backward.

The total length of the upper mandible is 42^{mm}; tip to posterior end of frontal lamina, 33^{mm}; to notch, 10^{mm}; greatest breadth (or hight), from palatine to end of frontal, 30^{mm}; transverse breadth, across frontal, 15^{mm}; transverse breadth, across anterior edges of alæ, 8^{mm}.

The lower mandible has a strongly incurved beak, with the cutting edges rather suddenly incurved at about the proximal third, and a well-developed, broad, V-shaped notch at base, beyond which there is a slightly prominent, broad tooth; alæ broad, the inner ends broader than the middle, well rounded; mentum short, with a broad dorsal emargination; gular lamina short, the inner edges incurved.

The total length of the lower mandible is 29^{mm}; tip of beak to end of mentum, 10^{mm}; to ventral end of gular, 21^{mm}; to bottom of notch, 11^{mm}; to inner ends of alæ, 24^{mm}; breadth, from inner ends of alæ to mentum, 28^{mm}; breadth of gular lamina, 17^{mm}; breadth of alæ, 12.5^{mm}; greatest transverse breadth, across alæ, 32^{mm}; transverse breadth, across anterior edges of alæ, at teeth, 11^{mm}.

These jaws agree pretty nearly in form and size with those of *O. pteropus*, as figured by Steenstrup, but the latter have a deeper notch in the upper mandible, with a more evident lobe beyond it, while the lower mandible has a broader and less triangular notch.

The buccal membrane is large, thin, prolonged into seven acute angles or lobes, of which the upper is in the median plane, opposite the interval between the dorsal arms; the six others are opposite the three other pairs of sessile arms. The inner surface of this membrane is covered, near the periphery, with small rounded papillæ; externally it is connected to the arm by seven membranous bridles, corresponding to the seven angles; of these the dorsal one forks, one branch going to the inner margin of each dorsal arm; the upper lateral ones join the marginal membrane of the upper angle of the upper lateral arms; the lower lateral ones join the lower marginal membrane of the third pair of arms; the ventral ones join the marginal membrane outside of the sucker-bearing face of the ventral arms. In front of the bases of each of the dorsal and tentacular arms there is a large opening to the space beneath this membrane.

The beak is closely surrounded by a thick, prominent, lobed, and wrinkled fleshy collar, with papillæ on its inner surface; outside of this there is a smooth, sharp-edged, erect collar, less prominent than the inner one.

The odontophore is similar to that of *Ommastrephes;* it is sharply bent upon itself anteriorly, with the ventral end less than half as long as the dorsal; the dentigerous zone is yellowish brown in color, and bordered laterally by a thin ridge formed by a row of small plates; the lateral membrane is broad, thin, and pale yellow, running straight across, from the ventral end, at right angles to the dorsal portion, and then folding back upon itself joins the dorsal part of the odontophore farther back, near its middle; beyond this point it is very narrow and rolled in. Length of the dorsal portion, 19^{mm}; of the ventral, 9^{mm}; breadth of the dentigerous zone, anteriorly, 5^{mm}; breadth of marginal membrane, anteriorly, 7^{mm}.

The median teeth (Plate XVII, fig. 4, *a*) are broad, with three stout points, the middle one nearly twice as long as the lateral; the inner lateral teeth (*b*) are much longer, with one long stout point and a short denticle on the outer side, below the middle; the two outer rows (*c*, *d*) have simple, long, and rather stout, curved teeth, those of the outermost row a little longer and narrower than the others. The teeth differ decidedly from those of *S. megaptera* in the shortness of the lateral denticles of the median and inner lateral teeth; moreover, all the teeth are stouter and less acute.

The pen (Plate XVII, figs. 5, 5 *a*) resembles that of *Ommastrephes;* it is long, widest anteriorly, bordered by strong ribs, obtusely pointed at the anterior end, gradually narrowing to the very narrow slender portion about three inches from the posterior end, beyond which there is a thin margin, which expands into a lanceolate form, widest at 1.25 inches from the end; the terminal portion forms a short, hollow hood, formed by the infolding of the margin, and marked by slender, divergent, raised lines, stronger laterally, and with a dorsal keel. The central rib begins at the anterior end, increases in size to the middle region, then narrows to the slender part, where it forms a slender, prominent rib, only visible dorsally, and then becoming confluent with the lateral ribs extends as a sharp keel to the end. The lateral ribs commence at about .75 inch from the anterior end, and each at first consists of three riblets; farther back another appears on the outside margin, but is separated only by a slender groove, and toward the slender part of the pen they all coalesce into a single rib on each side, which nearly meet in the middle line ventrally, where they are separated by a slender groove, which disappears farther on. Total length of pen, 349^{mm} (13.75 inches); greatest breadth, 22.5^{mm} (.90 inch); length of posterior cone or hood, $.9^{mm}$ (.35 inch); breadth of posterior expansion, 15^{mm}.

This specimen is entire, except that it has lost the clubs of the tentacular arms. It is in fair condition, though considerably contracted by long preservation in too strong alcohol. The head, however, has been pulled out from the mantle to an unnatural extent, so as to increase the total length from 3^{cm} to 4^{cm} at least. The ventral arms do not show any of the sexual modifications characteristic of the male squids, therefore, it is doubtless a female.

Most of the measurements are given in the table with those of *S. megaptera* (p. 103); some of the more general are as follows: Length from end of body to tip of dorsal arms, 69.8^{cm} (27.5 inches); to edge of mantle, dorsally, 37.5^{cm} (14.75 inches); to base of dorsal arms, 52^{cm} (20.5 inches); to center of eye, 47^{cm}; to lateral insertions of fin, length, 17^{cm} (6.75 inches); to outer angle of fin, along posterior edge, 18.4^{cm} (7.25 inches); breadth of fins transversely, 28.5^{cm} (11.25 inches); outer angle to lateral insertion, along front edge, 14^{cm} (5.5 inches); between lateral insertions, 5^{cm} (2 inches); breadth of body, 11.9^{cm}; circumference of body, 29.2^{cm} (11.5 inches).

This specimen, which was obtained at Bermuda, by Mr. G. Brown Goode, now belongs to the museum of Wesleyan University, Middletown, Conn. Mr. Goode informs me that it was picked up on the north shore of the island, in December, 1876, and that it was regarded by the inhabitants as a novelty or great rarity, and was noticed as such in the local newspapers.

Stenoteuthis pteropus has been recorded from the Mediterranean Sea and the warmer parts of the Atlantic Ocean.

Sthenoteuthis Bartramii Verrill.

Loligo sagittatus (*pars*) Lamarck, 1799; Anim. sans Vert., vol. vii, p. 665.
Loligo Bartramii Lesueur, Journ. Phil. Acad., I, vol. ii, p. 90, pl. 7, 1821. Blainville, Dict. Sci. Nat., vol. xxvii, p. 141, 1823.
Loligo sagittatus Blainv., Dict. Sci. Nat., vol. xxvii, p. 140.
Ommastrephes Bartramii D'Orb., Voy. Amér. Mérid., Moll., p. 55, 1838 (t. Gray); Céph. Acétab., pl. 2, figs. 11–20; Hist. Cuba, Moll., p. 59.
Gray, Catal. Moll. Brit. Mus., Cephal. Antep., p. 62, 1849.
Verrill, Invert. Vineyard Sound, &c., p. 341 [635], 1874 (*non* Binney in Gould, Invert. Mass.).
Tryon, Man. Conch., vol. i, p. 180, pl. 80, figs. 361, 362 (after D'Orb.).
Sthenoteuthis Bartramii Verrill, Trans. Conn. Acad., vol. v, p. 223, Feb., 1880; p. 288, Jan., 1881; Amer. Journ. Sci., vol. xix, p. 289, Apr., 1880.
Ommatostrephes Bartramii Steenstrup, Oversigt K. Danske Vidensk. Selsk. Forhandl., 1880, p. 79, fig. 2, p. 81, fig. 3, p. 89; auth. sep. copy (received Aug.), p. 9, fig. 2, p. 11, fig. 3, p. 19.

Body cylindrical, elongated, slender, tapering but little in front of the fin; anterior edge of mantle with a very slight median dorsal angle. Caudal fin short and transversely rhomboidal, with the outer angles acute, posterior angle obtuse, and the front edges rounded and projecting forward beyond the insertion. Length of fin (from insertion) to its breadth, as 1 : 2; length of fin to mantle, as 1 : 2.80, in a young female specimen with the body 3.25 inches long. Head short, as broad as the body; eye-opening angular, higher than long, with a narrow, oblique sinus. Nuchal crests nearly as in *O. illecebrosus*, consisting of a low, transverse, undulated ridge extending around both sides to the dorsal line, and with three raised longitudinal crests on each side. Siphon large, sunken in a deep pit; anterior border of the pit with a series of 6 to 12 or more (varying with age) small and short furrows, which extend inward only a short distance from the edge. Arms rather short, not very unequal; the dorsal ones are a little the shortest and smallest; the third pair are the longest, the second and fourth pairs are intermediate in length and nearly equal; the arms of the second pair are furnished with a well-developed membrane along the lower outer angle, and with a thin marginal membrane of moderate width along the inner angles, outside the suckers, that on the lower side extending beyond the suckers. Those of the third pair are compressed, with a well-developed membranous keel on the median outer edge, beyond the basal portion; on the lower inner angle there is a broad, thin, marginal membrane, extending beyond the suckers, and a narrow one on the upper side; the dorsal and ventral arms have narrow marginal membranes. Suckers of the dorsal and lateral arms furnished with horny rings, which have the edge divided into small, acute-triangular teeth, largest on the outer side; on the ventral arms the suckers are smaller, those on the proximal half of the arm having smooth-edged rings, while those on the distal portion are sharply toothed on the outer edge. Tentacular arms slender and moderately elongated, with distinctly broader clubs, which are keeled on the back side and furnished with a thin marginal membrane on each edge. The suckers form two median alternating rows of larger, oblique, dentate ones, of which seven to nine in each row are decidedly the largest; alternating with these, on each margin, there is a row of smaller, more oblique, sharply denticulate, marginal suckers; distal face of the club narrowed and covered with four rows of minute crowded suckers, and a small cluster at the tip; the proximal part of the club has an irregular group of few, small, denticulate suckers, beyond which, extending down on the upper margin of the arm, is a row of about five or six or more small, smooth-edged, connective suckers, alternating with small round tubercles of corresponding size; along the lower edge of the arm, for about the same distance, there is a row of more minute pediceled suckers. The horny rings of the larger median suckers are oblique, and the edge is divided into many small slender teeth, longer on the outer or higher margin; the teeth of the marginal suckers are similar, but more unequal and more incurved.

Specimens in alcohol generally show a distinct dark purplish brown dorsal stripe, where the chromatophores are very much crowded.

According to D'Orbigny (Hist. Cuba, Moll., p. 62) the colors of this species, when living, are very brilliant, and are continually changing. Along the middle dorsal line there is a broad violet stripe, with a stripe of reddish yellow on each side of it. These bands are closely defined, and do not grade into each other. Body elsewhere bluish; fins rosy, with a carmine-red tint each side of the darker median stripe. The surface is throughout covered with small reddish-violet chromatophores. The head is dark violet above, rosy beneath. Upon the eyes there are two elongated spots of brilliant blue, and below a spot of bright red.

The color of the ink, according to the same authority, is not black, but coffee-and-milk color. It is emitted very rapidly and discolors a large area. Length of body, 150^{mm}; diameter, 27^{mm}; diameter of head, 29^{mm}; length of tentacular arms, 75^{mm}; length of dorsal arms, 42^{mm}; length of third pair, 56^{mm}; length of fourth pair, 50^{mm}; length of caudal fin, 60^{mm}; breadth of fin, 95^{mm}.

A young specimen, in alcohol, has the following dimensions: Total length to tips of lateral arms, 121^{mm}; tail to base of arms, 93^{mm}; body, 82^{mm}; length of caudal fin, to insertion, 29^{mm}; its breadth, 58^{mm}; diameter of body, 16^{mm}; length of tentacular arms, 48^{mm}.

Middle Atlantic and West Indies to Brazil and Cape of Good Hope. Ranges chiefly between 35° south and 35° north latitude; common in the region of the Gulf Stream.

This is an exceedingly active species, swimming with great velocity, and not rarely leaping so high out of the water as to fall on the decks of vessels.* On this account it has been called the "*flying squid*" by sailors.

* D'Orbigny (Hist. Cuba, Moll., p. 62) relates that in a beautiful night in October, at 34° south latitude, off South America, he himself saw two specimens leap out of the water so high as to fall on the deck of the vessel, which was nearly fifteen feet above the surface of the water. It is supposed that this is done in their efforts to escape from predatory fishes that pursue them.

This is a more slender species than *O. illecebrosus*, with a shorter fin, and it has but four rows of small suckers on the distal part of the club, instead of eight. The most important differences, of generic value, are the presence of connective suckers and tubercles on the tentacular arms, and the great development of the marginal membranes on the lateral arms. The grooves in the siphon-pit are of comparatively little importance.

ARCHITEUTHIS Steenstrup (see page 23).

This genus, which includes the most gigantic species known, differs from *Sthenoteuthis* mainly in having a smaller and differently shaped caudal fin, and in lacking the broad lateral membranes on the lateral arms. The pen is also different, judging from the portions preserved. The large tentacular suckers are more evenly and regularly denticulated; and those of the sessile arms are smaller, with less claw-like teeth.

From *Ommastrephes* it differs in the form and size of the fin and pen, and especially in having connective suckers and tubercles at the bases of the tentacular clubs.

Architeuthis Harveyi Verrill (see pages 23–40).—Giant Squid.

(Plates I–VI.)

Fishing banks off Nova Scotia to Labrador. Northern Europe?

Architeuthis princeps Verrill (see pages 41–50).—Giant Squid.

(Plates VII–XI.)

Newfoundland and the Grand Banks to Labrador. Northern Europe?

FAMILY MASTIGOTEUTHIDÆ Verrill.

Bulletin Mus. Comp. Zool., viii, p. 100, March, 1881.

Body slender, pointed behind. Caudal fin large, rhombic. Mantle united to neck by three movable cartilages. Siphon with an internal valve and one pair of dorsal bridles. Eyes large, not prominent; lids free, simple. Buccal membrane 6-angled, without suckers. Arms free; suckers in two rows. Tentacular arms (in the typical species) not expanded into a club, the terminal portion round, tapering, covered with a multitude of minute suckers, in many rows. No auditory crests. Pen narrow, with a long, hollow posterior cone.

This family differs from *Ommastrephidæ* in lacking distinct lachrymal sinuses and auditory crests, in the remarkable character of the tentacular arms, and in the simple connective cartilages. From *Chiroteuthidæ* and *Histioteuthidæ* it differs in having the siphon provided with a dorsal bridle and internal valve, as well as in the armature of tentacular arms.

It is doubtful whether *Calliteuthis* belongs near this family, its tentacular arms being unknown, and its pen being entirely different. Possibly it may belong to the *Chiroteuthidæ*.

MASTIGOTEUTHIS Verrill.

Trans. Conn. Acad., vol. v, p. 296, Jan., 1881; Bulletin Mus. Comp. Zool., vol. viii, p. 100, March, 1881.

Body elongated, tapering to a point, confluent with the caudal fin posteriorly. Caudal fin very large and broad, rhomboidal, occupying about half the length of the body. Mantle fastened to the base of the siphon by an ovate, ear-shaped, elevated cartilage, on each side, fitting into corresponding deep, circumscribed pits on the base of the siphon. Siphon with a bilabiate aperture, an internal valve, and a pair of dorsal bridles. Eyes large, with round pupils; lids free, thin, apparently with a very small anterior sinus. Arms very unequal, the ventral ones much the longest. Suckers small, in two regular rows. Tentacular arms long and round, tapering to the tips, shaped like a whip-lash, without any distinct club; the distal portion is covered nearly all around with exceedingly numerous and minute suckers, which leave only a very narrow naked line along the outside. Pen narrow and bicostate anteriorly, very slender in the middle; posteriorly much larger, with a long tubular cone (figs. 1 *b*, 1 *c*). This remarkable genus differs widely from all others hitherto described in the character of the tentacular arms and suckers. This, with the great size of the caudal fin, gives a very peculiar aspect to the species.

Mastigoteuthis Agassizii Verrill.

Bulletin Mus. Comp. Zool., vol. viii, p. 100, pl. 1, fig. 1, pl. 2, figs. 2, 3–3 *e*, 1881; Trans. Conn. Acad., vol. v, p. 297, pl. 47, pl. 49, figs. 2, 3–3 *e*, Jan., 1881.

Plate XXI. Plate XXII, figures 2–2 *d*.

Body elongated, round anteriorly; posteriorly tapering rapidly to the slender, acute, terminal portion, which is confluent with the caudal fin to the tip. Front dorsal edge of mantle emarginate in the middle. Caudal fin very large and broad, transversely rhomboidal, obtuse posteriorly, its length, from origin to tip, about equal to half the combined length of the head and body. Eyes large, with thin lids, which appear to have had a distinct but very small sinus in front; pupils circular; iris brown, in alcohol. Sessile arms very unequal; ventral arms much larger and longer than the others, about equal to length of head and body; dorsal arms very small, scarcely one-third the length of the ventral pair; two lateral pairs nearly equal, decidedly longer and stouter than the dorsal pair. A delicate, thin, marginal membrane extends along the arms, outside the rows of suckers, to the slender tips. Suckers small, in two regular rows on all the arms, subglobular, with small oblique apertures, surrounded by small horny rings, which have a nearly entire margin, and by several series of minute plates (Plate XXII, fig. 2 *d*).

Basal web, between the arms, very small. In the smaller specimen, which is a male, the right ventral arm is longer than the left, and the tip appears to have been flattened, and the marginal membranes seem to have been wider, with the edges infolded, so as to form a sort of furrow on the outer side, but the suckers are mostly gone, and it is too much injured to be accurately described. Tentacular arms long, more than twice the combined length of the head and body, slender, round, gradually tapering to the tip, like a whip-lash, the distal half of their length covered with very numerous, crowded, minute, pediceled suckers (fig. 2 *b*), which cover nearly the entire surface along the terminal portion, leaving only a narrow naked line along the back, but farther from the tip this naked space becomes gradually wider and the band of suckers narrower, and after these crowded bands of suckers cease, scattered suckers, placed mostly two by two, extend for some distance along the proximal part of the arms. The suckers of the tentacular arms are so small that their form cannot be seen with the naked eye; they are deep, cup-shaped, with a small circular aperture, supported by a horny rim, which is often armed with two or three sharp teeth on one side (fig. 2 *c*).

Color of body and arms, so far as preserved in alcohol, deep brownish orange; on the upper side of the back and caudal fin the color is better preserved, and shows small, occellated, circular spots of orange-brown, with an inner circle of whitish and a central spot of purplish brown. Similar spots also exist on the head and arms, and also on the lower side of the body, where the color is best preserved.

A considerable amount of a bright orange oily fluid, insoluble in alcohol, exuded from the viscera. Examined by means of the spectroscope this fluid absorbed part of the green, all of the blue, and most of the violet rays. The stomach contained fragments of small crustacea. The pen is pale yellow, thin, and slender anteriorly, with two sublateral costæ, and narrow delicate margins outside the costæ; in the middle it becomes still thinner and narrower, with the margin inrolled; farther back the margins become much wider and then unite together ventrally, forming a long, hollow, conical portion, extending to the acute posterior tip; this portion is not so broad as deep, and has a slight dorsal keel and a ventral groove.

Measurements. (In millimeters).

Sex	Male.	Male.
Total length to end of sessile arms	137	232
Head and body combined	59	122
Length of body	46	99
Length of caudal fin, from origin	30	60
Breadth of caudal fin	42	75
Breadth of body	15	23
Length of dorsal arms	24	45
Length of second pair of arms	33	60
Length of third pair of arms	34	60
Length of ventral arms	80	112
Length of tentacular arms	....	312
Breadth of dorsal arms, at base	3	4
Breadth of ventral arms	6	7
Breadth of tentacular arms	2	4
Diameter of eye	7.5	9
Length of pen	....	198
Breadth of pen anteriorly	....	2.25
Breadth of pen posteriorly	....	2.50
Depth of pen posteriorly	....	4.50

Specimens examined.

No.	Locality.	Fathoms.	When received.	Name of vessel.	Received from—	Specimen.	
						No.	Sex.
24	cccxxv. N. L. 33° 25′ 20″; W. Lg. 76°	647	1880	Blake	Mus. Comp. Zool	1	♂
25	cccxxviii. N. L. 34° 28′ 25″; W. Lg. 75° 22′ 50″.	1, 632	1880	...do	.....do	1	♂

CALLITEUTHIS Verrill.

Amer. Journ. Sci., vol. xx, p. 393, for Nov., 1880 (published Oct. 25); Proc. Nat. Mus., vol. iii, p. 362, 1880; Trans. Conn. Acad., vol. v, p. 295, Jan., 1881; Bulletin Mus. Comp. Zool., viii, p. 111, March, 1881.

Body short, tapering to a small, free tip. Fins small, united behind the tip of the body. Pen with a short narrow shaft and thin lanceolate blade, as in *Loligo.* Siphon not sunken in a furrow, but united to the head by a pair of dorsal bands; an internal valve. Mantle united to the sides of the siphon by simple, linear, longitudinal, lateral ridges, corresponding with connective cartilages on the sides of the siphon, which are long-ovate, with a raised margin all around. A dorsal, elongated, connective cartilage on the neck, opposite the pen. Arms long, not webbed. Suckers in two rows, largest on the middle of the lateral and dorsal arms; horny rings of suckers smooth on most of the suckers, simply dentate on the distal ones. Eyes large, with rounded openings and thin, free lids. No nuchal frills or crests. Buccal membrane simple, sack-like, with seven connective bridles. Internal anatomy of the female similar to that of *Ommastrephes.* Oviducts and nidamental glands symmetrically developed on the two sides. Oviducts opening in front of the bases of the gills, the openings simple, long, narrow, oblique. Two long, ligulate nidamental glands, with acute anterior ends, lie side by side and a little apart, on the middle of the visceral mass, behind and over the heart; each of these consists of two halves, folded together, and covered on the inner surface with fine transverse laminæ; they open along the outer edge.

This genus may, perhaps, belong to the *Chiroteuthidæ.*

Calliteuthis reversa Verrill.

Amer. Journ. Sci., vol. xx, p. 393, Nov., 1880; Proc. Nat. Mus., vol. iii, p. 362, Dec., 1880; Trans. Conn. Acad., vol. v, p. 295, pl. 46, figs. 1–1 *b*, Jan., 1881; Bulletin Mus. Comp. Zool., vol. viii, p. 112, pl. vii, figs. 1–1 *b*, 1881.

Plate XXII, figures 1–1 *c*.

Body rather short, tapering backward, subacute posteriorly; front edge of mantle advancing somewhat in the middle and forming an obtuse angle; considerably emarginate beneath. Caudal fin small, short, thin, each half nearly semicircular, attached subdorsally, posterior end emarginate and free from the tip of the body, but not extending much beyond it. Head large, flattened above. Eyes very large, with simple, thin, free, circular lids, without any sinus. Openings of the ears behind the eyes, minute, with a small, erect, clavate, fleshy process of the skin. Arms long, tapering, equal to the length of head and body combined; the lateral pairs are equal; the dorsal and ventral nearly equal, somewhat shorter than laterals; suckers deeper than broad, well rounded, laterally attached by slender pedicels; horny rings with smooth, circular, thin edges, except on the small suckers, toward the tips of the arms, in which the outer edge is divided into a number of small, narrow, blunt teeth. On the ventral arms the suckers are much smaller. Basal web rudimentary; a narrow, thin, simple membrane along each side, outside the suckers. Tentacular arms rather slender, compressed, smooth at base, the ends absent. Color reddish brown. The ventral surface of the body, head, and arms is more ornamented than the dorsal surface, being covered with large, rounded verrucæ, their center or anterior half pale, the border or posterior half dark purplish brown; upper surface of body with much fewer and smaller scattered verrucæ; a circle of the same around the eyes; inner surfaces of sessile arms and buccal membranes chocolate-brown; tentacular arms lighter; suckers pale yellow, with a light brown band. Caudal fin white, translucent. Iris in the preserved specimen, brown. Gills with the free edge brown, and a brown line on the outer edges of all the laminæ

Total length, to end of lateral arms, 133^{mm}; to base of arms, 67^{mm}; mantle, 51^{mm}; of fin, 17^{mm}; breadth of fins, 24^{mm}; of body, 20^{mm}; diameter of eyeball, 16^{mm}; length of dorsal arms, 58^{mm}; of second pair, 67^{mm}; of third pair, 68^{mm}; of ventral pair, 60^{mm}; breadth of dorsal arms at base, 5^{mm}; of lateral, 6^{mm}; diameter of largest suckers, 1.2^{mm}.

Dredged by the steamer "Fish Hawk," of the U. S. Fish Commission, at station 894, about 100 miles south of Newport, R. I., N. lat. 39° 53′, W. long. 70° 58′ 30″, in 365 fathoms.

FAMILY CHIROTEUTHIDÆ Gray (restricted).

Loligopsidæ (pars) D'Orb., Céphal. Acétab., p. 320, 1835–1848.
Chiroteuthidæ (pars) Gray, Brit. Mus. Catal., Moll., vol. i, p. 42, 1849.

Body small, connective cartilages three, movable. Eyes with free, simple lids, no sinus. Siphon small, with neither internal valve nor dorsal bridle. Nuchal or auditory crests absent. Buccal membrane seven-angled, without suckers. Buccal aquiferous openings six. Sessile arms simple; suckers with horny rings, which are encircled by a groove; web rudimentary. Tentacular arms very long and slender, with a large club; tip with a spoon-shaped organ, opening backward; peduncle with connective suckers and tubercles; club with rows of singular small suckers, having a swollen bulb on the long pedicel. Pen lance-shaped, with a long, narrow shaft.

Chiroteuthis D'Orb. is the best known genus.

Chiroteuthis Bonplandi D'Orb. (?).

Loligopsis Bonplandi Verany, Acad. Turin, ser. ii, vol. i, pl. 5 (specimen without tentacular arms, t. D'Orb.).

Chiroteuthis Bonplandi D'Orbigny, Céphal. Acétab., p. 226 (description compiled from Verany).

Verrill, Bulletin Mus. Comp. Zool., vol. viii, p. 102, pl. 3, figs. 1–1 *b*, 1881; Trans. Conn. Acad., vol. v, p. 299, pl. 47, figs. 1–1 *b*.

Plate XXXII, figures 1–1 *c*.

A detached tentacular arm belonging to a species of *Chiroteuthis* was taken by the United States Coast Survey steamer "Blake," in the summer of 1880, at station ccciii, lat. 41° 34′ 30″, long. 65° 54′ 30″, in 306 fathoms.

The arm is very long and slender, the length being 780^{mm} (or over 30 inches), its diameter being from 1.5^{mm} to 2^{mm}, except near the base, where it is 3^{mm}, and at the terminal club, which is 6^{mm} broad and 54^{mm} long. The arm is white, with purplish specks, and is generally roundish, except at the club; along the greater part of its length there is a row of rather distant sessile suckers, the distance between them being usually from 12^{mm} to 18^{mm}; these suckers are larger than those of the club, and have a nearly flat upper surface and no horny marginal rim is preserved. A row of small, simple, scattered pits, perhaps homologues of these suckers, extends up the back side of the club. These smooth suckers evidently serve to unite the tentacular arms together when used in concert. The club is much stouter than the rest of the arm, convex on both sides, and but little flattened; on each side it is bordered by a well-developed scalloped marginal membrane, supported by a series of transverse, thickened, but flat, tapering, acute, muscular processes, with their ends prolonged beyond the edge of the intermediate membrane, producing a deeply-scalloped border; on the distal half of the club these muscular supports are separated by spaces greater than their breadth, but on the proximal portion they subdivide into two or three parts, which become crowded close together, showing only narrow intervals or merely a groove between them. At the tip of the arm there is a thick, ovate, dark purple, spoon-shaped, hollow organ, about 4^{mm} long, with its opening on the back side of the arm. This so strongly resembles the spoon-shaped organ of the hectocotylized arm of some Octopods as to suggest the possibility of a similar use for sexual purposes. The suckers are crowded in four or more indistinct rows. Their pedicels are long and slender, having beyond the middle a large, dark purple, fluted, swollen portion or bulb, beyond which the pedicel is more slender; the cup of the sucker is small and lateral, with a very oblique, oblong, horny rim, which is not distinctly toothed (fig. 1 *b*); but its extreme outer edge is sometimes slightly beaked and much thickened.

The fleshy border of the suckers is covered with small angular and irregular scales (fig. 1 *c*); its edge is tinged with purple.

This tentacular arm is referred to *C. Bonplandi* only provisionally, for no perfect specimen of the latter, with the corresponding arms present, has been described. It appears to differ from the tentacular arm of *C. Veranyi* D'Orb., which is the only other species sufficiently described to be recognized as belonging to this genus.

FAMILY HISTIOTEUTHIDÆ, nov.

Loligopsidæ (pars) D'Orbig., Céphal. Acétab., p. 320, 1835–1848.
Chiroteuthidæ (pars) Gray, Catal. Brit. Mus., Moll., vol. i, p. 42, 1849.

Body small, short, with caudal fins. Mantle united to the neck by three movable cartilages. Siphon with neither dorsal bridle nor internal valve. Head large. Nuchal crests absent. Eyes large, not prominent; lids free and simple; no sinus. Buccal membrane with six smooth lobes; buccal aquiferous openings four. Two brachial openings at the bases of the tentacular arms. Six upper arms united by a very broad web; suckers in two rows; rings convex, with small, oblique apertures. Tentacular arms long, with a well-developed club, bearing large central and small marginal suckers; proximal part of club with connective suckers and tubercles. Pen broad, short, lanceolate, much like that of *Loligo*.

HISTIOTEUTHIS D'Orbigny, 1839.

Histioteuthis Férussac & D'Orbigny, Histoire Naturelle des Céphalopodes Acétabulifères, p. 226.
Gray, Catal. British Mus., Moll., vol. i, p. 34, 1849 (description after D'Orbigny).

This genus is remarkable for having the six upper sessile arms united together nearly to their tips by a thin, elastic membrane or web. The ventral arms are also united together for a part of their length, and their common web is joined to the great web, in the median line, by a bridle-like membrane. The tentacular arms are very long, and have expanded clubs, with a broad dorsal keel. As in *Architeuthis* and *Sthenoteuthis*, they are furnished with a series of small smooth-rimmed suckers, alternating with tubercles, on the proximal part of the club and adjacent part of the arm, for the purpose of uniting the arms together at will; but in the following species a row of such suckers and tubercles also extends along one side of the club, opposite part of the large central suckers. The large suckers are serrated, and alternate in two rows; two rows of large marginal suckers exist on one side and two rows of much smaller ones on the other. At the extreme tip of the arm there is a cluster of small smooth-edged suckers, as in *Ommastrephes*, *Architeuthis*, &c.

The mouth is surrounded by a broad buccal membrane, with six angles or lobes, but without suckers. The body is relatively short, with short, bilobed caudal fins. The eyes are large, and have distinct lids. The dorsal bone or pen is thin, short, lanceolate, and somewhat quill-shaped, with a long blade.

The species, so far as known, are brilliantly colored, having occellated spots on raised verrucæ, in addition to the ordinary chromatophores of squids.

The two foreign species, hitherto described, are both from the Mediterranean.

Histioteuthis Collinsii Verrill.

Histioteuthis Collinsii Verrill, American Jo rnal of Science, vol. xvii, p. 241, March, 1879; vol. xix, p. 290, pl. 14, April, 1880; Trans. Conn. Acad., vol. v, p. 234, pls. 22, 27, figs. 3, 4, 5, pl. 37, fig. 5, 1880.

Tryon, Manual of Conchology, vol. i, p. 166, 1879 (description copied from the original one).

Plate XXIII, Plate XXIV, figures 3–6.

A large and handsome species, with the broad, thin, dark-brown web extending between and nearly to the ends of the six upper arms. The outer surface of the head and arms is covered with large, slightly raised warts or tubercles, which are dark blue with a whitish center, specked with brown; three rows extend along the ventral arms and two along the others; a circle of these surrounds the eyelids, but the edges of the eyelids are narrowly bordered with dark brown. Color between the warts pale purplish brown, with small, raised dark-brown spots, reddish specks, and white granules; web and inner surface of arms uniform dark reddish or purplish brown; suckers yellowish white, their pedicels specked with brown; tentacular arms light orange-brown. Eyes mutilated; their lids form a large, simple, rounded opening.

Tentacular arms slender, about 2 feet long and expanding near the end into a broad, long-oval, sucker-bearing portion or club (Plate XXIV, fig. 3), which is bordered by a membrane, widest on the upper edge; it ends in a tapering tip, on the back of which there is a thin, crest-like membrane or keel, enlarging proximally to its end, where it forms a rounded lobe. The most expanded portion of the club bears six rows of suckers, with finely serrate horny rings; the two central rows contain much the largest suckers, four or five in each; the more central of these two rows contains four suckers, larger than the rest, and of these the two median are largest; outside of these two median rows are two regular marginal rows of nearly equal, medium-sized, serrate suckers on the upper edge; and along the lower edge of the club there is one row of few similar but smaller ones; outside of these there is an incomplete alternating row of much smaller marginal ones. On the lower edge of the proximal portion of the club, extending from the middle backward, there is a row of four small, smooth-edged, unequal suckers, alternating with rounded, sessile tubercles that fit into corresponding suckers on the other arm; a row of similar but smaller suckers extends for about 6 inches along the inner surface in the median line of the arm, alternating at first singly, and then two by two, with tubercles, and gradually becoming more distant. The end of the arm, beyond the expanded club, bears minute serrate suckers, at first in six rows, decreasing to two toward the end. The extreme tip bears a small group of minute, smooth-edged suckers. The largest suckers of the club are decidedly constricted below the margin, and then swell out at the basal portion. The edge of the horny rim is divided into very numerous small, incurved, and crowded denticles, nearly equal in length, but part are thickened and obtuse, while the rest are more slender and acute. Diameter of the largest suckers 6.5^{mm}; of the largest in the second row, 5.5^{mm}; of the largest in the lateral rows, 3^{mm} to 4^{mm}; of the largest smooth-rimmed marginal suckers, 2^{mm} to 2.5^{mm}; of the smooth-rimmed suckers of the wrist, 1.5^{mm} to 2^{mm}.

Sessile arms stout, trapezoidal, tapering to slender tips, and bearing two rows of numerous suckers. All the arms on the left side are an inch or more longer than the corresponding right ones. The dorsal and ventral arms of the same side are about equal, and decidedly shorter than the two lateral pairs, which differ but little in length. Web about two-thirds as broad as the length of the arms, uniting the upper three pairs together, and as a narrowing border extending along their sides to the tips. The lower lateral arms have a thin, crest-line membrane on their outer median surface, commencing at the basal fourth and extending nearly to the tips. The ventral arms are united together, toward the base, by a web, which is also joined to the main web, in the median plane. A narrow outer web, arising from the outer angles of the arms, also unites all the arms together for a short distance above their bases.

The suckers (Plate XXIV, figs. 5, *a*, *b*) are all similar in form. The larger ones on the dorsal arms are, perhaps, a little larger than those on the lateral and ventral ones. The largest are subglobular, laterally attached, and gibbous; the aperture is small, usually with three or four flat, blunt, or rounded lobes or denticles on the outer margin, with none on the inner margin. The pedicels of the larger suckers are very stout at base, tapering up to their attachment on the lower side of the sucker, where they are small and slender. The largest suckers of the dorsal arms are 5^{mm} in diameter; their apertures, 2^{mm}; length of pedicels, 4^{mm} to 5^{mm}. The largest suckers on the ventral arms are not so large as those on the others; the largest are 4^{mm} in diameter. Only a few suckers (five or six), and these of very small size and nearly in one row, extend below the level of the ventral web, which is attached along the inner margin, inside the row of suckers. The larger ventral suckers are depressed and oblique, with a very one-sided horny ring, which has a small, oblique aperture, with about three bluntly rounded, slightly prominent lobes or denticles on the outer margin, while the inner margin is smooth.

The membranes about the mouth are arranged nearly as in *Ommastrephes*. The mouth is surrounded externally by a broad, elevated, smooth, dark chocolate-brown buccal membrane or collar, which is prolonged into six angular lobes, corresponding to all the intervals between the arms, except those between the second and third pairs;

this buccal collar is connected to the interbrachial membrane by six membranous bridles, corresponding to the six lobes; on both sides of the dorsal and ventral bridles are large pouches. The beak (Plate XXIV, fig. 4) is immediately surrounded by a thick, fleshy, lobed and wrinkled collar, and outside of this by another less prominent and less wrinkled one.

The exposed parts of the mandibles are black, the inner laminæ bright reddish brown. The beak of the upper mandible is very acute, strongly incurved, with scarcely any distinct notch at the base of the cutting edge, but with a conspicuously-excavated V-shaped area; the anterior edges of the alæ are irregularly and slightly denticulate or crenulate. The lower mandible has a much incurved beak, with the cutting edges decidedly concave, and a very small notch at their bases, but with a broad excavated area along their sides and bases; the anterior edges of the alæ are slightly convex and form a very obtuse angle with the edges of the beak or rostrum; a small, thin tooth exists just beyond the notch; the alæ are broadest near their inner ends; the gular lamina is peculiar in having a prominent, thickened, curved, lateral rib on each side, running to the end of the prolonged and subacute lateral lobes, and another dorsal one, running to the dorsal emargination. Length of upper mandible, 30^{mm}; hight, palatine to frontal, 20^{mm}; hight (or breadth) of palatine, 14^{mm}; tip of beak to end of frontal, 22^{mm}; to base of cutting edge (notch), 7.5^{mm}; notch to inner end of alæ (union with palatine), 7.05^{mm}; beak to posterior lateral border of alæ, 13.5^{mm}; transverse breadth across outer side of alæ, 9.5^{mm}. Lower mandible, length, 23^{mm}; inner ends of alæ to mentum, 22.5^{mm}; tip of beak to dorsal border of gular lamina, 17^{mm}; to inner ends of alæ, 18^{mm}; to notch, 8.5^{mm}; breadth of alæ in middle, 8^{mm}; greatest transverse breadth across alæ, 23^{mm}; across anterior edge, at teeth, 7.5^{mm}; notch to union of gular lamina and alæ, 6.5^{mm}; breadth of gular lamina, 12.5^{mm}.

The odontophore is rather short, the dorsal portion not much exceeding the ventral in length; the lateral membrane is broad and thin, its posterior border extending transversely straight across to the dorsal fold, nearly at right angles to the dorsal portion of the odontophore; the dentigerous portion, including a thickened lateral ridge outside the teeth, is light red in color. Length of dorsal portion, from anterior bend, 8.5^{mm}; of ventral portion, 8^{mm}; breadth of dentigerous zone, 3^{mm}.

The median teeth (Plate XXIV, fig. 6, *a*) are short, with a strongly incurved, acute central point, and with small, inconspicuous or rudimentary, blunt, lateral denticles on each side; the inner lateral teeth (*b*) are longer, without a distinct lateral denticle; the two outer rows have simple, rather slender, strongly incurved, acute teeth, the outermost a little longer and more slender. The plates along the border appear to be so closely united as not to be easily separated entire; they form a continuous but slight, narrow ridge, which has an undulated surface. The membrane lining the palate bears pale yellowish, scattered, stout, not very acute, and but slightly curved teeth, with bases not much enlarged; among these are clusters of small, stony, smoothish granules, often aggregated into masses of considerable size. The gular membrane also bears aggregations of small, smoothish, rounded, and angular granules, with others that are larger, oblong, and oval, smooth, and more or less regularly arranged. The œsophagus is very long and slender, dark colored.

Measurements of Histioteuthis Collinsii.

	Millimeters.	Inches.
Tentacular arms, length	609 and 635	24 and 25
Diameter at base	12.5	.50
Breadth of club, without membrane	17.5	.70
Its membranous border	6.2	.25
Length of club	69	2.75
Length of the slender tip	31	1.25
Of dorsal crest	37	1.50
Length of dorsal arm of left side	355	14
Of 1st lateral (2d pair)	432	17
Of 2d lateral (3d pair)	438	17.25
Of ventral arm	361	14.25
Breadth of lateral arms at base	22.5	.90
Thickness	19	.75
Diameter of eye-opening	22.5	.90
Diameter of head at base of arms	87	3.50
Breadth of web between arms	203 to 254	8 to 10
Diameter of largest suckers of tentacular arms	6.5	.26

Taken from the stomach of *Alepidosaurus ferox*, lat. 42° 49′, long. 62° 57′, off Nova Scotia, by Capt. J. W. Collins and crew of the schooner "Marion," 1879.

All parts back of the eyes are absent; the eyes are mutilated, but the specimen is otherwise in excellent preservation, even the web and suckers being nearly uninjured.

In addition to the original specimen, above described, another specimen, represented by the jaws alone, has been received by the United States Fish Commission from the Gloucester fisheries (lot 843). This was obtained on the Western Bank, off Nova Scotia.

Another beak was dredged by the "Fish Hawk," at station 893, south of Newport, R. I., in 372 fathoms.

These jaws agree well in size and all other characters with those of the original specimen (Plate XXIV, fig. 4).

FAMILY DESMOTEUTHIDÆ Verrill.

Trans. Conn. Acad., vol. v, p. 300, Feb., 1881.

For the reception of the genera *Desmoteuthis* V. and *Taonius* St., as defined below, I established this new family, which had previously been confounded with *Cranchidæ* and *Loligopsidæ*.

Body much elongated, pointed posteriorly; caudal fin narrow, terminal, mantle united to neck by a dorsal and two lateral muscular commissures. Pen lance-shaped, as long as the mantle, with a long, narrow shaft; blade incurved or hooded posteriorly. Œsophagus and intestine very much elongated. Nidamental glands and oviducts large, symmetrical. Eyes large, protuberant; lids free and simple. No auditory crests. Siphon large, with neither internal valve nor dorsal bridle.

Arms with depressed suckers. Tentacular arms with a well-developed club, bearing suckers.

DESMOTEUTHIS Verrill.

Taonius (*pars*) Steenstrup, 1861.
Desmoteuthis Verrill, Trans. Conn. Acad., vol. v, p. 300, Feb., 1881.

Body very long, tapering backward to a long, slender, acute caudal portion. Caudal fin long, narrow, tapering to a long, acute tip. Anterior edge of the mantle united directly to the head, on the dorsal side, by a commissure, so that there is no free edge medially, and the surface is continuous, as in *Sepiola;* the dorsal commissure extends backward and diverges within the mantle; two additional muscular commissures unite the lateral inner surfaces of the mantle to the sides of the siphon. Eyes very large and prominent, with simple circular lids. No aquiferous pores. Siphon large and prominent, with neither valve nor dorsal bridles. Arms small and short, subequal, with a basal web and lateral membranes; suckers smallest on the ventral arms, and urceolate, largest and flatish on the middle of the lateral and dorsal arms, feebly toothed. Pen extending the whole length of the body, very slender and of uniform width for more than half the length, then becoming broad-lanceolate, the terminal portion having the edges involute, forming a long, slender cone, into which the ovary extends. Nidamental glands large, symmetrically developed on the two sides. Gills small, situated in front of the middle of the body.

The genus *Taonius* was proposed by Steenstrup to include this and *T. pavo* (Les. sp.), but he has not, to my knowledge, definitely defined the genus. As *T. pavo* appears to be generically distinct from the present genus, I propose to retain *Taonius*, with *T. pavo* for its type. By many writers *T. pavo* has been placed in *Loligopsis* or *Leachia.* Steenstrup himself formerly referred *D. hyperborea* to *Leachia.* By Tryon both have been referred back to *Loligopsis.*

Loligopsis, as defined by D'Orbigny, in 1839, included *T. pavo*, as well as the type of *Leachia*, but he referred Lamarck's original type of *Loligopsis* to the genus, as amended by him, only with doubt.

It seems desirable, therefore, to explain this confusion, so far as possible.

Loligopsis Lamarck,* 1812 and 1822, was based only on an imperfect figure, made by Péron, of a small oceanic squid which had lost its tentacular arms. The supposed character of having *eight arms* was, for him, the only basis for the genus, no others being mentioned. The species (*L. Peronii*) was, however, described very briefly as a small squid with eight equal arms and two posterior, distinct caudal fins, and it was compared to *Sepiola.* It has apparently not been rediscovered by later writers, unless *L. chrysophthalma* D'Orb. be the same species, which is quite possible. The latter, as figured, is a small, *short-bodied species,*

*Extr. de Cours de Zool., p. 133, 1812 (t. D'Orb.); Animaux sans Vert., vol. vii, p. 659, 1822.

with distinct, separate, small caudal fins, which are free from the end of the body; its mantle-edge is also represented as free dorsally. This evidently is a generic type distinct from *Taonius* and *Desmoteuthis.* Indeed, it probably will be found not to belong to the same *family,* when actually studied. Therefore, it seems necessary to allow the name *Loligopsis* to remain connected with such small, short-bodied species, for which alone it was originally used. The genus, in its original sense, cannot yet be regarded as fully established.

Leachia Lesueur, 1821* (=*Perothis* (Esch.) Rathke, 1835), was also based on an *imperfect figure* of a small Pacific Ocean squid, which had likewise lost its tentacular arms. The only generic character given was, as in Lamarck's case, the presence of only eight arms—a purely fictitious character. The type of this genus was *Leachia cyclura* Les. It has a more elongated body, slender posteriorly, with a more or less rounded caudal fin, the two sides of the fin completely united together and to the posterior end of the body. The third pair of arms is much larger than the others. The anterior dorsal edge of the mantle is represented as *free* in all the figures, but, according to D'Orbigny, there is an internal dorsal commissure, and also two lateral ones. The visceral anatomy of one species of this group (*L. guttata* Grant), which D'Orbigny refers, probably correctly,† to the original *L. cyclura*, is pretty well known, and is widely different from that of *Desmoteuthis* (see Plate XXIV, fig. 1), as well as from that of *Taonius*, so far as the latter is known.

There can be no doubt whatever as to the generic distinctness of *Leachia*, if the *anatomy* be taken into account. (See the figures of Grant and D'Orbigny.)

Taonius Steenstrup, 1861 (type *T. pavo*). This differs from the two preceding genera in its more elongated form, narrow caudal fin, &c. From *Leachia* and *Desmoteuthis* it differs in the form of its pen. The dorsal edge of the mantle is represented and described as free by D'Orbigny. The anatomical characters are not known.

Desmoteuthis hyperborea Verrill.

Leachia hyperborea Steenstrup, Kongelige Danske Vidensk. Selsk. Skrifter, 5 r., vol. iv, p. 200, 1856 (sep. copies, p. 16).

Taonius hyperboreus Steenst., Oversigt Kgl. Danske Vidensk. Selsk., Forhandlinger, 1861, p. 83.

Verrill, Amer. Journ. Sci., vol. xvii, p. 243, 1879; vol. xix, p. 290, 1880.

Loligopsis hyperboreus Tryon, op. cit., p. 162 (inaccurate translation, after Steenstrup).

Desmoteuthis hyperborea Verrill, Trans. Conn. Acad., vol. v, p. 302, pl. 27, figs. 1, 2, pl. 29, fig. 1, Feb., 1881.

Plate XXIV, figures 1-3. Plate XXV, figures 1, 2 (anatomy).

♀. Body very long, tapering gradually backward, and ending in a

* Journal Philad. Acad., vol. ii, p. 89, pl. 2.

† Tryon criticizes this determination because Lesueur "describes and figures a smooth species," while *L. guttata* has two rows of curious tubercles *on the ventral side.* But as Lesueur only *described a figure of the dorsal surface,* his objection to this identification is absurd.

long, slender, acute tail; mantle soft and flabby, with a capacious branchial cavity; anterior dorsal edge advancing somewhat in the middle and directly united to the head, so as to leave no free edge medially, by a rather wide commissural band, the sides of which diverge as they extend backward within the mantle. Caudal fin long, narrow, lanceolate, narrowly acuminate to a very long, acute tip; the anterior insertions are wide apart, and the anterior border is rounded. Head short and small, exclusive of the eyes, which are very large, globular, and prominent, their lower sides in contact beneath the head; openings round, looking somewhat downward; pupils large and round; lids thin and simple. Siphon very large and prominent, extending forward between the eyes, but without a special groove; dorsal surface firmly united to the head by a thick commissure, leaving about half the length free; opening large, without any valve.

Arms comparatively small and short, none of them complete in our specimen except those of the third and fourth pairs, which are nearly equal in length, the ventral ones a little the shortest and most slender; the dorsal and second pairs of arms have lost their distal portions, but the parts of the dorsal arms remaining correspond in size with the ventral ones, and those of the second pair with the third pair. The arms are all united together by a thin, delicate basal web, which extends up some distance between the arms (farthest between the dorsal pair), and then runs along the sides of the arms, as broad, thin marginal membranes, to the tips. Suckers of the ventral arms smaller and different in form from those of the others, all of them being urceolate, with narrow apertures, surrounded by a slightly enlarged border, and having small horny rings, with the edge entire, or nearly so, on the proximal suckers, but on the smaller ones, toward the tip, with a few broad, blunt teeth on the outer edge. On the dorsal and lateral arms the basal suckers are ventricose and urceolate, like those of the ventral arms, but along the middle portion of these arms the suckers become much larger, and have a broad, shallow form, with wide apertures and expanded bases; the horny rings of these larger suckers are divided into several broad, bluntly rounded teeth on the outer edge; toward the tips of the arms the smaller suckers again become deeper, with more contracted apertures, and with a few more prominent denticles on the rings.

Outer buccal membrane with seven obtuse angles, and united to the arms by seven bridles, or commissures, of which the upper one is double. Exposed part of the beak black; mandibles very acute, strongly incurved.

Pen very thin and narrow, and of nearly uniform width (4^{mm}) for more than half its length; at about four-sevenths of its length from the anterior end it gradually expands laterally into a broad, very thin, lanceolate form, becoming, opposite the broadest part of the fin, 30^{mm} wide, with very delicate lateral expansions and with a pretty strong dorsal keel; farther back it tapers and is very acuminate, the lateral margins becoming involute, so as to form a very long, slender, acute, terminal, hollow cone, extending to the tip of the tail. The anterior end is obtusely rounded and thin; a short distance from the anterior end there are two thin lateral processes, directed forward, to which the commissural muscles were attached (Plate XXV, figure 2).

Color of entire body, siphon, and caudal fin dark brown, thickly covered with large, roundish, unequal spots of darker brown and paler brown, intermixed; head, eyes, arms, and web dark brownish purple, with crowded chromatophores; suckers yellowish.

Total length, to end of lateral arms, 16 inches; to dorsal edge of mantle, 13 inches; length of head, 1 inch; diameter of eye, 1 inch; length of caudal fin, 5 inches; its breadth, 1.80 inches.*

Measurements (in millimeters).

	A ♀.	B.
Length to tip of lateral arms	410	......
Length to base of arms	354	......
Length to base of mantle, above	330	210
Length of caudal fin	127	103
Breadth of caudal fin	46	18
Diameter of body	57	......
Diameter of eye	25	26
Length of 3d pair of arms	56	63
Length of ventral arms	52	38
Diameter of largest suckers of lateral arms	3	5
Length of pen	330	......
Of anterior linear portion	180	......
Of posterior lanceolate part	150	......
Breadth of anterior portion	3	......
Breadth of lanceolate part	30	......

A is the specimen described above; B is the specimen described by Steenstrup from Greenland. The latter had the dorsal arms 40mm long; 2d pair 50mm; tentacular arms 68 and 70mm, respectively. The larger size of the suckers of the latter may indicate that it was a male.

Our specimen was taken near the northern edge of the Gulf Stream, West long. 55°, by Thomas Lee, of the schooner "Wm. H. Oaks," January, 1879, and by him presented to the U. S. Fish Commission. Baffin's Bay, Northern Greenland (Steenstrup).

Notes on the visceral anatomy.

Plate XXV, figure 1.

The only specimen of this species obtained had the internal organs considerably injured, but the anatomy is so unlike that of the more common genera of squids that it seemed to me desirable to figure such parts as are preserved.

This specimen is a female, and the large nidamental glands (*x′*, *xx*, *xx′*) are symmetrically developed on the two sides; these are swollen, voluminous organs, composed of great numbers of internal lamellæ; the anterior ones (*x′*) occupy the region around and in front of the

* Some of these measurements are slightly larger than those originally given. This is due to the fact that the specimen has been kept, since first received, in somewhat weaker alcohol, and has become more relaxed in consequence of this, combined with repeated handling.

bases of the gills, extending forward and having an oblique, oblong opening (*op*, *op'*) on the outside of the anterior ends; the posterior ones (*xx*, *xx'*) are behind the gills and cover the branchial auricles; the oblique, slit-like opening is on the outer side of the posterior ends; the gland on the left side (*xx'*) was mutilated; the posterior vena cava in front of *r'* passes through the center of the posterior gland (*xx*). The ovary (*or*) is a very long organ, attached to the stomach (*s*) and to the sides of its long cœcal appendage; it extends far backward to near the tip of the tail, occupying the concavity of the pen (*p*); it consists of great numbers of small clustered folicles; connected with its anterior end, and attached to the stomach, there is a convoluted tube, probably an oviduct, not well shown in the figure; connected with and opening into the intestine, near its origin, there is a firm, roundish organ, with internal lamellæ, perhaps a part of the stomach or gizzard (fig. 1, *s*). The stomach was much mutilated, so that its form could not be certainly made out. What appears to have been a portion of the stomach, or else the anterior part of the cœcal appendage (*s*,*s*), had a cavity lined with numerous longitudinal folds; from this a very long, saccular, cœcal appendage, longitudinally plicated within (*s''*), runs back, along the ovary, into the caudal cavity of the pen. The œsophagus had been destroyed. The intestine (*l*, *h*) is very long and slender, internally longitudinally plicated, and externally covered along nearly its whole length, on one side, by close groups of small glandular folicles (*l*, *l*); the terminal portion is closely attached to the ventral edge of the small, smooth, firm, compressed, oblong-ovate liver (*i*), and its free, stout anal end (*h*) is provided with two slender, tapering cirri. The ink-sac (*i'*) is small, pyriform, between the front part of the liver and the rectum.

The gills (*g*, *g*) are small and short, situated far forward, and connected to the ventricle of the heart (*H*) by long afferent vessels (*bo*); the branchial auricles (*au*, *au*) are rounded, without terminal capsules; the ventricle of the heart (*H*), as preserved, is small and four-lobed, the largest lobe directed forward and passing into the anterior aorta. The condition of the specimen did not permit the circulation to be much studied. The two large, fusiform, cellular organs (*r'*, *r'*) are probably renal in nature; their interior is filled with large, irregular cavities or lacunæ, which appear to be connected with the posterior venæ cavæ (*vc''*).

TAONIUS Steenstrup (restricted).

Loligo (*pars*) Lesueur, Journ. Philad. Acad., vol. ii, p. 96, 1821.
Loligopsis (*pars*) D'Orbigny, Céph. Acétab., p. 320 (*non* Lamarck).
Gray (*pars*), Catal. Moll. Brit. Mus., vol. i, p. 39, 1849.
Taonius (*pars*) Steenstrup, Oversigt Kgl. Danske Vidensk. Selsk. Forh., 1861, pp. 70, 85.
Taonius Verrill, Trans. Conn. Acad., vol. v, p. 306, Feb., 1881.

This genus seems to bear about the same relation to *Desmoteuthis* that *Rossia* does to *Sepiola*. Its relations with *Loligopsis* and *Leachia* have already been discussed (pp. 301, 302). The body is short-pointed posteriorly. The caudal fin is long-cordate, but not slender-pointed. The pen is lance-shaped, the anterior portion being long, narrow, of nearly uniform width; posterior end broad-lanceolate, short-pointed posteriorly, and, according to the figures, without a cone at the tip. The anterior dorsal edge of the mantle is represented as free externally, but there is a dorsal commissure within the mantle-cavity, and a lateral one on each side. Arms short, subequal; suckers flat, denticulate, those of the tentacles with sharp, incurved teeth. Eyes large, globular, prominent; lids free and simple.

Siphon with neither valve nor dorsal bridle. No external ears, nuchal crests, nor cephalic aquiferous pores.

Taonius pavo Steenstrup.

Loligo pavo Lesueur, Journal Acad. Nat. Science Philad., vol. ii, p. 96, with a plate, 1821.

Loligopsis pavo Férussac & D'Orb., Céph. Acétab., p. 321, Calmars, pl. 6, figs. 1–4 (after Lesueur); Loligopsis, pl. 4, figs. 1–8 (details, original).

Binney, in Gould's Invert. Mass., ed. 2, p. 309 (but *not* the figure, pl. 26).

Verrill, Amer. Journ. Sci., vol. xix, p. 290, 1880.

Tryon, Amer. Mar. Conch, p. 9, pl. 1, fig. 3 (after Lesueur); Man. Conch., vol. i, p. 163, pl. 68, fig. 252, pl. 69, fig. 253, 1879 (descr. from Gray, figures from Lesueur and D'Orb.).

Taonius pavo Steenst., Oversigt Kgl. Danske Vidensk. Selsk. Forh., 1861, pp. 70, 85.

Verrill, Trans. Conn. Acad., vol. v, p. 306, Feb., 1881.

This species differs externally from the preceding in having a much shorter, obtuse, oblong-cordate fin, instead of a long, slender, pointed one, and by its very distinct coloration. According to Lesueur, the general color is carmine-brown, the mantle, head, and arms "covered on every part with very large ocellations, which are connected together by smaller intermediate ones." Length of mantle, 10 inches.

Sandy Bay, Mass. (Lesueur). Newfoundland (Steenstrup). Off Madeira (D'Orbigny).

No instance of the occurrence of this oceanic species on the New England coast has been recorded since the original specimen was described by Lesueur in 1821. The circumstances connected with the history of his specimen are such as to render it not improbable that some interchange of labels had occurred in his case. Therefore, the New England habitat for this species needs confirmation.

Lesueur's statement (loc. cit., p. 94) is that when at Sandy Bay, Mass. (on Cape Ann), in 1816, he saw a "great number" of squids ("*Loligos*") that had been taken by the fishermen for bait, and that "the beautiful color with which they were ornamented induced me to take a drawing of one immediately, but not then having leisure to complete it, I took a specimen with me to finish the drawing at my leisure. But recently [in 1821], upon comparing this specimen with my drawing, I was much surprised to perceive that I had brought with me a very distinct species from that which I had observed [*O. illecebrosus*]. I mention this circumstance to explain the cause of the brevity of the following description [of *O. illecebrosus*] taken from my drawing." The drawing was also inaccurate for the same reason.

MYOPSIDÆ D'Orbigny.

Eyes without regular lids, the integument of the head extending continuously over the eye, and becoming transparent over the pupil of the eye. In some genera (*Rossia*, &c.) there is a thickened fold of skin below the eye, constituting a sort of false lower eyelid. Pupil crescent-shaped. A small mucous pore in front of the anterior edge of the eye, connected with the orbital cavity.

FAMILY LOLIGINIDÆ.

Teuthidæ (*pars*) Owen, Proc. Zool. Soc. London, p. 285, 1847.
Loligidæ D'Orbigny, Céph. Acétab., p. 297, 1848.
Loligidæ (*pars*) Gray, Catal. Moll. Brit. Mus., vol. i, p. 66, 1849.
Loliginidæ (*pars*) H. & A. Adams, Genera, Moll., vol. i, p. 35.

Body more or less elongated, cylindro-conical. Fins elongated, united and acute posteriorly, sometimes extending the whole length of the body. Pen large, extending the whole length of the mantle, with an acute, short, pen-like anterior shaft, and a broader, thin, lanceolate blade. Connective cartilages of the mantle three, movable. Eyes without a thickened false lid. Siphon provided with an internal valve, and attached to the head by a dorsal bridle. Nuchal crests about the ears well-developed. Tentacular club large, with four rows of denticulated suckers on the middle portion. Horny rings of the suckers encircled externally by a raised median ridge.

On our coast this family is represented only by the genus *Loligo*. At Bermuda and in the West Indies a species of *Sepioteuthis* occurs, which will probably hereafter be found on our southern coast. In the latter the fins extend along the whole length of the mantle.

LOLIGO Lamarck, 1779.

Loligo (*pars*) Lamarck, Syst. Anim. sans Vert., p. 60, 1801.
Pteroteuthis (subgenus) Blainville, Man. Malac., p. 367, 1825.
Loligo (restricted) D'Orbigny, Céph. Acétab., p. 305, 1848.
Verrill, Trans. Conn. Acad., vol. v, p. 307, Feb., 1881.

Body elongated, tapering to a point behind; anterior edge of mantle free dorsally, and prolonged into a lobe, covering the end of the pen. Caudal fin posterior, elongated-rhomboidal, united to the sides of the body to the posterior tip. Mantle connected to the neck by a dorsal and two lateral connective cartilages; lateral cartilages of the mantle simple longitudinal ridges; corresponding cartilages, on the base of the siphon, irregularly ovate, with a median groove. Pen as long as the mantle, anteriorly narrow, with a central keel and two lateral ridges; posteriorly broad, thin, lanceolate, concave, but not involute. Head rather large; eyes without lids, covered with transparent skin, pupil crescent-shaped, encroached upon dorsally by the iris; a small mucous pore in front of the eyes; behind the eyes, on each side, there is an oblique transverse and two longitudinal, erect, thin crests, in relation with the ears. Siphon situated in a shallow groove, united to the head by a pair of dorsal bridles, and furnished with a large internal valve. Six buccal aquiferous pores, and a pair of branchial pores, one on each side, between the bases of the third and fourth pairs of arms. Buccal membrane with seven elongated points, covered on their inner surfaces with small suckers; in the female with a special organ (Plate XXVI, fig. 4, *s*), below the beak, on the ventral side, for the attachment of the spermatophores.

Sessile arms angular; basal web rudimentary or none; suckers in two rows, oblique, deep cup-shaped; horny rings toothed on the broad side, and surrounded with a median ridge. Male with one of the ventral arms (usually the left) hectocotylized, near the tip, by an enlargement of the bases of the pedicels of the suckers and a decrease or disappearance of the cups. Tentacular arms long and strong, with an expanded club, provided with marginal membranes and a dorsal keel; suckers, on the widest part, usually in four rows, those in the two central rows larger, broad-urceolate; smaller ones cover the proximal and distal portions; no connective suckers on the club or along the arm. Sucker-rings surrounded externally by a raised band.

Oviduct large, developed only on the left side. Nidamental glands large in front of heart. Eggs in fusiform, gelatinous capsules, attached by one end, and usually radially united into large clusters.

Loligo Pealei Lesueur (*typical form*).

Loligo Pealei Lesueur, Journ. Acad. Nat. Sci. Philad., vol. ii, p. 92, pl. 8, 1821.

Loligo Pealii Blainville, Dict. Sci. Nat., vol. xxvii, p. 144, 1823.

Férussac & D'Orbigny, Céph. Acétab., p. 311, Calmars, pl. 11, figs. 1–5, pl. 20, figs. 17–21 (details).

Gray (*Pealii*), Catal. Moll. Brit. Mus., vol. i, p. 71, 1849.

Binney, in Gould's Invert. Mass., ed. 2, p. 514, pl. 25, figs. 339, 340 (figure erroneously referred to *O. Bartramii*).

Verrill (*Pealii*), Report on Invert. Vineyard Sd., pp. 440, 635 (sep. copies, p. 341), pl. 20, figs. 102–105, 1877.

Tryon (*Pealii*), Man. Conch., vol. i, p. 142, pl. 51, figs. 133–140 (figs. from Fér. & D'Orb. and Dekay).

Verrill, Amer. Journ. Sci., vol. iii, p. 281, 1872; Amer. Naturalist, vol. viii, p. 170 (habits); Amer. Journ. Sci., vol. xix, p. 292, 1880 (descr.) (*Pealei*); Trans. Conn. Acad., vol. v, pp. 308–340, pl. 29, figs. 1–4, pl. 37, figs. 1–3, pl. 39, fig. 4, pl. 40, pl. 45, figs. 3, 4, 1881.

Brooks (*Pealii*), Develop. of the squid, in Anniver. Mem. Boston Soc. Nat. Hist. pl. 1–3, March, 1881 (embryology).

Loligo punctata Dekay, Nat. Hist. N. Y., Mollusca, p. 3, pl. 1, fig. 1, 1843 (young).

Binney, in Gould's Invert. Mass., p. 513 (after Dekay).

Tryon, Amer. Mar. Conch., p. 14, pl. 43, figs. 10, 11 (after Dekay).

Variety *borealis* Verrill.

Loligo Pealei var. *borealis* Verrill, Amer. Journ. Sci., vol. xix, p. 292, 1880.

Loligo Pealei Lesueur—(Continued).

Variety *pallida* Verrill.

Loligo pallida Verrill, Rep. Invert. Viney. Sd., in Rep. U. S. Com. Fish and Fisheries, vol. i, p. 635 [341], pl. 20, figs. 101, 101 *a*, 1874.

Tryon, Man. Conch., p. 143, pl. 52, figs. 141, 142 (descr. and figs. copied from preceding).

Verrill, Amer. Journ. Sci., vol. xix, p. 292, 1880.

Loligo Pealei var. *pallida* Verrill, Trans. Conn. Acad., vol. v, p. 317, pl. 28, figs. 1–6, 1881.

Plate XXVI, figures 1–4. Plate XXVII, figures 1–4 (pens). Plate XXVIII, figures 1–9, Plate XXIX (anatomy ♂). Plate XXX (young). Plate XXXI, figures 1–3. Plate XXXII, figure 2 (anatomy ♀).

Body rather elongated, more or less stout, according to state of distention or contraction,* tapering backward to a moderately acute posterior end, more acute in the male than in the female. Caudal fin long-rhomboidal, with the outer angles very obtusely rounded, and varying, according to age, in the ratio of its length to its breadth, and greatly, also, in the proportion that its length bears to that of the mantle.† The length of the caudal fin, in proportion to that of the body (mantle), although variable, normally increases with age, even after sexual maturity. In this species, with specimens having the mantle from 100^{mm} to 125^{mm} long, the ratio of the fin to the mantle usually varies from 1 : 1.80 to 1 : 1.90; with the mantle 150^{mm} to 175^{mm} long, the ratio usually becomes 1 : 1.65 to 1 : 1.75; in the largest specimens, with the mantle 260^{mm} to 400^{mm} long, the ratio varies from 1 : 1.50 to 1 : 1.65, rarely becoming 1 : 1.75. The ratio of the breadth of the caudal fin to the length of the mantle, in the larger male specimens, ranges from 1 : 2.12 to 1 : 2.40, varying considerably according to the mode of preservation; in the larger females it varies from 1 : 1.70 to 1 : 2.12.

The anterior ventral edge of the mantle recedes, in front of the siphon, in a broad curve, leaving an obtuse angle at either side, opposite the lateral cartilages; from these angles it again recedes, on the sides, in a concave line, and then projects considerably forward, forming a prominent median dorsal lobe, which gradually tapers from the base, and

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* The mantle, when the gill-cavity is distended with water, has a larger size than when the water is expelled by the contraction of its walls, which is usually the condition in which specimens die. Moreover, when the large stomach is distended with food, and when the ovary is distended, in the breeding season, with eggs, the form is stouter than usual.

† This variation is largely independent of sex, and is due partly to the ordinary changes during growth, partly to the condition of the muscular tissues at the time of death, and partly to the effects of the alcohol in which they have been preserved. These latter causes, in the case of preserved specimens, more or less obscure the effects of growth in causing the proportions to change.

The most marked effect of strong alcohol is to reduce the diameter of the body and the breadth of the caudal fin to a proportionally far greater extent than it does the length of the mantle and fin. Therefore, with specimens that have been preserved in too strong alcohol, the females resemble the males in form, and the males often look like a different species, on account of their unnaturally long and narrow fins and very slender bodies.

then rather suddenly narrows to a point, over the end of the pen; the point, when in its normal position, reaches as far forward as the posterior border of the eye, or even beyond it. Dorsal connective cartilage long, tapering backwards, with a very prominent, broad dorsal keel; the anterior end is free and shaped like the end of the pen. Siphon large, rounded anteriorly, with a broad, bilabiate opening; lateral cartilages (Plate XXIX, fig. 1, *f*) long and narrow, subacute anteriorly, posterior end with a thin, rounded outer lobe; median groove narrow. The connective cartilages of the mantle (fig. 1, *f'*) are simple longitudinal ridges, fading out gradually posteriorly. Head moderately large, usually narrower than the mantle, smaller in the male than in the female; eyes large; nuchal crests (fig. 1, *b*) above the ear, formed by longer upper, and shorter inferior, oblique, longitudinal membranes, the two united by a doubly curved or **V**-shaped membrane, having its angle directed forward, the whole having a rude **W**-shaped form.

Arms large, stout, the three upper pairs successively longer; the ventral ones a little shorter than the third pair, and a little longer than the second pair. All the arms have narrow, thin marginal membranes, strengthened by strong transverse muscular ridges. The first and second pairs of arms are trapezoidal at base; third pair stouter, compressed, with a keel on the middle of the outer side. Suckers in two regular rows on all the arms, deep, very oblique, largest on the lateral arms; those on the ventral arms are smaller, but otherwise similar. Horny rings yellowish or brownish (white when fresh), strong; on the larger proximal suckers the outer or higher side is divided into about six broad, flattened, incurved teeth, which are blunt, subtruncate, and sometimes even emarginate at tip, remainder of margin nearly even; the smaller suckers, toward the tips of the arms, have the teeth longer, much more slender, and more acute.

The tentacular arms (Plate XXVI, fig. 2) with fresh specimens, in full extension, may reach back nearly to the end of the body; with preserved specimens they seldom extend beyond the middle of the caudal fin; they are rather slender, compressed, with a narrow, thin membranous keel along the outer edge, becoming wider at the club; on the distal half of the club it is much wider and runs a little obliquely along the back part of the upper side, where it is usually folded down against the side, its inner surface being whitish. The club is rather broad and thick, with a wide, scalloped marginal membrane along each edge; these membranes are strengthened by transverse muscular ridges, which commence between the large central suckers and fork at the pedicels of the marginal ones. Along the center of the club there are two alternating rows of large, broad, depressed suckers, about seven in each, with a few smaller ones, of the same series, at both ends; along each edge, alternating with the large suckers, there is a row of smaller and more oblique marginal suckers, about half as large. The proximal part of the club bears only a few small denticulated suckers; the distal part bears a large number of small, sharply denticulated, pedicelled suckers, crowdedly arranged in four rows; close to the tips of the arms about twenty of the small suckers have smooth rims and very short pedicels, but are still in four rows. The large suckers vary greatly in relative size, according to age, sex, season, and locality (Plate XXXI, figs. 1, 2, 3); they are a little higher on one side than on the other, with a broad aperture, surrounded by a horny marginal ring, which is divided all around into sharp, unequal teeth, which are larger on the outer side (Plate XXVIII, figs 3, 4, *c*, *c*); usually one minute sharp tooth stands between two larger ones, and these sets of three stand between still larger and less acute ones; the horny ring is surrounded by a wide, thick, soft marginal membrane; below the border a groove surrounds the sucker, and below this there is a basal swelling, equaling or exceeding the margin in diameter. The smaller marginal suckers (Plate XXVIII, figs. 9, 9 *a*) have the aperture more oblique and the horny ring much wider on the outer side, with its outer sharp marginal teeth longer and more incurved; usually these have the teeth alternately larger and smaller.

The outer buccal membrane (Plate XXVI, fig. 4) is large, thin, with seven prominent, elongated, acute angles, all of which have a cluster of about ten to fifteen small pedicelled suckers, in two rows, on the inner surface (*a*, *b*, *c*, *d*). These suckers have horny rings, denticulated on one side. In the female there is a special thickened organ (*s*) in the form of a horseshoe on the inner ventral surface of the buccal membrane. This in the breeding season serves for the attachment of the spermatophores by the male.

The muscular pharynx (fig. 4, *e*, *f*) containing the jaws can be protruded its whole length. The inner buccal membrane (*f*) or sheath inclosing the beak (*m*) has a prominent, thickened, radially wrinkled and puckered anterior margin. On the ventral side the pharynx bears, externally, two thin chitinous plates, not connected with the jaws. The points and exposed edges of the beak are hard and black, becoming dark reddish brown farther back; the alæ and gular and palatine laminæ are thin and pale yellowish or light amber-color, in alcoholic specimens. The upper mandible (Plate XXVIII, figs. 5, 5 *a*, var. *pallida*) has a sharp, strongly incurved point; cutting edge regularly curved, with a triangular notch at its base, followed by a prominent triangular tooth on the alar edge, beyond which the edge is nearly straight, but recedes somewhat. Lower mandible with a sharply incurved point and sinuous cutting edges, which have a slight tooth below the middle and only a slight rounded notch at base, which passes gradually into the very oblique and receding alar edge. The bilobed palate is covered with a chitinous membrane, which bears transparent, small, sharp, recurved denticles.

Radula with pale amber-colored teeth and thin transparent borders. The median teeth (Plate XXVIII, figs. 6–8) are broad, with a long, acute median denticle, and a shorter, curved, and less acute lateral one, on each side; the inner lateral teeth (*b*) are short, strongly incurved, with a longer, acute central denticle and a smaller outer one, and with the inner angle of the base slightly prominent; the next to the outer lateral teeth (fig. 6, *c*) are much longer, broad, tapered, curved, acute; the outer teeth (fig. 6, *d*) are longer, more slender, more curved, triquetral, and very acute, with a large basal lobe. A row of thin, distinct, roundish scales (fig. 6, *e*) forms a border outside the teeth.

The pen (Plate XXVII, figs. 1–4) is thin, translucent, pale yellowish in fresh specimens, but brownish or amber-color in alcoholic specimens. It has a short, narrow, anterior shaft and a long, very thin, lanceolate blade, which is concave beneath, especially posteriorly, for the edges curve downward, but are not involute; the posterior tip is acute, a little thickened, and slightly curved downward, so that the posterior end is shaped something like the forward part of an inverted shallow canoe; the cavity at the extreme tip is slightly decked over in large specimens. In the male (fig. 4) the pen is relatively longer and the blade narrower than in the female. The extreme anterior end is thin and flexible, and rather sharply and abruptly pointed, being shaped like a pen; the shaft is rather stiff, with a strong, regularly rounded keel, convex above and concave beneath; outside of the keel the marginal portion curves outward and then upward, so that its convex surface is below, and the edge slightly turns up. The shaft, with its central keel and marginal ridges, extends to the posterior tip of the pen, decreasing regularly in width beyond the commencement of the blade. The blade is at first very narrow, and gradually increases in width; it is marked by numerous slightly thickened ridges, which diverge from the central line as they extend backward; the edges are very thin.

In the larger males the proportion of the greatest breadth of the blade to the total length of the pen varies from 1:7.50 to 1:9.36. In the females it varies from 1:5.60 to 1:6.10.

The following description of the colors was made from a freshly caught adult male specimen (1 G), taken in New Haven Harbor, May 18, 1880.

Upper surfaces of the body, head, and caudal fin thickly covered with rather large chromatophores, which are mostly rounded or nearly circular, except along the middle of the back, where they are more crowded and darker, and mostly have a long-elliptical form (perhaps accidental).

The chromatophores, when expanded, are light red to dark lake-red, varying to purplish red and pink; when contracted to small points, they become brownish purple.

On the head, behind the middle of the eyes, and toward the margin of the caudal fin, the spots are smaller and less numerous, the intervening bluish white ground-color showing more largely. Over most of the dorsal surface the chromatophores are arranged more or less evidently in circular groups; usually the central chromatophore is a large, round, dark-purplish spot; this is surrounded by a circular space of whitish ground-color, and by a circle of roundish chromatophores, mostly of different shades of lake-red and pink, and a deeper lying circle of pale canary-yellow ones. On the lower side they are so thinly scattered that they leave much of the translucent bluish white ground-color visible between them; along the median ventral line the spots are more numerous, producing a distinct median stripe. The caudal fin is clear bluish white beneath, and very translucent, becoming almost transparent near the margin.

Exposed part of the siphon similar to the ventral surface of the body, but with the spots more sparse, and mostly disappearing near the margin and at the base; lower side of the head, in front of the eyes, sparsely spotted. Outer and upper sides of the upper arms and outer surfaces of the ventral pair similarly, but somewhat more densely, specked; both sides of the ventral arms and lower sides of the lateral arms pinkish white and unspotted. Tentacular arms pale translucent, bluish white, with the outer surface, except at base, rather thinly specked with small purplish chromatophores; the inner surface and upper side of the tip and the suckers are translucent white; rings of suckers white.

On the inner surface of the dorsal and lateral arms, between the suckers, there are a few large chromatophores, and a double row of them runs out obliquely on the muscular thickenings of the marginal membrane, alternating with the suckers, on each side; suckers pure translucent, bluish white (becoming yellow or brown in alcohol).

The pupils of the eyes are deep bluish black; on the upper side they are encroached upon by a sinuous downward extension of the iris, which is silvery or pearly white, with brilliant, green, opalescent reflections at the upper margin.

Sexual differences.

The sexes differ to a considerable extent in proportions. If we compare specimens of equal length, the female will have the body relatively stouter and less tapered posteriorly than the male; the head is decidedly larger;* the arms are longer; the suckers are usually distinctly larger, especially those of the tentacular arms. But if we compare specimens having the head and arms of equal size, the male will be found to have a decidedly longer, more slender, and more tapered body, and a somewhat longer and narrower fin. (See Table B, for comparative proportions.)

In the adult male the circumference of the head to the mantle-length usually varies from 1:2.55 to 3.45, averaging about 1:3.10; in the female from 1:1.75 to 1:2.45, averaging about 1:2.25.

The ratio of the breadth of the fin to the mantle-length, in the male, varies from 1:2.12 to 1:2.45, averaging about 1:2.25; in the female, from 1:1.70 to 1:2.12, averaging about 1:1.90.

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*Some of the nominal European species of *Loligo*, that have been based on the smaller size of the head, arms, and suckers, are probably only the males of the common species. The sexual variations in this genus have apparently been very imperfectly understood by European writers generally.

The ratio of the diameter of the largest tentacular suckers to the mantle-length varies, in the male, from 1:50 to 1:90, averaging about 1:65; in the female it varies from 1:36 to 1:54, averaging about 1:45.

The proportion of the length of the dorsal arms to the mantle-length, in the male, averages about 1:3.50; in the female about 1:2.75.

The pen of the female is relatively broader and shorter than that of the male (see Table A).

The best and most positive external characters for distinguishing the sexes are the hectocotylized condition of the left ventral arm of the male, near the tip (Plate XXVI, figs. 3, 3 *a*), and the presence, in the female, of a horseshoe-shaped sucker, or place for attachment of the spermatophores, on the inner buccal membrane, below the beak (fig. 4, *s*,) These characters, however, are not present in the very young individuals, and in those with the mantle two or three inches long they appear only in a very rudimentary state.*

A.—*Sexual variations in the pen (measurements in inches).*

	♂ P.	♂ 9 V.	♂ 10 V.	♂ W.	♀ E.	♀ EE.	♀ 17 V.	♀ An.
Length of pen	10.50	10.20	9.55	8.50	7.75	7.65	7.55	7.50
Length of shaft	1.40	2.10	2.20	2.00	2.00	1.10	1.50	1.50
Length of blade	9.10	8.10	7.35	6.50	5.75	6.55	6.05	6.00
Breadth of shaft	.50	.35	.40	.40	.15	.38	.35	.35
Breadth of blade	1.40	1.15	1.02	.98	1.00	1.35	1.25	1.30
PROPORTIONS.								
Greatest breadth to length 1:	7.50	8.86	9.36	8.67	7.75	5.66	6.04	5.76

The specimen marked An is from Cape Ann, Mass. (var. *borealis*); that marked ♀ E is var. *pallida*, from Astoria, N. Y.; the rest are from Vineyard Sound, Mass.

The adult males have the left ventral arm conspicuously hectocotylized (Plate XXVI, figs. 3, 3 *a*) by an alteration and enlargement of the sucker-pedicels and a decrease in the size of the cups of the suckers, some of which usually disappear entirely, especially in the outer row. The modification commences at about the 18th to 20th sucker, by the swelling of the bases of the pedicels; on succeeding suckers this rapidly becomes more marked, and the swollen bases of the pedicels become more elongated and gradually become compressed transversely, while the size of the cups rapidly decreases till at about the 28th to 30th they are very minute and rest at the summits of the large, flattened, acute-triangular supports; from the 30th to 35th the cups usually become mere rudiments, or disappear in large males; beyond this the cups again grow larger and the pedicels decrease in size, till the small suckers become normal on the tip of the arm. About twenty-five to thirty of

* Professor Steenstrup formerly advanced the opinion that the males of *Octopus* and other genera of Cephalopods were provided with the hectocotylized arm from the first, but this we have not found to be the case. The hectocotylized condition of the arm in *Loligo* is developed in proportion to the development of the internal sexual organs, and is first distinctly noticeable in the larger of the young ones taken in autumn, and in the spring in the young ones that have survived their first winter.

the suckers of the outer row are thus modified in the larger males. Of the inner row a somewhat smaller number of suckers show distinct alteration, and these are less extensively altered; their pedicels are swollen and their cups reduced, but not to so great an extent, and usually none of the cups are entirely absent.

In young males, with the mantle about 70^{mm} to 90^{mm} (young of the previous year, or perhaps of the first year, when three to five months old), these modifications of the suckers began to appear, at first very indistinctly, by a slight enlargement of the bases of the pedicels and a scarcely noticeable decrease in the size of the cups. In specimens with the mantle 100^{mm} to 130^{mm} long (probably young of the previous year, nine months to a year old) the modification of the suckers, though much less marked than in the adults, is sufficiently distinct, the pedicels having become distinctly longer and stouter, while the cups are evidently reduced in size, but none of them are abortive in such specimens.

Loligo Pealei var. **borealis** Verrill.

Plate XXVII, figure 1 (pen). Plate XXXII, figure 2 (anatomy).

Since describing this variety, I have had opportunities to examine a much larger series of specimens from Cape Ann. These show very plainly that this form passes by intermediate gradations into the typical form, so that it cannot be considered as anything more than a local or geographical variety. The differences in the proportion of the fin to the mantle, noticed in the original specimens, do not hold good with a larger series. The only varietal character of much importance is the relatively smaller suckers, and this is much less marked in most of the later examples than in the former ones, and is a character that varies greatly in the specimens from every locality.*

In the original specimens the 'pen' (Plate XXVII, fig. 1), while having the general form of that of *L. Pealei*, tapers more gradually anteriorly, and has a narrower, more tapered, sharper, and stiffer anterior tip. The variations in proportion are sufficiently indicated by the measurements given in Tables A, B, and C, in which those specimens designated as 2 G to 5 G were measured while fresh. The one marked An ♀ is from the lot originally described as variety *borealis*, and illustrates the abnormally small size of the suckers.

Loligo Pealei var. **pallida** Verrill.

Plate XXVIII, figures 1–7. Plate XXIX, figure 1 (anatomy).

This geographical variety or subspecies is distinguished from the typical form chiefly by its shorter and stouter body in both sexes, its broader and larger caudal fin, and the larger size of the suckers, especially those of the tentacular club.

The caudal fin is broad-rhomboidal, often as broad as long, or even

* Probably those with abnormally small tentacular suckers are instances in which the arms, the clubs, or the suckers have been lost and afterwards reproduced, as explained below.

broader than long in adult specimens. The ratio of the breadth of the fin to the mantle-length in the larger specimens (with mantle 150^{mm} to 225^{mm} long) is, in the males, from 1 : 1.75 to 1 : 2.00, while in *L. Pealei*, of corresponding size, the ratio is 1 : 2.15 to 1 : 2.30; in the females of var. *pallida*, of similar size, the ratio varies from 1 : 1.45 to 1 : 1.75 (see Tables F, G). Tentacular arms long and slender, varying in length according to the amount of contraction, in extension longer than the body, the club or portion that bears suckers forming about one-third the whole length. In a few males the larger suckers on the middle of this portion are not so large as the largest on the lateral arms, but usually they are twice as large. In some females the principal suckers of the tentacular arms are very much larger than in others, and considerably exceed those of the males of equal length; they form two alternating rows, of eight to ten each, along the middle of the club; external to them there is a row of smaller suckers alternating with them on each side; the suckers toward the tips are very numerous, small, and crowded in four rows; at the tip there is a group of about twenty minute, smooth-edged suckers, in four rows. Outside of the suckers, on each side, there is a broad marginal membrane, having the edges scalloped, and strengthened between the scallops by strong transverse muscular ridges; another membranous fold runs along the back side, expanding into a broad membranous keel or crest near the end. The arms of the ventral pair are intermediate in length between those of the second and third pairs.

Ground-color of the body, head, arms, and fins pale, translucent yellowish white; the upper surface is covered with pale brown, unequal, circular spots, which are not crowded, having spaces of whitish between them; the spots are more sparse on the head and arms, but somewhat clustered above the eyes; entire ventral surface pale, with small, distant, brownish, circular spots, which are nearly obsolete on the siphon and arms. The general appearance of the animal, when fresh, is unusually pale and gelatinous. The pen is broad, quill-shaped, translucent, and amber-colored.

A medium-sized male specimen, recently preserved in alcohol, measured 145^{mm} from the base of the dorsal arms to the posterior end of the body; length of body, 120^{mm}; length of caudal fin, 70^{mm}; breadth of fin, 75^{mm}; length of first pair of arms, 42^{mm}; of second pair, 50^{mm}; of third, 60^{mm}; of ventral pair, 53^{mm}; of tentacular arms, 150^{mm}. (For other measurements, see Tables B to E.)

Astoria, Long Island, Nov. 16 and Dec. 7, 1871 (Robert Benner).

This form has been received hitherto only from the western part of Long Island Sound, where it is abundant with the schools of menhaden, on which it feeds.

Reproduction of lost parts.

I have observed in this species, as well as in *Ommastrephes illecebrosus*, numerous instances in which some of the suckers have been torn off and afterwards reproduced. In such examples new suckers of various sizes, from those that are very minute up to those that are but little smaller than the normal ones, can often be found scattered among the latter on the same individual. It seems to me possible that some of the specimens having the suckers on the tentacular arms unusually small may have reproduced all those suckers, or, still more likely, the entire arm.

I have seen specimens of this species, and also of *O. illecebrosus*, which, after having lost the tips, or even the distal half of one or more of the sessile arms, have more or less completely reproduced the lost parts.* In such cases the restored portion is often more slender and has smaller suckers than the normal arms, and where the old part joins the new there is often an abrupt change in size. Probably this difference would wholly disappear after a longer time.

An unquestionable and most remarkable example of the reproduction of several entire arms occurs in a small specimen taken off Newport, R. I., August, 1880. This has the mantle 70^{mm} long; dorsal arms, 22^{mm}; 3d pair of arms, 30^{mm}. The three upper pairs of arms are perfectly normal, but both the tentacular and both the ventral arms have evidently been entirely lost and then reproduced from the very base. These four arms are now nearly perfect in form, but are scarcely half their normal size on the left side, and still smaller on the right side. The left tentacular arm is only 24^{mm} long, and very slender, but it has the normal proportion of club, and the suckers, though well formed, are diminutive, and those of the two median rows are scarcely larger than the lateral ones, and delicately denticulated. The right tentacular arm is less than half as long (12^{mm}), being of about the same length as the restored ventral one of the same side; it is also very slender, and its suckers very minute and soft, in four equal rows. The right ventral arm is only 14^{mm} long; the left one 15^{mm} long; both are provided with very small but otherwise normal suckers.

In another specimen from Vineyard Sound, a female, with the mantle about 150^{mm} long, one of the tentacular arms had lost its club, but the wound had healed and a new club was in process of formation. This new club is represented by a small, tapering, acute process, starting out obliquely from the stump, and having a sigmoid curvature; its inner surface is covered with very minute suckers. The other arms are normal.

Eggs and young.

The eggs are contained in many elongated, fusiform, gelatinous capsules (Plate XXX, fig. 7) which are attached in clusters by one end to sea-weeds or some other common support; from the point of attachment they radiate in all directions. These clusters are often six or eight inches in diameter, containing hundreds of capsules, which are mostly from two

* Perhaps the *Dosidicus Eschrichtii* Steenstrup is only an *Ommastrephes* or *Sthenoteuthis* which had lost and partially reproduced the tips of all the arms. At any rate, no sufficient characters have been given to distinguish it generically.

to three inches long and filled with numerous eggs, the number varying from 20, or less, up to about 200. The transparent eggs are arranged, in the well-formed capsules, in six or more rows, and are so closely crowded that they touch each other and often take polygonal forms, especially when preserved.

How many of these capsules are deposited by one female is very uncertain. Probably several females are concerned in the formation of the larger clusters. The eggs are mostly laid in June and July, but many are laid in August, and some even in September. By the 11th of June, in the vicinity of New Haven, many of these eggs contain embryos in advanced stages of development (Plate XXX, figs. 1, 2). The embryos, before hatching, can swim around inside the eggs.

These embryos are very beautiful objects to observe under the microscope.

Even at this early period some of the chromatophores are already developed in the mantle and arms, and during life, if examined under the microscope, these orange and purple vesicles can be seen to contract and expand rapidly and change colors, as in the adult, but the phenomena can be far more clearly seen in these embryos owing to the greater transparency of the skin. In the young the chromatophores are very regularly and symmetrically arranged on the arms, head, and mantle. At this stage of development the eyes are brown. In these embryos a remnant of the yolk-sac (*y*) appears to protrude from the mouth, but it is really connected with the space around the mouth and pharynx, and into this it is eventually absorbed.

The more advanced of the embryos were capable of swimming about, when removed from the eggs, by means of the jets of water from the siphon (*s*), which is developed at an earlier stage. The arms (a'-a'''') are then short, blunt, very unequal, with few minute suckers; the dorsal arms are very small, while those of the 2d and 3d pairs are successively longer, and have distinct suckers; the tentacular arms (a''') are longer and larger than any of the others, and have larger suckers, which already, in some examples, can be seen to form four rows, but in this stage the peduncular part of these arms is short; the ventral arms (a'''') are about as long as the 2d pair, and bear several suckers. The mantle (*m*) is short, and the caudal fins (*f*) are very small, short, lateral, and separately attached to each side of the blunt posterior end of the body, thus recalling their adult condition in *Rossia*. The eyes (*e*) are large and prominent; the rudimentary beak (*d*) and odontophore (*l*) are distinctly visible. The two otoliths (*o*) are very distinctly visible, as highly refracting ovate bodies, above the basal part of the siphon, one on each side. The ink-sac (*i*), attached to the rectum (*t*), is conspicuous on account of its dark color; the gills (*g*) are provided with a small number of transverse processes; the heart (*h*) and the branchial auricles (h' h') are easily seen while they continue to pulsate. The pen exists only in a rudimentary condition, as a thin cartilage.

During July and August the young (figs. 3–5), from less than a quarter of an inch to an inch or more in length, swim free at the surface, and may often be taken in immense quantities with towing nets. They were particularly abundant in the summers of 1871 and 1873, in Vineyard Sound.

These young squids are devoured in inconceivable numbers by fishes of many kinds, and also by the adult squids of the same species, and by the larger jelly-fishes, and many other marine animals. The larger sizes, and even the adults, are also greedily devoured by blue-fish, black-bass, striped-bass, weak-fish, mackerel, cod, and many other kinds of fishes. Therefore, these "squids" are really of great importance as food for our most valuable market fishes. They are extensively used as bait by the fishermen.

Rate of growth.

I am not aware that any definite information has hitherto been published as to the rate of growth or length of life of any of our Cephalopods. By some writers it has been stated that the squids are all annual, but this seems to be a mere assumption, without any evidence for its basis.

Therefore, I have, for several years past, preserved large numbers of specimens of the young of *Loligo Pealei*, collected at different seasons and localities, in order to ascertain, if possible, the rate of growth and the size acquired during the first season, at least. One of the following tables (I) shows some of the data thus obtained.

There is considerable difficulty in ascertaining the age of these squids, owing to the fact that the spawning season extends through the whole summer, so that the young ones hatched early in June are as large by September as those that hatch in September are in the following spring. Owing to the same cause, most of the large lots of young squids taken in midsummer include various sizes; from those just hatched up to those that are two or three inches long. They are often mixed with some of those of the previous year, considerably larger than the rest. Earlier in the season (in May and the first part of June), before the first-laid eggs begin to hatch, the youngest specimens taken (60^{mm} to 100^{mm} long) are presumed to belong to the later broods of the previous autumn, while those somewhat larger are believed to be from earlier broods of the previous summer, and to represent the growth of one year very nearly.

Taking these principles as a guide, I have arrived at the following conclusions from the data collected:

1. The young squids begin to hatch at least as early as the second week in June, on the southern coast of New England, and continue to hatch till the middle of September, and perhaps later.

2. By the second week in July, the first hatched of the June squids have grown to the size in which the body (or mantle) is 30^{mm} to 48^{mm} long; but these are associated with others that are younger, of all sizes down to those just hatched. They begin to show a disposition to go in "schools" composed of individuals of somewhat similar sizes.

3. By the second week in August, the largest June squids have be-

come 50^{mm} to 68^{mm} in length of body, and the later broods are 5^{mm} to 30^{mm} long. As before, with these sizes occur others of all ages down to those just hatched. It should be observed, however, that in those of our tabulated lots taken by the trawl the very small sizes are absent, because they pass freely through the coarse meshes of the net.

4. By the second week in September, the June squids have the mantle 60^{mm} to 82^{mm} long. All the grades of smaller ones still abound. A few larger specimens, taken the last of August, and in September, 84^{mm} to 110^{mm} long, may belong to the June brood, but they may belong to those of the previous autumn.

5. In the first week of November, the larger young squids taken had acquired a mantle-length of 79^{mm} to 85^{mm}, but these are probably not the largest that might be found. Younger ones, probably hatched in September and October, 8^{mm} to 20^{mm} in length of body, occurred in vast numbers November 1, 1874. The specimens taken November 16, off Chesapeake Bay, having the mantle 40^{mm} to 70^{mm} long, probably belong to the schools hatched in the previous summer.

6. In May and June the smallest squids taken, and believed to be those hatched in the previous September or October, have the mantle 62^{mm} to 100^{mm} long. With these there are others of larger sizes, up to 152^{mm} to 188^{mm}, and connected with the smaller ones by intermediate sizes. All these are believed to belong to the various broods of the previous season. In these the sexual organs begin to increase in size and the external sexual characters begin to appear. The males are of somewhat greater length than the females of the same age.

7. In July, mingled with the young of the season, in some lots, but more often in separate schools, we take young squids having the mantle 75^{mm} to 100^{mm} long. These we can connect by intermediate sizes with those of the previous year taken in June. I regard these as somewhat less than a year old.

8. Beyond the first year it becomes very difficult to determine the age with certainty, for those of the first season begin, even in the autumn, to overlap in their sizes those of the previous year.

9. It is probable that those specimens which are taken in large quantities, while in breeding condition, during the latter part of May and in June, having the mantle 175^{mm} to 225^{mm} long in the females and 200^{mm} to 275^{mm} long in the males, are two years old.

10. It is probable that the largest individuals taken, with the mantle 300^{mm} to 425^{mm} long, are at least three years, and perhaps, in some cases, four years old. The very large specimens generally occur only in small schools and are mostly males. The females that occur with these very large males are often of much smaller size, and may be a year younger than their mates.

11. When squids of very different sizes occur together in a school, it generally happens that the larger ones are engaged in devouring the smaller ones, as the contents of their stomachs clearly show. Therefore,

it is probable that those of similar age keep together in schools for mutual safety.

12. Among the adult specimens of var. *pallida*, taken November 16 and December 7, at Astoria, there are several young ones, from 75^{mm} to 120^{mm} in length, with rudimentary reproductive organs. These may, perhaps, be the young of the year, hatched in June.

Distribution.

This species is found along the whole coast, from South Carolina to Massachusetts Bay.

It is the *common squid* from Cape Hatteras to Cape Cod. In Long Island Sound and Vineyard Sound it is very abundant, and is taken in large numbers in the fish-pounds and seines, and used to a large extent for bait. It is comparatively scarce, though not rare, north of Cape Cod. The young were trawled by us in many localities in Massachusetts Bay, in 1878. Large specimens were taken in the pounds at Provincetown, Mass., August, 1879. It was taken in considerable quantities, in breeding condition, in the fish-pounds at Cape Ann, near Gloucester, Mass., May, 1880 (var. *borealis*). It has not been observed north of Cape Ann. Its southern limit is not known to me, but it appears to have been found on the coast of South Carolina.

In depth, it has occurred from low-water mark to fifty fathoms. The eggs have often been taken by us in the trawl, in great abundance, at many localities along the southern shores of New England, in five to twenty-five fathoms.

It is known to be a very important element in the food-supply of the blue-fish, tautog, sea-bass, striped-bass, weak-fish, king-fish, and many other of our larger market fishes.

In the Gulf of Mexico this species appears to be replaced by another species (*Loligo Gahi* D'Orbigny). Of this we have several specimens, collected on the west coast of Florida, at Egmont Key, near Tampa Bay, by Col. E. Jewett and Mr. W. T. Coons. This species is closely allied to *L. Pealei*, but has a more slender form, with the caudal fin shorter and narrower in proportion to the length of the mantle. The pen has a shorter and broader shaft, and a narrower and more oblong blade, which has parallel, thickened, and darker-colored portions between the midrib and margins (Plate XXVII, fig. 5). The tentacular suckers have their horny rings more coarsely and equally toothed, there being only a partial alternation of larger and smaller teeth.

Along our southern coast, from Delaware Bay to Florida, a much shorter and relatively stouter species (*Loligo brevis* Blainv.) occurs, which might be mistaken by a careless observer for the present species. In addition to its shorter body, it has very different large tentacular suckers, with the teeth on the horny rim coarser and all of similar form and size. Its pen is also shorter and relatively broader, and different in structure (Plate XXXI, figs. 4–6).

B.—*Table to show sexual variations (measurements in inches).*

Loligo Pealei (♂ and ♀).	♂ 1 G.	♂ 4 V.	♂ 6 V.	♂ 5 V.	♂ a'.	♂ 9 V.	♂ 8 V.	♂ 10 V.	♀ 13 V.	♀ 1 V.	♀ 12 V.	♀ 2 V.	♀ 11 V.	♀ 5 G.	♀ An.	♀ 17 V.
Length to dorsal mantle-edge	12.00	11.70	11.50	11.40	11.00	10.30	10.00	9.55	10.00	9.40	8.62	8.30	8.25	8.00	7.30	7.75
Length to base of dorsal arms	13.80	13.00	12.50	12.50	12.00	11.50	10.90	10.60	11.40	10.50	9.75	9.50	9.75	9.35	8.20	9.25
Length of dorsal arms	3.50	3.15	3.10	3.30	3.25	3.40	2.80	2.70	3.60	3.40	2.82	3.30	3.15	3.10	....	2.80
Length of caudal fin	7.90	7.40	7.00	7.10	7.00	6.20	6.10	5.30	6.35	6.20	5.50	5.10	4.75	4.80	4.50	4.80
Breadth of caudal fin	5.00	4.90	5.00	4.90	5.00	4.80	4.70	4.15	4.75	4.60	4.50	4.80	4.60	4.10	4.00	4.35
Breadth between insertions	1.70	1.10	1.20	1.30	1.50	1.12	1.00	.95	1.50	1.30	.37	1.40	1.30	1.50	1.15	1.03
Breadth of body	....	1.75	1.90	1.70	1.80	....	1.70	1.10	1.90	1.85	1.70	2.00	1.75	....	1.20	1.45
Circumference of body	6.00	4.90	5.50	5.30	5.70	5.50	4.90	4.90	5.75	5.50	5.40	5.50	5.15	4.70	....	4.85
Breadth of head at eyes	1.50	1.50	1.30	1.40	1.50	1.42	1.20	1.18	1.60	1.50	1.58	1.40	1.55	1.40	1.40	1.30
Circumference of head in front of eyes	....	3.70	3.40	3.50	4.30	3.50	2.90	2.30	4.25	4.75	3.80	....	3.55	....	....	3.15
Diameter of largest tentacular suckers	.18	.19	.16	.18	.22	.20	.11	.11	.23	.20	.19	.21	.19	.15	.08	.15
Diameter of largest of 3d pair of arms	.11	.12	.12	.12	.11	.11	.08	.11	.15	.13	.13	.16	.12	.11	.06	.10
Length of pen	....	....	....	....	....	10.20	....	9.55	....	....	....	....	....	....	....	7.55
Breadth of pen	....	....	....	....	....	1.15	....	1.09	....	....	....	....	....	....	....	1.25
PROPORTIONS.																
Fin-length to mantle-length ... 1 :	1.51	1.58	1.64	1.60	1.57	1.66	1.63	1.79	1.57	1.51	1.56	1.60	1.73	1.66	1.62	1.61
Fin-breadth to mantle-length ... 1 :	2.40	2.38	2.30	2.32	2.20	2.14	2.12	2.28	2.10	2.04	1.91	1.72	1.79	1.95	1.82	1.79
Breadth to length of fin ... 1 :	1.58	1.51	1.40	1.44	1.40	1.29	1.29	1.27	1.34	1.34	1.22	1.06	1.03	1.17	1.12	1.10
Circum. of body to mantle-length ... 1 :	2.00	2.38	2.09	2.15	1.92	1.89	2.04	1.93	1.74	1.70	1.59	1.50	1.60	1.70		1.60
Circum. of head to mantle-length ... 1 :	....	3.11	3.38	3.25	2.55	2.94	3.44	4.13	2.35	1.98	2.26	....	2.32	....	....	2.46
Diam. large tent. suckers to length .. 1 :	66.66	61.04	71.87	63.33	50.00	51.50	90.90	86.36	43.50	47.00	45.36	39.52	43.42	53.33	91.25	51.66
Length of dorsal arms to length ... 1 :	3.43	3.71	3.70	3.45	3.38	3.01	3.57	3.51	2.78	2.76	3.05	2.51	2.61	2.58	....	2.77

The specimens in this table were selected from those that are best preserved. 1 G is from New Haven, measured while fresh; 1 V to 17 V are from Vineyard Sound, recently preserved and in good condition; *a'* is from Noank, Conn.; 5 G is from Cape Ann, Mass., measured before preservation; An is a specimen from Cape Ann; the latter and 8 V and 10 V have abnormally small suckers.

In the following table, C, A 1, is the typical form from Cape Cod, the largest specimen seen; An, *g'*, 2 G to 5 G, = var. *borealis*, from Cape Ann, Mass.; *a'*, *b'*, from Noank, Conn., typical; 6 V, from Vineyard Sound, Mass.; *c'*, typical, from New Haven. Those marked 1 G to 5 G were measured while fresh; the rest, after preservation in alcohol.

C.—*Table illustrating variations due to growth, sex, locality, and state of preservation (measurements in inches).*

Loligo Pealei (♂ and ♀), typical form and var. borealis.	♂ A 1.	♂ 1 G.	♂ a'.	♂ c'.	♂ 6 V.	♂ 3 G.	♂ 2 G.	♂ b'.	♂ 4 G.	♀ 5 G.	♀ g'.	♀ An.
Tail to tip of dorsal arms	20.75	17.30	15.20	15.75	15.50	15.20	14.70	14.60	13.10	12.20	9.75	10.20
Tail to tip of 2d pair of arms	21.25	17.70	15.50	16.00	16.00	16.00	15.10	14.80	13.70	12.60	10.05	10.50
Tail to tip of 3d pair of arms	21.75	18.00	16.00	15.70	16.50	16.30	15.80	15.30	....	13.40	10.50	10.85
Tail to tip of 4th pair of arms	21.05	17.40	15.30	16.00	15.75	16.00	15.10	15.10	14.10	12.70	10.00	10.50
Tail to tip of tentacular arms	24.50	23.00	17.50	20.00	20.50	20.50	19.00	16.90	13.20	15.00	12.50	13.50
Tail to base of dorsal arms	17.25	13.80	12.00	12.75	12.50	12.30	11.90	.90	10.10	9.35	8.00	8.20
Tail to center of eye	.25	12.60	11.20	12.00	11.70	11.75	11.00	10.70	9.50	8.75	7.20	7.50
Tail to mantle-edge, above	16.25	12.00	11.00	11.00	11.50	11.00	10.50	10.60	8.90	8.00	7.20	7.30
Tail to mantle-edge, below	15.00	11.00	10.25	....	10.50	10.25	9.75	9.75	....	7.30	6.55	6.70
Tail to insertion of fin	9.80	7.90	7.00	7.00	7.00	6.90	6.50	6.60	5.40	4.80	4.35	4.50
Tail to outer angle of fin	7.00	5.50	4.75	5.00	....	4.80	4.40	4.50	3.75	3.50	3.15	3.30
Breadth of fin	6.85	5.00	5.00	5.00	5.00	4.90	4.50	4.80	4.30	4.10	3.80	4.10
Between insertions	2.10	1.70	1.50	1.20	1.20	1.20	1.30	1.48	1.40	1.50	1.20	1.15
Outer angle to insertions	4.60	3.25	3.40	3.00	....	3.50	3.20	3.25	2.75	2.70	2.25	2.50
Circumference of body	7.20	6.00	5.70	....	....	4.40	4.75	5.30	4.10	4.20	4.25	4.80
Breadth of head at eyes	1.75	1.50	1.50	1.35	1.30	1.30	1.30	1.30	1.40	1.40	1.20	1.40
Breadth of siphon at cartilages	1.30	1.15	1.18	.98	....	....	1.05	1.10	1.95	....	.80	....
Aperture of siphon	.45	.35	.40	.40	....	....	.35	.40	.30	....	....	....
Length of dorsal arms	3.70	3.50	3.25	3.00	3.10	3.25	2.90	3.10	3.00	3.10	2.00	2.20
Length of 2d pair of arms	4.20	4.10	3.50	3.20	3.40	3.50	3.30	3.35	3.50	3.30	2.30	2.50
Length of 3d pair of arms	4.40	4.30	4.00	3.35	3.90	3.75	3.80	3.80	3.90	4.10	2.60	2.85
Length of 4th pair, from base	4.10	3.80	3.35	3.25	3.40	3.60	3.40	3.30	3.30	3.60	2.40	2.70
Length of tentacular arms	7.10	9.25	5.25	7.00	7.25	8.00	7.00	5.50	7.50	8.50	4.40	6.10
Length of tentacular club	2.90	2.80	2.60	2.00	2.40	2.60	2.50	2.55	2.50	2.50	1.50	1.85
Breadth of tentacular club	.90	.40	.75	.40	.50	.40	.35	.60	.40	.40	.35	.30
Breadth of dorsal arms	.35	.30	.31	.28	.24	....	.20	.27	....	....	.20	.23
Breadth of 2d pair of arms	.50	.35	.33	.30	.34	....	.30	.37	....	....	.30	.33
Breadth of 3d pair of arms	.50	.40	.45	.41	.35	....	.33	.43	....	....	.27	.30
Breadth of 4th pair of arms	.40	.35	.35	.32	.35	....	.32	.30	....	....	.28	.28
Breadth of tentacular arm	.30	.15	.20	.20	.17	....	.12	.20	....	....	.18	.15
Diameter of eye (external)	1.20	1.10	1.00	....	....	.80	.80	1.00	.65	.65	....	....
Largest on tentacular arms	.25	.18	.22	....	.16	.17	.15	.20	.19	.15	.12	.12
Largest on dorsal arms	.13	.08	.11	....	.10	.09	.09	.10	....	.10	.07	....
Largest on 2d pair arms	.15	.11	.13	....	.11	.11	.10	.12	....	.11	.10	....
Largest on 3d pair arms	.15	.11	.14	....	.12	.11	.11	.13	.10	.11	.10	.10
Largest on 4th pair arms	.12	.08	.10	....	.08	.08	.07	.09	.06	.08	.06	....
PROPORTIONS.												
Fin-length to mantle 1:	1.65	1.51	1.57	1.57	1.64	1.59	1.61	1.60	1.64	1.66	1.65	1.62
Fin-breadth to mantle-length 1:	2.37	2.40	2.20	2.20	2.30	2.24	2.33	2.20	2.06	1.95	1.89	1.78
Fin-breadth to fin-length 1:	1.43	1.58	1.40	1.40	1.40	1.40	1.44	1.37	1.25	1.17	1.14	1.09
Dorsal arm to mantle 1:	4.39	3.42	3.38	3.66	3.70	3.38	3.60	3.38	2.96	2.58	3.60	3.31
Circumference of body to length 1:	2.25	2.00	1.92	....	....	2.50	2.20	2.00	2.17	1.90	1.69	1.52
Diameter of tentacular suckers to mantle-length 1:	65.00	66.66	50.00	....	71.87	64.70	70.00	53.00	46.84	53.33	60.00	60.83

D.—*Table illustrating variations in the males, due mostly to age and mode of preservation (measurements in inches).*

Loligo Pealei (♂).	X.	Y.	Z.	R.	Q.	B.	E.	P.	D.	S.	G.	*oo.*	H.	J.	F.	*k.*	O.
Tail to end of longest sessile arms	16.15	16.70	16.30	15.25	14.81	......	14.00	14.00	13.65	13.20	12.40	12.80	12.75	12.30	11.80	12.00	10.90
Tail to mantle-edge, above	12.30	12.00	11.30	11.30	10.75	10.50	10.50	10.10	10.00	9.90	9.65	9.15	9.10	9.15	8.90	8.30	8.25
Tail to mantle-edge, below	11.00	10.70	9.35	10.40	9.30	9.75	9.80	9.00	......	8.80	8.10	8.40	8.20	8.50	8.20	7.25	7.50
Tail to insertion of fin	7.90	7.50	6.70	6.80	6.90	6.60	6.50	6.50	6.35	6.30	5.80	5.70	5.65	5.60	5.50	5.00	4.95
Tail to center of eye	11.60	12.40	12.00	11.50	10.91	......	10.40	10.30	10.15	9.50	9.20	9.30	9.20	9.20	8.90	8.40	8.00
Tail to base of dorsal arms	11.90	13.10	12.75	12.10	11.50	......	11.00	11.10	11.00	10.50	9.95	9.70	9.95	9.95	9.60	9.20	8.60
Eye to end of dorsal arms	3.80	3.75	3.20	2.80	3.40	......	3.40	3.30	2.80	3.40	2.70	3.20	3.15	2.50	2.50	3.10	2.55
Eye to end of 2d pair of arms	4.10	3.95	3.90	3.10	3.55	......	3.60	3.55	3.15	3.50	2.90	3.40	3.20	2.80	2.80	3.30	2.80
Eye to end of 3d pair of arms	4.55	4.30	4.30	3.70	3.90	......	4.00	4.10	3.50	3.70	3.20	3.50	3.35	3.11	2.90	3.60	2.90
Eye to end of ventral arms	4.30	4.15	4.00	3.40	3.60	......	3.50	4.10	3.20	3.40	3.00	3.20	3.30	2.90	2.80	3.20	2.70
Eye to end of tentacular arms	7.80	7.10	7.60	6.25	5.60	......	5.00	7.00	5.00	5.50	4.40	4.90	4.65	4.75	5.00	6.80	4.70
Breadth of head across eyes	1.65	1.55	1.45	1.65	1.35	1.30	1.50	1.75	1.30	1.30	1.10	1.30	1.20	1.28	1.25	1.10	1.05
Breadth of head in front of eyes	1.45	......	1.40	1.50	1.35	......	1.15	1.40	......	1.20	.80	1.25	1.05	1.05	1.05	1.00	1.00
Breadth of body	1.75	......	1.70	2.70	1.70	1.75	1.60	1.50	......	2.60	1.40	1.60	1.30	1.50	1.40	1.50	1.15
Breadth of fins	5.45	5.50	5.60	5.25	5.10	4.50	4.30	5.30	4.20	4.30	4.00	4.20	4.25	4.10	4.25	3.50	3.80
Circumference of body	5.40	5.45	5.00	5.15	4.80	......	4.75	5.10	4.60	4.80	4.00	4.75	3.85	4.50	4.25	4.50	3.70
Length of tentacular club	3.85	2.60	2.20	2.25	2.00	2.55	1.80	2.20	1.75	5.80	1.60	2.10	1.75	1.70	1.40	1.90	1.30
Length of dorsal arms	......	2.95	2.65	......	2.65	......	2.68	2.85	......	......	......	2.78	......	2.07	......	......	......
Diameter of largest tentacular suckers	......	.24	.21	......	.23	......	.18	.22	......	......	......	.24	......	.16	......	......	......
Diameter of largest on 3d pair of arms	......	.14	.13	......	.13	......	.11	.13	......	......	......	.13	......	.10	......	......	......
PROPORTIONS.																	
Length of fin to mantle-length 1 :	1.55	1.60	1.68	1.66	1.55	1.50	1.61	1.56	1.67	1.57	1.66	1.60	1.61	1.62	1.61	1.66	1.66
Breadth of fin to mantle-length 1 :	2.25	2.18	2.01	2.15	2.10	2.33	2.44	1.90	2.40	2.30	2.41	2.17	2.14	2.23	2.09	2.37	2.17
Breadth of fin to its length 1 :	1.44	1.36	1.19	1.30	1.35	1.46	1.51	1.23	1.51	1.46	1.45	1.35	1.32	1.36	1.29	1.42	1.30
Circumference of body to mantle-length 1 :	2.27	2.20	2.26	2.19	2.23	......	2.21	1.98	2.17	2.06	2.41	1.92	2.36	2.03	2.09	1.84	2.22
Dorsal arms to mantle-length 1 :	......	4.06	4.26	......	4.05	......	......	3.54	......	......	......	3.29	......	4.39	......	......	......
Large tentacular suckers to mantle-length 1 :	......	50.00	53.80	......	42.39	......	......	45.90	......	......	......	38.12	......	56.87	......	......	......

D.—*Table illustrating variations in the males, &c.*—Continued.

Loligo Pealei (♂).	W.	I.	L.	M.	N.	T.	*a''*.	K.	*f*.	*g*.	*h*.	V.	*b''*.	*c*.	*d*.	*e*.
Tail to end of longest sessile arms	11.70	11.15	11.85	11.20	10.35	10.65	11.30	11.25	11.40	9.90	9.45	9.05	8.65	8.10	7.55	7.00
Tail to mantle-edge, above	8.20	8.20	8.10	7.90	7.80	7.80	7.60	7.50	7.50	6.50	6.20	5.80	5.70	5.30	4.90	4.15
Tail to mantle-edge, below	7.10	7.65	7.60	......	6.90	7.30	6.80	7.10	6.70	5.90	5.40	5.05	5.30	4.75	4.50	3.80
Tail to insertion of fin	5.00	4.95	4.90	5.00	4.80	4.80	4.60	4.35	4.40	3.75	3.50	3.40	3.20	3.00	2.60	2.20
Tail to center of eye	8.15	8.00	8.40	7.90	7.70	8.00	7.50	7.50	7.60	6.30	6.11	6.40	5.70	5.15	4.90	4.80
Tail to base of dorsal arms	8.70	8.30	7.90	8.40	8.40	8.40	8.90	8.25	8.10	7.00	6.55	6.75	6.40	5.75	5.25	4.95
Eye to end of dorsal arms	3.05	2.80	2.90	2.75	2.30	2.20	3.20	3.50	3.50	2.90	2.60	2.30	2.40	2.45	2.05	1.95
Eye to end of 2d pair of arms	3.40	2.90	3.30	3.00	2.50	2.55	3.50	3.60	3.55	3.10	3.00	2.60	2.70	2.60	2.35	2.10
Eye to end of 3d pair of arms	3.55	3.15	3.45	3.30	2.65	2.65	3.80	3.75	3.80	3.60	3.30	2.65	2.95	2.90	2.65	2.20
Eye to end of ventral arms	3.45	3.20	3.45	3.10	2.55	2.60	3.45	3.75	3.80	3.25	3.20	2.60	2.60	2.90	2.35	2.20
Eye to end of tentacular arms	6.20	6.10	6.30	6.00	3.60	4.20	7.00	5.65	6.30	6.80	5.30	5.10	6.80	5.45	4.60	4.60
Breadth of head across eyes	1.25	1.30	1.00	1.20	1.10	1.15	1.40	1.20	1.20	1.25	1.10	.75	1.10	1.00	1.10	1.10
Breadth of head in front of eyes	1.20	1.10	1.00	......	.90	1.00	1.35	1.05	1.25	1.10	.90	.75	.95	.95	.95	.95
Breadth of body	1.50	1.35	1.35	......	1.30	1.20	1.60	1.40	1.60	1.25	1.30	1.00	1.10	1.15	1.10	1.00
Breadth of fins	3.90	3.80	3.65	3.50	3.30	3.25	3.70	3.80	3.70	3.40	3.35	2.85	2.90	2.40	2.50	2.30
Circumference of body	4.60	4.20	3.80	3.15	3.60	3.40	4.65	4.05	4.30	3.80	4.15	3.40	3.45	3.35	3.20	2.90
Length of tentacular club	1.95	1.80	2.00	1.75	1.25	1.50	2.50	2.10	2.40	2.20	1.95	1.50	1.70	1.80	1.50	1.25
Length of dorsal arms	2.18	2.12	......	......	......	......	......	......	......	......	2.05	......	......	......	......	......
Diameter of largest tentacular suckers	.19	.16	......	......	......	......	......	......	......	......	.15	......	......	......	......	......
Diameter of largest on 3d pair of arms	.10	.10	......	......	......	......	......	......	......	......	.11	......	......	......	......	......
PROPORTIONS.																
Length of fin to mantle-length 1 :	1.64	1.65	1.65	1.58	1.62	1.62	1.65	1.64	1.70	1.75	1.77	1.70	1.78	1.76	1.88	1.90
Breadth of fin to mantle-length 1 :	2.10	2.16	2.21	2.25	2.36	2.40	2.06	1.97	2.03	1.91	1.85	2.18	1.96	2.20	1.96	1.80
Breadth of fin to its length 1 :	1.28	1.30	1.34	1.43	1.45	1.47	1.24	1.19	1.19	1.09	1.04	1.28	1.10	1.25	1.04	.96
Circumference of body to mantle-length 1 :	1.78	1.95	2.13	2.50	2.16	2.29	1.63	1.85	1.74	1.71	1.49	1.70	1.65	1.58	1.53	1.43
Dorsal arms to mantle-length 1 :	3.76	3.86	......	......	......	......	......	......	......	......	3.02	......	......	......	......	......
Diameter of tentacular suckers to mantle-length 1 :	43.15	51.25	......	......	......	......	......	......	......	......	41.33	......	......	......	......	......

Those marked D–W were taken in Vineyard Sound, May and June, 1876, and were preserved in too strong alcohol, some of them (as T–W) being very much contracted; X, Y, Z, were captured June 6, at the same place, and are in fair condition, though too much hardened by the alcohol. Those marked *a–e* were taken October 14, 1875, in the pounds at Wood's Holl, Vineyard Sound, and are well preserved; *h* and *k* are from Savin Rock, near New Haven; *oo* is from Noank, Conn.

E.—*Table illustrating variations of the female, due mostly to age and mode of preservation (measurements in inches).*

Loligo Pealei (♀), typical variety.	13 V.	1 V.	A A.	12 V.	B B.	2 V.	11 V.	D D.	C C.	F F.	♀ U.	E E.	H H.	G G.
Tail to mantle-edge, above	10.00	9.40	9.10	8.62	8.60	8.30	8.25	7.95	7.70	7.65	7.40	7.20	6.10	5.95
Tail to mantle-edge, below	......	8.50	7.70	......	7.70	7.60	......	7.20	7.00	6.80	5.20	6.65	5.50	5.30
Tail to origin of fin	6.35	6.20	5.20	5.50	5.30	5.10	4.75	4.70	4.70	4.20	4.80	4.40	3.65	3.60
Tail to center of eye	......	9.60	9.75	9.00	8.20	8.70	9.15	8.10	7.80	8.00	3.00	7.60	6.05	6.00
Tail to base of dorsal arms	11.40	10.50	10.10	9.75	9.40	9.50	9.75	9.05	8.20	8.30	5.20	8.80	6.50	6.70
Length of dorsal arms	3.60	......	......	2.82	......	......	3.15	2.10	......	2.35	5.70	......	1.76	1.53
Eye to tip of dorsal arms	......	4.00	3.05	......	3.60	4.15	......	2.95	2.60	2.80	1.90	3.10	2.20	2.20
Eye to tip of 2d pair of arms	......	4.15	3.40	......	4.10	4.40	......	3.10	2.80	3.00	1.90	3.50	2.50	2.25
Eye to tip of 3d pair of arms	......	4.90	3.55	......	4.15	5.20	4.85	3.40	3.20	3.20	2.20	3.60	2.80	2.40
Eye to tip of 4th pair of arms	......	4.50	3.55	......	3.60	4.50	......	2.85	3.10	3.20	2.20	3.45	2.40	2.20
Eye to tip of tentacular arms	......	10.00	5.30	8.25	5.70	9.00	9.50	4.45	4.40	5.10	3.05	5.30	5.20	3.70
Length of club	......	2.15	2.00	2.30	2.35	2.10	2.55	1.60	1.65	1.90	1.00	1.75	1.55	1.30
Breadth of head at eyes	1.60	1.50	1.30	1.58	1.40	1.40	1.55	1.40	1.30	1.25	.90	1.30	1.05	1.10
Breadth of head in front of eyes	......	1.25	1.25	......	1.30	1.20	......	1.20	1.20	1.10	1.00	1.10	.90	.95
Circumference of head in front of eyes	4.25	......	......	3.80	......	......	3.55	3.55	......	3.50	2.55	......	3.00	2.90
Breadth of body	1.90	1.85	1.70	1.70	1.60	2.00	1.75	1.40	1.40	1.45	3.05	1.60	1.40	1.10
Breadth of caudal fins	4.75	4.60	5.15	4.50	4.70	4.80	4.60	4.10	4.10	3.60	.95	4.00	3.20	3.10
Breadth between insertions of fins	1.50	......	......	1.37	......	......	1.30	......	......	......	......	......	......	......
Circumference of body	5.75	5.50	5.30	5.40	4.90	5.50	5.15	4.40	4.30	4.30	......	4.80	3.90	3.45
Diameter of largest tentacular suckers	.23	.20	.19	.19	.26	.21	.19	......	.15	.18	......	.18	.15	.11
Diameter of largest on 3d pair of arms	.15	.13	.12	.13	.14	.16	.12	......	.10	.12	......	.10	.10	.08
PROPORTIONS.														
Fin-length to mantle-length 1:	1.57	1.51	1.75	1.56	1.62	1.62	1.73	1.69	1.63	1.82	1.73	1.63	1.67	1.65
Fin-breadth to mantle-length 1:	2.10	2.04	1.82	1.91	1.82	1.72	1.79	1.95	1.87	2.12	2.03	1.80	1.90	1.90
Breadth to length of fin 1:	1.34	1.34	1.00	1.22	1.12	1.06	1.03	1.14	1.14	1.16	1.17	1.10	1.14	1.16
Circumference of body to mantle-length 1:	1.74	1.70	1.71	1.59	1.75	1.50	1.60	1.80	1.79	1.77	......	1.50	1.56	1.72
Length of dorsal arms to mantle-length 1:	2.78	......	......	3.05	......	......	2.62	3.78	......	3.25	......	......	3.46	3.23
Tentacular suckers to mantle-length 1:	43.50	47.00	49.47	45.36	33.07	39.50	43.42	......	51.33	42.50	......	40.00	40.66	54.09

A A to H H were taken in the fish-pounds at Wood's Holl, Vineyard Sound, in June, 1876, and have been preserved in somewhat too strong alcohol. 1 V to 13 V were taken at the same place, May 28, 1880, and have been carefully preserved in alcohol of about 80 per cent.

F.—*Table illustrating variations of males of var. pallida, due to growth, to the states of contraction when preserved, and to individual peculiarities (measurements in inches).*

Loligo Pealei var. pallida (♂).	B.	I.	b.	Z.	A.	c.	G.	E.	i.	d.	h.	e.	k.
Tail to edge of mantle, above	9.30	9.15	9.00	8.70	8.50	8.20	8.00	8.00	7.95	7.65	7.90	7.70	7.55
Tail to edge of mantle, beneath	8.65	8.50	8.25	8.10	7.70	7.60	7.30	7.20	7.35	7.00	7.20	7.00	6.80
Tail to origin of fin	5.80	5.80	5.40	5.25	5.20	5.00	5.05	4.90	5.00	4.75	4.70	4.65	4.50
Tail to center of eye	9.60	9.85	9.30	9.20	8.80	8.70	8.70	8.40	8.30	8.00	8.05	7.80	7.80
Tail to base of dorsal arms	10.60	10.70	10.25	9.75	9.50	9.60	9.50	9.10	9.35	8.65	8.80	8.70	8.70
Eye to end of dorsal arms	4.45	4.15	4.10	3.80	4.20	4.10	4.00	3.80	4.05	3.55	3.50	4.00	3.40
Eye to end of 2d pair of arms	5.20	4.70	4.40	4.30	4.40	4.45	4.20	4.00	4.35	4.00	3.90	4.10	3.75
Eye to end of 3d pair of arms	5.20	5.20	4.70	4.55	4.80	5.20	4.50	4.30	4.80	4.30	4.45	4.55	4.15
Eye to end of 4th pair of arms	4.70	5.00	4.45	4.05	4.50	4.80	4.35	4.10	4.45	4.00	4.05	4.30	3.80
Eye to end of tentacular arms	10.30	10.80	9.30	9.90	10.15	9.10	9.50	8.90	9.90	9.00	8.75	9.30	6.70
Length of club of tentacular arms	2.90	2.80	2.60	2.50	2.80	2.75	2.60	2.15	2.50	2.65	2.60	2.70	2.60
Breadth of head across eyes	1.60	1.50	....	1.35	1.60	1.45	1.38	1.30	1.20	....	1.45	1.40	1.20
Breadth of head in front of eyes	1.40	1.20	1.20	1.15	1.40	1.30	1.20	1.00	1.15	....	1.25	1.15	1.05
Breadth of body	2.00	1.80	....	1.70	1.60	....	2.10	1.60	....	....	1.65	....	....
Breadth of caudal fins	5.15	5.00	4.50	4.60	5.00	4.60	4.50	4.50	4.50	3.90	4.40	4.10	3.75
Circumference of body	5.75	5.50	5.00	4.90	5.15	5.25	5.25	4.70	5.10	5.00	5.20	5.05	4.60
Diameter of largest suckers of club	.24	.22	....	.20	.21	....	.23	.18	....	....	.21	....	....
Diameter of largest suckers on 3d pair of arms	.13	.14	....	.11	.13	....	.12	.12	....	....	.13	....	....
PROPORTIONS.													
Length of fin to length of mantle 1:	1.60	1.57	1.66	1.65	1.66	1.64	1.58	1.63	1.59	1.61	1.68	1.65	1.67
Breadth of fin to length of mantle 1:	1.80	1.83	2.00	1.88	1.70	1.78	1.77	1.77	1.76	1.96	1.79	1.87	2.01
Breadth of fin to its length 1:	1.12	1.16	1.20	1.14	1.00	1.08	1.12	1.08	1.11	1.21	1.06	1.13	1.20
Large tentacular suckers to mantle-length 1:	38.75	41.59	....	43.50	40.47	....	34.78	44.44	....	....	37.62	....	....
Circumference of body to mantle-length 1:	1.61	1.66	1.80	1.77	1.65	1.56	1.52	1.70	1.55	1.53	1.51	1.52	1.64

All the specimens included in this table were taken nearly at the same time, in November and December of 1871, at Astoria, Long Island. The measurements are all from the specimens after they had been preserved in alcohol (of about 80 per cent.) for several years. They are only moderately contracted by the alcohol. They were sent to New Haven, in ice, before preservation, so that they were in a relaxed condition when put into alcohol.

F.—*Table illustrating variations of males of var. pallida, &c.*—Continued.

Loligo Pealei var. pallida (♂).	J.	f.	W.	1.	V.	a.	K.	L.	M.	Q.	S.	P.
Tail to edge of mantle, above	7.30	7.10	7.00	7.10	6.60	4.30	4.00	4.00	3.80	3.70	3.70	3.65
Tail to edge of mantle, beneath	6.70	6.50	6.20	6.30	6.10	3.80	3.40	3.40	3.20	3.20	3.30	3.20
Tail to origin of fin	4.40	4.00	4.20	4.30	3.90	2.30	2.10	2.00	2.00	2.00	1.80	2.00
Tail to center of eye	7.70	7.55	7.40	7.50	7.00	4.75	4.50	4.20	4.05	4.20	3.90	3.90
Tail to base of dorsal arms	9.15	8.30	8.15	1.80	7.30	5.20	5.00	4.70	4.50	4.60	4.30	4.40
Eye to end of dorsal arms	3.70	3.70	3.50	3.70	3.10	2.30	2.00	2.15	2.00	2.10	1.80	1.80
Eye to end of 2d pair of arms	4.00	3.80	3.60	4.15	3.70	2.50	2.30	2.50	2.20	2.40	1.90	2.10
Eye to end of 3d pair of arms	4.45	4.10	4.20	4.55	4.10	3.00	2.55	2.70	2.50	2.70	2.30	2.60
Eye to end of 4th pair of arms	4.30	3.80	4.00	4.00	3.60	2.70	2.20	2.65	2.45	2.40	2.30	2.20
Eye to end of tentacular arms	......	9.30	8.60	9.25	7.70	6.45	4.80	5.90	5.90	6.10	5.50	5.25
Length of club of tentacular arms	......	2.30	2.40	2.60	2.00	1.50	1.30	1.45	1.30	1.20	1.20	1.00
Breadth of head across eyes	1.20	1.25	1.20	1.20	1.20	.90	.90	.90	.80	.80	.80	.80
Breadth of head in front of eyes	1.10	1.10	1.00	.95	1.10	.75	.80	.75	.70	.70	.65	.70
Breadth of body	......	......	......	1.65	......	......	......	......	......	......	......	......
Breadth of caudal fins	4.10	3.95	4.00	3.90	3.30	2.40	2.10	2.50	2.00	2.00	2.10	1.90
Circumference of body	4.70	4.45	4.75	4.80	4.60	3.60	3.30	3.60	3.10	3.25	3.35	3.25
Diameter of largest suckers of club	......	......	......	.21	......	......	......	......	......	......	......	......
Diameter of largest suckers on 3d pair of arms	......	......	......	.13	......	......	......	......	......	......	......	......
PROPORTIONS.												
Length of fin to length of mantle 1:	1.65	1.77	1.66	1.69	1.69	1.86	1.90	2.00	1.90	1.85	2.05	1.85
Breadth of fin to length of mantle 1:	1.77	1.79	1.75	1.89	2.00	1.79	1.90	1.60	1.90	1.85	1.76	1.92
Breadth of fin to its length 1:	1.07	1.01	1.05	1.12	1.18	.95	1.00	.80	1.00	1.10	.85	1.05
Largest tentacular suckers to mantle-length 1:	......	......	......	33.80	......	......	......	......	......	......	......	......
Circumference of body to mantle-length 1:	1.55	1.59	1.47	1.47	1.43	1.19	1.21	1.11	1.22	1.13	1.10	1.12

G.—*Table illustrating variations of females of var. pallida, due to growth, &c. (measurements in inches).*

Loligo Pealei var. pallida ♀).	j.	Y.	l.	X.	D.	g.	m.	C.	T.	U.	H.	n.	F.	? sex O.	R.	N.
Tail to edge of mantle, above	8.40	8.15	7.00	6.70	6.35	6.25	6.20	5.10	4.65	4.60	4.25	3.90	3.85	3.60	3.60	3.62
Tail to edge of mantle, beneath	7.65	7.35	6.30	6.00	5.80	5.75	5.70	4.35	3.90	4.00	3.70	3.40	3.35	3.20	3.20	3.10
Tail to origin of fin	5.15	4.80	4.30	4.20	3.90	3.70	3.60	2.80	2.55	2.50	2.30	2.00	2.00	2.00	2.00	1.95
Tail to center of eye	8.80	8.50	7.35	7.10	6.50	6.70	6.50	5.25	4.80	4.70	4.30	4.20	4.15	4.00	4.00	4.00
Tail to base of dorsal arms	9.50	9.15	8.20	8.00	7.30	7.40	7.15	6.00	5.20	5.25	5.00	4.45	4.60	4.50	4.30	4.30
Eye to end of dorsal arms	4.15	3.80	3.60	3.30	3.30	3.00	3.00	2.10	2.05	2.40	2.00	1.30	1.90	1.60	1.80	1.80
Eye to end of 2d pair of arms	4.50	4.40	4.00	3.95	3.80	3.30	3.20	2.50	2.40	2.70	2.20	2.00	2.20	2.20	1.90	1.90
Eye to end of 3d pair of arms	5.00	4.60	4.60	4.30	3.95	3.70	3.70	3.05	2.55	3.15	2.55	2.55	2.65	2.45	2.40	2.25
Eye to end of 4th pair of arms	4.50	4.35	4.35	4.25	3.80	3.60	3.70	3.05	2.55	3.15	2.70	2.25	2.55	2.20	2.40	2.25
Eye to end of tentacular arms	10.10	9.30	9.80	9.10	8.90	7.80	8.30	7.10	5.50	6.50	5.45	5.15	5.90	5.20	5.30	5.10
Length of club of tentacular arms	2.90	2.45	2.70	2.60	2.20	2.00	2.10	1.60	1.10	1.40	1.20	1.30	1.35	1.10	1.80	1.15
Total length, tail to end of tentacles	19.00	17.80	17.10	16.20	......	14.45	15.00	12.00	.90	11.20	......	9.20	......	9.25	9.25	9.15
Breadth of head across eyes	1.45	1.40	1.30	1.30	1.40	1.10	1.15	1.00	.80	1.00	.90	.95	.90	.80	.90	.85
Breadth in front of eyes	1.30	1.30	1.20	1.20	1.10	.90	1.00	.85	......	.85	.75	.80	.60	.70	.75	.70
Breadth of body	1.90	1.85	......	......	1.55	......	......	1.40	2.70	......	1.35	......	1.20	......	......	......
Breadth of caudal fins	4.80	4.40	4.10	4.60	4.10	3.50	3.60	3.10	3.75	2.80	2.65	2.45	2.25	2.10	2.25	2.05
Circumference of body	5.50	5.50	4.80	4.90	4.60	4.40	4.40	4.20	......	4.00	......	3.50	3.50	3.20	3.25	3.05
Diameter of largest suckers on club	.25	.20	......	.22	.17	.18	.16	.15	......	.12	......	......	.08	......	......	......
Diameter of largest suckers on 3d pair of arms	.12	.13	......	.12	.10	.11	.11	.80	......	.08	......	......	.05	......	......	......
PROPORTIONS.																
Length of fin to length of mantle 1 :	1.63	1.69	1.62	1.59	1.62	1.68	1.72	1.82	1.82	1.84	1.84	1.95	1.92	1.80	1.80	1.85
Breadth of fin to length of mantle 1 :	1.75	1.85	1.70	1.45	1.54	1.78	1.72	1.65	1.72	1.64	1.60	1.59	1.71	1.71	1.60	1.76
Breadth of fin to its length 1 :	1.07	1.09	1.04	.91	.95	1.05	1.00	.90	.94	.89	.86	.81	.88	.95	.88	.95
Largest tentacular suckers to mantle-length 1 :	33.60	40.75	......	30.45	37.35	34.72	38.75	34.00	......	38.33	......	......	48.12	......	......	......
Circumference of body to mantle-length 1 :	1.52	1.48	1.45	1.36	1.38	1.42	1.40	1.21	1.24	1.15	......	1.11	1.10	1.12	1.10	1.18

The specimens included in this table were all taken at Astoria, Long Island. The measurements are all from alcoholic specimens, as in Table F.

I.—*Table to illustrate the rate of growth of Loligo Pealei, young.*

Locality.	Depth.	Date.	Length of mantle, in millimeters.	
			Young of the year.	Young of previous year.
		1875–'76.		
Vineyard Sound	Surface	July 7	36 = 25–35mm: 3 = 45–48mm	10 = 75–100mm.
Do	do	July 12	100 + = 10–20	
Do	do	July 15	4 = 50–68	9 = 70–100.
Do	do	July 16	500 + = 10–25	
Do	do	July 28	500 + = 10–30	
Do	do	Aug. 2	200 + = 15–35	
Do		Aug. 21	26 = 27–52	
Do		Aug. 27	18 = 23–50	
Do		Aug. 28	38 = 25–50: 2 = 55–63	
Do		Aug. —	30 = 25–45: 10 = 47–72	2 ♀ = 125–150: 1 ♂ = 175.
Do	6–20	Sept. 15	3 = 45–50	2 = 125–138.
Do		Oct. 13		1 = 188.
Do		Oct. 20	4 = 88–100	4 = 112–125.
Do	Surface	Nov. 1	1000 = 8–20: 3 = 75–82	1 = 152.
Do	do	May 15		3 = 152–188.
Do	do	June 3		80 = 62–100: 10 = 100–152.
		1880.		
Newport, R. I	Shore	July 27	4 = 28: 5 = 32–44	5 = 67–80: 1 = 95.
Narragansett Bay	8	Aug. 6	5 = 45–50	3 = 84–100.
Off Newport, R. I	16–26	Aug. 7	54 = 15–33: 49 = 32–44: 5 = 50–62.	3 = 89–108: 2 = 120–165.
Do	16–19	Aug. 12	90 = 15–25: 15 = 30–40	
Off Point Judith, R. I	16	Aug. 13	60 = 17–38: 20 = 38–55	1 = 115: 1 = 102.
Do	19	Aug. 14	133 = 16–33: 8 = 38–44	2 = 86–87: 2 ♀ = 105–112.
Narragansett Bay	4–12	Aug. 16	33 = 23–55: 14 = 50–70: 3 = 75–82	3 = 83–95.
Off Buzzard's Bay	21	Aug. 17	72 = 12–28: 5 = 30–42	
Narragansett Bay	6	Aug. 23	2 = 48–53: 3 = 70–80	
Off Block Island	13	Aug. 24	9 = 24–36: 8 = 40–55	
Do	5	Aug. 27	1 ♂ = 84	1 ♀ = 110.
Narragansett Bay	14	Aug. 31	7 = 38–46: 2 = 60–62	
Do	3–6	Sept. 1	2 = 32–46: 11 = 50–52	
Off Cuttyhunk Island	17	Sept. 3	23 = 32–50: 4 = 56–58: 1 = 82	2 = 130–140
North latitude 39° 48′ 30″, west longitude 70° 54′	252	Sept. 13	14 = 16–30	
Off Block Island		Sept. —	20 = 42–55: 10 = 55–72: 1 = 110	
Off Chesapeake Bay	18	Nov. 16	32	
VARIETY BOREALIS.				
		1878.		
Massachusetts Bay	10	Aug. 29	1 = 31	
Do	42	Sept. 16	1 = 38	
Do	47	Sept. 21	6 = 28–38: 1 = 50: 5 = 62	
Do	43	Sept. 26	2 = 31–38	
		1879.		
Off Cape Cod	15½	Sept. 9	2 = 38	
Do	42	Sept. 26	1 = 75	
Cape Ann	Shore	Oct., '80	5 ♂ 3 ♀ = 110–156	

J.—*Loligo Pealei. Specimens examined, mostly adult. To illustrate distribution, &c.*

[In last column *ad.* = adult; *br.* = breeding; *in.* = length of mantle in inches; *j.* or *juv.* = young *lg.* = large.]

No.	Locality.	Fath.	When collected.	Received from—	Specimens, sex and number.
	TYPICAL VARIETY.				
	New Haven, Conn		1867	Mr. Hooes	1 ♂.
	do			G. H. Perkins	1 ♂.
	Near New Haven	Shore	1870	A. E. Verrill	4 ad.
h. k	do	do	1874	do	♂ 4 ad.
c′	do	do	1876	do	6 ad.
1G	New Haven Harbor	do	May 18, 1880	do	♂ 1 lg. br.
	Long Island	do		C. C. Byrne	1 juv.
a′, b′, oo	Noank, Conn	do	1874	U. S. Fish Com	♂ 3 large.
	do	3–4	August 5, 1874	do	4 juv.
	do	6–8	August 24, 1874	do	8 juv.

J.—*Loligo Pealei*—Continued.

No.	Locality.	Fath.	When collected.	Received from—	Specimens, sex and number.
	TYPICAL VARIETY—Continued.				
	Vineyard Sound, Mass.	Shore	July and Aug., 1871.	U. S. Fish Com.	72 ad.
	....do	5–8	... do	....do	30 ad.
	Menemsha	Shore	August, 1874	V. N. Edwards	♂ 1: ♀ 2.
	Vineyard Sound	...do	July and Aug., 1875.	U. S. Fish Com.	7 ad.
	....do	5–12	July 12–26, 1875	....do	Eggs and juv.
	....do	5–16	August 4, 5, 1875	... do	juv.
	....do	6–20	September 15, 1875	....do	5 juv.
	....do	Shore	October 13, 1875	V. N. Edwards	3 = 5–7.5 in.
f. g	....do	... do	October 14, 1875	....do	3 = 5–7 in.
a–e	....do	...do	....do	....do	♂ 5 large.
	....do	...do	October 20, 1875	....do	5 = 4–5 in.
	....do	...do	November 1, 1875	....do	1 = 6 in.
	....do	...do	April 30, 1876	... do	♂ 10: ♀ 3.
	....do	...do	May 15, 1876	....do	3 = 6–7 in.
D–W	... do	...do	May and June, 1876	... do	♂ 15: ♀ 4 ad.
	....do	...do	June 3, 1876	... do	♂ 3 = 5–6 in.
X. Y. Z.	....do	...do	June 6, 1876	....do	♂ 3 large.
AA–HH	....do	...do	June, 1876	....do	39 ad.: ♀ 12.
1V–60V	....do	.. do	May 28, 1880	....do	♂ 48: ♀ 12 br.
	Narragansett Bay	... do	1880	Samuel Powell	10 ad.
A 1	Hyannis, Mass	...do	August, 1880		♂ 1 very lg.
	Narragansett Bay	...do	July 27, 1880	U. S. Fish Com.	6 j. = 3–3.7 in.
	Off Newport, R. I.	16–26	August 7, 1880	....do	5 j. = 3.5–6.5 in.
	Off Point Judith, R. I.	19	August 14, 1880	... do	2 j. = 1.1–1.4 in.
	Off Cuttyhunk Island	17	September 3, 1880	....do	2 = 5.1–5.5 in.
	South of Block Island	252	September 13, 1880	....do	14 juv.
	Off Chesapeake Bay	18	November 16, 1880	Z. L. Tanner	32 juv.
	VARIETY BOREALIS.				
An. 1–3 *g*	Annisquam, Mass	Shore	July, 1878	A. Hyatt	♀ 3 ad. br.
	Gloucester, Mass	... do	....do	A. E. Verrill	2 juv.
	Massachusetts Bay	47	September 21, 1878	U. S. Fish Com.	11 juv.
	Off Cape Cod	42	September 26, 1879	. do	1 juv.
	Provincetown, Mass	Shore	July, 1879	J. H. Blake	3 large.
2G–15G	Cape Ann, Mass	...do	May 18, 1880	A. H. Clarke	15 ad. br.
	....do	...do	October, 1880	....do	♂ 5: ♀ 3 juv.
	Salem, Mass	...do		J. H. Emerton	♂ 1: ♀ 2 ad.
	VARIETY PALLIDA.				
A–Z	Astoria, N. Y.	Shore	Nov. and Dec., 1870	Robert Benner	♂ 17: ♀ 9.
a–t	....do	...do	....do	....do	♂ ♀ 20 ad.
1–10	....do	...do	....do	... do	♂ ♀ ad.
	Great Egg Harbor, N. J.	...do	1872	A. E. Verrill	1, bass stom.

K.—*Specimens examined. Eggs and recently-hatched young of Loligo Pealei.*

Locality.	Fath.	When collected.	Received from—	Eggs or embryos.
Near New Haven	Shore	June 19, 1871	J. E. Todd	Well developed.
Vineyard Sound	5–10	July, Aug., 1871	United States Fish Com.	All stages.
Long Island Sound	4–8	August, 1874	......do	Well developed.
Fisher's Sound	Surface	July 28, 1874	......do	Just hatched.
Nantucket Sound	8–12	July 26, 1874	......do	Partly developed.
Vineyard Sound	8–16	August 5, 1875	......do	Do.
Do	5–10	July, Aug., 1875.	......do	All stages.
Do		Sept. 6, 1875	......do	New laid.
Near New Haven	Shore	June 11, 1880	S. I. Smith	Near hatching.
Off New Haven		August 3, 1880	J. F. Fowle	Half developed.
Gardiner's Bay		June 28, 1880	Schooner G. H. Bradley	New laid.
Off Newport, R. I.	8	August 6, 1880	United States Fish Com.	Fresh and well developed.
Do	22–26	August 7, 1880	......do	New laid and hatching.
Do	4½	August 16, 1880	......do	New laid and partly developed.
Narragansett Bay	6	August 23, 1880	......do	Fresh laid.
Do	12½	August 31, 1880	......do	Partly developed.
Buzzard's Bay	4–6	August 26, 1881	......do	Just hatching.

Notes on the visceral anatomy of Loligo Pealei.

(*See Plate XX, fig.* 2; *Plate XXIX, figs.* 1–3a; *Plate XXXII, figs.* 2, 3.)

The gills (*g*) are large and highly organized in this species, although considerably smaller than in *Ommastrephes.* The bases of the gills (*g*) are situated somewhat in advance of the middle of the mantle-cavity, or branchial chamber, and their tips, in fresh specimens, extend forward nearly to the base of the siphon (*f*). The branchial chamber is separated from the visceral cavity by a thin translucent membrane (the so-called peritoneal membrane), through which there are two circular openings (*u*), one a short distance in advance of the base of each gill; through these the secretion of the urinary organs (r, r') is doubtless discharged. Internally the visceral cavity is divided into several compartments by folds of thin membrane. The largest of these chambers contains the stomach and its cœcal lobe (S, S′). When the branchial cavity is opened on the ventral side, as in Pl. XXIX, fig. 1, and the thin membranes covering the viscera are removed, the renal organs (r, r') are seen as large and conspicuous organs, especially if the venous system has been injected with a colored fluid. These organs are mostly situated close around the heart, above, below, and in front of it, but two of them, in the form of pyriform glands (r', r'), which are firmer and have a more compact structure than the rest, extend along the posterior venæ-cavæ. These extend forward and unite with the two elongated, saccular organs (*r*, *r*), which extend across the ventral side of the heart and the bases of the gills, and passing farther forward, unite on the dorsal side of the intestine to form the anterior vena-cava; before they thus unite each one receives a vein from the intestine (r'') and gives off a large sacculated vessel, or branch, which, passing upward along the sides of the proximal part of the intestine, unite with two large lobulated renal sacs, which lie above and in front of the heart and surround the commencement of the intestine; these send tapering lobes backward, which receive the blood from the gastric veins; anteriorly they receive the hepatic veins; laterally they receive the large vessels or pallial veins from the sides of the mantle, and also communicate with the branchial auricles.

The heart (H) is a large, muscular, and somewhat unsymmetrical organ, varying in shape according to the state of contraction. Usually it is more or less obliquely four-cornered, with the right side largest and the posterior end more or less conical. From the posterior end arises a large artery, the posterior aorta, which gives off, close to its origin, two small arteries; one of these is median and goes forward to the ink-sac and intestine, passing below and across the heart; the other, arising laterally, in the male goes to the prostate gland and other organs connected with it (Pl. XXIX, fig. 2, *po*). A little farther back the posterior aorta divides into three large arteries; one of these (*o*) is situated in the median plane, and, crossing the branchial cavity along the curved anterior end of a thin, median, membranous partition, supplies the ventral and lateral portions of the mantle, sending branches both backward and forward; the other two main divisions (*o'*, *o''*) diverge as they go backward, and supply the caudal fins and adjacent parts of the mantle. The anterior aorta (*ao*) arises from the right anterior corner of the heart, and goes forward to the head, on the right side of the median line, by the side of the œsophagus. Just beyond the constriction, at its origin, it is somewhat bulbous. A short distance from its origin it gives off a large branch, the gastric artery (*so*), which sends a branch to the renal organs, and passes backward over the dorsal side of the heart to the anterior parts of the stomach, where it ramifies extensively.

The portion of the aorta which passes along and through the liver gives off several hepatic arteries that supply blood to the liver, and one branch emerges from the liver, on the dorsal side, and supplies the muscles of the neck-region. The ultimate divisions of the aorta supply the various organs of the head, and a large branch goes out to the tip of each arm, nearly in the center, sending branches to the suckers. A small vessel, the spermatic artery (fig. 2, *go*), arises from the anterior side of the heart, and, passing backward over the heart, supplies the spermary (*t*).

The large efferent or branchio-cardiac vessels from the gills (*bo*) enter the anterior lateral corners of the heart, their dilated basal portion serving, apparently, as auricles. The branchial auricles (*au*), situated just behind the bases of the gills, are nearly globular, with a small, rounded, whitish elevation on the free posterior end; anteriorly they receive the blood from the sacculated divisions of the anterior and posterior venæ-cavæ, above the heart, and from the veins (*v*, *vc'*) coming from the lateral portions of the mantle, behind the gills, and they give off the large afferent vessels (*bv*), which go to and run along the dorsal side of the gills. The anterior vena-cava (*vc*) receives the venous blood from a large cephalic venous sinus * which surrounds the pharynx, at the bases of the arms, and is also directly connected with another large sinus at the back of each eye-orbit. This cephalic sinus receives the blood from a large vein in the median line and near the inner face of each arm. The ophthalmic sinuses receive veins from the eye itself. Numerous small veins enter the anterior *vena-cava*, from each side, along its course, coming from the muscles of the head, neck, and siphon, and from the ink-sac, liver, &c. Two veins, sacculated posteriorly, go from the ink-sac and intestine back to the renal organs. A small but very distinct vein extends along the dorsal side of the efferent sperm-duct (*p*). Two large pallial veins, on each side, come

* The greater part of the venous system can be easily injected by inserting the canula into this sinus, through the folds of the buccal membranes, just between the bases of the arms and the jaws, or between the outer and inner buccal membranes. It can also be easily injected through the vena-cava in the lower side of the head.

from the sides of the mantle (*v*, *vc′*): one of them (*vc′*), receiving a branch from the gill, runs from the anterior part backward; the other (*v′*), from the middle part forward; these unite into one trunk before reaching the *venæ cavæ*. The posterior *venæ-cavæ* (*vc″*) arise mostly from the caudal fins, but receive branches from the postero-lateral portions of the mantle; each one receives two large branches, one anterior and the other posterior, just at the point where it leaves the inner surface of the mantle. From this point they run forward, parallel with the two posterior arteries, and converge to the region of the heart, where they join the great sacculated venous vessels; along a considerable portion of their course they expand and become large, elongated, fusiform organs (*r″*), probably renal in function, but much firmer, more definite in form, and finer in structure than the more anterior renal organs.

The gills (*g*) are long, triquetral, acute; in section they are nearly triangular (Pl. XXXII, fig. 3), with the free ventral sides convex, and the dorsal side flat or concave, except along the middle, where a thin median membrane (*d*) arises from a central ridge and unites the gill to the inner surface of the mantle. The gills are composed of large numbers of thin, transverse branchial laminæ (Fig. 3, *a*), which extend outward symmetrically, on each side, from the large median blood-vessels (*bo*, *bv*), each half of a lamina having a long ovate or elliptical outline. A somewhat firm central axis or column (*c*) gives support to the laminæ and the large blood-vessels. The great afferent vessel (*bv*) starts from the branchial auricle and runs along the median dorsal side of the gill, on the inner edge of the axial column (*c*); another parallel venous trunk or sinus (*v*) is seen near the dorsal edge of the column. Each branchial leaf receives from the afferent vessel (*bv*) a branch (*b*) which runs along the dorsal edge, giving off at regular intervals small transverse parallel branchlets, which in turn give off minute capillary vessels along their sides and fade out near the ventral border of the lamellæ. Parallel with these arise small capillary efferent vessels, which join larger transverse vessels between and parallel with the afferent ones; these in turn join the larger efferent vessel that runs along the ventral edge of the lamina, and these marginal vessels pour their contents into the large vessel (*bo*) which runs along the middle of the gill on the ventral side and carries the purified blood to the heart.

The alimentary tract is represented in a nearly dorsal view in Plate XX, fig. 2. In this figure the pharynx is shown in longitudinal section in a side view. The buccal membrane (*bm*); the pharynx with its horny jaws (*sm* the superior, and *im* the inferior mandibles); the odontophore, (*od*) armed with seven rows of recurved teeth on the radula; and the thin chitinous lining membrane, which bears numerous sharp, scattered, recurved teeth, both on the palate and in the throat, have already been described (pp. 134, 135). The œsophagus (*oe*) is a long, narrow, but dilatable tube, having two oblong salivary glands (*sg*) attached to it just at the bilobed anterior end of the liver (*l*); it then runs backward in a groove along the dorsal side of the liver to a point beyond its middle, where it passes obliquely through the liver, accompanied by the aorta (*ao*), and enters the stomach at *oc'*. The stomach consists of three parts, which are often sufficiently distinct externally when the stomach is empty, or nearly so, but when it is greatly distended with food (as often happens) the divisions almost disappear externally, and the whole becomes one great, long-pyriform sac. The first division (S), or "true stomach," is plicated internally and has thickened glandular walls. It is supplied with blood by a ramified vessel, the gastric artery (*so*), conspicuous on its dorsal surface. This lobe of the stomach is sometimes contracted into a firm glandular mass, strongly constricted where it joins the more saccular second stomach; but I have seen specimens, greatly distended with food, in which it was scarcely or not at all distinguishable as a lobe, and seemed nearly as thin and saccular as the other parts. The remainder of the stomach (S′, S″) usually has the form of a long, rounded, more or less swollen, fusiform sac, tapering backward to a more or less acute posterior end, which reaches back nearly to the end of the body; anteriorly its most swollen portion is about opposite the junction with the first stomach and just behind the heart; from this swollen portion it narrows rapidly, but extends forward to the posterior part of the liver, above and in advance of the heart, where it gives off the intestine (*h*). The more swollen and anterior portion of this sac or second stomach (S″) has a glandular lining, which, in part (S″), is distinctly radially plicated; and it is therefore clearly anatomically distinguishable from the thin and non-plicated posterior portion (S′) or cœcal lobe, which seems to serve mainly for the temporary storage of large quantities of food. The intestine (*h*, *h′*) is a rather wide, thin tube, of moderate length, it arises from the anterior end of (S″), close to the dorsal side of the heart; the anal orifice (*h′*) is provided with two slender clavate papillæ. The liver (*l*) is a long, rather narrow, somewhat fusiform organ, slightly bilobed anteriorly and pointed posteriorly; along about two-thirds of its length, from the anterior end, there is a deep dorsal groove in which the œsophagus and aorta are situated before they pass through its substance; the posterior end is undivided and pointed.

The ink-sac (*i*) is a large flask-shaped, or long-pyriform, blackish sac, with a long tapering duct (*i′*) terminating just within the anal orifice.

In the appearance and structure of the internal reproductive organs the sexes differ greatly. In the female (Pl. XXIX, figs. 3, 3a; Pl. XXXIII, fig. 2) the single large oviduct (*od*), situated on the left side, passes over the dorsal side of the base of the gill and terminates in a large ear-shaped external orifice (*op*) nearly surrounded by a broad membranous flap. The portion of the oviduct behind the base of the gill is enveloped by a large, swollen, bilobed nidamental gland (Pl. XXIX, figs. 3, 3a, *x′*; Pl. XXXIII, fig. 2, *x′*), which is abundantly supplied with blood-vessels, and internally is comprsed of a large number of thin, close, parallel lamellæ. Two very large, oblong, accessory nidamental glands (*xx*) lie side by side, loosely attached, nearly in the middle of the ventral side, covering and concealing the heart and most of the renal organs; each of these has a groove along the ventral side and a slit in the anterior end; internally they are composed of great numbers of thin lamellæ.

In front of and partially above the anterior ends of these, and attached to the intestine and ink-sac, there is another pair of accessory glands (*x*), roundish in form, with a large ventral opening, and having, in fresh specimens, a curiously mottled color, consisting of irregular red and dark brown blotches on a pale ground. Their internal structure is finely follicular. The ovary (*ov*) is large and occupies a large portion of the cavity of the body, posteriorly, running back into the posterior cavity of the pen, and in the breeding season extending forward nearly to the heart. In the breeding season the thin convoluted portion of the oviduct (*ov'*) is found distended with great numbers of eggs. At the same time the large glands (*x'*), around the oviduct, and the accessory nidamental glands (*x*, *xx*), destined to furnish the materials for the formation of the egg-capsules, and for their attachment, are very turgid and much larger than at other times.

The male (Pl. XL, figs. 1, 2) has no organs corresponding in position to the two pairs of accessory nidamental glands of the female, but the single efferent spermatic duct (*p*) occupies the same position on the left side as the terminal part of the oviduct of the female. It is, however, a much more slender tube, extending farther forward beyond the base of the gill, and its orifice is small and simply bilabiate. It extends backward over the dorsal side of the base of the gill to a bilobed, long-pyriform organ, consisting of a spermatophore-sac (*ss*) and a complicated system of glands and tubes (*pr*, *vd*) united closely together and inclosed in a special sheath. This organ consists of the following parts:

1. The vas-deferens (*vd*), which starts posteriorly from a small orifice (not figured) in the thin sheath of peritoneal membrane (*pr*) investing the testicle (*t*); it passes forward along the side of the spermatophore-sac, to which it is closely adherent, and throughout its length it is thrown into numerous close, short, transverse, flattened folds; anteriorly it joins the vesiculæ-seminales.

2. The vesiculæ-seminales (fig. 2, *pr*, in part) consist of three large, curved vesicles, closely coiled together, the third one having thickened, glandular walls; from the latter goes a duct which unites with the duct from the prostate gland to form the spermatic duct.

3. The prostate gland (*pr*, in part) consists of two curved lobes, which are closely coiled between and united to the vesiculæ-seminales.

4. The spermatic duct, formed by the union of the ducts from the vesiculæ seminales and prostate glands, is a nearly straight tube; it passes backward between the prostate glands and spermatophore-sac, close alongside of the vas-deferens (*vd*), to which it is closely bound down; it enters the spermatophore-sac (*ss*) near its posterior end, at an acute angle.

5. The spermatophore sac (*ss*) is a long, capacious, pyriform, or somewhat fusiform, thin-walled sac, pointed at its posterior end; its anterior end is directly continuous with the long efferent duct (*p*), which is often rather wide at its origin but tapers to a narrow anterior end. The terminal orifice is slightly bilabiate.

These organs receive blood through a special artery (fig. 2, *po*) which arises from the posterior aorta just back of the heart. After reaching the genital organ it divides into several branches; one going forward along the side of the efferent duct; one to the prostate glands and vesiculæ-seminales; one to the vas-deferens and adjacent parts.

Specimens taken in May, in the breeding season, have the efferent duct and the spermatophore-sac crowded with the spermatophores. In the spermatophore-sac, which is then much distended by them, they lie closely packed in a longitudinal position with their larger ends pointing somewhat outward toward the surface, and can be plainly seen through the transparent walls of the sac.

The spermatophores are slender, club-shaped, with the larger end rounded, tapering gradually to the smaller end, which is usually a little expanded at the tip and has a very small filament. They vary (in alcohol) from 8 to 10^{mm} in length and 4 to 5^{mm} in the greatest diameter. They contain a coiled rope of spermatozoa in the larger end and a complicated apparatus for automatically ejecting this rope in the smaller portion.

The "testicle" or spermary (*t*) is a compact, pale yellow, long, flattened organ, extending from the stomach (*s*) nearly to the end of the pen, in the posterior concavity of which it lies; a band of fibrous tissue, continuous with its sheath, extends from its posterior end into the hollow tip of the pen, to which it is attached. An arterial vessel, the spermatic artery (Pl. XL, fig. 2, *go*), which arises directly from the anterior edge of the heart, runs along the median dorsal line of the spermary and sends off numerous branches to the right and left (fig. 2, *t*). This artery is accompanied by a spermatic vein (*sv*), closely united to it.

Loligo brevis Blainville.

Loligo brevis Blainv., Journ. de Phys., March, 1823 (t. D'Orb.); Dict. des Sci. nat., vol. xxvii, p. 145, 1823.

D'Orbigny, Céphal. Acétab., p. 314, *Loligo*, pl. 13, figs. 4–6 (copied from Lesueur); pl. 15, figs. 1–3 (orig.); pl. 24, figs. 14–19 (orig.).

Tryon, Marine Conch., i, p. 142, pl. 52, figs. 143, 144 (after D'Orbigny).

Verrill, Trans. Conn. Acad., v, p. 343, 1881.

Loligo brevipinna Lesueur, Journ. Acad. Nat. Sci. Philad., vol. iii, p. 282 (with plate), 1824.

Tryon, Manual Conch., i, p. 142, pl. 51, figs. 128–130 (after Lesueur).

Plate XXI, figures 4–4*c*.

A small, short-bodied species, with short rounded caudal fins, very short upper arms, and large chromatophoric spots.

Body short, thick, well rounded, rather blunt posteriorly. Anterior edge of mantle with a well-developed median dorsal lobe, and well-marked lateral angles. Fins broad transversely, short, less than half the length of the mantle; outer edges well rounded; posterior end very obtuse. Arms all short, the two upper pairs much shorter than the two lower, the dorsal pair very short, considerably shorter than the upper lateral ones; ventral and lower lateral arms nearly equal in length. The dorsal arms are strongly compressed, with a well-marked, thin, dorsal keel; those of the second pair squarish at base, without a keel; those of the third pair are strongly compressed, bent outward at the base, and furnished with a high median keel, starting from the base, but highest in the middle; ventral arms triangular at base, with a wide membrane on the upper angle, which expands at the base and connects them with the third pair; a narrower membrane runs along the ventral margins. Tentacular arms rather stout at base, compressed farther out, in extension about as long as the body; club well developed, about twice as broad as the rest of the arm; its dorsal keel thin, elevated, oblique, commencing at about the middle of the club and extending to the tip. The larger tentacular suckers are very regularly arranged in four rows of 8 to 10 each, the lateral ones being not very much smaller than the median ones. The distal part of the club is covered with four regular rows of small suckers, and there is a terminal group of smaller, smooth-rimmed ones. The largest median suckers (Plate XXXI, figs 4*b*, 4*c*) are broad, cup-shaped, rather larger than the largest suckers of the lateral arms; their horny rims are armed with regular, sharp, incurved teeth, smaller on the inner side of the sucker, but there are few or no small teeth, alternating with the larger ones. The lateral suckers are relatively large, deep cup-shaped, oblique, with very sharp incurved teeth on the outer margin. The membranous borders of the large suckers are covered with minute, sharp, chitinous scales.

The suckers of the short arms are very deep and oblique, cup-shaped; their rims are much the highest on the outer or distal side, where the edge is divided into several broad, bluntly rounded denticles, separated by narrow intervals.

The pen (Plate XXXI, fig. 4*a*) is short with a broad lanceolate blade; the narrow part of the shaft is short; a thin border, widening backward to the blade, commences about half way between the tip and the proper blade; the latter is broad and thin, marked with divergent lines; posterior end obtuse.

In the female there is no tubercle on the buccal membrane for the attachment of spermatophores. I have not seen the male, nor has any writer described it distinctively.*

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* Professor Steenstrup, in a recent paper, (Sepiadarium og Idiosepius, < Vid. Selsk. Skr., 6 R., 1, 3, p. 242, note, 1881) has proposed to make this species the type of a new genus, *Lolliguncula*, because the female receives the spermatophores on the inner surface of the mantle, —a character that seems to be scarcely of generic value, unless it be reinforced by anatomical differences now unknown. Such characters may possibly exist in the unknown males.

The color is peculiar: it consists, on the body, in alcoholic specimens, of dark purplish chromatophores, everywhere pretty uniformly and regularly scattered, on a pale ground-color. When expanded these chromatophores are large and round; above the eyes they are so closely crowded as to form dark blotches; they also cover the outer surface of all the arms; underside of caudal fin white.

In alcohol, a medium-sized specimen measures from tip of tail to base of dorsal arms, 80^{mm}; total length of mantle, 71^{mm}; breadth of body, 22^{mm}; breadth of caudal fin, 52^{mm}; length of fin, 39^{mm}; length of dorsal arms, from base, 17^{mm}; of second pair, 23^{mm}; of third pair, 31^{mm}; of ventral arms 31^{mm}; of tentacular arms, 46^{mm}; of club, 22^{mm}.

A larger female specimen, from Charlotte Harbor, Florida, measured, in length of mantle, 130^{mm}; diameter of body, 36^{mm}; length of dorsal arms, 45^{mm}; of second pair, 55^{mm}; of third pair, 65^{mm}; of tentacular arms, 145^{mm}.

This species appears to have an extensive distribution along the warmer parts of the Atlantic coasts of America. It was originally described by Blainville as from Brazil. D'Orbigny records it from Rio Janeiro. It ranges northward to Delaware Bay. It is common on our southern coasts, from South Carolina to Florida, and I have seen specimens from Mobile Bay, Alabama, and from Louisiana.

Loligo brevis.—Specimens examined.

Number.	Locality.	Collected by—	When collected.	Received from—	Specimens, number and sex.
641	Mobile, Ala	Dr. Nott	1857	Museum of Comparative Zoölogy	3 ♀.
641	Charlotte Harbor, Fla			do	2 ♀.
	Hampton, Va	Dr. Marmion	1880	United States National Museum	1 ♀.
	Saint John's River, Fla	S. F. Baird		do	1 ♀.
	Louisiana Coast	Geo. W. Dunbar's Sons	1881	do	2 ♀.

SEPIOTEUTHIS Blainv., 1823.

This genus closely resembles *Loligo*, in external characters. It is distinguished chiefly by having the fins extending nearly the whole length of the mantle. The body is stout and depressed, somewhat as in *Sepia*. The pen is thin and horny, lanceolate, nearly as in *Loligo*, but is often thickened near the margins.

There are, however, important differences in the visceral anatomy. The eggs are much larger and fewer than in *Loligo*, and the ovary is short and broad, at the posterior end of the body.

Sepioteuthis sepioidea D'Orb.

Loligo sepioidea Blainville, Dict. Sci. Nat., xxvii, p. 146, 1823.

Sepioteuthis triangulata Rang, Mag. de Zool., p. 73, pl. 98, 1837 (t. D'Orbigny).

Sepioteuthis sepioidea D'Orbigny, Céph. Acétab., p. 298, *Sepioteuthes*, pl. 7, figs. 6–11; Hist. l'Ile de Cuba, Moll., p. 34, 1853.

Sepioteuthis sepioidea D'Orb.—(Continued.)

Gray, Catal. Moll. Brit. Mus., i, p. 81, 1849.

Tryon, Man. Conch., i, p. 153, pl. 63, fig. 216. (Description copied from Gray; figure from D'Orbigny.)

Verrill, Trans. Conn. Acad., v, p. 345, 1881.

Body oblong, stout, depressed, tapering but little, obtuse posteriorly. The fins, together, have a long, rhomboidal form, broadest in the middle and rounded posteriorly; they commence a short distance (5 to 10^{mm}) from the anterior border of the mantle and extend to the posterior end; a narrow crest-like extension of the fins, around the posterior end of the body, unites them together. Buccal membrane with seven long, acute lobes, without suckers. Sessile arms rather slender, the third pair much the largest; the first very short and compressed. Suckers with broad rims, having long, slender teeth on the outer side and smaller ones on the inner. Tentacular club with four rows of large suckers, about twelve in each; the central ones have the rims strongly and regularly denticulated with slender, acute teeth; the marginal ones are but little smaller, with similar teeth on the outer edge. The pen is broad, lance-shaped; the blade is wide and thin, without any marginal thickenings.

The male has the left ventral arm hectocotylized by the enlargement and elongation of the stems of the suckers, in both rows, on the distal part of the arms, as in *Loligo;* but in this species the cups are entirely obsolete on many of the stems in both rows, the stems becoming long, conical, with acute tips. The large spermatophore-sac is filled with spermatophores in some of the specimens examined by me, and there is a saccular enlargement of the efferent sperm-duct or "penis" near the terminal orifice. These specimens have the larger part of the inner surface of the siphon covered with a soft, whitish, glandular-looking membrane, which is thrown into longitudinal, convoluted folds.

A large female, taken in July, has a short, thick ovary, and is distended by comparatively few very large eggs (5–6^{mm} in diameter), which have a strongly reticulated surface before reaching the glandular part of the duct. The oviduct is very large, with large glands, and its external orifice is large and surrounded by a broad and very complicated border. The accessory nidamental glands are also very large. The short ovary is restricted to the posterior part of the body. This specimen had spermatophores attached to and around a large elevated area on the lower part of the inner surface of the inner buccal membrane.

This species is widely distributed along the warmer parts of the American coast and throughout the West Indies, extending as far north, at least, as Bermuda, from whence I have a specimen collected by Mr. G. Brown Goode. It may, therefore, occasionally occur as far north as Cape Hatteras, but I have seen no specimens from our coast, north of Florida.

From the Museum of Comparative Zoology I have received two specimens from Cuba (Professor Poey); two large males, with spermatophores in the sac, taken at Key West by Dr. J. B. Holder and Captain Pickering; and a large female, with ripe eggs in the oviducts, and spermatophores on the buccal membrane, taken July, 1859, at Fort Jefferson, by Capt. D. P. Woodbury. Other localities are Martinique (Blainville, Rang); Cuba (D'Orbigny); Honduras (Gray).

Family SEPIOLIDÆ Keff.

Kefferstein, in Bronn, Thier-Reich, iii, p. 1443, 1866.
Gill, Arrangement of Families of Mollusca, p. 2, 1871.
Tryon, Man. Conch., i, pp. 102, 155, 1879.

Body, short, thick, blunt posteriorly. Eyes with lower lid free, upper adherent; sometimes free all around; pupils often circular. Fins separate, laterally attached near the middle of the body. Tentacular arms more or less retractile into large sacs. Pen little developed, not reaching the end of the mantle; sometimes absent. Siphon-valve small; no dorsal bridles. Dorsal arms usually hectocotylized in the male. Eggs large, few, not enclosed in capsules.

This family is related to *Loliginidæ*, but differs widely from the latter in the eye-lids, visceral anatomy, &c.

STOLOTEUTHIS Verrill, 1881.

Body short, stout, rounded posteriorly. Eyes with *free eyelids;* pupils round. Pen none. Arms united together by a broad web. Fins large, narrowed at base. Mantle united directly to the head by a large dorsal commissure; lateral connective cartilages of the mantle elongated, fitting into elongated, margined pits on the base of the siphon. Siphon with an internal valve. Tentacular club with small, long-pediceled suckers, in eight or more rows; rims not toothed.

The males and some of the females have some of the middle suckers of the second pair of arms much enlarged. In the male, the suckers at the base of both dorsal arms are larger and more crowded than in the female, and the web is more swollen at the sides.

Stoloteuthis leucoptera Verrill.—Butterfly Squid.

Sepiola leucoptera Verrill, Amer. Journ. Sci., vol. xvi, p. 378, 1878.
Tryon, Man. Conch., i, p. 158, 1879. (Description copied from preceding.)
Verrill, Amer. Journ. Sci., xix, p. 291, pl. 15, figs. 4 and 5, April, 1880; Trans. Conn. Acad., v, p. 347, pl. 31, figs. 4 and 5; pl. 54, fig. 4, June, 1881.
Stoloteuthis leucoptera Verrill, Trans. Conn. Acad., v, Oct., 1881.

Plate XXXVI, figures 1, 1*a*, 2.

Size moderate; the largest specimens observed are probably full-grown. Body short, thick, swollen, with the mantle smooth. Ventral surface, in the middle, with a large, somewhat flattened, brown, heart-shaped or shield-shaped area, bordered with blue, and surrounded, except in front, by a silvery white band, having a pearly or opalescent luster. Eyes large, with round pupils; lids free all around. Fins large, thin, broadly rounded, in the living specimens nearly as long as the body; the posterior lobe reaches nearly to the end of the body; the anterior edge extends beyond the front of the mantle to the eye. The anterior edge of the mantle is prominent and emarginate beneath; laterally it recedes to a great extent; above it is broadly attached to the head. Sessile arms short, with a wide basal web, extending beyond the middle; upper ones shortest; third pair longest; suckers in two rows, except at tip of ventral arms of largest male, where they form four rows.

Tentacular arms slender, thickened at base, tapering, extending back as far as the end of the body; club scarcely as wide as the arm, with a free crest at its base, above, curled in preserved specimens; the suckers are numerous and very minute, arranged in many rows.

Upper surface of the body is opalescent in some lights, thickly spotted with orange-brown, spots most numerous in the middle line and extending to the upper surface of the head; some also occur on the outer surfaces of the arms; anterior part of the head white; fins, arms and extremity of body translucent bluish white, with a thick, transparent, outer integument; upper surface of the eyes opalescent, with silvery blue and red tints; head, below the eyes, silvery white; above the eyes, blue.

The largest specimen (♂), taken in 1879 (Plate XXXVI, fig. 1), when living had the head, above, in front of the eyes, whitish, with few chromatophores; back and the base of the fins thickly spotted with brown; posterior part of the back with an emerald-green iridescence. Sides of the body, below the fins, and posterior end of the body, silvery white. A large, shield-shaped, ventral area of brown, with a bright blue iridescence, and bordered with a band of brilliant blue, occupies most of the lower surface. Fins, transparent whitish, except at base. Lower side of head, siphon, and outer bases of the arms, light brown. Eyes blue above, green below.

Length of the original type-specimen (♀), to the base of the arms, 14^{mm}, in alcohol; of mantle above, 8^{mm}; breadth, 7^{mm}; breadth across fins, 16^{mm}. The larger specimen, of 1879, is 31^{mm} (1.25 inch) long, from the end of the body to the bases of the arms; breadth of body, 25^{mm} (1 inch); length of arms, 19^{mm} (.75 inch). The largest specimen is a male.

The males (fig. 5) of this species, and some of the females, have a group of two or three decidedly and abruptly larger suckers on the middle of the second pair of arms (Plate XXXVI, fig. 1*a*); other females, of equal size, have no such enlarged suckers; in the male, additional suckers along the middle portion of the lateral arms are also distinctly larger than on the other arms. The only evidence of true hectocotylization is the presence of larger and more crowded suckers at the base of both dorsal arms of the male. This species is an exceedingly beautiful one, when living, owing to the elegance and brilliancy of its colors and the gracefulness of its movements. In swimming it moves its fins in a manner analogous to the motion of the wings of a butterfly. This fact, and its bright colors, suggested the English name that I have applied to it.

Three specimens, two very young, were taken by the writer and party, of the United States Fish Commission, in the trawl-net, 30 miles east from Cape Ann, Mass., in 110 fathoms, August, 1878. Two large specimens were taken by us off Cape Cod in 94 and 122 fathoms, with the bottom temperature 41° F., August and September, 1879. Recently we have taken it in deeper water (182–388 fathoms) about 100 miles south of Martha's Vineyard. It was, in each case, associated with *Octopus Bairdii* and *Rossia sublevis*.

Station.	Locality.	Fath.	When collected.	Received from—	Specimens, number and sex.
194	Gulf of Maine	110	Aug. 31, 1878	United States Fish Commission	3 j.
303	Off Cape Cod	122	Aug. 21, 1879	do	1 ♂
342	do	94	Sept. 10, 1879	do	1l. ♀
947	Off Martha's Vineyard	312	Aug. 9, 1881	do	1l. ♀; 1 j.
952	do	388	Aug. 24, 1881	do	1l. ♀
998	do	302	Sept. 8, 1881	do	1l. ♂; 1l. ♀
999	do	266	do	do	1 ♀
1026	do	182	do	do	3 j.

ROSSIA Owen.

Rossia Owen, Trans. Zool. Soc., London, 1828 (t. Gray).
Owen, in J. Ross, Second Arctic Voyage, Appendix, p. xcii, pl. 100, 1835.
D'Orbigny, Céphal. Acétab., p. 242.
Gray, Catal. Moll. Brit. Mus., i, p. 88, 1849.

Mantle-edge free from the head, dorsally, with a small median angle; it adheres to the head by a longitudinal connective cartilage having three ridges, fitting into three grooves, which form an ovate or horseshoe-shaped cartilage on the back of the head; two elongated, simple, cartilaginous ridges, one on each side, also fit into ovate pits on the base of the siphon. A free eyelid is developed beneath the eye. Pupils indented above. An aquiferous pore, on each side, between the third and fourth pairs of arms. No olfactory crests. Tentacular arms more or less retractile into cavities below the eyes; club well-developed, usually with numerous, nearly equal, minute suckers, in about eight rows; rims not toothed; borders scaled.

The males differ from the females in having larger suckers on the middle of the lateral arms; both dorsal arms are slightly hectocotylized.

Rossia Hyatti Verrill.—(Hyatt's bob-tailed squid.)
Verrill, Amer. Journ. Sci., vol. xvi, p. 208, 1878.
Tryon, Man. Conch., i, p. 160, 1879. (Description compiled from preceding.)
Verrill, Amer. Jour. Sci., xix, p. 291, pl. 15, figs. 1 and 2, April, 1880; Trans. Conn. Acad., v., p. 351, pl. 27, figs. 8, 9; pl. 30, fig. 1; pl. 31, figs. 1, 2; pl. 46, fig. 5, 1881.

Plate XXXV, figures 2, 5, 6. Plate XXXVI, figures 3–6. Plate XXXVII, figure 1.

Body subcylindrical, usually broader posteriorly; in preserved specimens variable in form according to contraction. Dorsal surface covered with small, conical, scattered, whitish papillæ, which are also found on the upper and lateral surfaces of the head and the bases of the arms; those around the eyes largest; one on the mantle, in the median line, near the front edge, is often elongated. Front border of mantle sinuous, slightly advancing in the middle, above. Fins moderately large, nearly semi-circular, attached from the posterior end for about four-fifths the whole length, the front end having a small, rounded, free lobe. The distance from the posterior junction of the fins to the end of the body is less than that from the anterior junction to the edge of the mantle, the center of the fin being at about the middle of the body. Siphon elongated, conical, with a small opening. Head depressed, more than half the length of the body. Eyes large, the lower eyelid prominent, but not much thickened. Sessile arms short, united at their bases by a short web, which is absent between the ventral arms; the dorsals are shortest; the third pair the longest and largest; the second pair and ventrals about equal in length. Suckers (Pl. XXXVI, fig. 5, *a*), numerous, sub-globular, not very small, the margin bordered with several rows of minute scales; near the base of the arms they are biserial, there being usually four to six thus arranged in each row; then, along the rest of the length of the arms, they become more crowded and form about four rows, those in the two middle rows alternating with those in the marginal rows; toward the tip they become very small and crowded, especially on the dorsal and ventral arms. The number of suckers varies with age, but on one of the original specimens they were as follows: on each dorsal arm, sixty; on one of the second pair, fifty-five; of third pair, fifty-three; of ventral, sixty-five. In this specimen (♀), the third arm of the right side and the ventral arm of the left side were abruptly terminated (accidentally), while the others were tapered to acute points.

The tentacular arms, in preserved specimens, will extend back to the posterior end of the body; the naked portion is smooth, somewhat triquetral, with the outer side convex and the angles rounded; terminal portion widening, rather abruptly, long ovate-lanceolate, curved and gradually tapered to the tip; the sucker-bearing portion is bordered by a wide membrane on the upper, and a narrow one on the lower margin; the suckers (Plate XXXVI, fig. 5, *b*, *c*) are very small, sub-globular, crowded in about eight to ten rows in the widest portion.

The males (Pl. XXXVI, fig. 6) differ from the females in the relatively greater size of the suckers on the middle of the lateral and ventral arms, those toward the tips becoming abruptly smaller, while in the female they decrease more gradually.

Color, pinkish, thickly spotted with purplish brown above, paler and more sparsely spotted beneath and on the outside of the long arms; the inner surfaces of the arms and front edge of the mantle are pale.

Length, of a medium-sized specimen, from bases of the arms to the posterior end of the body, 40^{mm}; of body, 25; of head, 15; breadth of body, 17; of head, 17; length of fins, 15; of insertion, 11; breadth of a fin, 8; front of fin to edge of mantle, 5; length of the free portion of the dorsal arms, 12.5; of second pair, 15; of third pair, 18; of ventrals, 13; of tentacular arms, 40; breadth of dorsal arms, at base, 3.5; of second pair, 3.5; of third pair, 4; of ventrals, 3.5; of tentacular arms, at base, 2; at expanded portion, 3.5; length of latter, 10.5; diameter of largest suckers of sessile arms, 0.9; length of free portion of siphon, 7^{mm}.

This species has been taken in numerous localities, by the dredging parties of the U. S. Fish Commission, in 1877, 1878, and 1879, off Cape Cod; in Mass. Bay, 40–50 fathoms; off Cape Ann, in the Gulf of Maine, 50–100 fathoms; off Cape Sable, N. S., 88–92 fathoms; off Halifax, N. S., 57–100 fathoms, on a fine, compact, sand and mud bottom. It occurs in 40–100 fathoms. It has also been received through the Gloucester halibut fishermen, from the Banks, off Nova Scotia and Newfoundland.

One specimen (lot 241), presented by Capt. Chris. Olsen and crew, of the schooner "William Thompson," was taken in 60 fathoms, N. lat. 44° 20′, W. long. 59°. Another (lot 372), which was presented by Capt. C. D. Murphy and crew, of the schooner "Alice M. Williams," was taken in 7 fathoms, off Miquelon Island.

The relatively large eggs (Pl. XXXV, fig. 5) are laid in August and September, in small clusters, slightly attached together, in the large oscules or cavities of several species of sponges.

It is frequently associated with *Octopus Bairdii* V, and the following species.

This species has a strong general resemblance to *R. glaucopis* Lovén, as figured in the admirable work of G. O. Sars, but the latter has shorter lateral arms, and the suckers of the sessile arms are in two rows, while they are four-rowed in our species.

Rossia Hyatti.—Specimens examined.

Station.	Locality.	Fath.	Bottom.	When collected.	Received from—	Specimens, number and sex.
				1877.		
30, 31	Off Salem, Mass	48	Mud	Aug. 13	U. S. Fish Com.	2 j.
33	Off Cape Ann, 13 miles	90	....do	Aug. 14	....do	1 l. ♂.
42–46	Off Cape Sable, N. S., 30 miles.	88–90	Sandy mud	Aug. 21	....do	1 ♂ : 1 ♀ : 3j.
48	Off Cape Sable, N. S., 20 miles.	59	Rocky	Aug. 21	....do	1 j. ♀.
85–86	Off Halifax, N. S., 26 miles.	101	Fine sand	Sept. 6	....do	2 l. ♀.
	Gulf of Maine and Massachusetts Bay.					
				1878.		
130	Off Cape Ann, 14 miles	49	Mud	July 23	....do	3 j.
156	Off Gloucester, Mass., 8 miles.	42	Sandy mud	Aug. 15	....do	2 j.
163	Off Cape Ann, 6½ miles	73	Fine sand	Aug. 16	....do	1 ♂ : 2 j. ♀.
164	Off Cape Ann, 7 miles	75	... do	Aug. 16	... do	1 ♀.
181	Off Gloucester, Mass	45	Mud	Aug. 29	....do	4 ♀.
184	Off Gloucester, Mass., 5 miles.	45	....do	Aug. 29	....do	1 j.
211	Off Cape Ann, 6 miles	60	Soft mud	Sept. 17	....do	1 j. ♂ : 1 j. ♀
214	Off Cape Ann, 7 miles	57	Fine muddy sand	Sept. 17	....do	1 ♀.
217	Off Cape Ann, 6 miles	45	Soft mud	Sept. 18	....do	1 l. ♂.
218	......do	45	....do	Sept. 18	....do	1 l. ♀ : 1 j.

Rossia Hyatti—Continued.

Station.	Locality.	Fath.	Bottom.	When collected.	Received from—	Specimens, number and sex.
	Gulf of Maine and Massachusetts Bay—Continued.					
				1878.		
223	South of Cape Ann, 7 miles.	47	Soft mud	Sept. 24	U. S. Fish Com.	1 ♂.
234	Off Gloucester, Mass., 5½ miles.	43	....do	Sept. 24	....do	1 ♀.
238	Off Gloucester, Mass., 4½ miles.	43	....do	Sept. 26	....do	2 j.
				1879.		
264	Off Cape Cod, 15 miles	80	Blue mud	July 29	....do	1 l. ♂.
276	Off Cape Cod, 7½ miles	47	....do	Aug. 1	....do	1 l. ♀.
324	Off Cape Cod, 11 miles	45	Fine sand	Sept. 1	....do	1 l. ♂.
364	Off Cape Cod, 15 miles	70	....do	Sept. 18	....do	1 l. ♀: 3 j. ♀.
372	Off Chatham, Mass., 21 miles.	70	....do	Sept. 19	....do	1 ♂.
Lot.	*Gloucester fisheries.*					
241	North latitude 44° 20′, west longitude 59°.	60		Dec., '78	....do	1 j.
372	Off Miquelon Island	7		July, '79	....do	1 j.
39 Gl.	Off Gloucester, in cod				....do	1 l. ♀.

Rossia sublevis Verrill.—(Smooth bob-tailed squid.)

Rossia sublevis Verrill, Amer. Jour. Sci., vol. xvi, p. 209, 1878.

Tryon, Man. Conch., i, p. 160, 1879. (Description compiled from preceding.)

Verrill, Amer. Journ. Sci., xix, p. 291, pl. 15, fig. 3, Apr., 1880; Bulletin Mus. Comp. Zool., viii, p, 104, pl. 3, figs. 2–4; pl. 7, fig. 4, 1881; Trans. Conn. Acad., v, p. 354, pl. 30, fig. 2; pl. 31, fig. 3; pl. 46, fig. 4; pl. 47, figs. 2–4, 1881.

Plate XXXIV, figures 2–6. Plate XXXVII, figure 2.

Larger and relatively stouter than *Rossia hyatti*, with the fins larger and placed farther forward, the front edge of the large, free lobe reaching nearly to the edge of the mantle. Head large and broad; eyes large. Sessile arms more slender and less unequal in size than in the preceding, and with the suckers in two regular rows throughout the whole length. Anterior edge of the mantle scarcely sinuous, advancing but little dorsally. Upper surface of the body and head nearly smooth, but in the larger specimens, especially in the males, usually with a few very small whitish papillæ, most numerous near the front edge of the mantle. Color, nearly as in the preceding species. The male differs from the female in having larger suckers on the lateral arms of both pairs (Plate XXXIV, fig. 6), and to a less extent on the ventral arms.

The large suckers are oblong, with a groove or constriction around the middle, the part below the groove larger than that above it; the aperture is small, ovate, with a smooth rim; their pedicels are short and laterally attached. In the female the corresponding suckers are not only smaller, but are differently shaped, the basal portion being smaller than the upper portion. The suckers of the tentacular arms are very numerous, minute, shallow, cup-shaped, with oblique rims and slender pedicels; they are nearly equal and appear to form 8 to 12 rows.

Young specimens, with the mantle less than 12^{mm} in length, can scarcely be distinguished sexually, by external characters. Such specimens are not easily distinguished from the young of *Rossia Hyatti*, of similar size.

One of the original specimens (♀) measured, from the base of the arms to the end of the body, 46^{mm}; length of body, 31; of head, 15; breadth of body, 22; of head, 23; length of fins, 20; of their insertion, 16; breadth of fins, 10; front edge of fin to edge of mantle, 2.5; length of free portion of dorsal arms, 16; of second pair, 17; of third pair, 20; of ventrals, 15; of tentacular arms, 25; breadth of dorsal arms at base, 3; of second pair, 3; of third, 3.5; of ventrals, 3.5; of tentacular arms, 3.5; of the terminal portion, 3.75; its length, 10; diameter of largest suckers of sessile arms, .8; length of free portion of siphon, 7^{mm}.

The pen is but little developed, small and thin, much shorter than the mantle. The shaft is narrow; the blade increases in breadth rather abruptly, and is somewhat shorter than the shaft; its posterior portion is very thin, with the edge ill-defined.

One of the specimens (No. 16), taken by Mr. Agassiz in 257 fathoms, is a young female differing somewhat from the others in having the arms shorter, with the suckers more crowded, so that they apparently form more than two rows. Possibly this should be referred to *R. Hyatti* Verrill. Its back is smooth. All three specimens from this same region differ somewhat from those taken farther north, in shallower water, in having larger eyes and shorter and stouter arms.

This has been taken by the dredging parties of the U. S. Fish Commission, in the trawl-net, at various localities, in 1877, 1878, and 1879, in 45 to 110 fathoms, off Massachusetts Bay, in Massachusetts Bay, off Cape Cod, off Cape Sable, N. S., and off Halifax. It has been brought in by the fishermen of Gloucester, Mass., from the banks off Nova Scotia and Newfoundland. It was also trawled in some numbers, and of both sexes, by the U. S. Fish Commission, on the "Fish Hawk," in 1880, off Newport, R. I., in 155 to 365 fathoms; and in November, 1880, by Lieut. Z. L. Tanner, on the "Fish Hawk," off the mouth of Chesapeake Bay, in 157 fathoms; and by Mr. Agassiz, on the "Blake," in 233–260 fathoms, and as far south as lat. 32° 33′ 15″. It has also been dredged, in 1881, by the U. S. Fish Commission, at several stations, about 100 miles southward of Martha's Vineyard, in 160–458 fathoms (fifty-two specimens). The eggs, which are like those of *R. Hyatti*, were taken at 895, 897, 939, 1033.

This species very closely resembles the *Rossia glaucopis* Lovén, of Northern Europe, as figured by G. O. Sars. The latter is, however, more papillose, and has smaller eyes and head, if correctly figured. Some of the specimens taken this year resemble Sar's figure more than any of those previously observed. It is possible, therefore, that a larger series of European specimens would show that they are of the same species.

Measurements of Rossia Hyatti and R. sublevis, in millimeters.

	R. Hyatti.	R. sublevis.
Length from base of arms	40	46
Length of body	25	31
Length of head	15	15
Breadth of body	17	22
Breadth of head	17	23
Length of fin	15	20
Length of insertion	11	16
Breadth of fin	8	10
Front edge of fin to edge of mantle	5	2.5
Length of free portion of dorsal arms	12.5	16
Length of free portion of second pair	15	17
Length of free portion of third pair	18	20
Length of free portion of ventral arms	13	15
Length of free portion of tentacular arms	40	25
Breadth of dorsal arms	3.5	3
Breadth of second pair	3.5	3
Breadth of third pair	4	3.5
Breadth of ventral arms	3.5	3.5
Breadth of tentacular arms	2	3.5
Breadth of terminal portion	3.5	3.75
Length of terminal portion	10.5	10
Diameter of largest suckers	.8	.8
Length of free portion of siphon	7	6

Rossia sublevis.—Specimens examined.

Station.	Locality.	Fath.	Bottom.	When collected.	Received from—	Specimens, number and sex.
	United States Fish Commission.					
84	Off Halifax, N. S., 26 miles	101	Fine sand	1877. Sept. 6	U. S. F. C.	1 l. ♀: 1 j.
85, 86	......do	101	....do	Sept. 6	....do	1 ♂: 1 j. ♀
161	Off Cape Ann, 6 miles	54		1878. Aug. 6	....do	1 l. ♂
194	Off Cape Ann, 33 miles	110	Muddy	Aug. 31	....do	
264	Off Cape Cod, 15 miles	80	Blue mud	1879. July 29	....do	1 ♂: 1 l. ♀: 3 j.
324	Off Cape Cod, 11 miles	45	Sand	Sept. 1	....do	1 l. ♂
364	Off Cape Cod, 15 miles	70	....do	Sept. 18	....do	1 j.
	United States Fish Commission. Off Newport, R. I.					
868	North latitude 40° 2′ 18″, west longitude 70° 23′ 6′.	192	Sandy mud	1880. Sept. 4	....do	1 ♂: 5 ♀
870	North latitude 40° 2′ 36″, west longitude 70° 22′ 58″.	155	....do	Sept. 4	....do	1 ♂: 1 ♀
880	North latitude 39° 48′ 30″, west longitude 70° 54′.	252	....do	Sept. 13	....do	1 l. ♂
893	North latitude 39° 52′ 20″, west longitude 70° 58′.	372	Mud	Oct. 2	....do	1 j.
894	North latitude 39° 53′, west longitude 70° 58′ 30″.	365	....do	Oct. 2	....do	1 l. ♂: 1 j. ♀
895	North latitude 39° 56′ 30″, west longitude 70° 59′ 45″.	238	....do	Oct. 2	....do	1 l. ♂: 1 l. ♀: 5 j.
897	Off Chesapeake Bay	157		Nov. 16	....do	1 l. ♂ (eggs).
	Blake Expedition, United States Coast Survey.					
310	North latitude 39° 59′ 16″, west longitude 70° 18′ 30″.	260		1880.	A. Agassiz	1 ♀ ad.
320	North latitude 32° 33′ 15″, west longitude 77° 30′ 10″.	257		1880.	....do	1 ♀ ad.
321	North latitude 32° 43′ 25″, west longitude 77° 20′ 30″.	233		1880.	....do	1 ♀ j. ?
Lot.	*Gloucester fisheries.*					
265	North latitude 42° 49′, west longitude 62° 57′.	250		Jan., '79	U. S. F. C.	1 j.

Rossia sublevis—Continued.

Station.	Locality.	Fath.	Bottom.	When collected.	Received from—	Specimens, number and sex.
	United States Fish Commission. Off Martha's Vineyard.					
				1881.		
924	S. ½ W. 83½ m. from Gay Head.	160	....	July 16	U. S. F. C.	1 l. ♀: eggs.
925	S. ½ W. 86 m. from Gay Head..	224	....	....	....do	2 l. ♂
939	S by E. ½ E. 98 m. from Gay Head.	258	....	Aug. 4	....do	19: eggs.
943	SSW. 83 m. from Gay Head...	153	....	Aug. 9	....do	1
945	S. by W. ¾ W. 84½ m. from Gay Head.	202	....	Aug. 9	....do	1 l. ♂: 4 ♀
946	S. by W. ¾ W. 87½ m. from Gay Head.	241	....	Aug. 9	....do	2 ♂: 3 ♀
947	S. by W. ¾ W. 89 m. from Gay Head.	312	....	Aug. 9	... do	6
951	S. 85 m. from Gay Head.......	219	....	Aug. 23	....do	5 ♂: 2 ♀
952	S. ¼ E. 87½ m. from Gay Head.	388	....	Aug. 23	....do	2 ♀
997	SSW. ¼ W. 103½ m. from Gay Head.	335	....	Sept. 8	....do	1 ♂
1025	SSW. ½ W. 95 m. from Gay Head.	216	....	Sept. 8	....do	3 ♀
1026	SSW. ½ W. 93½ m. from Gay Head.	182	....	Sept. 8	....do	2 ♀
1028	SSE. ¾ E. 108½ m. from Gay Head.	410	....	Sept. 14	....do	1 l. ♂
1029	SSE. ¾ E. 109½ m. from Gay Head.	458	....	Sept. 14	....do	1 j.
1032	SSE. ½ E. 107 m. from Gay Head.	208	....	Sept. 14	....do	5
1033	SSE. ½ E. 106 m. from Gay Head.	183	....	Sept. 14	....do	1 j.: eggs.
1045	Off Delaware Bay.............	312	Mud............	Oct. 10	....do	3 l. ♂: 1 j.

Rossia megaptera Verrill.

Trans. Conn. Acad., v, p. 349, pl. 38, fig. 1, pl. 46, fig. 6, June, 1881.

Plate XXXV, figures 3, 4.

Body short, broad, depressed, covered with a soft flabby integument, which forms a loose border posteriorly; the front edge of the mantle extends forward dorsally into a prominent angle, but recedes very much ventrally. Fins very large and broad; their anterior insertions being but little back of the antero-lateral edge of the mantle, and their posterior insertion close to the end of the body; the free borders of the fins are thin and undulated, extending forward anteriorly beyond the edge of the mantle, while the length, from base to outer edge, is about equal to the breadth of the back between the bases of the fins.

Head very large and broad, the width exceeding that of the body. Eyes very large and prominent; lower eyelids well developed but not much thickened. Tentacles remarkably long and slender, in extension about twice as long as the head and body together. The tentacular club is somewhat thicker than the rest of the arm, rather long, narrow, tapering to the tip, and covered with numerous minute, nearly globular, slender pedicelled suckers, arranged in many rows. (Plate XXXV, fig. 4, *a*, *b*, *c*.)

Sessile arms of moderate length; rounded, very slender at tip; the 1st, 2d, and 3d pairs are successively longer, while the ventral pair is about equal to the 1st. Suckers rather small, nearly globular, arranged in two rows on all the arms (fig. 4, *a*). The suckers are all similar, but are a little larger on the 3d pair of arms. The margin is surrounded by small scales, in many rows; the marginal scales are larger, forming a circle of denticles.

Color purplish brown with rather large chocolate-brown chromatophores; outer portion of fins pale, thin and translucent; edge of mantle, siphon, under side of head and arms, and greater part of tentacular arms whitish, with only minute chromatophores.

Measurements of Rossia megaptera.

	Millimeters.	Inches.
Length, end of body to dorsal edge of mantle, exclusive of membrane	32	1.25
Length, end of body to ventral edge of mantle	24	.95
Length, end of body to base of dorsal arms	57	2.25
Length, end of body to tip of dorsal arms	86	3.40
Length, end of body to tip of second pair	95	3.75
Length, end of body to tip of third pair	103	4.08
Length, end of body to tip of fourth pair	95	3.75
Length, end of body to tip of tentacular arms	188	7.45
Breadth of body and fins together	63	2.50
Breadth of body between bases of fins	22	.85
Breadth of body, beneath fins, exclusive of membrane	28	1.10
Breadth of head across eyes	36	1.40
Breadth of fins antero-posteriorly	27	1.08
Length of fins, base to edge (outer)	22	.85
Diameter of eyes	19	.75
Diameter of large suckers of lateral arms	1.50	.06
Diameter of large suckers of club	.25	.01
Breadth of club	4	.16
Length of club	24	.95

Southern coast of Newfoundland, in 150 fathoms, Capt. K. Markuson and crew, schooner "Notice," June, 1880.

This species is remarkable for the great size of the fins and eyes, and for the length of the tentacular arms. It appears to be a species specially adapted for inhabiting greater depths than the species hitherto discovered. It has the same soft, flabby integument observed in *Octopus lentus* and *Stauroteuthis syrtensis*, found at similar depths. But the looseness of the skin may be due in part to the condition of the specimen when preserved. The tentacular suckers are unusually small.

HETEROTEUTHIS Gray (revised.)

Heteroteuthis (sub-genus) Gray, Catal. Moll. Brit. Mus., i, p. 90, 1849.
Verrill, Trans. Conn. Acad., v, p. 357, June, 1881.

The body is short, thick, rounded posteriorly. Fins large and lateral. Head and eyes large. The anterior border of the mantle-edge is free, dorsally. Pen shorter than the mantle, narrow anteriorly; posterior blade small, slightly expanded laterally. Club of the tentacular arms well developed, with numerous suckers, in many rows, those in the upper marginal rows decidedly larger than the rest; the edge of the aperture is denticulated by small acute scales. Middle suckers of the lateral and ventral arms distinctly larger in the female; in the male, abruptly very much larger than the others. In the male, the left dorsal arm is hectocotylized by having much smaller and more numerous suckers, arranged in four rows, and by the development of a marginal membrane.

Heteroteuthis tenera Verrill.

Amer. Journ. Sci., xx, p. 392, November, 1880; Proc. Nat. Mus., iii, p. 360, 1880; Bulletin Mus. Comp. Zool., xiii, p. 103, pl. 3, figs 5–5*b*; pl. 7, figs. 2–2*d*, 3–3*b*, 1881; Trans. Conn. Acad., v, p. 357, pl. 46, figs. 2–2*d*, 3–3*b*; pl. 47, figs. 5–5*b*, 1881.

Plate XXXIII. Plate XXXIV, figure 1.

A small and delicate species, very soft, translucent, and delicately colored when living.

Body short, cylindrical, scarcely twice as long as broad, posteriorly usually round, but in strongly contracted, preserved specimens, often narrowed and even obtusely pointed; front edge of mantle sometimes with a dorsal angle extending somewhat forward over the neck, but usually emarginate in alcoholic specimens. Fins very large, thin, longer than broad, the outer edge broadly rounded, the anterior edge extending forward quite as far as the edge of the mantle, and considerably beyond the insertion of the fin, which is itself well forward. The length of the fin is about two-thirds that of the body; the base or insertion of the fin equals about one-half the body-length; the breadth of the fin is greater than one-half the breadth of the body. Head large, rounded, with large and prominent eyes; lower eyelids free, slightly thickened; pupils indented above. Arms rather small, unequal, the dorsal ones considerably shorter and smaller than the others, the second pair longest.

In the male, the left dorsal arm is greatly modified, and very different from its mate; lateral and ventral arms are subequal. In both sexes, and even in the young, the suckers along the middle of the four lateral and two ventral arms are distinctly larger than the rest, but in the larger males this disparity becomes very remarkable, the middle suckers (Plate XXXIII, figs. 1, 1*a*, 1*b*, 3) becoming greatly enlarged and swollen, so that eight to ten of the largest are often six or eight times as broad as the proximal and distal ones; they are deep, laterally attached, with a raised band round the middle, and a very small round aperture, furnished with a smooth rim. In the female (Plate XXXIV, fig. 1) the corresponding suckers, on the lateral arms, are about twice as broad as the rest. The suckers are in two regular rows, on the lateral and ventral arms, in both sexes, except at the tip, where they form four rows.

In the male, the left dorsal arm becomes thickened, and larger from front to back, and is usually curled backward (Plate XXXIII, figs. 1–3); its suckers become smaller and much more numerous than on the right arm, being arranged in four crowded rows, except near the base, where there are but two; the sucker-stalks also become stout and cylindrical, or tapered, their diameter equaling that of the suckers. The right arm remains normal, with two alternating rows of suckers, regularly decreasing to the tip, as in both the dorsal arms of the female.

Tentacular arms long, slender, extensible; club distinctly enlarged, usually curled in preserved examples. The suckers on the club are numerous, unequal, arranged in about eight close rows; those forming the two or three rows next the upper margin are much larger than the rest, being three or four times as broad, and have rows of small scale-like denticles around the rims. (Plate XXXIII, figs. 2*a*, 3*a*, 3*b*.)

Pen small and very thin, soft, and delicate. It is angularly pointed or pen-shaped anteriorly, the shaft narrowing backward; a thin lanceolate expansion, or margin, extends along nearly the posterior half (fig. 2*b*).

Upper jaw with a sharp, strongly incurved beak, without a notch at its base. Lower jaw with the tip of the beak strongly incurved, and with a broad, but prominent, rounded lobe on the middle of its cutting edges (fig. 2, *a*, *b*).

Odontophore with simple, acute-triangular median teeth; inner laterals simple, nearly of the same size and shape as the median, except at base; outer laterals much longer, strongly curved forward (fig. 2*c*, 2*d*).

Color, in life, pale and translucent, with scattered rosy chromatophores. In the alcoholic specimens, the general color of body, head, and arms is reddish, thickly spotted with rather large chromatophores, which also exist on the inner surface of the arms between the suckers, and to some extent on the tentacular arms and bases of the fins; outer part of fins translucent white; anterior edge of mantle with a white border.

Length of body 25 to 30 millimeters.

Twenty-seven specimens of this species were obtained, by Mr. A. Agassiz, on the "Blake," in 1880, from six stations, ranging in depth from 71 to 233 fathoms. It was taken, later in the season, in great abundance, by the U. S. Fish Commission, off Newport, R. I., in 65 to 252 fathoms; and off the mouth of Chesapeake Bay, in November, by Lieut. Z. L. Tanner, on the "Fish Hawk," in 18 to 57 fathoms. In 1881 it has also been dredged, at several stations, off Martha's Vineyard, in 45 to 182 fathoms.

It is easily distinguished from the species of *Rossia* by the large size of the suckers along the middle of the lateral arms; by the inequality of the suckers on the tentacular clubs; and by the peculiar hectocotylized condition of the left dorsal arm of the male. The existence of large chromatophores on the inner surfaces of the arms, between the suckers, is also a good diagnostic mark, by which to distinguish it from all our species of *Rossia*, which have the corresponding parts whitish, or with few and very small chromatophores.

The eggs of this species, containing, in several instances, embryos so far developed as to permit accurate identification, have been taken in August and September, by the U. S. Fish Commission, at many of the stations where the adults were obtained. They were especially numerous at stations 865–867, 872–874, in 1880; and at stations 922, 940, 949, in 1881. These eggs are attached to the surface of ascidians, worm-tubes, skate's eggs, dead shells, etc., singly, but placed side by side, in smaller or larger groups. They are about 3^{mm} in diameter, pearly white, and nearly round, but are slightly flattened where attached, and have a small, conical eminence, on the upper side.

Heteroteuthis tenera.—Specimens examined.

No.	Station.	Locality.	Fath.	When received.	Specimens, number and sex.
		United States Fish Commission. Off Martha's Vineyard.		1880.	
	865	North latitude 40° 05′, west longitude 70° 23′	65	Sept. 4	3 ♂ : 7 ♀ : eggs.
	866	North latitude 40° 05′ 18″, west longitude 70° 22′ 18″.	65	Sept. 4	3 ♂ : 6 ♀ : eggs.
	867	North latitude 40° 05′ 42″, west longitude 70° 22′ 06″.	64	Sept. 4	4 ♂ : 10 ♀ : eggs.
	869	North latitude 40° 02′ 18″, west longitude 70° 23′ 06″.	192	Sept. 4	20 + ♂ & ♀
	870	North latitude 40° 02′ 36″, west longitude 70° 22′ 58″.	155	Sept. 4	15 ♂ : 17 ♀
	871	North latitude 40° 02′ 54″, west longitude 70° 23″ 40″.	115	Sept. 4	18 ♂ : 11 ♀ : 32 juv.
	872	North latitude 40° 05′ 39″, west longitude 70° 23′ 52″.	86	Sept. 4	1 ♂ : 2 ♀ : eggs.
		Off Newport, R. I.		1880.	
	873	North latitude 40° 02′, west longitude 70° 57′	100	Sept. 13	5 ♂ : 1 ♀ : eggs.
	874	North latitude 40° 00′, west longitude 70° 57′	85	Sept. 13	10 ♂ : 6 ♀ : eggs.
	875	North latitude 39° 57′, west longitude 70° 57′ 30″	126	Sept. 13	1 ♂
	876	North latitude 39° 57′, west longitude 70° 56′	120	Sept. 13	8 ♂ : 6 ♀
	877	North latitude 39° 56′, west longitude 70° 54′ 18″	126	Sept. 13	6 ♂ : 4 ♀
	878	North latitude 39° 55′, west longitude 70° 54′ 15″	142½	Sept. 13	1 ♂ : 1 ♀
	879	North latitude 39° 49′ 30″, west longitude 70° 54′	225	Sept. 13	6
	880	North latitude 39° 48′ 30″, west longitude 70° 54′	252	Sept. 13	2 ♂
		Off Chesapeake Bay.			
	899	North latitude 37° 22′, west longitude 74° 29′	57½	Nov. 16	3 ♂ : 2 ♀
	900	North latitude 37° 19′, west longitude 74° 41′	31	Nov. 16	1 juv.
	901	North latitude 37° 10′, west longitude 75° 08′	18	Nov. 16	21 ♂ : 3 ♀
		Blake Expedition, U. S. Coast Survey.			
17, 18	313	Off Charleston, S. C	75	1880	7 ♂ : 5 ♀
19	314	North latitude 32° 24′, west longitude 78° 44′	142	1880	2 ♂ : 1 ♀
20	316	North latitude 32° 7′, west longitude 78° 37′ 30″	229	1880	1 ♀ juv.
21	321	North latitude 32° 43′ 25″, west longitude 77° 20′ 30″.	233	1880	5 ♀
22	327	North latitude 34° 00′ 30″, west longitude 76° 10′ 30″	178	1880	1 ♂ : 3 ♀
23	345	North latitude 40° 10′ 15, west longitude 70° 4′ 30″	71	1880	2 ♀ juv.
		United States Fish Commission. Off Martha's Vineyard.		1881.	
	918	S. ½ W. 61 m. from Gay Head	45	July 16	1 ♂ : 1 ♀
	919	S. ½ W. 65 m. from Gay Head	51½	July 16	4 ♂
	920	S. ½ W. 68½ m. from Gay Head	61	July 16	3 ♂ : 5 ♀
	921	S. ½ W. 73 m. from Gay Head	65	July 16	6 ♂ : 6 ♀
	922	S. ½ W. 77 m. from Gay Head	69	July 16	1 ♀ : eggs.
	940	S. by E. ½ E. 97 m. from Gay Head	130	Aug. 4	1 ♀ : eggs.
	944	SSW. 82 m. from Gay Head	124	Aug. 9	1 ♂ : 1 ♀
	949	S. 79½ m. from Gay Head	100	Aug. 23	1: eggs.
	950	S. 75 m. from Gay Head	69	Aug. 23	1 ♂ : 2 ♀
	1026	SSW. ¾ W. 93½ m. from Gay Head	182	Sept. 8	1 ♂
	1027	SSE. ¾ E. 105½ m. from Gay Head	93	Sept. 14	1 ♂
	1038	North latitude 39° 59′, west longitude 70° 06′	146	Sept. 21	5 ♂ : 3 ♀
	1043	Off Delaware Bay	130	Oct. 10	1 ♂

ORDER II.—OCTOPODA Leach.

Cephalopoda octopoda Leach, Zool. Miscel., iii, 1817 (t. Gray).
Férussac, Tab. Syst., p. 18, 1821.
D'Orbigny, Tab. Méthod., p. 45, 1825; D'Orbig., Céphal. Acétab., p. 1.
Octocera Blainv., Dict. Sci. Nat., xxxii, 1824.
Octopia Gray, Cat. Moll. Brit. Mus., i, p. 3, 1849.

Arms eight, similar, all furnished with suckers in one or two rows; often more or less united by a web; natatory crests wanting. Suckers sessile, not oblique, destitute of horny rings or hoops. No tentacular arms. Head often larger than the body. Body short and thick, obtuse posteriorly, usually destitute of fins. Fins, when present, small, lateral, supported by an internal transverse cartilage. Mantle extensively united to the head by a dorsal commissure. Siphon without an internal valve, united directly to the head. No olfactory crests. Eyes united to the internal lining of the sockets so as to be immovable; usually furnished with lids. No outer buccal membrane. Aquiferous pores and cavities usually absent; cephalic pores sometimes present. Internal longitudinal shell or pen absent. An external shell is present only in the genus Argonauta. In this case it is formed as a secretion from the inner surface of the expanded distal portion of the two dorsal arms of the female only, and serves mainly as a receptacle for the eggs. One of the arms of the third pair, commonly the right, is hectocotylized in the male. Sometimes the entire arm is modified and sometimes the tip only.

FAMILY PHILONEXIDÆ D'Orbigny.

Philonexidæ (pars) D'Orbig., Moll. Viv. et Fos., i, 199, 1845 (t. Gray).
Gray, Catal. Moll. Brit. Mus., i, p. 24, 1849.

Body stout, oval, destitute of lateral fins. Branchial opening large. Edge of mantle united to the base of the siphon laterally by a complicated, prominent cartilage or button, fitting in a corresponding pit on the inner surface of the mantle. Dorsal commissure narrow. Head with aquiferous pores communicating with large aquiferous cavities. Arms simple, more or less united by webs. Suckers prominent.

In the male, the hectocotylized arm is developed in a sac, the entire arm being modified, and usually, when perfected, it becomes detached from the body. Probably this arm is lost and regenerated each year.

PARASIRA Steenstrup.

Parasira Steenstrup, Vidensk. Meddel. naturh. Forening, Kjöbenhavn, 1860, p. 333.
Kefferstein, in Bronn, Thier-Reich, iii, p. 1449, 1866.
Tryon, Man. Conch., i, p. 104. Verrill, Trans. Conn. Acad., v, p. 361.

Body short, thick, pouch-like, usually ornamented with raised ridges. Mantle united directly to the head dorsally; connected laterally to the base of the siphon by a deep pit and a raised, cartilaginous tubercle on each side, which fits a corresponding cartilaginous tubercle and pit, near the base of the siphon (something as a button fits into a button-hole), so that it can be separated only by using considerable force. Arms long, slender; web rudimentary. Suckers prominent, in two alternating rows. Gill-opening wide. Siphon large, intimately united to the head except at its free extremity, which is situated far forward, between the ventral arms. A large aquiferous pore, each side of the siphon, at the bases of the ventral arms.

Sexes are widely different. The hectocotylized, third right arm of the male is developed in a pedunculated sac.

Parasira catenulata Steenstrup.

Octopus tuberculatus Risso(?), Hist. nat. de l'Eur. mérid., iv, p. 3, 1826 (t. d'Orbig.).
Octopus catenulatus Férussac, Poulpes, pl. 6, bis, ter., 1828 (t. D'Orbig.).
Philonexis tuberculatus Fér. and D'Orbig., Céph. Acétab., p. 87, pl. 6, bis, ter.
Parasira catenulata Steenstrup, Vidensk. Meddel. naturh. Forening, Kjöbenhavn, 1860, p. 333.
Verrill, Amer. Journ. Sci., xix, p. 293, Apr., 1880; Trans. Conn. Acad., v, p. 362, pl. 33, figs. 2, 2*a*, 1881.

Plate XL, figures 2, 2*a*.

Female: Body relatively large, swollen, rather higher than broad, dilated below, larger in front, obtusely rounded posteriorly; upper surface smooth or finely wrinkled; lower surface covered with prominent, rounded verrucæ, or small hard tubercles, which are connected together by raised ridges, five (sometimes six) of which usually run to each tubercle, thus circumscribing angular depressed areas, each of which usually has a dark-colored spot in the center; on the sides these tubercles are less prominent and less regular, gradually fading out above. The head is decidedly smaller than the body, and smooth both above and below. The eyes are prominent, but the external opening is small, round, with simple border. The gill-opening is large, and extends upward on the sides of the neck to the level of the upper side of the eyeballs. The siphon-tube is completely united by its basal portion to the lower side of the head; its free portion is large and elongated, starting from well forward, between the bases of the ventral arms. There is a conspicuous aquiferous pore, at each side of the base of the siphon, just back of the ventral arms. The arms are stout, not very long; the inner surface is broad, with two rows of rather widely separated suckers, which run along the margins of the arms; the suckers are rather large, and considerably raised, on stout bases; the first suckers form a regular circle around the mouth; two or three basal suckers are nearly in a single row. The suckers are cup-shaped, with a deep central pit, around which there are strong radial ridges; toward the base of the arms the soft, swollen rims of the suckers are wrinkled and lobulated; farther out they are smooth and even. The beak is black, with sharp tips. It is surrounded by a thick, wrinkled buccal membrane.

The arms are slightly united at base by a narrow web, which also runs along each of the outer angles of the six upper arms, forming more or less wide marginal membranes, according to the state of contraction, and by their contractions causing the arms to curl in various directions; one of these membranes frequently disappears, the other being so stretched as to become wide, when the arm is strongly recurved; on the ventral arms the upper membrane becomes strongly developed, while the lower one is abortive. There is also a slight marginal membrane along the inner margins, running between the suckers and connecting them together. The dorsal and ventral arms are considerably larger and longer than the two lateral pairs, the dorsal ones are the stoutest. The two lateral pairs are about equal in size and length. On the dorsal arms there are about 96 suckers; on the lateral ones about 80 that can be counted with the naked eye. The tips are very slender and covered with very minute suckers.

Color of body and head above, and of upper arms, deep brownish purple; lower surfaces of body and head with siphon and ventral arms, pale yellowish.

A fine specimen of this interesting species was taken in Vineyard Sound, Mass., by Mr. V. N. Edwards, in 1876. It was not known previously from the American coast, and has been regarded as peculiar to the Mediterranean and West Indies. The total length of this specimen is 203 millimeters; of mantle, 51 millimeters; circumference of body, 152 millimeters; length of dorsal arms, from eye, 137 millimeters; second pair, 94 millimeters; of third pair, 84 millimeters; of fourth pair, 134.5 millimeters.

The remarkable tubercles of the ventral surface mostly have five ridges converging to each, rarely six. In all other respects it agrees with the figures of Férussac and D'Orbigny. According to Targioni-Tozzetti, *P. catenulata* is distinct from *P. tuberculata*. If so, our species should bear the former name. Steenstrup considers *Octopus carena* Ver., the male.

FAMILY ALLOPOSIDÆ Verrill.

Trans. Conn. Acad., v, p. 365, 1881.

Body thick, obtusely rounded; arms extensively webbed; mantle united directly to the head, not only by a large dorsal commissure, but also by a median-ventral and two lateral longitudinal commissures, which run from its inner surface to the basal parts of the siphon. The male hectocotylized right arm of the third pair is developed in a cavity in front of the right eye, and when mature, protrudes from an opening on the inner surface of the web, between the second and fourth pairs of arms, and finally becomes detached. It is furnished with two rows of large suckers, and with a fringe along the sides. The mode of attachment of the mantle to the head is similar to that of *Desmoteuthis*, among the ten-armed cephalopods.

ALLOPOSUS Verrill.

Alloposus Verrill, Amer. Journ. Sci., xx, p. 393, Nov., 1880; Proc. Nat. Mus., iii, p. 362, Dec., 1880; Bulletin Mus. Comp. Zool., viii, p. 112, March, 1881; Trans. Conn. Acad., v, p. 365.

Allied in some respects to *Philonexis* and *Tremoctopus*. Body thick and soft, smooth; arms (in the male only seven) united by a web extending nearly to the ends. Suckers sessile, simple, in two rows; mantle united firmly to the head by a dorsal, ventral, and two lateral muscular commissures, the former placed in the median line, at the base of the siphon; free end of the siphon short, well forward.

In the male, the hectocotylized right arm of the third pair is developed in a sac in front of the right eye (Plate XXXIX, figs. 1, 1*a*); as found in the sac, it is curled up, and has two rows of suckers; the groove along its edge is fringed; near the end, the groove connects with a rounded, obliquely placed, broad, flat or slightly concave lateral lobe, with transverse wrinkles or plications on the inner surface; the terminal portion of the arm is a long-fusiform, smooth process.

The permanent attachment of the mantle to the siphon, by means of commissures, is a very distinctive character.

Alloposus mollis Verrill.—Webbed devil-fish.

Alloposus mollis Verrill, Amer. Journ. Sci., xx, p. 394, Nov., 1880; Proc. Nat. Mus., iii, p. 363, 1880; Trans. Conn. Acad., v, p. 366, pl. 50, figs. 1, 1*a*, 2, 2*a*; pl. 51, figs. 3, 4; Bulletin Mus. Comp. Zool., viii, p. 113, pl. 4, figs. 3, 4; pl. 8, figs. 1–2*a*, March, 1881.

Octopus?, sp., Verrill, Bulletin Mus. Comp. Zool., p. 109, pl. 4, fig. 3, 1881.

Plate XXXIX, figs. 1, 1*a*, 2, 2*a*. Plate XLII, fig. 7. Plate XLIV, fig. 1.

Body stout, ovate, very soft and flabby. Head large, as broad as the body; eyes large, their openings small. Arms rather stout, not very long, webbed nearly to the ends, the dorsal much longer than the ventral arms; suckers large, simple, in two alternating rows. Color deep purplish brown, with a more or less distinctly spotted appearance. Total length of a medium-sized specimen, 160^{mm}; of body, to base of arms, 90^{mm}; of mantle, beneath, 50^{mm}; of dorsal arms, 70^{mm}; breadth of body, 70^{mm}. Other specimens are very much larger.

This season two very large females, nearly equal in size, were taken: one at station 937, in 506 fathoms; the other at 994, in 368 fathoms. The former weighed over 20 pounds. Length, while fresh, posterior end of body to tip of 1st pair of arms, 787^{mm} (31 inches); of 2d pair, 812^{mm} (32 inches); of 3d pair, 711^{mm} (28 inches); of 4th pair, 711^{mm} (28 inches); length of mantle, beneath, 178^{mm} (7 inches); beak to end of 4th pair of arms, 559^{mm} (22 inches); breadth of body, 216^{mm} (8.5 inches); breadth of head, 280^{mm} (11 inches); diameter of eye, 64^{mm} (2.5 inches); of largest suckers, 10^{mm} (.38 of an inch). The body was remarkably soft and gelatinous in appearance, and to the touch, while living. In fact it did not have sufficient firmness to retain its natural shape when out of water, and when placed in a large pan it accommodated itself to the shape of the vessel, like a mass of stiff jelly. Color, in life, pale bluish white specked with rusty orange-brown chromatophores; inner surface of arms dark purplish brown, suckers white.

One mature, detached, hectocotylized arm (Plate XLIV, fig. 1) was taken November 16. This has two rows of large, six- or seven-lobed suckers, a very long fringe, composed of thin, flat, lacerate processes, along each side; the terminal process is fusiform, acute, and loosely covered with a thin, translucent membrane, beneath which the inner surface, bearing chromatophores, can be seen. Length of this arm, 200^{mm}; its breadth, 20^{mm}; length of terminal process, 30^{mm}; its diameter, 7^{mm}; diameter of largest suckers, 6^{mm}; length of fringe, 15^{mm}.

Two detached and somewhat mutilated arms, with portions of a third arm and of the basal web, of a large Octopod, probably of this species, were taken by Mr. Agassiz in 1880, at station 336, north latitude, 38° 21′ 50″, west longitude, 73° 32′, in 197 fathoms. (Plate XLII, fig. 7.)

The largest of these arms is 420mm long and 36mm broad. The suckers are large, prominent, subglobular, with a contracted aperture, and have a thin membrane around the outer margin. They form two alternating, rather distant rows, except near the base, where several that are somewhat smaller than those farther out stand nearly in one row, with wide spaces between them. Diameter of largest suckers, 9 to 11mm; distance between their centers, 20 to 35mm. Color, dark purple.

Taken by the "Fish Hawk," at stations 880, 892, 893, 895, about 100 to 115 miles south of Newport, R. I., in 225 to 487 fathoms, Sept. and Oct., 1880; off the mouth of Chesapeake Bay, at station 898, November 16, 1880, in 300 fathoms, by Lieut. Z. L. Tanner; and off Martha's Vineyard, 310-715 fathoms, 1881.

Alloposus mollis.—Specimens examined.

Station.	Locality.	Fath.	When received.	Received from.	Specimens.
	Off Newport, R. I.				
	N. lat. *W. long.*				
880	39° 48′ 30″ 70° 50′ 00″	252	Sept. 13, 1880	U. S. Fish Com.	2 ♂ : 1 ♀
881	Farther southward	325	Sept. 13, 1880	......do	1
892	39° 46′ 00″ 71° 05′ 00″	487	Oct. 2, 1880	......do	1
893	39° 52′ 20″ 70° 58′ 00″	372	Oct. 2, 1880	......do	2
895	39° 56′ 30″ 70° 59′ 45″	238	Oct. 2, 1880	......do	1
	Off Chesapeake Bay.				
898	37° 24′ 00″ 74° 17′ 00″	300	Nov. 16, 1880	......do	4
	Off Delaware Bay.				
336	38° 21′ 50″ 73° 32′	197	——, 1880	"Blake" expedition	1 l. frag.
	Off Martha's Vineyard.				
937	S. by E. ½ E. 102 m. from Gay Head.	506	Aug. 4, 1881	U. S. Fish Com.	1 l. ♀
938	S. by E. ⅜ E. 100 m. from Gay Head.	310	Aug. 4, 1881	......do	1 j.
952	S. ¼ E. 87½ m. from Gay Head	388	Aug. 23, 1881	......do	1 j.
953	S. ⅛ E. 91½ m. from Gay Head	715	Aug. 23, 1881	......do	1 j. ♀
994	SSW. ¼ W. 104½ m. from Gay Head.	368	Sept. 8, 1881	......do	1 l. ♀

FAMILY ARGONAUTIDÆ Cantr.

Cantraine, Mall. Médit., p. 13, 1841; H. & A. Adams, Genera, vol. i, p. 23.

Argonauta argo Linné.

Shells of this species, some of them entire, were taken by the "Fish Hawk" at several of the stations 70 to 115 miles south of Martha's Vineyard and Newport, R. I., in 64 to 365 fathoms. At least nine specimens were dredged. At station 894, in 365 fathoms, two entire and nearly fresh shells were taken, and another nearly complete. They belong to the common Mediterranean variety. Fragments were also taken at stations 865–7, 871, 873, 876, 892, 895.

The capture of a living specimen, probably of this species, on the coast of New Jersey, has been recorded by Rev. Samuel Lockwood, in Amer. Naturalist, xi, p. 243, 1877.

FAMILY OCTOPODIDÆ D'Orbigny.

Octopodidæ (*pars*) D'Orbigny, Moll. Viv. et Fos., i, pp. 159, 164, 1845 (t. Gray); (*pars*) Céphal. Acétab., p. 3.
Octopidæ Gray, Catal. Moll. Brit. Mus., i, p. 4, 1849.

Head very large; external ears, small, simple openings, behind the eyes. Body short, thick, rounded posteriorly, destitute of lateral fins and internal cartilages. Mantle united to the head by a broad dorsal commissure. No complex connective cartilages, nor commissures, uniting the mantle and base of siphon. Opening to gill-cavity narrow.

Siphon large. Arms with either one or two rows of suckers, and with a more or less developed basal web. Eyes furnished with an internal translucent lid and also capable of being covered by the external integument. Sexes similar externally, except that in the male the right arm of the third pair is hectocotylized by the formation of a spoon-shaped organ at the tip.

ELEDONE Leach.

Octopus (*pars*) Lamarck; Cuvier; Blainville, etc.
Eledone Leach, Zool. Misc., iii, 137, 1817 (t. Gray); D'Orbig., Céphal. Acétab., p. 72 (subgenus); Gray, Catal. Moll. Brit. Mus., i, p. 21, 1849.

Body, mantle, and siphon as in *Octopus*. Suckers in a single row on all the arms. In the male the right arm of the third pair is hectocotylized by the formation of a small spoon-shaped tip and a lateral groove, nearly as in some species of *Octopus*.

Eledone verrucosa Verrill.

Bulletin Mus. Comp. Zool., viii, p. 105, plates 5, 6, March, 1881; Trans. Conn. Acad., v, p. 380, pl. 52, 53, 1881.

Plate XLIV, figs. 3, 3*a*.

A stout species, covered above with prominent, rough, wart-like tubercles, and with a circle of the same around the eyes; four or five of those above the eyes are larger and more prominent. Body thick, broad-ovate, swollen beneath, moderately convex above, obtusely rounded posteriorly.

Male: Head as broad as the body, whole upper surface of body and head to base of arms covered with prominent and persistent, unequal warts, which are roughened by sharp conical papillæ, eight or ten on the larger warts, but only two or three on the smaller ones; the warts diminish in size anteriorly, and on the sides, before they disappear; around the eyes they form irregular circles; just above each of the eyes there are two much larger ones, bearing more than twenty conical papillæ; there is one before and one behind these, of somewhat smaller size. Eyes large, the lower lid purple and thickened, overlapping the upper one, which is thin and whitish.

Arms considerably longer than the head and body, not very stout, compressed, bearing a single crowded row of large whitish suckers, which are mostly separated by spaces less than half their diameter; margins of suckers soft and much thickened. The three lower pairs of arms are very nearly equal in length and size; the dorsal ones are a little shorter and smaller. A thin web unites all the arms for about one-fourth of their length, and runs up along their sides for about half their length. The male has the third right arm (Plate XLIV, fig. 3, 3*a*) hectocotylized at the tip; the modified tip is preceded by 45 suckers, and is bordered ventrally by a broad membrane, having a white groove along its inner surface; the terminal organ (fig. 3*a*) consists of a small, ovate-triangular, fleshy disk, with its inner surface slightly concave and finely wrinkled transversely, and terminating proximally in a small point.

Color dark purplish brown, darker purple beneath. Chromatophores small and densely crowded.

The female is considerably larger than the male, and has the warts over the back and around the eyes relatively smaller, but of the same character. The arms appear to be larger than those of the male, but this is probably due to the fact that the male has become more contracted by the stronger alcohol in which it was placed.

This female specimen illustrates well the uselessness of the attempts to divide the species of *Octopus* and allied genera into groups or sections according to the relative lengths of the arms, as J. E. Gray and others have done, for in this and many other cases the proportions of the arms of the right side would throw it into one section; those of the left side into another. The male would have to be put into a third section.

The two known examples of this species were both taken by Mr. A. Agassiz, while dredging on the United States Coast Survey steamer "Blake," in 1880.

Measurements in millimeters.

	No. 12. Male.	No. 13. Female.	
		Right side.	Left side.
Total length	202	360	....
End of body to center of eye	58	100	....
Breadth of body	55	65	....
Breadth across eyes	49	....	....
Length of dorsal arms, from mouth	135	255	260
Length of second pair of arms	155	260	235
Length of third pair of arms	....	225	240
Length of hectocotylized arm	130	....	....
Length of modified tip	4.5	....	....
Length of ventral arms	145	210	225
Greatest breadth of lateral arms	12	18	18
Diameter of largest suckers	3	5	5

Specimens examined.

No.	Stat.	Locality.	Fath.	When received.	Specimens.	
					No.	Sex.
12	305	N. lat. 41° 33′ 15″; W. long. 65° 51′ 25″	810	1880	1	♂
13	312	N. lat. 39° 50′ 45″; W. long. 70° 11′	466	1880	1	♀

OCTOPUS Lamarck, 1799.

Octopus (*pars*) Lamarck, Syst. des Anim. sans Vert., p. 60, 1801. Cuvier, Rég. Anim., ii, 1817. D'Orbigny, Céphal. Acétab., p. 3. Gray, Catal. Moll. Brit. Mus., i, p. 4, 1849. Verrill, Trans. Conn. Acad., v, p. 367, 1881.

Body short, thick, more or less rounded, usually flattened, often tubercular or warty, but sometimes smooth, usually with one or more tubercles or cirri situated above the eye. Mantle directly united to the head, dorsally, by a broad commissure, extending below the eyes to the base of the siphon. Base of the siphon without any complicated, connective cartilages. Arms united by a more or less extensive basal web. Suckers sessile, in two alternating rows. Siphon not intimately united to the whole length of the head, the free terminal portion situated behind or beneath the eyes. No aquiferous pores nor brachial pouches.

The sexes are similar in form. In the male the right arm of the third pair is hectocotylized, its terminal portion being changed into a spoon-shaped organ, smooth on the outer, convex side and furnished with a series of transverse ridges on the inner concave side, and with a basal angular lobe, from which a groove or furrow extends along the lower margin of the arm to the basal web. In some species of *Octopus* the modified tip is very small, but in others, very large.

The female has the oviducts symmetrically developed on both sides. The egg-sacs are large, pyriform, not very numerous, attached by the small end.

Octopus Bairdii Verrill.—Baird's devil-fish.

Octopus Bairdii Verrill, Amer. Journ. Sci., v, p. 5, Jan., 1873; xix, p. 294, 1880; American Naturalist, vii, p. 394, figs. 76, 77, 1873; Am. Assoc. Adv. Sci. for 1873, p. 348, pl. 1, figs. 1, 2, 1874.

G. O. Sars, Mollusca Regionis Arcticæ Norvegiæ, p. 339, pl. 33, figs. 1–10 (♀), pl. xvii, figs. 8*a* to 8*d* (dentition and jaws), 1878.

Tryon, Man. Conch., i, p. 116, pl. 32, figs. 37, 38 (description and figures from the papers by A. E. V.).

Verrill, Trans. Conn. Acad., v, p. 368, pl. 33, figs. 1, 1*a*; pl. 34, figs. 5, 6; pl. 36, fig. 10; pl. 38, fig. 8; pl. 49, figs. 4, 4*a*; pl. 51, figs. 1, 1*a*; Bulletin Mus. Comp. Zool., viii, p. 107, pl. 2, figs. 4, 4*a*; pl. 4, figs. 1, 1*a*, 1881.

Plate XLI, figures 1, 2, 3, 3*a*. Plate XLII, figures 1–5.

The body is short, thick, somewhat depressed, broadly rounded posteriorly, separated from the head only by a slight constriction at the sides. Head almost as broad as the body, swollen above and around the eyes, concave in the middle above; around the eyes, and especially in front and above, there are numerous small, conical, often irregular and rough tubercles; a little removed from the upper side of each eye is a much larger, rough, irregularly conical, erectile cirrus, which has some small, more or less prominent, conical papillæ on its surface; the whole upper surface of the body, head, and arms is also covered with minute scattered papillæ, which are usually but little prominent, but in some of the larger males they become much larger and more numerous, and have the form of small prominent warts.

The jaws (Plate XLII, fig. 3) have rather blunt, slightly incurved tips, with the angle at the bases of the cutting edges round and without any distinct notch. The odontophore (Plate XLII, fig. 4) has a median row of large, acute teeth with broad bases, without lateral denticles; the inner lateral teeth are much smaller, with curved, acute-triangular points; outer lateral teeth longer and more acute; marginal plates large and distinct.

Siphon large, tapering, capable of being bent in all directions, so as to be used for swimming either forward, backward, or sideways, according to its direction.

Arms subequal, relatively short, stout, tapering to slender points, connected for about one-third of their length by a web, which extends as a narrow membrane along their margins to near the ends. Suckers small, not crowded, alternating pretty regularly in the two rows; in the original type-specimen, which was not full-grown, the arms of the first pair each had about sixty-five suckers; those of the fourth pair about sixty. In a larger example (♀) the dorsal arms have about 94 suckers; the third pair about 100; the ventral ones about 90.

In the male, the right arm of the third pair has its terminal portion, for about a third of its entire length, modified for reproductive purposes into a large spoon-shaped organ (Plate XLI, fig. 1*a*), broadly elliptical in outline, with the sides incurved, and the end somewhat trilobed; interior deeply concave, with ten to twelve, and occasionally, in the largest examples, thirteen elevated transverse folds; at the base, there is a fold bent into an acute angle, the apex directed forward, leaving a deep V-shaped sinus behind it, which is a continuation of a shallow groove, formed by a thickening of the web along the lower side of the arm, and terminating midway between it and the fourth arm. At the end, the arm terminates in a small conical tip, between the two broadly rounded lobes of the spoon-shaped organ; at the base of this organ there is a slight constriction; the basal portion of the arm bears 30 to 37 suckers, like those on the other arms. The modified portion of the arm is considerably longer than the distance between the constriction at its base and the interbrachial web, and about equal to one-half the total length of the part which bears suckers. The corresponding arm on the left side is of the ordinary form, and has, in medium-sized examples, about 51 suckers.

The female differs but little from the male, externally, except in lacking the modification of the third right arm.

Some of the larger females were filled with mature eggs. These are large and rather numerous, occupying a large part of the interior of the body. They are enclosed in long-pyriform sacs, with the small end tapering to a filiform point, by which they adhere.

Length of the original male specimen, in alcohol, exclusive of the arms, 44^{mm}; breadth of the body, 31^{mm}; between eyes, 18^{mm}; length of arm, of the first pair, from mouth, 57^{mm}; from mouth to edge of web, 18^{mm}; length of modified portion of third right arm, 18^{mm}; breadth of this organ, when expanded, 11.5^{mm}. Subsequently, considerably larger specimens, both male and female, have been taken.

One of the largest males (station 878) measures, from tip of dorsal arms to end of body, 163^{mm}; from edge of dorsal web to end of body, 75^{mm}; from edge of mantle beneath, to end of body, 38^{mm}; breadth of body, 48^{mm}: of head, 41^{mm}; length of dorsal arms, to beak, 110^{mm}; of second pair, 112^{mm}: of third pair, 115^{mm}; of fourth pair, 110^{mm}; of hectocotylized arm, 85^{mm}; length of terminal spoon, 33^{mm}; its breadth, 17^{mm}. This specimen has 13 transverse lamellæ in the spoon.

One of the largest females (station 895) taken in the breeding season and filled with eggs, in alcohol, measures, from tip of dorsal arms to end of body, 170^{mm}; edge of dorsal web to end of body, 90^{mm}; mantle, beneath, 46^{mm}; breadth of body, 55^{mm}; of head, 41^{mm}; length of dorsal arms, from beak, 125^{mm}; of second pair, 120^{mm}; of third pair, 115^{mm}; of fourth pair, 115^{mm}.

When living, the ground-color was usually pale, translucent, bluish white above, thickly specked with light orange-brown and dark purplish brown. Its colors were changeable, but apparently less actively so than in the squids.

This species was first discovered by the writer while dredging, in 1872, on the United States Steamer "Mosswood", in the Bay of Fundy, off Eastport, Me., in 75 to 80 fathoms. Although so recently discovered, it proves to have a very extensive range, both geographically and in depth. It is one of the most common and characteristic inhabitants of the bottom, in 100 to 500 fathoms, along our entire coast, from South Carolina to Newfoundland. It was taken in the trawl, by the U. S. Fish Commission, in 1872, 1873, 1874, 1877, 1878, 1879, 1880, and 1881, in depths ranging from 50 to 500 fathoms, at numerous localities, from off Halifax, N. S., and the Bay of Fundy, to the region 90 to 100 miles south of Martha's Vineyard and Newport, R. I., where it is common and of large size. It was obtained by Mr. A. Agassiz, on the "Blake", in 1880, at various stations, from N. lat. 41° 34′ 30″, to 32° 43′ 25″, in 178 to 524 fathoms.

In November, 1880, it was taken by Lieut. Z. L. Tanner, on the "Fish Hawk", off the mouth of Chesapeake Bay, in 157 to 300 fathoms.

The Gloucester fishermen have brought in several specimens from the banks off Nova Scotia and Newfoundland. These were presented by Captain Murphey and crew, of the schooner "Alice M. Williams" (lots 372, 501, 917); by Capt. J. W. Collins and crew, of the "Marion" (lot 264); by Capt. J. F. Critchett and crew, of the "Commonwealth" (lot 421); by Mr. E. Perkins, of the "Grace L. Fears" (lot 351); by Mr. Robert Hurlburt, of the "Barracouta" (lot 605); by Capt. Thomas Olsen and crew, of the "Epes Tarr" (lot 771); and by Capt. J McDonald and crew, of the "G. P. Whitman" (lot 792).

Prof. G. O. Sars has taken it, off the Norwegian coast, in 60 to 300 fathoms.

It occurs both on soft muddy bottoms and on hard bottoms. Both sexes often occur together, but the males are usually the most numerous.

Males, with spermatophores escaping, have been taken, from July 27 to September 21, at stations 138, 161, 163, 223, &c.

One of the specimens obtained by Mr. Agassiz is remarkable for the length and slenderness of the cirrus above the eyes (Plate XLI, fig. 3). This is an immature male, and does not appear to differ in any other way from ordinary specimens, of similar size. The appendage of the hectocotylized arm is small and not fully developed (as is always the case in young males), and has an ovate-triangular form, a slightly concave surface, and only a few transverse lamellæ.

This species resembles *O. lentus*, but has a much larger and rough or lacerate cirrus above the eye. The modified arm of the male is also different.

It is somewhat related to *O. Grœnlandicus* Dewh., but the male of the latter has the third right arm much longer, with the modified spoon-shaped portion relatively very much smaller and quite different in form, and with more numerous folds, and the basal part bears 41 to 43 suckers; the other arms also have more numerous suckers; the web is less extensive and the body is more elongated, and appears to be smooth, and destitute of the large cirri above the eyes.

O. obesus has the spoon-shaped part of the third right arm relatively larger, and several of the basal suckers of the other arms in a single row. It also differs in other respects.

Specimens of this species were kept alive for several days, in order to observe its habits. Several characteristic drawings, some of which are here reproduced (Plate XLI, fig. 2; Pl. XLII, figs. 1, 2), were made from life by Mr. J. H. Emerton, showing its different attitudes.

When at rest it remained at the bottom of the vessel, adhering firmly by some of the basal suckers of its arms, while the outer portions of the arms were curled back in various positions; the body was held in a nearly horizontal position, and the eyes were usually half-closed and had a sleepy look; the siphon was usually turned to one side, and was long enough to be seen in a view from above.

When disturbed, or in any way excited, the eyes opened more widely, especially at night; the body became more contracted and rounded, and was held more erect; the small tubercles over its surface and the larger ones above the eyes were erected, giving it a very decided appearance of excitement and watchfulness.

It was rarely, if ever, observed actually to creep about by means of its arms and suckers, but it would swim readily and actively, circling around the pans or jars, in which it was kept, many times before resting again.

In swimming backward the partial web connecting the arms together was used as an organ of locomotion, as well as the siphon; the web and the arms were alternately spread and closed, the closing being done energetically and coincidently with the ejection of the water from the siphon, and the arms, after each contraction, were all held pointing straight forward in a compact bundle, so as to afford the least resistance to the motion (Plate XLI, fig. 2). As the motion resulting from each impulse began to diminish sensibly, the arms were again spread and the same actions repeated. This action of the arms and web recalled that of the disk of the jelly-fishes, but it was much more energetic.

The siphon was bent in different directions to alter the direction of the motions, and by bending it to the right or left side, backward motions in oblique or circular directions were given, but it was often bent directly downward and curved backward, so that the jet of water from it served to propel the animal directly forward. This, so far as observed, was its only mode of moving forward. The same mode of swimming forward has previously been observed in cuttle-fishes (*Sepia*) and in squids (*Loligo*).

This species was much more active and animated in the night than during the day. It is probably largely nocturnal in its habits, when at liberty. None of the specimens could be induced to take food, and none survived more than four or five days, although the water was frequently renewed to keep it cool and pure. They had been rather roughly handled by the dredges and trawls, without doubt; but the unavoidable exposure to the higher temperature of the water, near and at the surface, especially in summer, is sufficient to kill many of the deep-water animals, while others that live for a short time never entirely recover from the injury thus received.

Octopus Bairdii.—Specimens examined.

No.	Locality.	Fathoms.	Bottom.	When collected.	Specimens.
	United States Fish Commission.				
					Number and sex.
	Bay of Fundy	75		1872	1 ♂ : 1 j. ♂ : 1 j. ♀
	do	80		1872	1 l. ♂
	do	60		1872	1 ♂
	Off Grand Menan Island	97–110	Gravel	1872	1 j. ♂
	Casco Bay	64		1873	1 med.
				1877	
32	Gulf of Maine	90	Mud	Aug. 14	1 l. ♂ (fig'd).
32	do	90	do	Aug. 14	2 l. ♂ : 2 m. ♂
45	Off Cape Sable	91	Fine sand	Aug. 21	1 l. ♂ : 4 j. ♂ : 4 j. ♀
85–86	Off Halifax	101	do	Sept. 6	4 ♂ : 4 ♀
	Gulf of Maine and Massachusetts Bay.				
				1878.	
130	Off Gloucester, Mass	49	Mud	July 23	1 ♂
138	Off Cape Ann	59	Muddy	July 29	1 j. ♂ : 2 l. ♂ : 2 ♀
156	do	42	Mud	Aug. 15	1 j.
161	do	54	Sand	Aug. 16	1 l. ♂ : 1 j. ♂ : 1 j. ♀
163	do	73	Fine sand	Aug. 16	5 j. ♂ : 3 l. ♂ : 1 j. ♀
164	do	75	do	Aug. 16	2 ♂ : 3 j. ♂ : 2 l. ♀ : 3 j. ♀
182	South of Cape Ann			Aug. 29	4 j. ♀
184	Off Gloucester, Mass	45	Muddy	Aug. 29	3 j. ♀ : 1 j. ♂
199	Off Cape Ann	58	Mud	Sept. 2	1 j. ♂ : 2 l. ♂ : 1 l. ♀ : 2 j. ♀
207	Off Gloucester, Mass	42	Soft mud	Sept. 16	1 j. ♂
211	Off Cape Ann	60	Mud	Sept. 17	4 j. ♂ : 2 j ♀ : 1 ♀
213	do	68	do	Sept. 17	1 l. ♂

Octopus Bairdii—Continued.

No.	Locality.	Fathoms.	Bottom.	When collected.	Specimens.
	Gulf of Maine and Massachusetts Bay—Continued.				
				1878.	
214	Off Cape Ann	57	Fine sand	Sept. 17	1 m. ♀
223	......do	47	Soft mud	Sept. 21	2 ♂ : 1 ♀ : 1 l. ♀
233	South of Cape Ann	45	....do	Sept. 24	1 j. ♂
234	......do	43	....do	Sept. 24	2 j. ♂ : 1 j. ♀
238	Off Cape Ann	43	....do	Sept. 26	2 ♀
				1879.	
264	Off Cape Cod	80	Mud	July 29	2 j. ♂ : 1 j. ♀ : 1 l. ♀
342	......do	94	....do	Sept. 10	2 m. ♂ : 1 j. ♀
364	......do	70	Hard sand	Sept. 18	3 l. ♂ : 2 j. ♂ : 2 l. ♀
372	Off Chatham, Mass	70	Sand	Sept. 19	1 l. ♀
	Off Newport, R. I.				
	N. lat. W. long.			1880.	
869	40° 02′ 18″; 70° 23′ 06″	192	Mud and sand	Sept. 4	1 l. ♀ : 3 j. ♀
870	40° 02′ 36″; 70° 22′ 58″	155	Fine sand	Sept. 4	1 l. ♂ : 3 j.
874	40° 00′ 00″; 70° 57′ 00″	85	Mud	Sept. 13	1
878	39° 55′ 00″; 70° 54′ 15″	142½	....do	Sept. 13	1 l. ♂
879	39° 49′ 30″; 70° 54′ 00″	225	Fine sand	Sept. 13	1 ♂ : 1 ♀
880	39° 48′ 30″; 70° 54′ 00″	252½	Mud	Sept. 13	1 ♂ : 1 ♀
892	39° 46′ 00″; 71° 05′ 00″	487	....do	Oct. 2	1 l. ♀
893	39° 52′ 20″; 70° 58′ 00″	372	....do	Oct. 2	2 ♂ : 2 ♀
894	39° 53′ 00″; 70° 58′ 30″	365	Sand	Oct. 2	3 l. ♂ : 3 ♀
895	39° 56′ 30″; 70° 59′ 45″	238	Mud	Oct. 2	2 l. ♂ : 2 l. ♀
	Off Chesapeake Bay.				
	N. lat. W. long.				
897	37° 25′ 00″; 74° 18′ 00″	157½	Sand	Nov. 16	1 l. ♂
898	37° 24′ 00″; 74° 17′ 00″	300	Mud	Nov. 16	2 ♂ : 4 ♀
	Blake Expedition, United States Coast Survey.				
	N. lat. W. long.				
303	41° 34′ 30″; 65° 54′ 30″	306		1880	1 ♂ (fig'd).
332	35° 45′ 30″; 74° 00′ 48″	263		1880	4 ♂ : 1 ♀ j.
327	34° 00′ 30″; 76° 10′ 30″	178		1880	1 ♂ : 1 ♀
310	39° 59′ 16″; 70° 18′ 30″	260		1880	1 ♂
336	38° 21′ 50″; 73° 00′ 32″	197		1880	1 ♂ j.
321	32° 43′ 25″; 77° 20′ 30″	233		1880	1 ♂ : 1 ♀ j.
306	41° 32′ 50″; 65° 55′ 00″	524		1880	1 ♂ j.
	Off Martha's Vineyard, United States Fish Commission.				
				1881.	
925	S. ½ W. 86 miles from Gay Head	224	Sand and mud	July 16	1 l. ♂ : 3 j. ♂
939	S. by E. ½ E. 98 miles from Gay Head	258	Sand and mud	Aug. 4	1 ♂ : 1 ♀ : 1 j.
945	S. by W. ¾ W. 84½ miles from Gay Head	202	Sand and mud	Aug. 9	3 ♀ : 1 ♂
946	S. by W. ¾ W. 87½ miles from Gay Head	241	Sand and mud	Aug. 9	4 ♀ : 5 ♂ : 2 j.
947	S. by W. ¾ W. 89 miles from Gay Head	312	Sand and mud?	Aug. 9	1 l. ♀ : 4 ♂
951	S. 85 miles from Gay Head	219	Mud	Aug. 23	4 ♀ : 2 ♂
952	S. ½ E. 87½ miles from Gay Head	388	Sand and mud	Aug. 23	4 ♀ : 2 ♂
994	SSW. ½ W. 104½ miles from Gay Head	368	Mud	Sept. 8	1 l. ♂
997	SSW. ½ W. 103½ miles from Gay Head	335	Mud	Sept. 8	1 j. ♂
998	SSW. ½ W. 102½ miles from Gay Head	302	Mud	Sept. 8	1 ♂ : 1 ♀
1025	SSW. ½ W. 95 miles from Gay Head	216	Mud	Sept. 8	4 j.
1026	SSW. ½ W. 93½ miles from Gay Head	182	Mud	Sept. 8	1 l. ♂ : 1 l. ♀
1028	SSE. ¾ E. 108½ miles from Gay Head	410	Mud	Sept. 14	1 ♂
1033	SSE. ½ E. 106 miles from Gay Head	183	Sand & gravel	Sept. 14	1 ♂
1035	SSE. ½ E. 103½ miles from Gay Head	120	Sand	Sept. 14	1 l. ♂
1045	Off Delaware Bay	312	Mud	Oct. 10	1 l. ♂
1047	Off Delaware Bay	156	Sand	Oct. 10	1 ♀

Octopus Bairdii—Continued.

Lot.	Locality.	Fathoms.	Bottom.	When collected.	Specimens.
	Gloucester Fisheries.		VESSEL.	1879-'80.	
264	42° 49′ N. lat.; 62° 57′ W. long....	250	Marion	Jan.	1 l. ♂
351	44° 17′ 00″ N.; 58° 10′ 00″ W.....	120	Grace L. Fears	June 5	1 j.: 1 m. ♀
372	Off Miquelon Island..............	7	Alice M. Williams.	July —	1
421	Banquereau, off Nova Scotia.....	300	Commonwealth	Aug. 14	1 m. ♀
501	43° 14′ 00″ N.; 61° 07′ 00″ W.....	250	Alice M. Williams.	Oct. 9	1 m. ♀
721	Grand Bank	....	Guy Cunningham.	July 8	1 l. ♀
605	Brown's Bank	....	Barracouta ...	Jan. —	1 mutilated.
771	Off Saint Peter's Bank	80	Epes Tarr	July —	1 ♂: 1 ♀
792	....	....	G. P. Whitman	Aug. —	1 l. ♂
917	Banquereau, N. S	....	Alice M. Williams.	....	1 l. ♂

In the last column of this table, *l*=large; *j*=young; *m*=medium sized; ♂=male; ♀=female.

Octopus lentus Verrill.

Verrill, Amer. Journ. Sci., xix, p. 138, Feb., 1880; p. 294, April, 1880; Trans. Conn. Acad., v, p. 375, pl. 35, figs. 1, 2; pl. 51, fig. 2; Bulletin Mus. Comp. Zool., viii, p. 108, pl. 4, fig. 2, ♂.

Plate XLIII, figures 1, 2, female. Plate XLIV, figure 2, male.

Female (type-specimen): body broad, stout, depressed, slightly emarginate at the posterior end, rather soft to the touch, and in some specimens gelatinous in appearance; a thin, soft, free, marginal membrane runs along the sides and around the posterior end of the body, becoming widest (about 12^{mm}) posteriorly; in some of the more strongly contracted specimens this membrane is but little apparent. Head large, broad, depressed, with the eyes large and far apart; above each eye there is a small, simple, conical, acute, contractile cirrus. A well-developed, thin web connects the arms, considerably above their bases, and then runs up to the tips as a broad margin to each arm.

The arms are rather large, stout at base, with a broad inner face, and taper gradually to very slender tips; the first and third pairs are nearly equal in length; those of the second are also about equal in length to the fourth pair, but are somewhat shorter than the first and third. The arms on the right side are all somewhat longer than the corresponding ones on the left. The arms, measuring from the beak, are more than twice as long as the body. The suckers are arranged in two distinct rows, to the base.

Color of head and body, above, and of body, beneath, deep reddish-brown, closely specked with darker brown, and with many small roundish spots of whitish on the body and arms.

Length of the type-specimen (female) from the beak to end of body, not including marginal web, 60^{mm}; breadth of web, 22; total length, 194; breadth of body, 40; breadth of head across eyes, 32; of eye-openings, 10; of eye-balls, 17; length of mantle, beneath, 38; length of first pair of arms, 112 and 105; of second pair, 103 and 96; of third pair, 112 and 106; of fourth pair, 94 and 97; breadth of those of the three upper pairs, 8; of the ventral pair, 7^{mm}.

Male: Body depressed, rounded posteriorly, with only a trace of a lateral and posterior fold; surface soft and nearly smooth, but showing a small number of minute white papillæ sparsely scattered over the dorsal surface. Cirrus above the eye small and simple, usually contracted into a small wart-like papilla. Head broad and flattened; eyes large. Arms rather long and slender, with slender tapering tips, their bases united by a rather wide web. Suckers small, very prominent, forming two regular rows quite to the base.

The first two pairs of arms are nearly equal and somewhat longer than the two lower pairs, which differ but little between themselves. The hectocotylized arm (third of right side) bears thirty five suckers, in two rows, and a remarkably large, terminal spoon-shaped organ, which occupies more than a third of the total length of the arm; its sides are bent up and the edges inrolled, so as to form a deep cavity; its outer end is broadly rounded laterally, and terminates in a central, narrow, acute lobe; internally there are nine large, high, oblique lamellæ, with deep fossæ between them; the proximal end has a large, acute, triangular lobe, with involute margins; from this lobe a broad groove extends along the lower edge of the arm to the margin of the web; where it terminates there is a distinct thickening of the bounding membrane.

The two males of this species, described above, were dredged by Mr. Agassiz, on the Blake, in 1880, in 464 and 603 fathoms. They agree well in the peculiar characters and large size of the appendage of the hectocotylized arm. The females only were previously known. Although these males have a mere trace of the loose membranous fold of skin, along the sides and around the posterior end, so conspicuous in the original female specimen of this species, they agree so well in other characters that I unite them without much hesitation. It is probable that the presence or absence of the membranous fold, in this and other species, may be due merely to differences in the state of contraction when they die, or even to differences in the strength of the alcohol.

Measurements in millimeters.

	Right side. ♂	Left side. ♂	Right side. ♀	Left side. ♀
Total length	95	....	194	....
Posterior end to center of eye	34	....	....	....
Eye to tip of dorsal arms	64	....	....	....
Breadth of body	28	....	40	....
Breadth of head	22	....	32	....
Length of dorsal arms from mouth	65	61	112	105
Length of second pair from mouth	61	....	103	96
Length of third pair from mouth	....	52	112	106
Length of hectocotylized arm from mouth	58	....	....	....
Length of fourth pair	....	53	94	97
Length of spoon-shaped appendage	23	....	....	....
Breadth of the same	16	....	....	....

The first specimen of this species was taken off Nova Scotia, near Le Have Bank, in 120 fathoms, by Capt. Samuel Peeples and crew of the schooner "M. H. Perkins", and presented to the U. S. Fish Commission. A few others have since been brought in by the Gloucester fishermen from the bank fisheries. Mr. A. Agassiz dredged it on the Blake in 1880, as far south as N. lat. 33° 42′ 15″. It ranges in depth from 120 to 603 fathoms.

In the soft consistency of the flesh and skin this species resembles *Octopus obesus*. It differs in the shorter and posteriorly emarginate body, and especially in the arrangement of the suckers, which in that species are in a single series toward the bases of the arms.

Octopus lentus.—Specimens examined.

No.	Stat.	Locality.	Fath.	When coll'd.	Specimens. No. and sex.
7	326	N. lat. 33° 42′ 15″, W. long., 76° 0′ 50″ (Blake)	464	1880	1 ♂ 1 ♀
10	329	N. lat. 34° 39′ 40″, W. long., 75° 14′ 40″ (Blake)	603	1880	1 ♂ (fig'd).
553	....	Le Have Bank, N. S. (sch. M. H. Perkins)	120	1879	1 ♀ (fig'd).
718	....	S. of Newfoundland (sch. Proctor Brothers)	150	1880	sm. ♀
737	....	St. Peter's Bank (sch. Augusta H. Johnson)	200	1880	1 l. ♀
807	....	Banquereau (sch. Epes Tarr)	....	1880	1 ♀
808	....	N. lat. 44° 32′; Gr. Bank (sch. Guy Cunningham)	... ...	1880	1 ♀

Octopus obesus Verrill.—(Stout devil-fish.)

Octopus obesus Verrill, American Journ. Sci., vol. xix, p. 137, Feb., 1880; vol. xix, p. 294, Apr., 1880; Trans. Conn. Acad., vol. v, p. 379, pl. 36, figs. 3, 4, 1881.

Plate XLII, figures 6, 6*a*.

Male: Remarkable for the great size of the spoon-shaped organ of the right arm of the third pair. Body relatively large, stout, oblong-oval, somewhat flattened above, obtusely rounded at the posterior end; soft and somewhat gelatinous in texture; skin, so far as preserved, smooth, soft. No cirrus exists above the eye, in our specimen, but the skin is not so well preserved in that region as to render it certain that a small one may not have existed, in life. Eyes very large.

Arms moderately long, the dorsal longest, others successively shorter; all are somewhat laterally compressed at base, tapering to long, slender tips; a moderately developed web connects them together at base. The hectocotylized arm (third of right side), bears at the end a very large, broad and thick, but not very deep, spoon-like organ, occupying more than a third of the total length of the arm; its inner surface is crossed by eleven oblique, thick, rounded folds or ribs, ten of them converging backward to the median line and at their outer ends joining a marginal thickening; the distal end terminates in a median pointed lobe, with a thin, rounded, lateral lobe each side of it; the proximal border is formed by the last (eleventh) fold, which is V-shaped, with the apex pointing distally. A broad, thin, marginal membrane extends along the lower side of the arm, from the terminal organ to the base. The suckers have been partly detached from this arm.

The suckers of all the arms are moderately large, nearly globular in form, rather numerous; the first six to ten at the base are nearly in one line, except on the left arm of the sceond pair, and appear to form only a single row; in this part the inner face of the arm is narrow, most so on the right arm of the second pair, and least on the left arm of the same pair; farther out this face becomes broader and the suckers are in two distinct rows. The suckers are destroyed on the distal portion of all the arms.

The color of the body and arms is mostly destroyed, but so far as preserved, is pale pinkish, more or less thickly speckled with distinct reddish brown spots, most conspicuous at the bases of the arms and above the eyes (elsewhere the color is probably not so well preserved). Length of body, from posterior end to base of arms, 82^{mm}; to center of eye, 72; to edge of mantle, beneath, 49; to tip of right dorsal arm, 213; left, 198; to tips of second pair, 200; to tip of right arm of third pair, 173; of left, 197; to tip of right of fourth pair, 187; of left, 178: to edge of web, 110; breadth of body, in middle, 46; breadth of head, across eyes, 38; breadth of dorsal arms, at base, 8; diameter of largest suckers, 3; length of spoon-shaped end of right arm of third pair (hectocotylized), 35; breadth, 16; length of the rest of arm, to mouth, 65^{mm}.

Taken from the stomach of a halibut, 36 miles east from the N. E. light of Sable Island, in 160 to 300 fathoms, by Charles Ruckley, of the schooner H. A. Duncan, and presented by him to the U. S. Fish Commission, 1879.

A second, smaller specimen, apparently of this species, was also taken from the stomach of a halibut, from Banquereau, off Nova Scotia, in 150 fathoms, and presented to the U. S. Fish Commission by Capt. Chas. Markuson and crew, of the schooner "Notice", April, 1880. The latter specimen was, however, in too bad condition to afford any additional characters.

This species differs from *Octopus Bairdii* V. and *O. lentus* V., from the same region, in its longer and larger body, and especially in having the basal suckers in a single row. The 'spoon' of the hectocotylized arm is very much larger than in *O. Grönlandicus*, and considerably larger and flatter and more deeply trilobed at the end than in *O. Bairdii.*

Octopus piscatorum Verrill.—(Fishermen's devil-fish.)

Octopus piscatorum Verrill, Amer. Journ. Sci., vol. xviii, p. 470, Dec., 1879; vol. xix, p. 294, Apr., 1880; Trans. Conn. Acad., v, p. 377, pl. 36, figs. 1, 2, 1881.

Plate XL, figures 1, 1*a*.

The body of the female is smooth, depressed, about as broad as long; obtusely rounded posteriorly, not showing any lateral ridges nor dorsal papillæ. No cirrus above the eyes. Arms long, rather slender, tapering to long, slender, acute tips, the upper ones a little (2.5^{mm}) shorter than those of the second pair, which are the longest; the third pair are about one-half inch (12^{mm}) shorter than the second; the ventral pair about one-fourth inch (6^{mm}) shorter than the third. In our specimen all the arms on the right side are somewhat shorter than those on the left, and the web between the 1st and 2d pairs is narrower, due perhaps to recovery from an injury. The web between the arms, except ventrally, is of about equal width, and scarcely more than one-fourth the length of the arms, measuring from the beak. Between the ventral arms the web is about half as wide as between the lateral.

The suckers are moderately large, alternating in two regular rows, except close to the mouth, where a few stand nearly in a single line; about fourteen to sixteen are situated on the part of the arms included within the interbrachial web. The whole number of suckers on one arm is upwards of seventy.

Color of the alcoholic specimen, deep purplish brown, due to very numerous crowded, minute, specks; eyelids whitish. The front border of the mantle, beneath, and the base of the siphon and adjacent parts, are white; end of siphon brown. Lower side of head and arms lighter than the dorsal side.

Total length, from posterior end of body to tip of arms, of 1st pair, 158^{mm}; 2d pair, 160; 3d pair, 146; 4th pair, 133; to web between dorsal arms, 82; between ventral arms, 63; to edge of mantle, beneath, 30; to center of eye, 39. Breadth of body, 31; of head across eyes, 30; breadth of arms, at base, 55; diameter of largest suckers, 2.5; length of arms beyond web, 1st pair, 76; 2d pair, 82; 3d pair, 71; 4th pair, 69^{mm}.

Two specimens of this species, both females, have been obtained. The first was from Le Have Bank, off Nova Scotia, in 120 fathoms, taken by Capt. John McInnis and crew, of the schooner "M. H. Perkins", October, 1879 (lot 530); the second was taken by Capt. David Campbell and crew, of the schooner "Admiral", near the Grand Bank, north latitude, 44° 07′; west longitude, 52° 40′, in 200 fathoms, December, 1879 (lot 590).

This species resembles *O. Grönlandicus*, of which the males alone have been described, and it may eventually prove to be the female of that species.

This species is easily distinguished from *O. Bairdii*, by its more elongated body, its much longer and more tapered arms, with shorter web; by the absence of the large, rough, pointed papillæ, or cirri, above the eyes, and by its general smoothness. The white color of the underside of the neck, siphon, and mantle-border also appears to be characteristic.

Octopus rugosus Bosc.

I have seen several specimens of a large *Octopus*, allied to *O. vulgaris* of Europe, which were taken at Beaufort, N. C., and near Fort Macon. It is probably *O. rugosus*.

FAMILY CIRRHOTEUTHIDÆ Keff.

Kefferstein, in Bronn, Thier-Reich, iii, p. 1448, 1866.

Body somewhat elongated, furnished with a short, thick tapering fin on each side, supported by an internal transverse cartilage. Mantle extensively united to the head. Arms united nearly to the tips by a broad umbrella-shaped membrane or web. Suckers in a single row, alternating with slender cirri.

STAUROTEUTHIS Verrill.

Amer. Journ. Sci., vol. xviii, p. 468, Dec., 1879; Trans. Conn. Acad., v, p. 382, 1881.

Allied to *Cirrhoteuthis*, but with the mantle united to the head all around, and to the dorsal side of the slender siphon, which it surrounds like a close collar, leaving only a very narrow opening around the base of the siphon, laterally and ventrally. Fins long, triangular, in advance of the middle of the body. Dorsal cartilage forming a median angle, directed backward. Body flattened, soft, bordered by a membrane. Eyes covered by the integument. Web not reaching the tips of the arms, the edge concave in the intervals. Suckers in one row, with a pair of slender cirri, alternating with them, along most of the arm. Cirri absent between the basal and terminal suckers.

Stauroteuthis syrtensis Verrill.—(Finned devil-fish.)

Verrill, Amer. Journ. Sci., vol. xviii, p. 468, Dec., 1879; xix, p. 294, pl. 16, Apr., 1880; Trans. Conn. Acad., vol. v, p. 382, pl. 32, figs. 1–5, 1881.

Plate XXXVIII, figures 1–5.

Female: Head broad, depressed, not very distinct from the body. Eyes large. Body elongated, flattened, soft or gelatinous, widest in the middle, narrowed but little forward, but decidedly tapered, back of the fins, to the flat, obtuse, or subtruncate tail. The sides of the head and of the body, forward of the fins, are bordered by a thin soft membrane, about 12^{mm} wide. The fins are elongated, sub-triangular, obtusely pointed, placed in advance of the middle of the body, supported by internal cartilages which unite with a transverse dorsal V-shaped one, situated behind the fins. Siphon elongated, about 12^{mm} long, slender, round, with a small terminal opening. Mantle-edge so contracted and thickened around the base of the siphon as to show only a very small opening, and united to it in the middle line anteriorly or dorsally. Eyes large, distinctly visible through the integument.

Arms long, slender, sub-equal, each united to the great web by a broad membrane developed on its outer side, widest (about 38^{mm} or 1.5 inches) in the middle of the arm, while the edge of the web unites directly to the sides of the arms and, as a border, runs along the free portion toward the very slender tip. This arrangement gives a swollen or campanulate form to the extended web. Edges of the web incurved between the arms, widest between the two lateral pairs of arms. The arms bear each fifty-five or more suckers, in a single row. Those in the middle region are wide apart (12^{mm} or more) with a pair of slender, thread-like cirri, about 25 to 32^{mm} long, midway between them. The cirri commence, in a rudimentary form, between the 5th and 6th suckers, on the dorsal arms, and between the 7th and 8th, on the lateral and ventral ones. They cease before the 23d sucker on the dorsal and lateral arms, and before the 22d on the ventral ones, which bear each 14 pairs of cirri. Near the mouth, and beyond the last cirri on the free portion of the arms, the suckers are more closely arranged. The jaws (figures 4, 5) have short, pointed and but little incurved tips; the cutting edges of both jaws have regularly curved outlines. They are small, with a deep cavity.

Beyond the last cirri on the dorsal arms there are 33 to 35 small suckers. The 2d arm on the right side appears to be imperfect. On this arm there are but 19 suckers beyond the last cirri; then follow 15, or more, minute, wartlike tubercles, extending to the tip. Color, in alcohol, generally pale with irregular mottlings and streaks of dull brownish; inner surface of arms and web, toward the base, and membrane around the mouth, deep purplish-brown.

Length from end of body to base of arms, 160^{mm}; length to posterior base of fins, 63; to anterior base, 101; width across fins, 126; in advance of fins, 53 (not including lateral membrane); across eyes, 44; across end of tail, 30; diameter of eye, 30; width of fins, at base, 33; their length, 44; length of arms, 330 to 355; portion beyond web, 63 to 76. Edge of extended web, between upper arms, about 101; between lateral arms, about 203; entire circumference of web, about 1218^{mm}, but its exact extent cannot be ascertained, because in our specimen the web between the ventral arms was badly torn.

The oviduct is single and nearly median, its orifice being a little to the left of the median line. A large nidamental gland, consisting of a posterior, yellowish portion, and a much larger, round, dark brown, anterior portion, surrounds the oviduct; the portion behind these glands is thin, tubular, and contains large round ova. The anterior portion, in front of the glands, is large and much thickened, and terminates in a slightly bilabiate orifice, at the base of the siphon. From the portion of the oviduct in front of the large glands, I took a large mature egg, covered with a hard, dark reddish brown case.

The egg, seen endwise, has a broad, elliptical outline, and while the two ends are truncated and smoothish, the sides are ornamented with numerous regular, roughened, elevated ribs. Greatest breadth of the egg, 11^{mm}; thickness, 7^{mm}; length, 6^{mm}. The anal orifice is not raised on a distinct elevation. A small urethral papilla arises in front of the base of each gill.

The only known example of this remarkable species was taken by Capt. Melvin Gilpatrick and crew, schooner "Polar Wave", north latitude

43° 54′, west longitude 58° 44′, on Banquereau, about 30 miles east of Sable Island, Nova Scotia, in 250 fathoms. Presented to the U. S. Fish Commission, September, 1879. (Lot 472.)

Measurements of Stauroteuthis syrtensis.

	Inches.	Millimeters.
Length, posterior end to tip of dorsal arms	......	....
Length to tip of second pair	....	....
Length to tip of third pair	....	....
Length to tip of fourth pair	....	....
Length to edge of web between dorsal arms	....	....
Length to base of dorsal arms	6.30	160
Length to center of eye	5.75	146
Length to anterior base of fin	4.00	101
Length to posterior base of fin	2.70	68
Length to outer end of fin	3.75	95
Breadth across fins	5.00	126
Breadth of fins at base	1.30	33
Breadth of body in middle, excluding border	2.10	53
Breadth of body, with membranous border	3.00	76
Breadth of head across eyes	1.75	44
Breadth of eye	1.00	25
Length of arm-tips beyond last cirri, first pair	4.00	101
Length of arm-tips beyond last cirri, second pair	4.00	101
Length of arm-tips beyond last cirri, third pair	4.25	108
Length of arm-tips beyond last cirri, fourth pair	3.50	89
Length of longest cirri	1.25	32
Length of siphon	.50	12.5
Its breadth	.20	5
Upper mandible, total length	.52	13
Its height	.36	9
Beak to posterior lateral border of alæ	.16	4
Height of palatine lamina	.32	8
Lower mandible length	.40	10
Its height	.38	9.5
Beak to posterior border of alæ	.24	6
Beak to inner end of alæ	.30	7.5
Breadth (or depth) of gular lamina	.20	5

SUPPLEMENT.

After the preceding pages were put in type, a number of additional specimens were received, some of them of great interest. Among these there are some forms that appear to have been previously unknown. These are, therefore, described in this place. Moreover, several papers have been published, on the same subject, during the printing of this report. Some of these include certain of the species above described, and, therefore, may well be noticed here.

ARCHITEUTHIS Harting, 1861. (See pp. [25], [114].)

Architeuthus Steenstrup, Förhandl. Skand. Naturf., 1856, vii, p. 182, 1867 (no description.)

Plectoteuthis Owen, Descriptions of some new and rare Cephalopoda. Part II. < Trans. Zool. Soc. London, xi, part 5, p. 156, pl. 34, 35, June, 1881.

Professor Owen, in the paper quoted, has given a somewhat detailed description, with figures, of the large cephalopod arm, long preserved in the British Museum. This arm had previously been pretty fully described by Mr. Saville Kent, in 1874, whose description has already been quoted by me. (See pp. [57–59].) Professor Owen, like Mr. Kent, fails to state to which pair of arms the specimen belongs. This is a very important omission, for in *Architeuthis*, as in many other genera, the arms belonging to different pairs differ in form and structure. The describers of this arm would, doubtless, have been able to ascertain to which pair it belongs by a direct comparison with the arms of *Ommastrephes*, or any other related form. For this arm, Professor Owen endeavors to establish a new genus and species (*Plectoteuthis grandis*). The genus is based mainly on the fact that there is a marginal crest along each outer angle, and a narrow protective membrane along each side of the sucker-bearing face. These peculiarities are precisely those seen in the *ventral arms* of *Architeuthis*, and have already been described by me in former articles, and in this report (see pp. [35], [37], [44]), both as found in *A. Harveyi* and *A. princeps*. Similar membranes or crests are found on the *dorsal* arms of *Sthenoteuthis pteropus* (see Pl. XVII, fig. 7 *a*), and other related species.

The suckers on the arm, as described and figured by Professor Owen, are like those of *Architeuthis*. Therefore there is no ground whatever for referring this arm *to any other genus*, and *Plectoteuthis* must become a synonym of *Architeuthis*.

Whether the arm in question belongs to a species distinct from those already named, I am unable to say. There is, apparently, nothing to base *specific* characters upon, except the form of the suckers and of their horny rings. But the description of the horny rings is not sufficiently precise, nor the figures sufficiently detailed to afford such characters. If the arm is one of the ventral pair, as seems probable, the suckers, as figured by Professor Owen, and especially as more fully described by Mr. Kent, are of the same form, and agree closely, but not perfectly, with those of either of the Newfoundland specimens, for in the latter the suckers of the ventral arms are not denticulated on the inner side, or but slightly so. But they also agree well with those of *Architeuthis Hartingii*, as figured by Harting. Those of the original *A. dux* Steenst. have neither been described nor figured.

As this arm cannot, at present, be referred with certainty to any of the named species, it may be best to record it as *Architeuthis grandis*, until better known.

In the same article, Professor Owen has given a good figure (pl. 33, fig. 2) of the tentacular arm of the Newfoundland specimen (my No. 2), copied from the same photograph described by me (see pp. [6], [33], [34]). To this he applies, doubtless by mistake, the name, *Architeuthis princeps*,* without giving any reason for not adopting my conclusion that it belongs to *A. Harveyi*. But he does not, in any way, refer to the latter species, although he mentions the specimen (my No. 5), or rather the photograph of the specimen, on which that species was based. He apparently (p. 162) supposes that both photographs and Mr. Harvey's two series of measurements refer to the same specimen, which is by no means the case, as had been sufficiently explained by me, in several former papers.†

The brief account, given by Professor Owen, of the large cephalopods described by others, includes none additional to those noticed by me in this report. On the other hand, he omits those described by Harting; those described by Mr. Kirk, from New Zealand; those from Alaska; and several others.

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* By a singular mistake, Professor Owen, on p. 163, states that this species was named *A. princeps* by Dr. Packard, in February, 1873. But according to his own statement, on p. 161, the specimen was not actually obtained till December, 1873, *at least nine months after* Dr. Packard's article was printed. In truth, the name *princeps* was first given by me, in 1875, to designate a pair of large jaws, as explained on p. 41. Neither this nor any other name appears on the cited page of Dr. Packard's article, though he elsewhere referred it doubtfully to *A. monachus*.

† It seems incredible that Professor Owen could have made these mistakes had he examined either of my former papers in which these specimens have been described in detail, not only from the photographs but also from the preserved specimens. He does, however, refer to my detailed paper in the Trans. Conn. Acad., vol. v. But as he states (p. 162) that in it a "brief notice is given of Mr. Harvey's squid," it is fair to suppose that the reference is taken at second hand, for it is not to be supposed that he would have considered my description, covering over sixteen pages, and accompanied by five plates, as a "*brief notice.*" None of my earlier papers are referred to, nor does he mention the large species, *Moroteuthis robusta*, in his account of the large cephalopods hitherto described.

I have heard of but one authentic instance* of the occurrence of specimens of this genus at Newfoundland, since the finding of the small specimen (No. 24), in April, 1880. (See pp. [18], [34–40].)

The latest specimen (No. 27) was taken at Portugal Cove, Newfoundland, November 10, 1881. According to a description in the New York Herald, of November 25th, this specimen was nearly perfect, and had been shipped to New York, packed in ice. The following measurements of the fresh specimen were given on the authority of Inspector Murphy, chief of the Board of Public Works Department: Length of body, 5.5 feet; length of the head, 1.25 feet; total length, to end of tentacular arms, 28 feet; circumference of body, 4.5 feet; breadth of caudal fin, about 1.25 feet. A photograph of this example was made by Mr. E. Lyons, of St. Johns. This specimen is considerably smaller than the Logie Bay specimen (No. 5), but if in as good preservation as stated, it will, when it can be studied, give an opportunity to complete the description of the head, eyes, and certain other parts that have not been seen in good condition in any of the previous specimens.

STHENOTEUTHIS Verrill, 1880. (See p. [99].)

Ommatostrephes Steenstrup, Overigt K. D. Vidensk. Selsk. Forh., p. 89, Aug., 1880; the same, March, 1881.

Xiphoteuthis (subgenus) Owen, op. cit., p. 104, pl. 28, figs. 1, 2, June, 1881 (*non* Huxley).

This generic group has been discussed by Professor Steenstrup in two recent papers,† published during the printing of this report. In the first paper quoted,‡ Professor Steenstrup gives figures (cuts) which, with the descriptive remarks, will hereafter enable others to identify his *Ommatostrephes pteropus* with more certainty. He has given diagramatic cuts of the base of the tentacular clubs, showing the arrangement of the connective suckers and tubercles of *O. pteropus*, *O. Bartramii*, *O. gigas*, *O. pelagicus*, *O. oualaniensis*, and *Dosidicus Eschrichtii* (p. 11), and cuts (p. 9), showing the siphonal grooves of *O. pteropus*, *O. Bartramii*, *O. pacificus*, *Todarodes sagittatus* (="*O. todarus*"), and *Illex Coindetii* (="*O. sagittatus*," auth.). On pp. 19 and 20 he has given a synoptical table of the several genera that he recognizes in this group, which he names, *Ommatostephini* (= *Ommastrephidæ* Gill, Tryon, Verrill). On plate 3, he figures "*Illex Coindetii*," female, with the gill-cavity opened, showing a

*A purely fictitious and sensational account of an imaginary capture of an *Architeuthis* has been published in Lippincott's Magazine, for Aug., 1881, p. 124, by Mr. Charles F. Holder.

†De Ommatostrephagtige Blæksprutter indbyrdes Forhold. <Oversigt K. D. Vidensk. Selsk. Forhandl., 1880. Presented April, 1880. [Author's edition received Aug., 1880.]

Professor A. E. Verrils [*sic*] to nye Cephalopodslægter, Sthenoteuthis og Lestoteuthis. Bemærkninger og Berigtigelser, 1 pl. ["avec un résumé en Francais," not received]. From the same, 1881. Advance copy, received by me, through the kindness of the author, is dated, in MSS, March 3, 1881.

‡The part of this paper relating to the nomenclature of the genus *Ommastrephes* (*Illex* Steenst.) has already been discussed on pp. [82], [83].

large cluster of spermatophores attached to the inner surface of the mantle, behind the base of the gill, and a smaller one, in front of the gill.

In the second article referred to above, Professor Steenstrup discusses the genus *Sthenoteuthis* versus "*Ommatostrephes*." He recognizes the identity of *Sthenoteuthis* and his restricted genus *Ommatostrephes*, as well as the priority of date of the former. He also refers to *S. megaptera* as "*Ommatostrephes megaptera*."

In the last paper* quoted above, Professor Owen has described a cephalopod, without locality, under the name of *Ommastrephes ensifer*, for which he proposes the subgeneric name, *Xiphoteuthis*. The latter name is, however, preoccupied. His species is a typical example of my genus *Sthenoteuthis* (1880), and appears to be identical in every respect with *S. pteropus* (see my Plate VII, figs. 2, 2*a*, and Plate XVII), as described by me. But Professor Owen fails to mention one of the most characteristic features of this group of squids, viz, the connective tubercles and smooth suckers on the proximal part of the tentacular club. Nor is his figure sufficiently detailed to indicate this character, nor even the actual arrangement and structure of the other suckers of the club. The high median crest and broad marginal web of the third pair of arms are well shown, but these are about equally broad in *S. pteropus* and *S. megaptera*, and are also present in all the related species of this group.

Owen's specimen had a total length of 3 feet; length of body 15 inches; of head to base of dorsal arms, 3.7; of third pair of arms, 12; of tentacular arms, 21; breadth of caudal fin, 12.6; length of their attached base, 6.6; breadth of body, 5; length of first, second, third, and fourth pairs of arms, 8.9, 11, 12, and 9.6 inches, respectively. The specimen is a female. It agrees very closely in size with the Bermuda specimen described by me, and its proportions do not differ more than is usual with alcoholic specimens of any species preserved under different circumstances, and in alcohol of different strength. The original specimen of *S. megaptera* is considerably larger.

Ommastrephes illecebrosus V. (See p. 83.)

This species was taken in many localities this year by the U. S. Fish Commission, in deep water, off Martha's Vineyard. Most of the living specimens were young, but large ones were often taken from the stomachs of bottom-dwelling fishes, in the same region, showing conclusively that it regularly inhabits those depths.

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*Among the other species figured and described in this paper, there is a handsome species from the China Sea, described as *Loligopsis ocellata*, sp. nov. (pp. 139–143, pl. 26, figs. 3–8; pl. 27, figs. 1, 2). This is evidently not a true *Loligopsis*, and belongs, in all probability, to my genus *Calliteuthis*. It agrees very closely, even to the coloration and the form of the fins and pen, with my *C. reversa*, but differs in having serrated suckers. It is much larger than my specimen, but, like the latter, had lost the tentacular arms. This species should, therefore, be called *Calliteuthis ocellata*. The genus probably belongs to the Chiroteuthidæ.

Additional specimens examined.

Station.	Locality.	Fathoms.	Date.	Received from.	No of specimens and sex.
	Off Martha's Vineyard.		1881.		
918	S. ½ W., 61 miles from Gay Head	45	July 16	U. S. F. C.	1 l., from fish.
919	S. ½ W., 65 miles from Gay Head	51½	July 16	....do	2 l., from Lophius.
923	S. ½ W., 78½ miles from Gay Head	96	July 16	....do	3 juv.
924	S. ½ W., 83½ miles from Gay Head	110	July 16	... do	5 juv.
925	S. ½ W., 86 miles from Gay Head	224	July 16	....do	1 juv.
939	S. by E. ½ E., 98 miles from Gay Head.	258	Aug. 4	....do	1 l.; 1 juv.
940	S by E. ½ E., 97 miles from Gay Head.	130	Aug. 4	....do	1 l.; 1 juv.
949	S. W., 79½ miles from Gay Head	100	Aug. 23	....do	1 l., in Lopholatilus.
1025	S. S. W. ¼ W., 95 miles from Gay Head	216	Sept. 8	... do	1 l., in fish.
1033	S. S. E. ½ E., 106 miles from Gay Head	183	Sept. 14	....do	1 l., in Merlucius.
1038	S. by E. ¼ E., 89½ miles from Gay Head	146	Sept. 21	do	1 l.
	Newfoundland	Surface.	1880.	H. L. Osborn	3 l. ♂; 10 l. ♀.

Mr. H. L. Osborn, in the American Naturalist, vol. xv, p. 366, May 1881, has given an account of the habits of this squid, at Newfoundland, and of the methods of capturing it there for bait.

Enoploteuthis Cookii Owen. (See p. [53].)
Trans. Zool. Soc. London, xi, p. 150, pl. 30, figs. 1–3; pl. 31, figs. 1–4; pl. 32, figs. 1–6; pl. 33, fig. 1 (restoration), June, 1881.
Seppia unguiculata Molina, 1810 (no description).
Enoploteuthis Molinæ D'Orbigny, Ceph. Acétab., p. 339.
?*Enoploteuthis Hartingii* Verrill, this vol., p. [53], pl. 12, fig. 4; pl. 15, fig. 5, 1880.

Professor Owen has very recently described in detail, and has given excellent figures of most of the existing parts of this large and remarkable cephalopod, which have been preserved so long and have so often been referred to, but hitherto have never been scientifically described, (see p. [53]). It is to be regretted, however, that Professor Owen has neither described nor figured the dentition of the radula in a manner to enable it to be used as a systematic character. His statement in regard to it is of the most general kind, and shows only that there are seven rows of teeth. It is also a matter of surprise that he has not compared any of the portions described with the corresponding parts of the equally large and very closely allied *Enoploteuthis*, carefully described and figured by Harting in 1861 (see p. [53]), and to which I have given the well-merited name, *E. Hartingii*. It is not improbable that the two forms are really identical, but this cannot be certainly determined from the figures, because the corresponding parts are not always represented in the same positions, and it is uncertain whether the corresponding arm is preserved in the two cases. Harting figures, rather poorly, the teeth of the radula, which appear to be very peculiar, if his figure is correct, (see my Plate XV, fig. 5, *c*, *d*).

The shape of the mandibles appears to be different in the two species, however, and the large hooks also differ in form.

LESTOTEUTHIS V.=**CHELOTEUTHIS** V.=**GONATUS** Steenst. (*non* Gray).

The second of Professor Steenstrup's recent papers* contains a detailed discussion of *Gonatus Fabricii* Steenst., with which he also unites *Onychoteuthis Kamtschatica* Midd., the type-species of my genus *Lestoteuthis* (see p. [70]). He may be correct in uniting these forms, for he states that he has received specimens that agree with *Gonatus Fabricii*, from the North Pacific.† Moreover, taking the characters of the genus *Gonatus*, as *now understood*, by Professor Steenstrup, the description and figures of Middendorff's species apply well to that genus, and my description of *Lestoteuthis* well defines *Gonatus* Steenst., except for the mistake in regard to the tip of the pen. But when I proposed the genus *Lestoteuthis*, no writer had ever so described *Gonatus*, and the data necessary for the correlation of the two species *did not exist* in the literature of the subject. I have already alluded (p. [79] and elsewhere) to some of the very serious errors of Gray, H. & A. Adams, and others, as to the *generic* and even *family* characters of *Gonatus*.‡ Professor Steenstrup, in his last paper, has exposed a greater number of errors, some of which are questionable. He has, however, been fortunate in securing specimens of larger size and in better condition than those examined by other writers, and has given good figures and a very full exposition of the characters of this very interesting species. Two excellent specimens were taken by our party, this season, on the "Fish Hawk." One of these is an adult male; the other is young, with the mantle 30^{mm} long. The latter agrees well in size and form with the specimen described and figured by G. O. Sars, as *Gonatus amœnus*, while the former agrees with Steenstrup's figure of the adult *G. Fabricii*. But both differ decidedly from a Cumberland Gulf specimen, which is doubtless the *real Gonatus amœnus* Gray, and has four rows of true suckers on all the arms, and no hooks. It does not appear that Steenstrup has seen this form.

The fortunate acquisition of these specimens has enabled me to ascertain, for myself, not only that Professor Steenstrup is correct in considering two of the forms that have been described from the North Atlantic as simply the young and adult of the same species, but also that all the

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*See note on p. [200].

†The figures, however, show differences in the form of the pen and caudal fin, which, if correct, may still indicate specific differences.

‡The genus *Gonatus*, as established by J. E. Gray, if we judge by his description, was a very different group from what Steenstrup understands by it. Among the false characters given by Gray are the following: 1, It was said to have no eyelids; 2, to have no valve in the siphon; 3, to have no siphonal dorsal band. But he also says that it has nearly equal and similar suckers in four series, on all the arms, "all with small circular rings"; and the club was said to have "ranges of small, nearly sessile, equal-sized cups," with one "large sessile cup, armed with a hook in the middle of the lower part." From the fact that he received his specimens from Greenland (coll. Möller), we must believe that he actually had before him the real *G. amœnus*. My specimen from Cumberland Gulf has the suckers as described by Gray, *on all the arms*.

Most of Gray's errors have been copied and adopted by Woodward, H. & A. Adams, Tryon, and many other writers.

essential and peculiar features of the armature, both of the sessile and of the tentacular arms, including the special, lateral connective suckers and tubercles of the club, are present, though minute, even in the very young individuals, such as described by G. O. Sars. The fact that these characters have been overlooked is undoubtedly due, in many cases, to the imperfectly preserved specimens that have been examined. This was, at least, the case with the only American specimens seen by me until this year. They had all been taken from fish stomachs, and had lost more or less of their suckers and hooks.

A careful and direct comparison of the adult *G. Fabricii* with the mutilated specimen which was last year described by me as *Cheloteuthis rapax*, has convinced me that they are identical, and, therefore, *Cheloteuthis* becomes a synonym of *Lestoteuthis*. Two of the characters, viz: the supposed presence of two central *rows of hooks* on the ventral, as well as on the lateral arms, and the supposed *absence* of the small marginal suckers on the lateral arms, relied upon for characterizing *Cheloteuthis*, were doubtless due to post-mortem changes. The ventral arms had lost the horny rings of the suckers, and the soft parts had taken a form exceedingly like that of the sheaths of the hooks of the lateral arms. But by the careful use of reagents, I have been able to restore the original form of some of the distal ones sufficiently to show that they actually were sucker-sheaths. The third character, originally considered by me as more reliable and important, was the existence of the peculiar, lateral connective suckers and alternating tubercles on the tentacular club. This is *now* shown by Professor Steenstrup to be a character of his *Gonatus*. But no one had previously described such a structure in connection with that genus. Even in the recent and excellent work of G. O. Sars, in which "*G. amœnus*" is described in some detail, and freely illustrated, there is no indication of any such structure, although the armature of the club is figured (see my Plate XV, fig. 1*b*), nor is the difference between the armature of the ventral and lateral arms indicated.*

I add a new description of the genus *Lestoteuthis*, and also of my largest example of *L. Fabricii*.

LESTOTEUTHIS Verrill (revised). (See pp. [70], [78].)

Gonatus Steenstrup, op. cit., pp. 9–26 (*non* Gray).
Gonatus Verrill, Trans. Conn. Acad., v, pp. 250, 290, 1880 (*non* Gray).
Lestoteuthis Verrill, Trans. Conn. Acad., v, p. 250, Feb., 1880; p. 390, Oct., 1881.
Cheloteuthis (*Chiloteuthis* by typ. error) Verrill, Trans. Conn. Acad., v, p. 292, Jan., 1881.
Cheloteuthis Verrill, Bulletin Mus. Comp. Zool., viii, p. 109, March, 1881.

Odontophore with only five rows of teeth. Mandibles very acute, strongly compressed. Lateral connective cartilages of the mantle are

* According to Gray, in *Gonatus* all the sessile arms bear four rows of similar and nearly equal suckers; according to G. O. Sars they all have two central rows of sucker-hooks. My former description was based mainly on the figures and description of G. O. Sars, my only specimen, at that time, being an imperfect young *Lestoteuthis*, like that of Sars.

simple ridges; those of the siphon ovate. Nuchal olfactory crests one or more on each side, longitudinal. Caudal fin of adult, large, spear-shaped. Ventral arms with four rows of denticulated suckers. No trace of hectocotylization detected.* Lateral and dorsal arms with two marginal rows of small suckers and two median rows of larger hooks. Tentacular arms with a central row of hooks, the two distal ones largest; with a large distal and two lateral groups of small suckers, in numerous rows; and with a lateral group of peculiar connective suckers, alternating with tubercles, near the lower margin, and a row of smaller ones extending for a long distance down the margin of the arm; upper margin of the arm with a band of small, pediceled suckers along about half its length. Pen narrow, with a short, hollow, posterior cone.

Gonatus Gray, typical (*non* Sars, Steenst.), differs in having on all the arms four rows of true suckers, all of which are similar, and have the marginal ring divided into a series of several sharp denticles on the higher side. This may be a sexual character, but the two forms should be kept separate, awaiting further evidence. Steenstrup does not give the sex of his specimens.

Lestoteuthis Fabricii (Fabr.) Verrill. (See pp. [76], [79].)

? *Onychoteuthis Kamtschatica* Middendorff, 1849.

Gonatus Fabricii Steenstrup (*pars*), in Mörch, Faunula Molluscorum Ins. Færöerne, <Vid. Meddel. nat. For., 1867, p. 102; Faunula Mollusc. Islandiæ, <Vid. Meddel. nat. For., Kjöbenhavn, 1868, p. 227.

Gonatus Fabricii Mörch (*pars*), in T. R. Jones, Arctic Manual, p. 130, 1875.

Steenstrup, Oversigt over d. Kongl. D. Vidensk. Selsk. Forh., 1881. [Sep. copy, p. 26], pl. 1, figs. 1-7.

Verrill, (*pars*) Trans. Conn. Acad., v, p. 291; this vol., p. [79].

Cheloteuthis rapax Verrill, Trans. Conn. Acad., v, p. 293, pl. 49, figs. 1-1f; Bulletin Mus. Comp. Zool., viii, p. 110, pl. 2, figs. 1-1f, 1881.

Plate XV, fig. 1-1*c*, 2-2*d*, 3-3*f*, 4. Plate XLV, fig. 1-1*d*.

Body elongated, tapering to an acute posterior end; anterior edge of mantle nearly even dorsally, with a slight median emargination; lateral angles well-marked, in line with the internal connective cartilage, which forms a long, simple, longitudinal ridge. Caudal fin broad, spear-shaped, broadest in advance of the middle; the lateral angles are well rounded; the tip is very acute; the anterior lobes are broadly rounded, projecting forward beyond the insertion. Head large, short, and broad; eyes large, occupying most of the sides of the head; eye-lids well developed, thickened, with a narrow, oblique sinus. Siphon large, in a deep groove, with two stout, dorsal bridles; lateral connective cartilages large, long-ovate, posterior end broadest. One olfactory crest on each side, behind the eye, in the form of a low, longitudinal membrane; slight indications of another, lower down; a small, fleshy, flattened, projecting papilla near the auditory opening. The outer buccal mem-

* My largest specimen, although apparently adult, is not sexually mature. An older specimen might be hectocotylized.

brane has seven distinct angles. Arms rather long and strong; trapezoidal in section. The dorsal arms are considerably shorter than the others; order of length is 1, 2, 4, 3; the third is but little longer than the second pair; ventral arms decidedly more slender than the others.

Ventral arms with four rows of denticulated suckers (Plate XLV, fig. 1*c*), those of the two inner rows larger; lateral and dorsal arms with two marginal rows of small suckers and two inner rows of larger incurved hooks, inclosed, except at the sharp tips, in muscular sheaths, which have lateral basal expansions and short pedicels. (Plate XLV, fig. 1*b*.) Tentacular arms* long and strong, quadrangular; in my specimen they reach back beyond the base of the fin; the club is large and broad, with a long, narrow distal portion, having a strong dorsal keel; in the middle are two very large, curved hooks (figs. 1, 1*a*), the distal one smaller; proximal to these there is a row of five smaller hooks, decreasing proximally, and between these and the large hooks there is, on one arm, a single small sucker, on the other arm a single sucker takes the place of the proximal hook, while an odd, small sucker stands to one side of the row; along the upper margin of the club there is a broad band of small, denticulated suckers, on long pedicels, arranged in oblique, transverse rows of five or six; this band of suckers is interrupted opposite the large hooks; beyond the hooks a large group of similar small suckers covers nearly the whole distal portion of the club (Plate XLV, fig. 1); at the tip of the club there is a circle of small smooth suckers; along the lower margin of the middle portion of the club there is a band of small suckers, like those on the other margin; along the basal third of the margin and supported on a thickened marginal expansion of the club, there is a row of six special, smooth, connective suckers, at the inner ends of transverse, muscular ridges (fig. 1*e*); between and alternating with these suckers, there are deep pits and as many small, round tubercles, destined to fit the suckers and ridges of the other club; continuous with these a row of similar, but smaller, sessile, connective suckers and tubercles extends down along the margin of the inner face of the arm, for about half its length, becoming smaller and more simple proximally; an irregular band, formed of two or three rows of small, pediceled and denticulated suckers, extends down the other margin of the arm, with some scattered ones along the middle.

The pen (Plate XLV, fig. 1*d*) is thin, long and narrow; anterior part about half as wide as the middle portion, slender, concave, with thickened margins; the anterior end is very thin, acute; the two marginal ribs converge gradually, as they run backward, and unite near the posterior end; the widest part of the pen is a little behind the middle; the thin margins begin at about the anterior third, gradually increasing in

*The figure given (Plate XV, fig. 3) of the somewhat injured tentacular club of the type of *Chelotenthis rapax* represents the structure nearly correctly, but many of the small suckers and tubercles on the arm, below the club, had been destroyed, the edge above *e'* is injured, and of the large hooks (*a*, *a'*) only the sheaths remain.

width to the widest part, when they still more gradually decrease posteriorly; but toward the end they expand into the obliquely hooded portion, or terminal hollow cone; this portion is strengthened by a dorsal mid-rib, and by numerous small ribs which radiate forward from the tip, one on each side being stronger than the rest. In life, the cone contained part of the testicle, and at the tip a cartilaginous core. Length of pen, in alcohol, 133^{mm}; greatest breadth, 7^{mm}; of shaft, 2.5^{mm}; length of cone, on shortest side, 7^{mm}.

General color of body, fins, head and arms, deep reddish brown, tinged with purple; back darkest; the color is due to large chromatophores rather uniformly and closely scattered over the whole surface; on the arms and siphon they are smaller, but they cover all the surfaces of the arms, except the lower side of the tentacular arms and the face of the club. Total length, 263^{mm} (10.25 inches); length of mantle, 153^{mm} (6 inches); length of dorsal arms, 57^{mm}; of 2d pair, 71^{mm}; of 3d pair, 77^{mm}; of 4th pair, 70^{mm}; of tentacular arms, 100^{mm}; length of fin, from insertion, 63^{mm}; from anterior lobe, 70^{mm}; greatest breadth, 68^{mm}, breadth of head, 29^{mm}.

Notes on the visceral anatomy of the male.

In its anatomy this species resembles *Ommastrephes*. The branchial cavity is very large, extending back nearly to the base of the fin; the median longitudinal septum is far back, gills very long, but not reaching the margin of the mantle, attached nearly to the tip; its structure is like that of *Ommastrephes*. Liver orange-brown, very large, massive, nearly as in *Ommastrephes*, but larger, extending back farther than the base of the fin. The circulatory and renal systems are similar to those of *Ommastrephes*, in most respects. The posterior aorta goes back some distance before it divides, about opposite the base of the fin, into the medio-ventral artery of the mantle, and a caudal artery. Two large ventral renal organs lie below and to each side of the heart, and blend together, in front of it, into a large mass, which has a pointed lobe extending forward; posteriorly two lobes extend back, as usual, along the posterior venæ-cavæ. The first stomach is rounded and the second stomach is a large, long-pyriform sac; the intestine is long; the ink-sac is long-pyriform. The reproductive organs are small, indicating that the specimen is still immature, and probably only one year old. The spermary or "testicle" is small (length 18^{mm}, diameters 2^{mm} and 4^{mm}), flattened, tapering backward, partly inclosed by the hooded portion of the pen, and with the anterior end attached laterally to the posterior end of the cæcal lobe of the stomach. The prostate gland, vesiculæ-seminales and spermatophore-sac are small; the efferent duct is long and slender, extending forward over and beyond the base of the left gill.

MOROTEUTHIS Verrill. (See pp. [65], [70].)

Type, *Onychoteuthis* (or *Lestoteuthis?*) *robusta*, Trans. Conn. Acad., v, pp. 246–250.
Moroteuthis Verrill, Trans. Conn. Acad., v, p. 393, Oct., 1881.

After referring the type of *Lestoteuthis* to *Gonatus* (not of Gray), Professor Steenstrup admits that the gigantic species, *L.* (?) *robusta* V., is the representative of a distinct genus, to which he would restrict the name, *Lestoteuthis*.

But *L. Kamtschatica* was especially given by me as *the type of Lestoteuthis*, and the characters of the genus were derived entirely from that species, while *L. robusta* was referred to it only with great doubt, owing to the fact that its armature is almost unknown. Therefore, if *Lestoteuthis* hereafter becomes a complete synonym, it should be dropped, when it cannot be kept for its special type-species. For the gigantic species, I proposed (Amer. Journ. Sci., vol. xxii, p. 298, Oct., 1881) a new genus, *Moroteuthis*.

This genus will have, as known characters: A long, narrow, thin pen, terminating posteriorly in a conical, hollow, many-ribbed, oblique cone, which is inserted into the oblique, anterior end of a long, round, tapering, acute, *solid*, cartilaginous terminal cone, composed of concentric layers, and corresponding to the solid cone of *Belemnites* in position and relation to the true pen; elliptical connective cartilages on the base of the siphon; nuchal, longitudinal crests, three, much as in *Ommastrephes;* eye-lids with a distinct sinus; caudal fin large, broad, spear-shaped; ventral arms with smooth-rimmed suckers at the base. The rest of the armature is unknown.

Moroteuthis robusta is the only known species.

Chiroteuthis lacertosa Verrill. (See p. [119].)

Chiroteuthis Bonplandii? Verrill, Trans. Conn. Acad., v, p. 299 (*non* Verany).
Chiroteuthis lacertosa Verrill, Trans. Conn. Acad., v, p. 408, pl. 56, figs. 1–1*f*, Nov., 1881.

Plate XLVI, figs. 1–1*f*.

A nearly complete male specimen of a *Chiroteuthis*, lacking only the tentacular arms and the distal portion of the left ventral arm, was received after the preceding pages were put in type. The stumps of the tentacular arms, remaining, bear the same kind of unarmed sessile suckers as did the arm described on p. [119], and figured on Plate 32, figs. 1–1*b*. It appears to be a new species, and is very distinct from *C. Bonplandii*. The sessile arms are very large in proportion to the head and body, and the ventral arms are much larger than any of the others. The body is small, obconic, tapering rapidly backward to the origin of the caudal fin, where it becomes very small, and continues to taper to the very slender posterior end. The median dorsal angle of the mantle-edge projects far forward, as a broad angular lobe; lateral angles rounded and not prominent. Caudal fin relatively large, as compared with the body, broad-ovate in outline, widest near the middle, tapering backward to an acuminate, slender tip; very broadly rounded laterally, narrowing abruptly anteriorly; the anterior lobes are small, rounded, and project only slightly forward beyond the insertions. Siphon large, with a well-formed valve, far back from the orifice; dorsal bridles rudimentary. Connective cartilages on the base of the siphon, broad-ovate, ear-shaped, with two rounded prominent lobes projecting into its concavity, one posterior, the other ventral, so that the pit is three-cornered (fig. 1*b*). The corresponding connective cartilages of the mantle consist of two pits, separated by a prominent, triangular tubercle (fig. 1*c*). Head large, in proportion to the body, tapering backward from the bases of the arms. Eyes large; lids thin and simple, without a distinct lachrymal sinus. Behind and below each eye is a long (4^{mm}), slender, clavate papilla (fig. 1*f*), probably olfactory in function.

The sessile arms are large and, except the ventral, unusually rounded; the inner or sucker-bearing faces are much less differentiated than usual, scarcely differing from the other sides in color, and bordered by only a slight or rudimentary membrane on each side; the rounded prominences from which the sucker-pedicels arise are also colored and not much raised. The dorsal arms are rather long and tapering, but much shorter and smaller than the others, slightly compressed, and with a slight median crest distally. The next pair are similar in form and structure, but considerably longer and larger. The third pair are much longer and larger, with the outer angles well rounded, and a strong median crest extends nearly to the base, but is wider distally, where the arms are strongly compressed. The ventral arms are considerably longer and stouter than the third pair, and very different from all the others in form; they are strongly compressed in the direction parallel with the median plane of the head, and have the lower and outer angles well rounded, and the sucker-bearing face wide and scarcely differentiated from the lateral faces; but on the superior lateral side there is a wide and thick crest running the whole length of the arms, giving them a strongly and obliquely compressed appearance. The suckers on the ventral arms are smaller, fewer, and more distant than on any of the others; those at the bases are largest and three or four stand nearly in a single row; farther out, along the middle of the arm, they are distantly arranged in two rows and rapidly become small. The left ventral arm shows no signs of being hectocotylized; the right one, however, has lost half its length by mutilation. On all the other arms the suckers are regularly and much more closely arranged in two rows, and decrease more gradually in size from near the base to the tips.

The suckers *on all the arms* are similar in form; they are rather deep, narrowed at the rim, slightly constricted above the middle, and swollen below, and very oblique at the base; the pedicels are slender and nearly laterally attached; the horny rings are very deep and oblique, and strongly denticulated on the outer or higher side, but on all the arms they are *smooth on the inner side;* the median, outer denticles are long, slender, close together; laterally they become shorter, broader, acute-triangular and curved forward. On the larger suckers (Plate XLVI, figs. 1*d*, 1*e*) the outer teeth are obtuse, but on the distal ones they become more slender and acute. The margins of the suckers are surrounded with small, elongated scales.

The buccal membrane is thin and much produced, with the angles little prominent; it is attached to the arms by eight thin, but wide, bridles, the two superior ones united together near their origin. The web between the arms is rudimentary but distinct. The pen (fig. 1*a*) is very unlike that of *C. Veranyi*, as figured and described by D'Orbigny. It has a long, narrow shaft, of nearly uniform width, and a long posterior portion, a little wider than the shaft, corresponding in length to that of the caudal fin; at the commencement, this portion expands into narrow, free, incurved margins, but these unite quickly so as to form a long, narrow, angular, tubular portion, tapering to a very slender tip; this portion (fig. 1*a''*) has a distinct dorsal keel, with a groove each side of it, two dorsal angles, and a ventral angle along each side; the narrow shaft has a dorsal keel, with the sides bent down abruptly, nearly at right angles, and a little incurved, so as to produce a squarish keel above, with a deep angular groove below, while the very narrow margins bend outward abruptly (fig. 1*a'*); the shaft increases very slightly in width, to near the subacute anterior end, but preserves the same form, and there is no distinct dilation of the margin anteriorly, such as D'Orbigny figures in the pen of *C. Veranyi*, nor does the posterior portion resemble his figure, though if split open and flattened out it would resemble it more nearly.

This specimen is an adult male, in the breeding condition, for its spermatophore-sac is much distended with spermatophores. The color is much like that of *C. Veranyi*. It is everywhere thickly specked with small, purplish brown chromatophores, except on the buccal membrane and the bases of the tentacular arms, where there are but few; the head, around the eyes, and the end of the siphon are darker; a row of very distinct, rather large, round, dark purple spots runs along the inner surface of the ventral arms, just outside of, and alternating with, the upper row of suckers, which they about equal in size.

Total length, to end of ventral arms, 383^{mm}; to end of third pair, 366^{mm}; to end of dorsal arms, 298^{mm}; tail to dorsal mantle edge, 125^{mm}; to base of dorsal arms, 178^{mm}; length of dorsal arms, 120^{mm}; of second pair, 150^{mm}; of third pair, 188^{mm}; of ventral, 205^{mm}; length of caudal fin, 60^{mm}; its greatest breadth, 41^{mm}; breadth of head at eyes, 20^{mm}; of dorsal arms, 7^{mm}; of third pair, 10^{mm}; of ventral arms, 13^{mm}; of bases of tentacular arms, 3^{mm}; diameter of largest suckers of lateral arms, 2.25^{mm}.

Brown's Bank, off Nova Scotia, taken from the stomach of a cod (lot 956). Presented to the United States Fish Commission by Capt. Wm. Dempsy and crew, of the schooner "Clara F. Friend," June, 1881.

The internal anatomy is somewhat peculiar in several respects, but will not be fully described in this place.

The gills are short and broad, with very long lamellæ. The reproductive organs occupy a large part of the visceral cavity. The testicle is a large, thick, broad-ovate organ, with the two sides folded together around and closely united to the large cæcal lobe of the stomach. The testicle does not extend back beyond the origin of the caudal fin, the visceral cavity being very narrow in that region. The prostate gland and vesicula seminalis are large and swollen, and the spermatophore-sac is also large. The efferent duct is large and long, extending far forward; it expands at the end into a spade-like form, with an acute tip; its orifice is oblique ear-shaped, situated on one side, near the end, and is protected by a lobe or flap. The stomach is saccular, and the large cæcal lobe is not very long. The liver is thick. The posterior aorta goes far back, nearly to the origin of the fin, before dividing, for the median septum of the branchial cavity is placed far back. The ink-sac has the ordinary pyriform shape.

A second smaller specimen, which proves to be a young female, in excellent preservation, was trawled by Lieut. Z. L. Tanner, on the "Fish Hawk," October 10, 1881. This was taken, off Delaware Bay, in 435 fathoms, (station 1048).

This specimen agrees nearly with the type-specimen, described above, in the form and proportions of the body, head, arms, caudal fin, pen, etc., and in the structure and denticulation of the suckers. The caudal fin is slightly broader in proportion, while the suckers are deeper and relatively smaller, especially those on the ventral arms, which are decidedly smaller than those on the lateral ones. They are finely and sharply denticulated on the outer edge, as in the type.

The color is, however, quite different, for in this example the skin and flesh are translucent and beautifully specked with regular, round, often rather large, not crowded, dark brownish red chromatophores; the larger of these, especially on the under side of the fin and body, are ocellated; on the head and arms the chromatophores become smaller and more crowded, more nearly as in the type. The row of large dark purple spots, along the ventral arms, are, in this example, decidedly raised and wart-like. One of the tentacular arms is perfect. These are very long and slender, and bear, along their whole length, relatively large rounded, wart-like, dark purple, sessile suckers having a small central pit. These suckers are about two-thirds as broad as the diameter of the arm, and from close to the base of the arm to the distal fourth they are separated by spaces mostly equal to about twice their diameter; distally they are less numerous. The tentacular club*

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* This arm differs considerably from the one described on p. [119] and figured on Plate XXXII, figs. 1–1*b*, especially in having much more numerous sessile suckers along the whole length of the arm, and in having sharply denticulated suckers on the club. This may indicate that the latter belonged to a different species. But it is possible that the latter had suffered injury, before preservation, sufficient to cause these differences.

is well developed, with a broad marginal membrane along each side, having scolloped or notched edges. The club terminates in an ovate, subacute, dark purple, hollow organ, with its opening on the outer side of the arm. The suckers (Plate XLV, fig. 5) are regularly arranged in four rows. The stalk is long, with a dark purple, fluted summit surmounted by a very slender pedicel, bearing the sucker, which is hooded, with a lateral opening; the horny ring bears several slender, sharp teeth on the outer side, the central one being much the longest; the soft rim of the sucker is covered with many rows of small scales, the inner ones with acute tips. The lateral suckers do not alternate with the median, but the two arise close together, opposite each other, and in line with the teeth on the edge of the marginal membrane. The inner surface of the club is specked with brown chromatophores, and the marginal membranes are crossed by brown lines, corresponding to the notches in their edges.

Total length to end of ventral arms, 194^{mm}; to end of third pair, 150; to end of dorsal arms, 127; tail to dorsal mantle edge, 59; to base of dorsal arms, 86; length of dorsal arms, 41; of second pair, 56; of third pair, 69; of ventral, 110; of tentacular arms, 180; of club, 17; breadth of club, 5; length of caudal fin, 27; its greatest breadth, 24; of dorsal arms, 4; of third pair, 5; of ventral arms, 8; of bases of tentacular arms, 1.5; diameter of largest suckers of lateral arms, 1^{mm}.

This species differs widely from *C. Bonplandii* in the sessile arms, etc. It is much more nearly related to *C. Veranyi*, from which it differs decidedly in the pen; in the suckers; and in the caudal fin, if these parts are correctly described and figured, for the latter.

BRACHIOTEUTHIS Verrill.

Trans. Conn. Acad., v, p. 405, Nov., 1881.

Allied to *Chiroteuthis*. Differs in having the lateral connective cartilages of the siphon simple, long-ovate, and the corresponding cartilages of the mantle in the form of simple, linear ridges; a rhombic caudal fin; pen with a simple, linear, anterior portion, suddenly expanding into a much broader, lanceolate, posterior portion, which is naturally infolded; arms slender, the ventral ones not distinctly obliquely compressed; tentacular club without a spoon-like cavity at tip.

The siphon has a valve and dorsal bridle as in *Chiroteuthis*, and the suckers, so far as preserved, are similar, but those of the club are more numerous, and their pedicels apparently had a less prominent bulb below the sucker.

In addition to the type-species, this genus probably includes the *Chiroteuthis Bonplandii* Verany, from the eastern Atlantic.

C. Bonplandii, as figured, has a very similar pen, but the shape of the caudal fin is different, and the arms are more nearly equal in length. The arms are also represented as having small swellings at the tips. Its tentacular arms are not known.

Brachioteuthis Beanii Verrill.

Trans. Conn. Acad., v, p. 406, pl. 55, figs. 3-3*b*; pl. 56, figs. 2, 2*a*, Nov., 1881.

Plate XLV, figs. 3-3*b*. Plate XLVI, figs. 2, 2*a*.

Male: Body rather small, tapering backward to an acute posterior end; dorsal mantle-edge with a broad obtuse angle; caudal fin large in proportion to the body, broad rhomboidal; outer angles prominent, anterior to the middle; the anterior lobes project forward considerably beyond the insertions, and are rounded. The form of the fin is much like that of *Ommastrephes.* Head thickened at the bases of the arms, not so large in proportion to the body as in *C. lacertosa.* Eyes large, eye-lids thin. Siphon large, with two strong dorsal bridles; internal valve broad, rounded, somewhat back from the orifice; connective cartillages long-ovate, broadest behind (fig. 2*a*); dorsal cartilage of neck oblong, with a strong median ridge and two deep parallel grooves. Lateral cartilages of mantle (fig. 2) are simple linear ridges, extending to the edge of the mantle. Arms not very large, somewhat rounded, long and slender; the dorsal ones are much smaller and shorter than the others; two lateral pairs nearly equal in size and length, more than two-thirds the length of the mantle. Ventral arms shorter and much more slender than the lateral, more than half the length of the mantle; the ventral arms show but little of the compressed, oblique form, so conspicuous in the preceding species, and the crest or fold of skin along the outer-ventral angle is narrow, thin, and not very conspicuous; the suckers on the ventral arms are in two alternating, not distant rows, often appearing almost as if in one row toward the base, where they become smaller, but are of the normal cup-shaped form, with finely denticulate rings and slender pedicels; the tips of both ventral arms are much injured, but small, normal, long pediceled suckers can be traced to the tip of the left arm; the right arm is denuded of its skin and suckers at the tip. The suckers of the four lateral arms are in two rather close rows, larger, oblique, low cup-shaped, attached by slender pedicels, which are somewhat swollen just below the suckers; most of them have lost their horny rings; marginal membranes rudimentary. Web between the arms rudimentary.

Tentacular arms very long and slender, in alcohol about twice the length of the mantle; a few scattered sessile suckers are found along the whole length of the arms; tentacular club well-developed, long-ovate, oblique, with a thick wrist and flat or concave sucker-bearing face; suckers small and very numerous, crowdedly arranged in many rows (probably sixteen rows or more), some of the middle ones larger than the rest; suckers not well preserved, but all appear to have been alike in form; pedicels long and slender, with a smooth and not very large swelling below the base of the sucker; the suckers have lost their horny rims, but the sheaths are shaped much like those of *C. lacertosa,* the distal portion being hood-shaped, with a lateral opening, while the basal part is swollen laterally. The tip of the club is simple, without any such spoon-shaped appendage as is found in the preceding species. Buccal membrane large, with a free thin edge which scarcely forms angles.

Pen (fig. 3*a*) with a narrow, linear anterior portion, consisting of more than half its length, decreasing in width backward, then suddenly expanding into the posterior portion, which is broad and thin, and infolded, so as to form a large, compressed posterior cavity; the anterior portion is concave beneath, with no mid-rib, the edges ex-curved and slightly thickened; when spread out and flattened the posterior portion has a lanceolate form, rather abruptly widening anteriorly and very gradually tapering backward, with a double midrib, and some delicate lines parallel to it, while the lateral expansions are very thin and delicate.

The teeth on the odontophore (Plate XLV, fig. 3*b*) form seven rows: the median ones have a large, acute, central, and two small lateral denticles; the inner lateral teeth have a large, acute inner denticle, and a very small outer one; the next to the outer teeth are somewhat stouter than the outermost, which are very acute and strongly curved; no marginal plates were observed.

Color of body mostly destroyed, in the typical specimens, but small, light purplish brown chromatophores are uniformly scattered over the parts best preserved; this is also the case on the head, siphon, and outer surfaces of the arms, where the skin is well preserved; scattered spots also occur on the inner surfaces, between the suckers.

The male described above has the mantle 62^{mm} long; length of caudal fin, 31; its breadth, 36; end of tail to base of arms, 85; length of dorsal arms, 26; of second pair, 48; of third pair, 45 + (tips gone); of fourth pair, 35; of tentacular arms, 118; of sucker-bearing portion of club, 16; breadth of tentacular arms, 2; of club, 4; of lateral arms, at base, 3.5; of ventral arms, 3; diameter of eye-ball, 8; of largest suckers of lateral arms, 1.2; length of pen, 62; of anterior, narrow portion, 38; its breadth anteriorly, where widest, 2; where narrowest, 1.25; length of posterior portion, 24; its breadth, 8^{mm}.

The supposed female has lost the tail, but the arms are in better condition than those of the male; it differs from the male in having distinctly smaller suckers on the lateral arms. Length of dorsal arms, 27^{mm}; of second pair, 44; of third pair, 46; of fourth pair, 37; of tentacular arms, 120; of club, 16^{mm}.

A larger specimen (station 994), which has lost its head and pen and therefore cannot be positively identified, has a much darker color. It is dark purplish brown over the whole body.

Two typical specimens were obtained off Martha's Vineyard, at stations 1031 and 1033, in 255 and 183 fathoms; one, of doubtful identity, at station 994, in 368 fathoms, by the U. S. Fish Commission, in 1881. All three were from fish-stomachs.

This interesting species was named in honor of Dr. T. H. Bean, the ichthyologist, who took charge of the fishes on the "Fish Hawk" this season.

Histioteuthis Collinsii Verrill. (See p. [121].)

Plate XXIII. Plate XXIV, figs. 3–7. Plate XXV, figs. 1, 1*a*. Plate XLV, figs. 6, 6*a*.

The teeth of the odontophore originally described and figured (p. [123], Plate XXIV, fig. 6) were not the most developed of those on the same odontophore; therefore, I have prepared another figure (Plate XXIV, fig. 7). The pedicels of the larger suckers on the tentacular club are very peculiar. They are, when extended, long and remarkably stout, their diameter being more than half that of the sucker. They are cylindrical, and are capable of being invaginated to near the middle, so that they can be lengthened out or very much shortened by a sort of telescopic motion. The upper end is thick, and so fits the basal part of the broad sucker that it acts as a piston, very perfectly. (Plate XXXV, figs. 1, 1*a*.)

Two additional examples of this interesting species have been received. The first is in nearly the same condition as, but is considerably smaller than, the one originally described. The head and arms alone remain, but these are well enough preserved to show the characteristic color-marks. It was taken from a cod, on the western part of the Grand Bank, N. F., by Captain Johnson and crew, of the schooner "Augusta Johnson" (lot 962). Presented to the U. S. Fish Commission, June, 1881.

The last example also consists only of the head and sessile arms, and is not in so good condition as either of the others referred to. It is about as large as the one originally described. This was taken by Capt. Chas. Anderson and crew, of the schooner "Alice G. Wonson," in 180 fathoms, near the northeast part of George's Bank, October, 1881.

Desmoteuthis tenera Verrill.

Trans. Conn. Acad., v, p. 412, pl. 55, figs. 2–2*d*, pl. 56, fig. 3.

Plate XLV, figs. 2–2*d*. Plate XLVI, fig. 3.

Two small but perfect specimens of this new species were taken in the "trawl-wings"* this season, at station 952, in 388 fathoms.

The specimens are both males, but show no positive evidence of hectocotylization. The eyes are very large and prominent, occupying the whole of the sides of the head, wide apart dorsally, but nearly in con-

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* The "trawl-wings," which were first invented and used by the U. S. Fish Commission, this summer, consist of fine nets attached to a support extending out from each end of the trawl-beam. When in use they are about two feet above the sea bottom. They are provided with an interior funnel-shaped net to prevent the escape of animals captured. They have been of great value to us for capturing, and retaining in excellent condition, many kinds of free-swimming deep-sea animals, not otherwise obtainable, or if taken in the trawl crushed by the great masses of fishes, echinoderms, actiniæ, etc., usually taken in every haul in those waters.

Among the things captured in the "trawl-wings" are not only several cephalopods (including *Alloposus*, *Lestoteuthis*, *Rossia*), but *Cymbulia calceolus*, and other Pteropods; vast numbers of *Sagitta*, one of them bright orange-colored; numerous species of Copepod crustacea, some of them of great size; Schizopods; Salpæ; Acalephs, including one very remarkable new form of Siphonophora, etc.

tact beneath; eye-lids thin, entire. The body is long, somewhat fusiform, slightly smaller in advance of the middle. The tissues are exceedingly thin, delicate, pale, and translucent, so that the pen and other organs can be seen through the mantle. Anteriorly the edge of the mantle is directly attached to the head, medially, by a muscular commissure, and there is *no free edge* (such as D'Orbigny figures in *Taonius pavo*) at the narrow middle portion of this band. This commissure is broader within the mantle, and there is another large, oblique, muscular commissure, extending forward to the edge of the mantle, on each side, extensively uniting the inner surface of the mantle to the sides of the siphon. These commissures leave only a rather narrow opening to the gill-cavity, on each side, and one small ventral one, and the interior ventral cavity is partitioned off from the lateral ones.

The siphon is large, projecting forward between the lower sides of the large eyes; it has no valve in the ordinary place, but toward the base, on the dorsal side, there are two erect, rounded, ear-like flaps, each accompanied by a prominent papilla (*i'*), and farther forward a raised, median, transverse fold, and a central papilla (*i*). (Plate XLV, fig. 2*d*.)

The caudal fin is comparatively small, narrow-ovate, tapering to a short, blunt posterior end, and with the anterior lobes narrowed and scarcely projecting beyond the insertions.

Arms rounded, rather slender, tapering to slender tips; those of the third pair are much the longest, and like the second pair, bear along the distal half suckers much larger than the proximal ones; tips short, with few small suckers. The dorsal and ventral arms are about equal, and not much more than half as long as the third pair; they bear smaller suckers, in two rows, regularly decreasing distally. The second pair is intermediate in length between the first and third pairs, with two rows of larger suckers on the outer half, suddenly decreasing distally, with minute ones close to the tip. The large suckers (fig. 2*b*, 2*c*) on the second and third pairs of arms are much larger than the others, but similar in form, deep cup-shaped, convex in the middle, obliquely attached, with a smooth horny rim, except on the distal ones, which have blunt denticles externally. There are about sixteen of these suckers on each of the lateral arms, but eight or ten are decidedly larger than the rest. The large suckers commence nearly at the middle of the arms and extend to very near the tips. The third pair of arms have a thin median carina on the outer side, along the distal third. All the arms have a wide marginal or protective membrane along the inner edges, outside the suckers; these membranes are strengthened by transverse thickened, muscular processes, opposite each sucker; between these the membrane recedes so that the edge is scolloped. The ventral arms have also a membrane along the outer, ventral angle. I am unable to detect any positive signs of hectocotylization, either in the dorsal or ventral arms. Perhaps the presence of the very large suckers on the lateral arms may be a sexual character, but if so, they are symmetrical on the two sides.

Tentacular arms (Pl. XLVI, fig. 3), rather stout, tapering from the thickened base, and in our specimens, equalling in size, and not much longer than, those of the third pair; club well developed, rather broader than the rest of the arm, with a dorsal keel and wide, marginal, protective membranes; the suckers are arranged in four regular rows; the larger suckers are about equal in size to the larger ones of the dorsal arms; of these there are eight or nine in each row, the marginal ones are scarcely smaller than the median ones and similar in shape, but more oblique, all there suckers are cup-shaped, obliquely attached, with long pedicels; the marginal ring is denticulated all around, the teeth on the outer or higher side being slender, sharp, and incurved; those on the inner side minute. The distal part of the club is short, and covered with four rows of small suckers, similar to the larger ones in shape and armature; at the tip is a small group of minute suckers, apparently unarmed. At the proximal end of the club there is a group of small denticulated suckers, and four irregular rows of minute, connective suckers, attached by short pedicels, extend along the inner surface of the arm to the middle or beyond; these are interspersed with minute tubercles, more distinct distally, near the club. The outer buccal membrane is narrow, without distinct angles.

The pen is very thin, pale yellow; the anterior portion is narrow and slender; the posterior portion, commencing opposite the origin of the fins, is lanceolate, with two faint, close ribs along the middle, and less distinct parallel lines each side of these; the tip is a hollow cone, about 10^{mm} long.

The teeth of the odontophore (Pl. XLV, fig. 2 *a*) form seven rows; the median teeth have a very large and long median denticle, and a small lateral one on each angle; the inner lateral teeth have a large inner and a very small outer denticle; the two outer rows of teeth are rather stout; a marginal row of rather ill-defined elliptical plates on each side.

Color of mantle pale yellowish white, with scattered, conspicuous, round, or more or less elliptical, purplish-brown spots, 2 to 3^{mm} in diameter, and 5 to 10^{mm} apart. Eyes dark purplish or chocolate-brown; head, siphon, and outer surfaces of arms thickly specked with purplish brown chromatophores.

The length of the largest specimen is 163^{mm}, from end of tail to tip of third pair of arms; length of mantle dorsally, 116^{mm}; mantle to base of dorsal arms, 11^{mm}; diameter of eyes, 17^{mm}; breadth of head across eyes, 30^{mm}; breadth of body, 26^{mm}; length of caudal fin, 45^{mm}; its breadth, 28^{mm}; length of dorsal arms, 20^{mm}; of second pair, 25^{mm}; of third pair, 32^{mm}; of fourth pair, 20^{mm}; of tentacular arms, 35^{mm}; of club, 11^{mm}; breadth of lateral arms, at base, 3.5^{mm}; diameter of largest suckers, 2.5^{mm}.

Off Martha's Vineyard, 87½ miles from Gay Head, station 952, in 388 fathoms. U. S. Fish Commsssion, Aug. 4, 1881.

Notes on the visceral anatomy.

Anatomically, this species closely resembles *Desmoteuthis hyperborea*. (See Plate XXV, fig. 1.) It has a similar short, thick, compressed, ovate liver, with the intestine in a groove along its ventral edge, and the small ink-sac imbedded in its antero-ventral surface. The gills are laterally placed, short, with long lamellæ. The heart is small, irregularly tubular, oblique, with four angles or lobes where joined by the principal vessels. The efferent vessels from the gills are long and conspicuous, because the bases of the gills are distant from the heart.

The alimentary tract consists of a short, narrow rectum, attached to the liver, and ending in a bilabiate aperture, guarded by two slender papillæ; of a long, rather wide, tubular portion, extending back to the base of the caudal fin, and covered, along the ventral side, with lateral rows of clusters of small follicular glands, which, near the liver, diverge into two, separate, large, lateral clusters; posteriorly, where the rows of follicles cease, there is a small, firm, bean-shaped glandular organ, lamellose within, probably serving as a gizzard; this is followed by a long tubular, or fusiform, more or less saccular stomach and a cæcal appendage, running back nearly to the end of the body; at its anterior origin this cæcal appendage is separated from the stomach by a constriction.

The testicle is a rather small, slender, lanceolate organ, attached laterally, for its whole length, to the side of the cæcal appendage. The prostate gland and vesiculæ seminales have their usual position at the base of the left gill, but they are small and probably not fully developed; the efferent duct extends over and a short distance beyond the base of the gill, and is slender and pointed. The renal organs are very different from those of the common squids (*Loligo* and *Ommastrephes*). The posterior part of the anterior vena-cava becomes glandular in front of the heart; there it parts, sending a long, smooth vein to the base of each gill; there each of these veins expands into an ovate renal organ, before joining the branchial auricles.

Architeuthis Harveyi Verrill. (No. 27; see p. [201].)

Since the preceding pages were put in type, I have been able to examine the specimen* mentioned on p. [201].

This specimen was purchased by Mr. E. M. Worth, and preserved, in alcohol, at his museum, 101 Bowery street, New York, where I had a good opportunity to examine it, about two weeks after it had been put in alcohol.

Although this is more nearly complete than any specimen hitherto brought to this country, the arms and suckers are not so well preserved

* An account of this specimen, accompanied by a wood-cut, apparently copied from the photograph, was published in "Harper's Weekly" for December 10. This figure, though poor, gives a fair idea of the general appearance of the creature as it would look if lying flabby and collapsed on the shore. The peculiar appearance of the caudal fin was due to mutilation of that organ.

as in some of the other examples. All the sessile arms have lost more or less of their tips, so that the actual length cannot be given, and many of their suckers are either injured or lost; the tentacular arms are also injured and most of the large suckers of the clubs are destroyed; the caudal fin was not only torn by handling, but one-half of it had, apparently, been destroyed and the wound healed before the death of the creature,* so that its true form cannot be determined; the eye-balls were burst, and most of the pen was gone.

The head, eye-lids, siphon, and front edge of the mantle are, however, in fair condition, and as these parts have not been well preserved in any of the previous examples, some new and valuable facts were learned in regard to the structure of these organs.

Many of the following characters are of generic value: The eye-lids were large, not much thickened, and only slightly angulated, and with a shallow sinus; diameter of opening about 120^{mm} (4.5 to 5 inches). The transverse nuchal crests, behind the eyes, are distinct, but only slightly elevated; of the longitudinal ones, only one, on each side, is distinct, but it is short and not very high; the others (unless they had been rubbed off) are rudimentary. The siphon is large and broad; aperture, 102^{mm} (4 inches) broad, slightly bilabiate, with a broad valve within; dorsal bridles moderately developed. Siphon-pit shallow, *smooth*. Connective cartilages, on base of the siphon, simple, long-ovate, slightly oblique, and only a little concave. Connective cartilages on the sides of the mantle short, and close to the front edge, very simple, consisting of a short, slightly raised, longitudinal ridge. The dorsal angle of the mantle-edge projects forward considerably beyond the sides, as an obtuse angle; the lateral angles are also distinct. The body is large and broad in the middle and anteriorly, but tapers very rapidly to the base of the caudal fin, which is relatively small.

This specimen, when examined by me, measured as follows: Length of mantle, to the lateral angles of the front edge, 4.16 feet; from edge of mantle to inner base of ventral arms, 1.25 feet; circumference of body, 4 feet; length of caudal fin, tip to anterior end of lobe, 21 inches; breadth of one-half of fin, median line of tail to outer edge, 8 inches; length of tentacular arms, 15 feet; of club, 2 feet; from first of the large median suckers to the tip, 20 inches; length of ventral arms (minus tips), 4.66 feet; their circumference at base, 8.5 inches; length of the dorsal arms (minus tips), 4.5 feet; their circumference, 7.5 inches; circumference of second pair of arms, 7.5 inches; of third pair, 8.5 inches; diameter of largest suckers of sessile arms, .75 of an inch.

The arms have a stout appearance, especially toward the base, and do not differ very much in size. In the form of the arms and in the structure of the suckers this specimen agrees essentially with those that

* Owing to this fact, which was not understood by those who saw and figured it at first, some of the cuts that have been printed give the tail very peculiar and remarkable forms.

I have already described. The mandibles are nearly black; their anterior alar edges have a deep notch and a prominent tooth.

The color, which is partially preserved on the arms and ventral side of the body, agrees very well with that of *Ommastrephes illecebrosus.* The skin is bluish or pinkish, thickly specked with small purplish brown chromatophores.

Architeuthis princeps? V. (No. 28.)

In a letter from the Rev. M. Harvey, dated December 19, 1881, he informs me that he had been told by Mr. C. D. Chambers, magistrate of Harbour Buffet, Placentia Bay, N. F., that a very large specimen of *Architeuthis* had been found on the beach at Hennesey's Cove, Long Island, Placentia Bay, during the first week of November last. This was discovered by Albert Butcher and George Wareham, who cut a portion from the head. The specimen had been much mutilated by crows and other birds. The locality is uninhabited. The men estimated the length of the body and head at 26 feet, but this is probably too large an estimate.

Conspectus of the families, genera, and species of Cephalopoda included in this paper.

In the following synopsis the species that have actually been proved to belong to the fauna of the northeastern coast of America, or the waters adjacent, are numbered serially. They have all been personally studied by me, except *Taonius pavo.*

Subclass DIBRANCHIATA. (See p. [73].)

Order I.—DECACERA Blainville. (See p. [75].)

OIGOPSIDÆ. (See p. [75].)

The division called *Oigopsidæ* includes two very diverse groups, differing very widely in their visceral anatomy, as well as in the structure of the eyes, siphon, and mantle connections. These may be called *Teuthidea* and *Taonidea.*

The former will include all the Oigopsidæ described in this paper except the *Desmoteuthidæ.* The *Taonidea* will include the *Desmoteuthidæ* and also several allied forms, which have usually been carelessly referred to *Loligopsis.*

TEUTHIDEA Verrill.

Eyes with free lids, not stalked. Siphon with a subterminal valve. Mantle attached to the siphon by free connective cartilages. Stomach large, pouch-like; intestine short; liver very large; ink-sac large. Pen horny, well developed, as long as the mantle. One of the ventral arms is usually hectocotylized in the male. Arms with suckers, or with claws, or with both.

FAMILY TEUTHIDÆ Owen (restricted). (See pp. [69], [75].)

For a brief synopsis of the previously known genera of this family, see pp. [69–70].

ENOPLOTEUTHIS. (See pp. [70], [203].)

Enoploteuthis Hartingii Verrill. (Pp. [53], [203].)
Enoploteuthis Cookii Owen = *E. Molinæ* D'Orb. (Pp. [53], [203].)

MOROTEUTHIS Verrill. (See pp. [70], [209].)

Moroteuthis robusta (Dall) Verrill. (Pp. [65], [209].)

GONATUS Gray. (See pp. [204], [206].)

Gonatus amœnus Gray. (Pp. [204], [206].)

LESTOTEUTHIS Verrill (See pp. [70], [76], [78], [204], [205].)

1. **Lestoteuthis** Fabricii (Licht.) Verrill. (Pp. [76], [79], [206].)

FAMILY OMMASTREPHIDÆ. (See pp. [80], [201].)

OMMASTREPHES. (See pp. [81–83], [202].)

Ommastrephes (*pars*) D'Orbigny, Voy. Am. Mérid., 1835; Céphal. Acétab., p. 341.
Illex and *Todarodes* Steenstrup, Oversigt k. Danske Vidensk. Selsk. Forhand., 1880, p. 90.

2. **Ommastrephes illecebrosus** (Les.) Verrill. (Pp. [83], [202].)

STHENOTEUTHIS Verrill. (See pp. [99], [201].)

3. **Sthenoteuthis megaptera** Verrill. (P. [100].)
Sthenoteuthis pteropus (Steenst.) Verrill. (Pp. [103], [107], [202].)
4. **Sthenoteuthis Bartramii** (Les.) Verrill. (P. [112].)

ARCHITEUTHIS (Steenst.) Harting, 1881. (See pp. [1–20], [23], [51–65], [114], [199].)

Architeuthus Steenst., 1856 (no description).
5. **Architeuthis Harveyi** Verrill. (Pp. [23–40], [114], [200–201], [219].)
6. **Architeuthis princeps** Verrill. (Pp. [41–50], [114].)
Architeuthis monachus (Steenst.). (Pp. [24], [51–62].)
Architeuthis dux (Steenst.) Gervais. (Pp. [24], [51], [200].)
Architeuthis Hartingii Verrill. (Pp. [53], [200].)
Architeuthis Bouyeri Verrill. (Pp. [54–57].)
Architeuthis (?) **Mouchezi** Velain. (Pp. [63–65].)
Architeuthis grandis (Owen) Verrill. (Pp. [57–59], [200].)

The number of the foreign species, mostly nominal and imperfectly known, will undoubtedly be much reduced when they become better known. Probably *A. dux* and *A. Bouyeri* are identical, but there is as yet no proper zoological description of either. The former has been very briefly described by Gervais, and Harting has published an outline figure of one of the mandibles.

FAMILY MASTIGOTEUTHIDÆ Verrill. (See p. [114].)

MASTIGOTEUTHIS Verrill. (See p. [115].)

7. **Mastigoteuthis Agassizii** Verrill. (P. [115].)

FAMILY CHIROTEUTHIDÆ Gray (restricted). (See p. [118].)

CHIROTEUTHIS D'Orb. (See p. [118].)

Chiroteuthis is the only genus in this family that has been hitherto recognized.

8. **Chiroteuthis lacertosa** Verrill. (Pp. [119], [209].)

BRACHIOTEUTHIS Verrill. (See p. [213].)

9. **Brachioteuthis Beanii** Verrill. (P. [214].)

CALLITEUTHIS Verrill. (P. [117].)

10. **Calliteuthis reversa** Verrill. (P. [117].)
Calliteuthis ocellata (Owen) Verrill. (P. [202].)

FAMILY HISTIOTEUTHIDÆ Verrill. (See p. [120].)

HISTIOTEUTHIS D'Orbigny. (See p. [120].)

11. **Histioteuthis Collinsii** Verrill. (Pp. [121, 216].)

TAONIDEA Verrill.

Eyes large, stalked or prominent, having free lids, but no sinus. Mantle united to base of siphon and back of neck by three muscular commissures. Siphon large, without a true subterminal valve, but usually with special elevated processes, or flaps, in the basal portion. Stomach small, far back; intestine very long, covered with lateral follicular glands; liver small, far forward; ink-sac small. Pen slender anteriorly, as long as the mantle. Hectocotylized arm not observed. All the arms bear suckers.

FAMILY DESMOTEUTHIDÆ Verrill. (See p. [124].)

Body much elongated, mantle united to the neck by three muscular commissures. Siphon without a true valve, but with three peculiar, special thickenings, or raised processes,* in its basal portion. Eyes prominent. Intestine very long; ink-sac small.

DESMOTEUTHIS Verrill. (See p. [125].)

12. **Desmoteuthis hyperborea** (Steenst.) Verrill. (P. [126].)
13. **Desmoteuthis tenera** Verrill. (P. [216].)

TAONIUS Steenstrup (restricted). (See p. [129].)

14. **Taonius pavo** (Les.) Steenstrup. (See p. [130].)

MYOPSIDÆ D'Orbigny. (See p. [131].)

This artificial division includes two very diverse groups, which not

* Of these organs the median dorsal one is larger and more complicated than the others (see Pl. LV, fig. 2*d*, *m*; and fig. 4*a*). It seems to me probable that this organ is the true homologue of the foot of gastropods.

only differ widely in the condition of the eyes, but also in the nature of the hectocotylization of the arms, and in anatomical characters.

To one of these groups, containing the family *Sepiolidæ*, I propose to apply the name *Sepiolidea.*

The other division, *Sepidea*, includes the families *Sepidæ*, *Loliginidæ*, *Idiosepidæ*, and perhaps *Spirulidæ;* but the latter might, perhaps, be best placed with several fossil forms in a division of which it is the sole surviving genus.

SEPIDEA Verrill.

The integument extends entirely over the eye, and there is a pore in front of it. Pupil crescent-shaped. Body commonly elongated. Pen various, rarely absent, usually large, broad-lanceolate or ovate, either horny or calcareous (spirally coiled, tubular, and chambered in *Spirula*, in which it is posteriorly situated). One of the ventral arms of the male is usually hectocotylized.

Mantle usually with three connective cartilages, rarely with one (dorsal) or three muscular commissures.

FAMILY LOLIGINIDÆ. (See p. [131].)

LOLIGO Lamarck. (See p. [131].)

15. Loligo Pealei Les. (P. [132].)
16. Loligo (Lolliguncula) brevis Blainv. (P. [161].)

SEPIOTEUTHIS D'Orbig. (See p. [163].)

Sepioteuthis sepioidea D'Orb. (See p. [164].)

SEPIOLIDEA Verrill.

In this group the eye-lids may either be entirely free all around, or the upper one may be attached to the eye-ball. Pupil either round or crescent-shaped. Body short, obtuse. Fins lateral, separated. Pen small or rudimentary, sometimes absent. Sucker-rings smooth. Dorsal arms, in the male, usually hectocotylized, one or both.

FAMILY SEPIOLIDÆ. (See p. [165].)

STOLOTEUTHIS Verrill. (See p. [165].)

17. Stoloteuthis leucoptera Verrill. (P. [165].)

ROSSIA. (See p. [167].)

18. Rossia megaptera V. (P. [173].)
19. Rossia Hyatti V. (P. [167].)
20. Rossia sublevis V. (P. [170].)

HETEROTEUTHIS Gray. (See p. [174].)

21. Heteroteuthis tenera V. (P. [175].)

ORDER II.—OCTOPODA Leach. (See p. [177].)

FAMILY PHILONEXIDÆ D'Orb. (See p. [178].)

PARASIRA Steenst. (See p. [178].)

Vidensk. Meddel. Naturh. Forening, Kjöbenhavn, 1860, p. 333.

22. **Parasira catenulata** Steenst. (P. [179].)

FAMILY ARGONAUTIDÆ Cantr. (See p. [182].)

ARGONAUTA Linné.

23. **Argonauta argo** Linné. (P. [182].)

FAMILY ALLOPOSIDÆ Verrill. (See p. [180].)

ALLOPOSUS Verrill. See p. [180].)

24. **Alloposus mollis** Verrill. (P. [181].)

FAMILY OCTOPODIDÆ D'Orb. (See p. [183].)

OCTOPUS Lam. (See p. [185].)

25. **Octopus Bairdii** Verrill. (P. [185].)
26. **Octopus lentus** Verrill. (P. [191].)
27. **Octopus piscatorum** Verrill. (P. [194].)
28. **Octopus obesus** Verrill. (P. [193].)

Octopus rugosus Bosc. (P. [195].)
Octopus vulgaris Lam. (P. [72].)
Octopus punctatus Gabb. (P. [72].)

ELEDONE Leach. (P. [183].)

29. **Eledone verrucosa** Verrill. (P. [183].)

FAMILY CIRRHOTEUTHIDÆ Keff. (See p. [196].)

STAUROTEUTHIS Verrill. (P. [196].)

30. **Stauroteuthis syrtensis** Verrill. (P. [196].)

EXPLANATION OF THE PLATES.

All the figures were drawn from nature by Mr. J. H. Emerton, except when otherwise stated.

PLATE I.

Figure 1.—*Architeuthis Harveyi* (No. 5). Head and arms; $\frac{1}{9}$ natural size. From a photograph of the specimen when freshly caught. The back of the head rests upon an oar, so as to cause the beak to protrude, while the arms hang down in a reversed position. The diameter of the bathing tub was 38.5 inches: *a*, left, and *a'*, right ventral arms; *b*, left, and *b'*, right arms of the third pair; *c*, left, and *c'*, right arms of the second pair; *d'*, right dorsal arm, mostly concealed behind the others; *e*, left, and *e'*, right tentacular-arms, folded several times over the oar; *i* to *iv*, the 'club'; *i* to *ii*, the 'wrist'; *ii* to *iii*, the part bearing large suckers; *iii* to *iv*, the terminal division; *o*, the beak.

Figure 2.—Part of the body and caudal fin of the same specimen; $\frac{1}{9}$ natural size. From a photograph made at the same time with the preceding; *u*, mantle cut open; *t*, tip of tail; *b*, right, and *l*, left lateral lobes of the caudal fin.

PLATE II.

Figure 1.—*Architeuthis Harveyi.*—A restoration, $\frac{1}{22}$ natural size, based on the preceding figures and on the specimens received. (See note, p. 9.)

PLATE III.

Figure 1.—*Architeuthis Harveyi* (No. 5). Upper mandible; natural size.

Figure 2.—Lower mandible of same; natural size; lacks a small piece at *a*.

Figure 3.—Posterior part of the 'pen' of the same specimen; $\frac{1}{6}$ natural size. The dotted lines indicate missing parts.

Figures 4, 4*a*.—*Architeuthis Harveyi.* (Specimen No. 4.) The two sides of the broken lower mandibles; natural size.

Figures 1 and 2 were drawn by Mr. J. H. Blake, from the alcoholic specimens; figure 3 was restored and drawn by the author; figures 4 and 4*a* are camera-drawings by the author.

PLATE IV.

Figure 1.—*Architeuthis Harveyi* (No. 4). One of the larger suckers from the tentacular arms; natural size. From a dried specimen.

Figure 1*a*.—Portion of the marginal ring of the same sucker, seen from the inside; enlarged.

Figure 2.—The same. (No. 24.) Distal part of arm. Front view; natural size.

Figure 2*a*.—The same. Front view. 50th sucker of 2nd pair of arms; enlarged 12 diameters. The marginal scales are destroyed on one side.

Figure 3, 3*a*.—*Architeuthis Harveyi* V. (No. 2). Horny ring of one of the marginal suckers of the club; 3, side view; 3*a*, the same, front view; enlarged 3 diameters.

Figure 4.—*Architeuthis Harveyi* (No. 5). Suckers of tentacular-club; side view, natural size; *a*, one of the larger suckers; *b*, one of the marginal suckers.

Figure 5.—The same specimen. Horny marginal ring of one of the suckers from near the base of ventral arm; enlarged 2 diameters.

Figures 6 and 6*a*.—The same specimen. One of the largest and least oblique of the horny rings from a sucker near the base of one of the lateral arms; top and side views; enlarged $1\frac{1}{2}$ diameters.

Figures 7 and 7*a*.—The same specimen. One of the rings from a medium-sized and more oblique sucker of the middle portion of the lateral arms; top and side views; enlarged $1\frac{1}{2}$ diameters.

Figure 8.—The same specimen. Another ring from a more distal, smaller, and more oblique sucker, top view; enlarged $1\frac{1}{2}$ diameters.

Figures 9 and 9*a*.—The same specimen. One of the horny rings from one of the smooth-rimmed, sessile, connective suckers on the 'wrist' of the 'club' of the tentacular arms; top and side views; enlarged 3 diameters.

Figures 10 and 10*a*.—The same specimen. One of the small suckers from the distal portion of the 'club', top and side views; enlarged 3 diameters.

Figure 11.—The same specimen. Caudal fin; $\frac{1}{10}$ natural size; drawn from the preserved specimen.

Figures 4, 5 and 11 were drawn by the author, also figure 8, which is a camera-drawing. The others are by J. H. Emerton.

Plate V.

Figure 1.—*Architeuthis Harveyi* V. (No. 5). Teeth of the odontophore, from the anterior portion; enlarged 18 diameters; *a*, median; *b*, inner lateral; *c* and *d*, the two outer lateral teeth; *e*, marginal plates. Drawn from detached teeth.

Figure 2.—The same specimen. Teeth from farther back, on the dorsal portion of the odontophore. Lettering as in fig. 1.

Figure 3.—The same specimen. Anterior portion of odontophore, showing the teeth nearly in their natural positions; enlarged about 3 diameters.

Figure 4.—The same specimen. Portion of the membrane lining the palate, showing the teeth, and hard granules attached to it; enlarged.

Figure 4*a*.—The same specimen. Two of the granules from the membrane lining the mouth; enlarged 18 diameters.

Figure 5.—The same specimen. Another portion of the lining membrane of the palate; enlarged.

Figure 6.—*Architeuthis Harveyi* V. (No. 24). Teeth of odontophore; *a*, median; *b*, inner-lateral; *c*, *c′*, and *d*, from two outer lateral rows; enlarged about 24 diameters. Drawn from detached teeth.

Figure 7.—The same specimen. Portion of radula, showing most of three transverse rows of teeth; enlarged 18 diameters.

Figure 8.—The same specimen. Otolith; *a*, side view; *b*, front view; much enlarged. All the figures are camera-drawings by the author.

Plate VI.

Figure 1.—*Architeuthis Harveyi* V. (No. 24). Young. Pharynx and beak, with odontophore; *o*, œsophagus; natural size.

Figure 2.—The same. Distal part of tentacular-arm, with club; natural size.

Figures 3 and 3*a*.—The same. Segment from distal portion of left arm of the third pair of sessile arms, front view; 3*a*, the same, side view; natural size.

Figure 4.—The same. Basal portion of right arm, of second pair. Front view; natural size.

Plate VII.

Figure 1.—*Architeuthis princeps* V. Side view. Restored mostly from No. 13; $\frac{1}{30}$ natural size.

Figure 2.—*Sthenoteuthis pteropus* V. Side view of the specimen from Bermuda; $\frac{1}{6}$ natural size.

Figure 2*a*.—Caudal fin of the same specimen. Dorsal view; $\frac{1}{6}$ natural size.

PLATE VIII.

Architeuthis princeps V. (No. 14). General figure; from the recently preserved specimen; restored in accordance with the measurements of the freshly caught specimen; $\frac{1}{32}$ natural size. Drawn by the author.

PLATE IX.

Figures 1 and 1*a*.—*Architeuthis princeps* Verrill (No. 14). A marginal ring from one of the large suckers of the tentacular-arm; 1, side view, enlarged 1½ diameters; 1*a*, portion of the rim; enlarged 3 diameters.

Figures 2 and 2*a*.—The same specimen. One of the medium-sized, oblique rings of a sucker from the distal part of a sessile arm; enlarged 1½ diameters; top and side views.

Figures 3 and 4.—The same. Top and side views of one of the smaller and more distal rings, from a sessile arm; enlarged 3 diameters.

Figures 5 and 6.—The same. Top and side views of a complete sucker, with its pedicel, from the middle of a sessile arm; enlarged 1½ diameters.

Figure 7.—The same. Top view of one of the smaller, very oblique, distal sucker-rings, from a sessile arm; enlarged 3 diameters.

Figure 8.—The same. Portion of the horny ring of a medium-sized sucker from the middle of a sessile arm; top view; enlarged 6 diameters; from a camera-drawing.

Figure 9.—The same. Side view of the horny ring of one of the largest and least oblique of the suckers from near the base of the lateral arms; enlarged 1½ diameters.

Figure 10.—The same. Side view of the horny ring of one of the marginal suckers of the tentacular-club; enlarged 3 diameters.

Figure 11.—*Architeuthis princeps* (No. 13). Portions of the horny ring of one of the large suckers of the tentacular-arm, much enlarged; *a* and *b*, portions of the margin, from the outside; *c*, portion seen from the inside.

Figures 8 and 11 are camera-drawings by the author; all the others are by J. H. Emerton.

PLATE X.

Figure 1.—*Architeuthis princeps* V. (No. 14). Caudal fin from beneath; from the specimen a few days after it had been placed in alcohol; about $\frac{1}{6}$ natural size.

Figure 2.—The same specimen. After it had been preserved several months in strong alcohol; about $\frac{1}{6}$ natural size.

Figure 1 was drawn by J. B. Holder, M. D.; figure 2 by the author.

PLATE XI.

Figure 1.—*Architeuthis princeps* V. (No. 10). Upper jaw; natural size.

Figure 2.—The same. Lower jaw; the dotted line shows the parts that are present on the opposite side.

Figure 3.—*Architeuthis princeps* (No. 1). Part of lower jaw; side view; natural size.

Figure 3*a*.—The same. Front view; natural size. The rest of this beak had been destroyed.

Figures 1 and 2 were drawn by the author; figure 3 by J. H. Emerton.

PLATE XII.

Figure 1.—*Architeuthis Hartingii* V. Lower mandible, showing the anterior portion only; natural size.

Figure 1*a*.—The same. Section of a sucker from a sessile arm of the same specimen; 1*b*, horny ring of the same; natural size. After Harting.

Figure 1*c*.—The same. Teeth on the radula. After Harting.

Figure 2.—*Architeuthis dux* Steenstrup. Lower mandible; natural size. Copied from Harting's figure, after Steenstrup.

Figure 3.—*Architeuthis monachus* Steenstrup (Type specimen). Lower mandible; natural size. After Steenstrup.

Figure 4.—*Enoploteuthis Hartingii* Verrill. Anterior portion of jaws; natural size. After Harting.

Figure 5.—*Moroteuthis robusta* Verrill. Section of the solid, terminal cone of the pen; natural size.

PLATE XIII.

Figure 1.—*Moroteuthis robusta* (Dall) V. Side view of one of the specimens, as found on the beach; $\frac{1}{25}$ natural size.

Figure 2.—The same. Dorsal view. The dotted lines indicate portions of the arms that had been destroyed; $\frac{1}{25}$ natural size.

Figure 3.—The same. Side view of the head and siphon, with the anterior part of the mantle, cut open; *e*, the eye; *s*, siphon; *o*, *o'*, *o''*, the three nuchal olfactory crests; *c*, *c'*, *c''*, the connective cartilages attaching the mantle to the neck; *c*, lateral cartilage of mantle; *c'*, lateral cartilage at base of siphon; *c''*, dorsal cartilage of neck; *m*, *m'*, cut edge of mantle.

Figure 4.—The same. The entire dorsal 'pen'; side view; $\frac{1}{22}$ natural size.

Figure 5.—The same. Ventral view.

Figure 6.—The same. A portion from the middle of the 'pen', less reduced.

All the figures were made from the fresh specimens by Mr. W. H. Dall.

PLATE XIV.

Figure 1.—*Moroteuthis robusta* (Dall) Verrill. Odontophore; side view; enlarged $3\frac{3}{4}$ diameters.

Figure 2.—The same. Part of a row of the teeth from near the anterior bend of the odontophore; enlarged 22 diameters; *a*, median tooth, front view; *a'*, side view of same; *b*, first lateral; *b'*, the same, side view; *c*, second lateral, front view; *d*, outer lateral, front view.

Figure 3.—The same. One of the inner lateral teeth, side view; enlarged 54 diameters.

Figure 4.—The same. Median tooth, side view; enlarged 54 diameters.

Figure 5.—The same. Upper mandible, natural size.

Figure 6.—The same. Lower mandible, natural size.

Figure 7.—The same. Anterior end of terminal cone, showing a portion of the posterior end of the 'pen' inserted into it; $\frac{1}{2}$ natural size.

Figure 8.—The same. Section of a ventral arm, close to the base; natural size; *a'*, one of the suckers, side view; *b* and *b'*, marginal membranes; *c*, crest or membrane along outer angle; *e*, median vein, near inner surface.

Figures 1 to 4 are camera-drawings by the author; the rest are by J. H. Emerton.

PLATE XV.

Figure 1.—*Lestoteuthis Fabricii* Verrill. Young. Pen; enlarged 2 diameters. Copied from G. O. Sars as *Gonatus amœnus*.

Figure 1*a*.—The same. Part of odontophore. Copied from G. O. Sars.

Figure 1*b*.—The same. Portion of tentacular club, front view; enlarged. Copied from G. O. Sars.

Figure 2.—The same. Young. General figure, dorsal view; enlarged 2 diameters From an American example.

Figures 2*a*, 2*b*.—The same. Front and side views of one of the suckers from the outer rows of a lateral arm of the same specimen.

Figures 2*c*, 2*d*.—The same. Front and side views of a hook-sucker from the median rows of the same arm.

Figure 3.—*Lestoteuthis Fabricii* Verrill (*Cheloteuthis rapax*). Club of tentacular arm, front view; enlarged 2 diameters. The horny hooks are lost from the claws *a*, *a'*, *a''*; *b*, *c*, small lateral suckers; *d*, *d'*, small suckers of distal portion; *e*, *e'*, connective suckers and tubercles.

Figure 3*a*.—The same specimen. One of the suckers corresponding to *c* of figure 1, front view; much enlarged.

Figure 3*b*.—The same specimen. A small sucker, corresponding to *d* of figure 1.

Figures 3*c*, 3*d*.—The same specimen. Front and side views of one of the claws, with its enclosed horny hook or 'nail', from the middle of a lateral arm; enlarged 8 diameters.

Figure 3*e*.—The same specimen. Connective cartilage from base of siphon, front view; enlarged 2 diameters.

Figure 3*f*.—The same specimen. Beak and pharynx, side view; enlarged 2 diameters.

Figure 4.—The same specimen. Teeth of the odontophore; enlarged 22 diameters.

Figure 5.—*Enoploteuthis Hartingii* Verrill. Two hooks, *a*, *b*, from the arms, side views; *c*, *d*, median and lateral teeth of the odontophore. After Harting.

Figure 6.—*Onychoteuthis Banksii*. One of the large hooks from the middle of the club; *a*, side view; *a'*, front view; *b*, *b'*, corresponding views of one of the smaller hooks of the club; *c*, side view; *c'*, front view of horny ring from one of the small suckers in the proximal cluster of connective suckers and tubercles of the club; enlarged 6 diameters.

Plate XVI.

Figure 1.—*Sthenoteuthis megaptera* Verrill. Type specimen. Body seen from beneath; ⅓ natural size; from the alcoholic specimen.

Figure 2.—The same specimen. Part of the membrane lining the palate; enlarged 8 diameters; *a* and *b* are from different places.

Figure 3.—The same specimen. A single row of teeth from the odontophore; enlarged 8 diameters.

Figure 4.—The same specimen. Teeth from the odontophore; enlarged 16 diameters; *a*, two median teeth; *b*, inner lateral teeth; *c* and *d*, teeth of the two outer lateral rows. Drawn from the detached teeth.

Figure 5.—The same specimen. Two of the outer lateral teeth, profile view; enlarged 16 diameters.

Figure 6.—The same specimen. Several lateral teeth in their natural sequence; enlarged 16 diameters.

Figure 7.—The same specimen. Two teeth from the next to the outer row; enlarged 16 diameters.

Figures 8 and 8*a*.—The same specimen. Twenty-second sucker of a ventral arm; front and side views, enlarged 2 diameters.

Figure 9.—The same specimen. One of the largest suckers from the club of the tentacular arm; front view; enlarged 2 diameters.

Figure 10. *Sthenoteuthis megaptera* V. from George's Bank. Large sucker from the tentacular club, front view; enlarged 2 diameters.

Figures 8, 8*a*, and 9 are by J. H. Emerton; the others are by the author; 2 to 7 are camera-drawings.

Plate XVII.

Figure 1.—*Sthenoteuthis megaptera* Verrill, from George's Bank. Beak and inner buccal membrane, front view; natural size.

Figure 2.—The same. Another specimen. Side view of jaws and odontophore; natural size.

Figure 3.—*Sthenoteuthis pteropus* Verrill, from Bermuda. Jaws; *a*, upper; *b*, lower mandible; natural size.

Figure 4.—The same specimen. Isolated teeth from odontophore; enlarged 25 diameters; *a*, median teeth, front view; *b*, inner lateral; *c*, middle lateral; *d*, outer lateral tooth.

Figure 5.—The same specimen. Anterior end of the pen; natural size.

Figure 5*a*.—Posterior end of the same pen.

Figure 6.—The same specimen. Connective cartilage from the base of the siphon; natural size.

Figure 7.—The same specimen. Transverse sections of some of the arms; *a*, of dorsal; *b*, of second pair; *c*, of third pair; natural size. The suckers are omitted.

Figure 8.—The same specimen. Rings of suckers of the sessile arms, enlarged 2 diameters; *a*, *a′*, side and front views of the 15th and 13th suckers of a ventral arm; *b*, *b′*, side and front view of one of the largest suckers of a lateral arm; *c*, *c′*, side and front views of one of the larger suckers of a dorsal arm.

Figure 9.—The same specimen. Part of the border of one of the larger suckers (12th) of the second pair of arms; more enlarged, showing part of the dentate edge of the horny ring, with a portion of the circle of small plates, attached to the membranous border.

Figures 4 and 7 are by the author; fig. 4 is a camera-lucida drawing.

Plate XVIII.

Figure 1, 1*a*.—*Ommastrephes illecebrosus* V. Young male from Provincetown, Mass. General figure of ventral side; $\frac{6}{7}$ natural size; 1*a*, club of the right tentacular arm, front view; $1\frac{5}{7}$ natural size.

Figure 2.—The same. Club and part of tentacular arm, of a larger female specimen; enlarged $1\frac{5}{7}$ diameters.

Figure 3, 3*a*.—The same. Hectocotylized right ventral arm of a large male specimen, from Eastport, Me., showing the sexual modification of the suckers and their peduncles toward the end of the arm; 3*a*, transverse section of the modified portion of the same.

Figure 4.—The same. Pen of a young specimen; $\frac{6}{7}$ natural size.

Figures 5 and 5*a*.—The same. Side and front views of a large sucker of the lateral arms; enlarged $\frac{5}{3}$ diameters.

Figures 6 and 6*a*.—The same. Side and front views of a smaller distal sucker of the lateral arms; enlarged $\frac{5}{3}$ diameter.

Figure 7.—The same. ♀. Side view of the horny ring of one of the largest suckers of the club; enlarged $3\frac{3}{4}$ diameters.

Figure 8.—The same. From Eastport, Me. Part of the teeth of the odontophore, in their natural positions; enlarged 10 diameters; *a*, median teeth; *b* and *b′*, inner lateral teeth; *c*, middle lateral teeth; *d*, outer lateral teeth.

Plate XIX.

Figure 1.—*Ommastrephes illecebrosus*. Male, $\frac{1}{2}$ natural size. Opened on the ventral side. The peritoneal membrane, most of the renal organs on the right side, and the reproductive organs, except the testicle (*t*), have been removed. M, mantle cut open; F, caudal fin; P, posterior part of pen; S, stomach; S′, cœcal lobe; H, systemic heart; *c*, the eye; *b*, olfactory or nuchal crests; *d*, siphon; *f*, *f*, connective cartilages on the base of the siphon; *f′*, *f′*, connective cartilages of the mantle, which fit into *f*, *f*; *m′*, lateral muscles of neck; *g*, *g*, gills; *l*, liver; *i*, ink-sac; *h*, intestine or rectum; *a o*, anterior aorta, going to head; *b o*, efferent branchial vessel; *o*, median ventral artery of mantle; *o′*, *o′*, lateral arteries going to mantle and fins; *a u*, branchial auricles; *v c*, anterior vena-cava; *v c″*, posterior vena-cava of left side (the right one has been removed); *r r*, saccular ventral renal organs; *r′*, more compact glandular (renal) organ, connected with the posterior venæ-cavæ; *t*, testicle or spermary; *p″*, hooded posterior tip of pen, inclosing the end of the spermary. From an alcoholic specimen.

Figure 2.—The same. Jaws; enlarged $1\frac{1}{2}$ diameters; *a*, superior; *b*, inferior mandible.

Figure 3.—The same. Part of the teeth of the odontophore in their natural positions, enlarged 25 diameters; *a*, median teeth; *b* and *b′*, inner lateral teeth; *c*, middle lateral teeth; *d*, outer lateral teeth.

Figure 4.—The same. Side view of the head and siphon, after removal of part of the mantle, ⅔ natural size; 1, 2, 3, 4, bases of 1st to 4th pairs of sessile arms; *t a*, base of tentacular arm; *m*, mantle; *b*, *b′*, olfactory crests around the ear; *d*, siphon; *f*, *f*, one of the connective cartilages for attaching it to the mantle.

Figure 4*a*.—The same. Lateral connective cartilage, *n*, on the inside of the mantle, which fits closely into the cartilage pit (*f*) on the base of the siphon.

Figures 5 and 5*a*.—The same. Side and front views of one of the larger suckers of the lateral arms; enlarged 4 diameters.

Figures 6 and 6*a*.—The same. Side and front views of a smaller distal sucker of the lateral arms; enlarged 4 diameters.

Figure 3 is from a camera-lucida drawing by the author.

PLATE XX.

Figure 1.—*Ommastrephes illecebrosus* Verrill. Female; less than natural size. Lettering as in Plate 19, figure 1, with the following additional letters: *b″*, lower nuchal facet, with the auditory pore; *u*, urethreal openings in the peritoneal membrane, communicating between the gill-cavity and the visceral cavity, containing the renal organs, *r*, *r*; *v c′*, lateral pallial veins, or venæ-cavæ; *o v*, ovary; *o d*, *o d′*, right and left oviducts; *o p*, the anterior opening; *o x*, *x x*, nidamental glands.

Figure 2.—*Loligo Pealei*, var. *pallida*. Anatomy of the alimentary canal, &c.; ⅔ natural size. The organs are shown nearly in a dorsal view, except the jaws, which are viewed from the side and in section; *b m*, buccal membrane; *s m*, section of superior mandible; *i m*, of inferior mandible; *o d*, of odontophore, with teeth; *o e*, *o e′*, œsophagus; *s g*, salivary glands; *s d*, salivary duct; *g l*, subœsophageal ganglion; *l l*, liver; *ao*, *ao*, anterior aorta, running parallel with the œsophagus along and through the liver; S, first stomach; S′, second stomach or cœcal appendage; S″, third stomach, strongly plicated within; *h*, intestine or rectum; *h′*, anal orifice and papillæ; *i*, ink-sac; *i′*, orifice of its duct; H, ventricular heart; *bo*, cut end of one of the branchio-cardiac vessels; *g o*, genital artery, going to testicle; *so*, *so*, branches of gastric artery; *t*, testicle or spermary; *v d*, vas deferens; *p r*, prostate gland and vesiculæ seminales; *s s*, spermatophore-sac; *p*, 'penis' or efferent duct.

PLATE XXI.

Figure 1.—*Mastigoteuthis Agassizii* Verrill. Dorsal view; slightly enlarged.

Figure 1*b*.—The same. Pen; ventral view; enlarged 2 diameters.

Figure 1*c*.—The same. Side view of the same pen.

PLATE XXII.

Figure 1.—*Calliteuthis reversa* Verrill. Ventral view; natural size.

Figure 1*a*.—The same. Beak, buccal membranes and base of arms; front view; natural size.

Figure 1*b*.—The same. One of the larger suckers from a lateral arm; much enlarged.

Figure 1*c*.—The same. Pen; ventral view; somewhat enlarged.

Figure 2.—*Mastigoteuthis Agassizii* Verrill. Front view of the beak, buccal membranes (*b*, *d*), and bases of the arms; enlarged 2 diameters.

Figure 2*a*.—The same. Side view of head, siphon, and anterior part of mantle, showing the cartilage (*c*), on the inner surface of the mantle, which interlocks with *c′* on the base of the siphon; *e*, olfactory (?) papilla near the ear; *p*, an aquiferous pore (?); *s*, siphon; *t a*, base of tentacular arms; 1, 2, 3, 4, bases of corresponding pairs of arms.

Figure 2*b*.—The same. Portion from near the end of one of the tentacular arms; enlarged 16 diameters.

Figure 2*c*.—The same. Suckers from the tentacular arm; much enlarged; *a*, side view; *a′* and *a″*, front views.

Figure 2*d*.—The same. One of the suckers from the middle of a lateral arm; front view; much enlarged.

Figure 2*e*.—The same Three rows of teeth on the radula, in their natural positions; enlarged nea.ly 50 diameters.

PLATE XXIII.

Histioteuthis Collinsii Verrill. Side view of the head and arms; from the preserved specimen; $\frac{3}{8}$ natural size. Drawn by J. H. Emerton.

PLATE XXIV.

Figure 1.—*Desmoteuthis hyperborea* V. Ventral view of a female; $\frac{1}{2}$ natural size.

Figure 2.—The same specimen. Dorsal view of the head and arms. Part of the arms are imperfect.

Figure 2*a*.—The same. One of the arms, left of the third pair; natural size.

Figure 2*b*.—The same. One of the larger suckers from the middle of third pair of arms; front view; enlarged 8 diameters.

Figure 3.—*Histioteuthis Collinsii* V. Original type. One of the tentacular arms; front view; $\frac{4}{5}$ natural size.

Figure 4.—Beak of the same specimen; *a*, upper; *b*, lower mandible; natural size.

Figure 5.—Suckers of the same specimen; *a*, side, and *a*′, front view of one of the larger suckers of lateral arm; *b*, side, and *b*′, front view of a distal sucker; enlarged $2\frac{1}{2}$ diameters.

Figure 6.—The same specimen. Teeth of the odontophore; isolated and enlarged 25 diameters; *a*, median; *b*, inner lateral; *c*, and *d*, outer laterals; *e*, marginal plate; *h*, *g*, and *f*, other views of the lateral teeth. The teeth are not drawn in their natural positions.

Figure 7.—The same specimen. Teeth on the radula in their natural positions; enlarged 22 diameters.

Figure 6 is from a camera-lucida drawing by the author.

PLATE XXV.

Figure 1.—*Desmoteuthis hypoborea* Verrill. Female; about $\frac{1}{2}$ natural size. Specimen opened on the ventral side. M, mantle; F, caudal fin; P, P′, posterior part of pen; *c*, *c*, eyes; *d*, siphon; *d o*, aperture of same; *d*″, base and posterior entrance of same; *f*′, commissure attaching the siphon to the mantle laterally; *g*, *g*, gills; *i*, ink-sac; S′, first stomach, or gizzard; S, S, lobes of stomach; S″, cœcal lobe; *l*, *l*, long, tubular intestine, plicated within, and with clusters of follicular glands externally along the sides; *h*, rectum; *j*, liver; H, systemic heart or ventricle; *b o*, branchial efferent vessels; *a*, *u*, branchial auricles; *v c*″, posterior vena-cava; *r*′, renal organs; *o v*, ovary; *o v*′, some ovules larger than the rest; *o p*, *o p*′, right and left oviducts; *x*′, nidamental glands of the oviducts; *x x*, *x x*′, accessory nidamental glands. From a somewhat mutilated specimen.

Figure 1*a*.—The same. Pen; ventral view; $\frac{1}{2}$ natural size.

PLATE XXVI.

Figure 1.—*Loligo Pealei* Lesueur. Female from Vineyard Sound. Ventral view; $\frac{3}{8}$ natural size; 1, dorsal arms; 2, 3, 2d and 3d lateral arms; 4, ventral arms; *t*, tentacular arms; *a*, ventral olfactory crests around the ear; *e*, eye; *p*, aquiferous pore; *s*, siphon.

Figure 2.—The same. Tentacular a·m of a large male; enlarged $1\frac{1}{3}$ diameters.

Figures 3, 3*a*.—Front and side views of the hectocotylized left ventral arm of a male, showing the sexual modifications of the suckers and their peduncles, toward the tip; enlarged $1\frac{1}{3}$ diameters.

Figure 4.—The same. Female; front view of the beak and buccal membranes; natural size; *m*, mandibles; *f*, inner fold; *e*, second fold of the buccal membrane; *a*, dorsal; *b*, *c*, lateral; *d*, ventral angles of the outer buccal membrane, with their small suckers; *s*, peculiar horseshoe-shaped tubercle, for the attachment of the spermatophores during copulation.

Plate XXVII.

Figure 1.—*Loligo Pealei*, var. *borealis*. Female specimen, from Annisquam, Mass. Pen; natural size. Represented as flattened to show the full width of the thin portion.

Figure 2.—*Loligo Pealei* Les. Female specimen, from Vineyard Sound. Pen; natural size; represented as before in the same manner.

Figure 3.—The same. Pen of a young specimen from Vineyard Sound; natural size. Represented in the same way.

Figure 4.—The same. Pen of a male; $\frac{3}{4}$ natural size. Viewed in the same manner as figures 1 and 2.

Figure 4*a*.—The same. Pen; side view of tip; enlarged.

Figure 5.—*Loligo Gahi* D'Orb. Pen; $\frac{3}{4}$ natural size.

Plate XXVIII.

Figure 1.—*Loligo Pealei*, var. *pallida* Verrill. Male, from Ansonia, N. Y. Dorsal view; about $\frac{1}{4}$ natural size.

Figure 2.—The same. Pen; about $\frac{1}{3}$ natural size.

Figure 3.—The same. Male. Suckers enlarged 3 diameters; *b′*, front view of tenth, from third arm; *b*, side view of the same; *c*, side view of the horny ring of the fifth large sucker of the tentacular club; *c′*, front view of the same.

Figure 4.—The same. Female. Suckers: *a*, lateral, and *a′*, front view of tenth sucker from the third pair of arms; *e*, side, and *e′*, front view of the fifth large sucker of the tentacular arm; enlarged 3 diameters.

Figure 5.—The same. Upper mandible: *a*, rostrum or tip of the beak; *b*, the notch; *c*, the inner end of ala; *d*, the frontal lamina; *e*, the palatine lamina; *a b*, the cutting edge of beak; *b c*, anterior or cutting edge of ala.

Figure 5*a*.—The same. Lower mandible: *a*, rostrum; *a b*, cutting edge; *b c*, anterior edge of ala; *d*, mentum or chin; *e*, gular lamina.

Figure 6.—The same. Part of the teeth of the odontophore; enlarged 50 diameters; *a*, median tooth, front view; *c*, next to outer lateral teeth; *d*, outer lateral teeth; *e*, marginal plates; all are in their natural positions, except *a*.

Figure 7.—The same. Portion of the radula; enlarged 22 diameters.

Figure 8.—*Loligo Pealei.* Portion of the radula; enlarged about 20 diameters.

Figures 9, 9*a*.—The same. Male; side and front views of the horny ring of one of the marginal suckers of the tentacular club; enlarged 10 diameters.

Figure 10.—Teeth on the lining membrane of the palate; enlarged 25 diameters.

Figure 11.—*Chiroteuthis lacertosa.* One of the tentacular suckers; front view; enlarged 75 diameters.

Figure 11*a*.—The same sucker, with pedicel; front view; enlarged 22 diameters.

Figures 5 and 5*a* were drawn by the author; figure 9 was drawn by J. H. Blake, from nature; the rest, by J. H. Emerton.

Plate XXIX.

Figure 1.—*Loligo Pealei*, var. *pallida.* Male. Ventral view; about $\frac{2}{3}$ natural size. The mantle has been cut open, a little to one side of the median line; most of the peritoneal membrane has been removed. C, lower side of head; M, mantle; F, caudal fin; *a*, lachrymal pore; *a′*, muscles; *b*, olfactory crests; *c*, eye; *d*, siphon, cut open; *d″*, cavity of siphon; *e*, valve of siphon; *f*, one of the connective cartilages of the siphon; *f′*, one of the connective cartilages of the mantle, in the form

of a ridge, fitting into the siphonal cartilage; *g*, left gill; *h*, rectum; *h'*, termination of the intestine or rectum; *i*, ink-sac; *i'*, duct of ink-sac; *l*, portion of liver, in position; *m'*, *m'*, muscular columns connecting the head and siphon with dorsal portion of the body; H, systemic heart, or ventricle, crossed by the artery of the ink-sac; *a o*, bulbous base of anterior aorta; *o*, ventral pallial artery, or median branch of the posterior aorta, supplying the ventral parts of the mantle; *o'*, one of the caudal arteries or lateral branches of the posterior aorta going to the caudal fin and posterior parts of the mantle; *a u*, *a u*, branchial auricles; *b v*, afferent vessel going to the gills; *b o*, efferent branchial vessels, returning the blood to the ventricle, their swollen basal portions acting as auricles; *v c*, anterior vena-cava; *r*, *r*, ventral renal organs, two ventral sacculated branches of the vena-cava (on the left side, the vein from the ink-sac and rectum is shown); *r'*, *r'*, two pyriform renal organs, or sacculated and glandular portions of the posterior venæ-cavæ, directly connected with *r*, *r*; *v*, *v c'*, lateral pallial veins, going to the dorsal sacculated divisions of the venæ-cavæ; *v c''*, *v c''*, two posterior venæ-cavæ, returning from the caudal fin and mantle; S, the first stomach, or gizzard; S', large, saccular cœcal appendage of the stomach; S'', glandular, plicated stomach, in continuation with the anterior portion of S'; *t*, spermary or testicle; *p r*, prostate gland, with the vesiculæ-seminales and spermatophore-sac; *p*, efferent sperm-duct or 'penis'; P, posterior portion of the pen.

Figure 2.—The same. Dorsal view of the reproductive organs, part of the renal organs, heart, etc., dissected out. The lettering is as in figure 1, with the following additions: *v d*, *v d'*, vas-deferens, closely folded upon itself; *v s*, vesiculæ-seminales; *s s*, spermatophore-sac; *p o*, genital artery; *g o*, spermatic artery and vein; *p t*, part of peritoneal membrane.

Figure 3.—*Loligo Pealei.* Female in the breeding season. Oviduct, filled with ova, dissected out. Ventral view, about ½ natural size; *v o*, commencement of convoluted, thin membranous portion of oviduct; *o d*, entrance to glandular portion; *o d'*, glandular portion of oviduct, surrounded by the large, laminated gland, *x'*, the arterial vessels of which have been injected; *o p*, orifice of the oviduct.

Figure 3*a*.—The same specimen, seen from the dorsal side.

Figures 2, 3 and 3*a* are from drawings by the author.

PLATE XXX.

Figure 1.—*Loligo Pealei.* Embryo taken from the egg, ventral view, much enlarged; *a*, *a*, *a*, ventral arms, tentacular arms, and third pair of sessile arms; *c*, *c*, eyes on stout peduncles or lobes from the sides of the head; *m*, mantle-edge; *h*, branchial auricles; *y*, unabsorbed yolk-mass.

Figure 2.—The same. An embryo, within the egg, somewhat more advanced than figure 2, side view, less enlarged. The lettering is as in figure 2, with the following additions: *a'*, second pair of arms; *a''*, third pair; *a'''*, tentacular arms; *a''''*, ventral arms; *s*, orifice of siphon; *o*, otoliths; *f*, rudimentary caudal fins. Chromatophores are developed on the mantle.

Figure 3.—The same. An embryo at the period of hatching. Ventral view, enlarged about 15 diameters. The yolk-sac (*y*) is nearly absorbed; a^3, third pair of sessile arms; *t a*, tentacular arms; *v a*, ventral arms; *b*, beak; *l*, odontophore; *r*, teeth on the radula; *s*, siphon; *o t*, otolith; *m*, mantle; *f*, caudal fin; *g*, *g'*, gills; *i*, ink-sac; *t*, rectum; *h'*, *h'*, branchial auricles; *u*, *u'*, rudiments of the stomach.

Figure 4.—The same. Young, just hatched, seen as a transparent object, enlarged 6 diameters; from a specimen raised from the eggs at Newport, R. I., August 5th. Ventral view; a^3, the third pair of arms; *t a*, tentacular arms; *va*, ventral arms; the suckers show on *t a*, the tentacular arms; *b*, the beak; *l*, odontophore; *e*, the eye; *f*, caudal fin; *g*, gill; *h*, ventricle of the heart; *h'*, *h'*, branchial auricles; *i*, ink-bag; *m*, mantle; *o t*, otoliths; *s*, siphon; *s'*, base of siphon; *t*, end of intestine; *u*, stomach; *y*, portion of yolk-sac, not yet absorbed. The chromatophores are omitted.

Figure 5.—The same. A somewhat older larva, taken swimming at the surface. Dorsal view; enlarged about 7 diameters. The dorsal arms are still very small; the tentacular arms are much the largest; the chromatophores are large and symmetrically arranged, but only a part of them are shown in the figure; the caudal fins do not reach the posterior end.

Figure 6.—The same. Young female. Dorsal view of a specimen taken at Newport, R. I., in August. Enlarged 2 diameters. From a fresh specimen.

Figure 7.—The same. One of the egg-capsules, slightly enlarged.

Figure 8.—The same. A very young embryo, earlier than figure 1; dorsal view; *a*, rudiments of the arms; *o*, otoliths; *s*, inner folds of the siphon; *g*, rudiments of the gills; *c*, "eye-stalks," or swellings of the sides of the head; *m*, mantle; *p*, shell-area; *y*, yolk.

Figures 1 and 2 are from camera-drawings by the author; figure 8 is copied from Brooks; the rest are by J. H. Emerton.

PLATE XXXI.

Figure 1.—*Loligo Pealei.* Portion of middle of club, showing the four rows of suckers; enlarged 4 diameters. From an individual having larger suckers than usual.

Figure 2.—The same. Portion of the middle of the tentacular club of a specimen from the same lot and of nearly the same size as figure 1, but having small tentacular suckers; enlarged 4 diameters; *a*, *a'*, largest median suckers; *b*, *b'*, lateral suckers.

Figure 3.—The same. Portion of the horny ring and marginal denticles of one of the large median suckers of the tentacular club; much enlarged.

Figure 4.—*Loligo brevis* Bv. Female. Dorsal view; natural size.

Figure 4*a*.—The same specimen. Pen; natural size.

Figure 4*b*.—The same. Portion of horny ring and marginal scales of one of the large tentacular suckers; much enlarged.

Figure 4*c*.—The same sucker; less enlarged; front view. From a mounted specimen which, by contracting, has everted the denticulated border of the rim.

PLATE XXXII.

Figure 1.—*Chiroteuthis lacertosa* Verrill. One of the tentacular arms, outer side; natural size.

Figure 1*a*.—The same. Front view of club; enlarged 2 diameters.

Figure 1*b*.—The same. One of the suckers, front view; enlarged 10 diameters.

Figure 2.—*Loligo Pealei*, var. *borealis.* Female, in the breeding season. Ventral view; about ½ natural size. The mantle has been cut open nearly in the median line and the peritoneal membrane partly removed. The lettering is the same as in figure 1 of Pl. XXIX, with the following additions: 1, 2, 3, 4, first, second, third, and fourth pairs of sessile arms: *t a*, tentacular arms; *d'*, external orifice of siphon; *o v*, *o v'*, ovary, mostly concealed by the oviduct; *v o*, commencement of glandular portion of oviduct; *x'*, large gland surrounding the oviduct; *o d'*, anterior portion of oviduct; *op*, orifice of oviduct; *x x*, pair of large, ventral, laminated, nidamental glands; *x*, pair of folliculated and mottled, accessory nidamental glands; *u*, one of the urethral openings of the peritoneal membrane.

Figure 3.—The same. Section of gill; enlarged about 8 diameters; *a*, one of the lamellæ with the efferent vessel along its edge; *a'*, its outer end; *b o*, the main efferent or branchio-cardiac vessel, returning the blood to the heart; *b v*, the main branchial vein, or efferent vessel; *b*, one of the branches supplying a lamella; *v*, another vein in the muscular stem, *c*; *d*, membrane uniting the gill to the mantle; *e*, membrane running across the dorsal side of the gill.

Plate XXXIII.

Figure 1.—*Heteroteuthis tenera* Verrill. Front view of male; enlarged 2 diameters.

Figures 1*a*, 1*b*.—The same. Front and side views of one of the larger suckers of the lateral arms of the same specimen; more enlarged.

Figure 2.—The same. Jaws, side view; enlarged 4 diameters; *a*, superior; *b*, inferior mandible.

Figure 2*a*.—The same. Tentacular club; enlarged 5 diameters.

Figure 2*b*.—The same. Pen; enlarged 6 diameters.

Figure 2*c*.—The same. Part of the radula; much enlarged.

Figure 2*d*.—The same. Part of the radula; more enlarged.

Figure 3.—The same. Dorsal view of a male; enlarged 2 diameters.

Figure 3*a*.—The same. One of the larger marginal suckers of the tentacular club, front view; much enlarged.

Figure 3*b*.—The same. Portion of the margin of the sucker, more enlarged, to show the scales.

Plate XXXIV.

Figure 1.—*Heteroteuthis tenera* Verrill. Dorsal view of female; enlarged 2 diameters.

Figure 1*a*.—The same. A group of eggs; enlarged 2 diameters.

Figure 2.—*Rossia sublevis* Verrill. ♀. Dorsal view; natural size.

Figure 2*a*.—The same. One of the suckers of the tentacular club, side view; much enlarged.

Figure 2*b*.—The same. Marginal scales on the edge of the same sucker; more enlarged.

Figure 3.—The same. Pen, ventral view; enlarged 6 diameters.

Figure 4.—The same. Ventral view; enlarged 1½ diameters.

Figure 5.—The same. One of the arms of the third pair, from another female example; enlarged 3 diameters.

Figure 6.—The same. Corresponding arm of the male; enlarged 3 diameters.

Plate XXXV.

Figure 1.—*Histioteuthis Collinsii* Verrill. One of the largest median suckers of the tentacular club; side view; enlarged 4 diameters.

Figure 1*a*.—The same. One of the suckers from next to the outer row, of the same club; enlarged 4 diameters.

Figure 2.—*Rossia Hyatti* Verrill. Side view of young male; enlarged 1½ diameters; from life.

Figure 3.—*Rossia megaptera* Verrill. Female; dorsal view; natural size.

Figure 4.—The same. Suckers; enlarged 22 diameters; *a*, front view of one of the largest from the third pair of arms; *b*, *c*, *d*, three suckers from the tentacular club.

Figure 5.—*Rossia Hyatti* Verrill. Egg containing an embryo; enlarged 6 diameters. The shaded portion represents the yolk still remaining unabsorbed.

Figure 6.—The same. Pen; enlarged 6 diameters.

Plate XXXVI.

Figure 1.—*Stoloteuthis leucoptera* Verrill. Male; from a specimen taken in 1879; enlarged 1½ diameters.

Figure 1*a*.—The same specimen. Male; upper lateral arm, showing the greatly enlarged, middle suckers; enlarged 4 diameters.

Figure 2.—The same. Young female; ventral view; enlarged 3 diameters.

Figure 3.—*Rossia Hyatti* Verrill. A young specimen; enlarged 1½ diameters.

Figure 4.—The same. Adult female; dorsal view; enlarged 1½ diameters.

Figure 5.—The same. Female; suckers; enlarged 22 diameters; *a*, one of the largest from third pair of arms, side view; *b*, *c*, two forms of suckers from the tentacular club.

Figure 6.—The same. Lateral arm of a male; enlarged 3 diameters.

PLATE XXXVII.

Figure 1.—*Rossia Hyatti* Verrill. Female; ventral view of the head and arms; enlarged 3 diameters.

Figure 2.—*Rossia sublevis* Verrill. Female; ventral view of the head and arms; enlarged 3 diameters.

PLATE XXXVIII.

Figure 1.—*Stauroteuthis syrtensis* Verrill. Dorsal view; $\frac{3}{10}$ natural size.

Figure 2.—The same. Lower side of head; *s*, siphon; *e*, eye; *a*, the auditory pore.

Figure 3.—The same. The siphon, turned back.

Figures 4 and 5.—The same. Superior and inferior mandibles; enlarged $2\frac{2}{3}$ diameters.

This plate was drawn by the author, from the alcoholic specimen, except figures 4 and 5, which are by J. H. Emerton.

PLATE XXXIX.

Figure 1.—*Alloposus mollis* Verrill. Young male; side view, showing the sac containing the hectocotylized arm, cut open, so as to expose the partially developed arm; $\frac{1}{2}$ natural size.

Figure 1*a*.—The same specimen. Hectocotylized arm removed from the sac; enlarged 2 diameters.

Figure 2.—The same. Young female; ventral view; $\frac{1}{2}$ natural size.

Figure 2*a*.—The same specimen. Dorsal view; $\frac{1}{2}$ natural size.

PLATE XL.

Figure 1.—*Octopus piscatorum* Verrill. Female; original type. Ventral view; $\frac{2}{3}$ natural size.

Figure 1*a*.—The same specimen. Dorsal view.

Figure 2.—*Parasira catenulata* Steenst. Female; front view; $\frac{1}{2}$ natural size.

Figure 2*a*.—The same specimen. Side view of body and head; $\frac{1}{2}$ natural size.

PLATE XLI.

Figure 1.—*Octopus Bairdii* Verrill. Male; ventral view; natural size; *h*, terminal spoon-shaped organ of the hectocotylized arm; *i*, the groove along the lower side of the arm.

Figure 1*a*.—The same specimen. Hectocotylized arm; enlarged 2 diameters.

Figure 2.—The same. Male; figured in the act of swimming; dorsal view; *a*, terminal spoon of hectocotylized arm. From a living specimen; nearly natural size.

Figure 3.—*Octopus Bairdii* var. Verrill. Side view of a young male, enlarged about $1\frac{1}{2}$ diameters.

Figure 3*a*.—The same specimen. Terminal appendage of the hectocotylized arm; more enlarged.

PLATE XLII.

Figure 1.—*Octopus Bairdii* Verrill. Male; dorsal view from a living specimen; nearly natural size.

Figure 2.—The same. Side view, from life; nearly natural size.

Figure 3.—The same. Jaws; *s*, superior; *i*, inferior mandibles; enlarged 2 diameters.

Figure 4.—The same. Portion of odontophore; enlarged 22 diameters.

Figure 5.—The same. Spermatophores. A, one with the inner sac (*S*) partly extruded; *i*, the point from which the extension commences; enlarged $1\frac{1}{2}$ diameters; B, another spermatophore in its original condition; *a*, filament at large end; *b*, filament at small end.

Figure 6.—*Octopus obesus* Verrill. Male; original type. Basal portion of one of the lateral arms, to show the arrangement of suckers; enlarged $1\frac{1}{2}$ diameters.

Figure 6*a*.—The same. Terminal portion of the hectocotylized arm; enlarged 2 diameters.

Figure 7.—*Alloposus mollis* Verrill. Part of a large mutilated specimen. Portion of an arm, with suckers, from near the base: natural size.

Plate XLIII.

Figure 1.—*Octopus lentus* Verrill. Female; original specimen. Ventral view; $\frac{2}{3}$ natural size.

Figure 2.—The same specimen. Dorsal view; $\frac{2}{3}$ natural size.

Plate XLIV.

Figure 1.—*Alloposus mollis* Verrill. An entire, detached, mature hectocotylized arm; $\frac{3}{4}$ natural size.

Figure 2.—*Octopus lentus* Verrill. Side view of a male; enlarged about $1\frac{1}{2}$ diameters.

Figure 3.—*Eledone verrucosa* Verrill. Side view of a male; $\frac{3}{5}$ natural size.

Figure 3*a*.—The same specimen. Distal portion of the hectocotylized arm, to the edge of the basal web, showing the terminal appendage and the lateral groove.

Plate XLV.

Figure 1.—*Lestoteuthis Fabricii* V. One of the tentacular arms; enlarged 2 diameters.

Figure 1*a*.—The same. The larger claw; side view.

Figure 1*b*.—The same. Lateral arm; enlarged 2 diameters.

Figures 1*b*′, 1*b*″.—The same. One of the hooks; enlarged 4 diameters.

Figure 1*c*.—The same. Portion of ventral arm; enlarged 2 diameters.

Figure 1*d*.—The same. Pen, ventral view; a little less than natural size.

Figure 2.—*Desmoteuthis tenera* V. General figure of male, dorsal view; natural size.

Figure 2*a*.—The same. Teeth of odontophore; enlarged 22 diameters.

Figure 2*b*.—The same. One of the larger suckers of the lateral arms; front view; enlarged 8 diameters.

Figure 2*c*.—The same sucker; side view.

Figure 2*d*.—Valve-like apparatus within base of siphon; larger than natural size; *S*, orifice of siphon; *m*, median organ; *i*′, lateral papilla, and *i*, medio-dorsal papilla; *n*, *n*′, lateral cushions.

Figure 3.—*Brachioteuthis Beanii* Verrill. Dorsal view of the male; natural size.

Figure 3*a*.—The same. Pen, ventral view; enlarged slightly.

Figure 3*b*.—The same. Teeth of the radula; enlarged 22 diameters.

Figure 4.—*Desmoteuthis hyperborea*. Side view of one of the large suckers of the 3d pair of arms; side view; enlarged 8 diameters.

Figure 4*a*.—The same. Peculiar organs on the interior of the medio-dorsal side of the base of the siphon; enlarged 2 diameters; *i*, median, *i*′, lateral papillæ.

Figure 5.—*Chiroteuthis lacertosa* V. Young female. One of the suckers of the tentacular arms; front view; enlarged 22 diameters.

Figure 6.—*Histioteuthis Collinsii*. One of the larger suckers of the median rows of the tentacular club; side view; enlarged 2 diameters.

Figure 6*a*.—The same. One of the suckers of the sublateral rows of the tentacular club.

Plate XLVI.

Figure 1.—*Chiroteuthis lacertosa* Verrill. Dorsal view of the male; a little less than three-quarters natural size; *t a*, stump of one of the tentacular arms, with a few of the sessile suckers remaining.

Figure 1*a*.—The same. Ventral view of the pen; enlarged about 3 diameters.

Figure 1*a'*.—The same. Section of the anterior part of the pen; 1*a''*, section of the posterior part of the pen; much enlarged.

Figure 1*b*.—The same. Connective cartilage of siphon; enlarged 3 diameters.

Figure 1*c*.—The same. Lateral connective cartilage of mantle.

Figures 1*d*, 1*e*.—The same. One of the larger suckers of the 3d pair of arms; front and side views; enlarged 6 diameters.

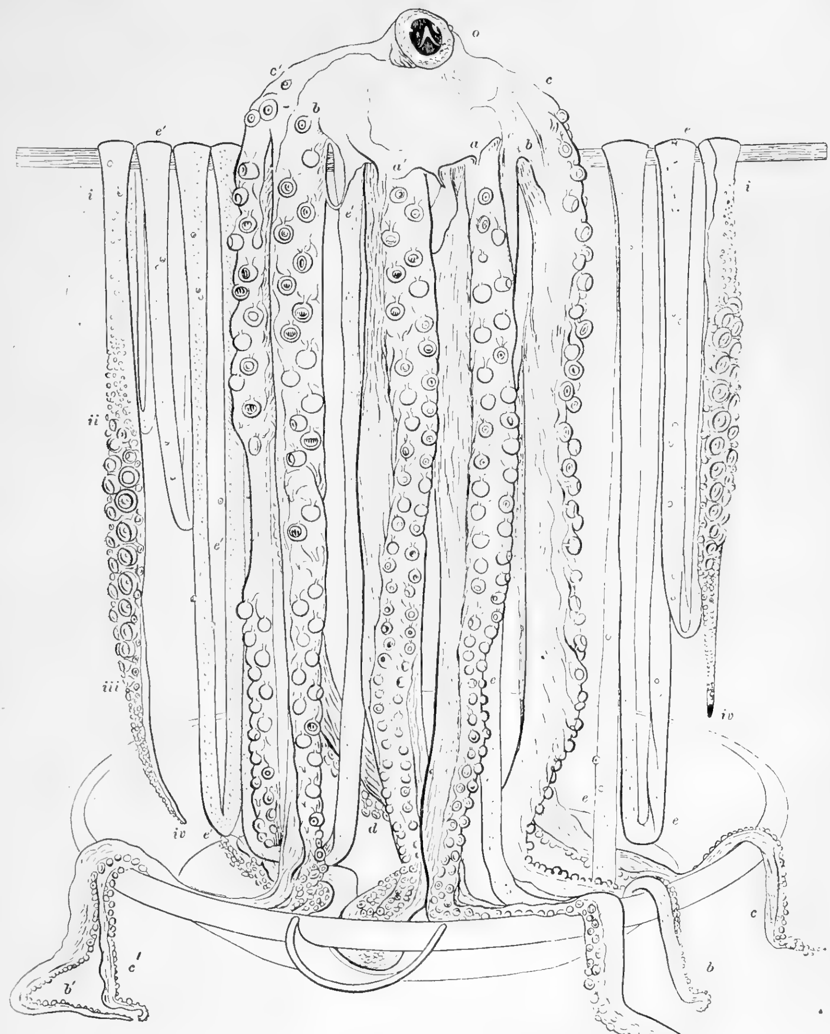
Figure 1*f*.—The same. Papilla, or rhinophore, from behind and below the eye; enlarged 3 diameters.

Figure 2.—*Brachioteuthis Beanii* V. Connective cartilage of the mantle; enlarged.

Figure 2*a*.—The same. Lateral connective cartilage of the siphon; enlarged.

Figure 3.—*Desmoteuthis tenera* V. Tentacular arm; enlarged 3 diameters.

1



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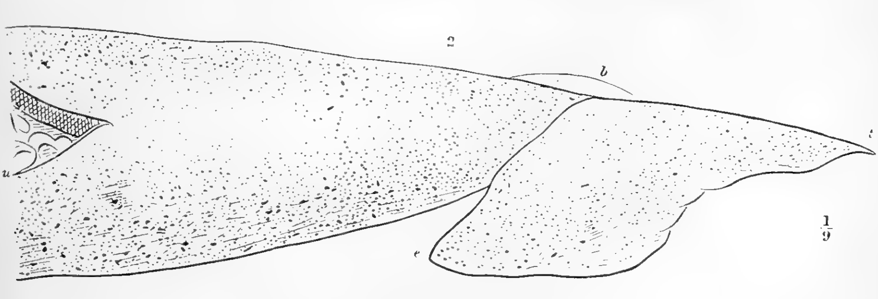

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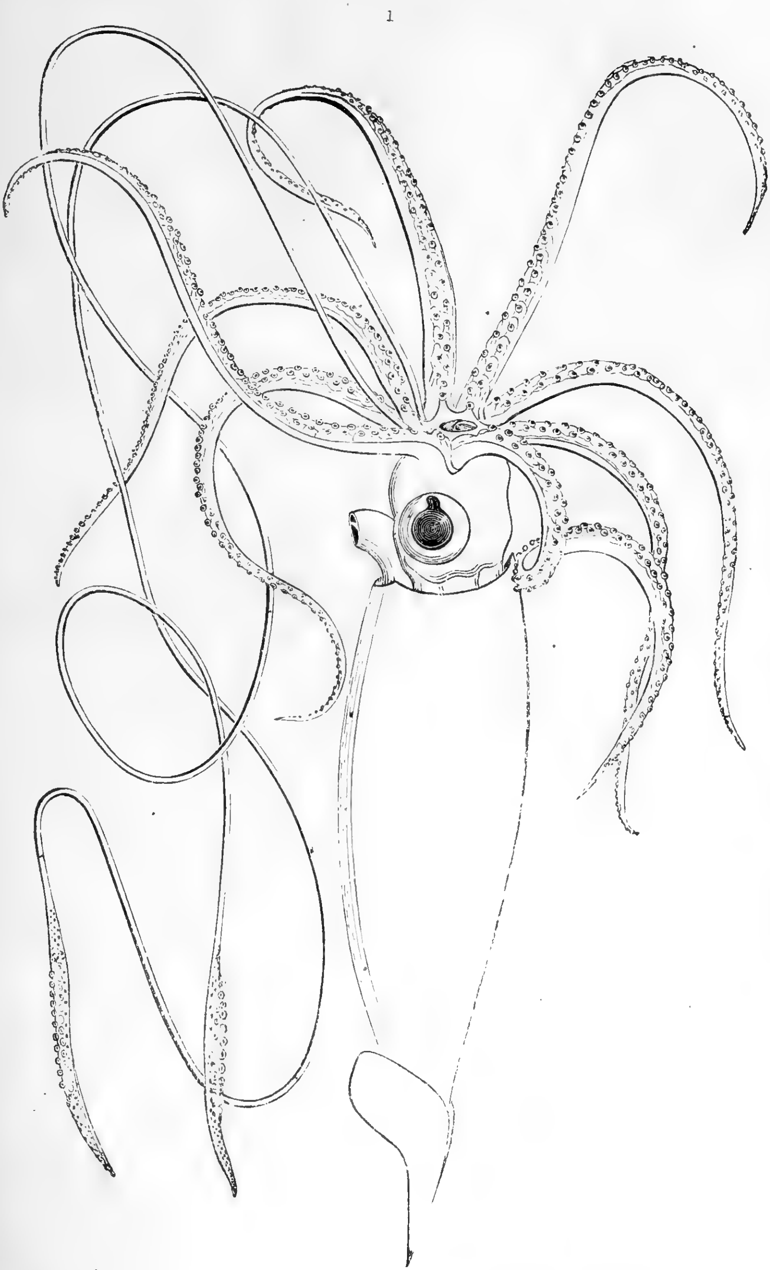

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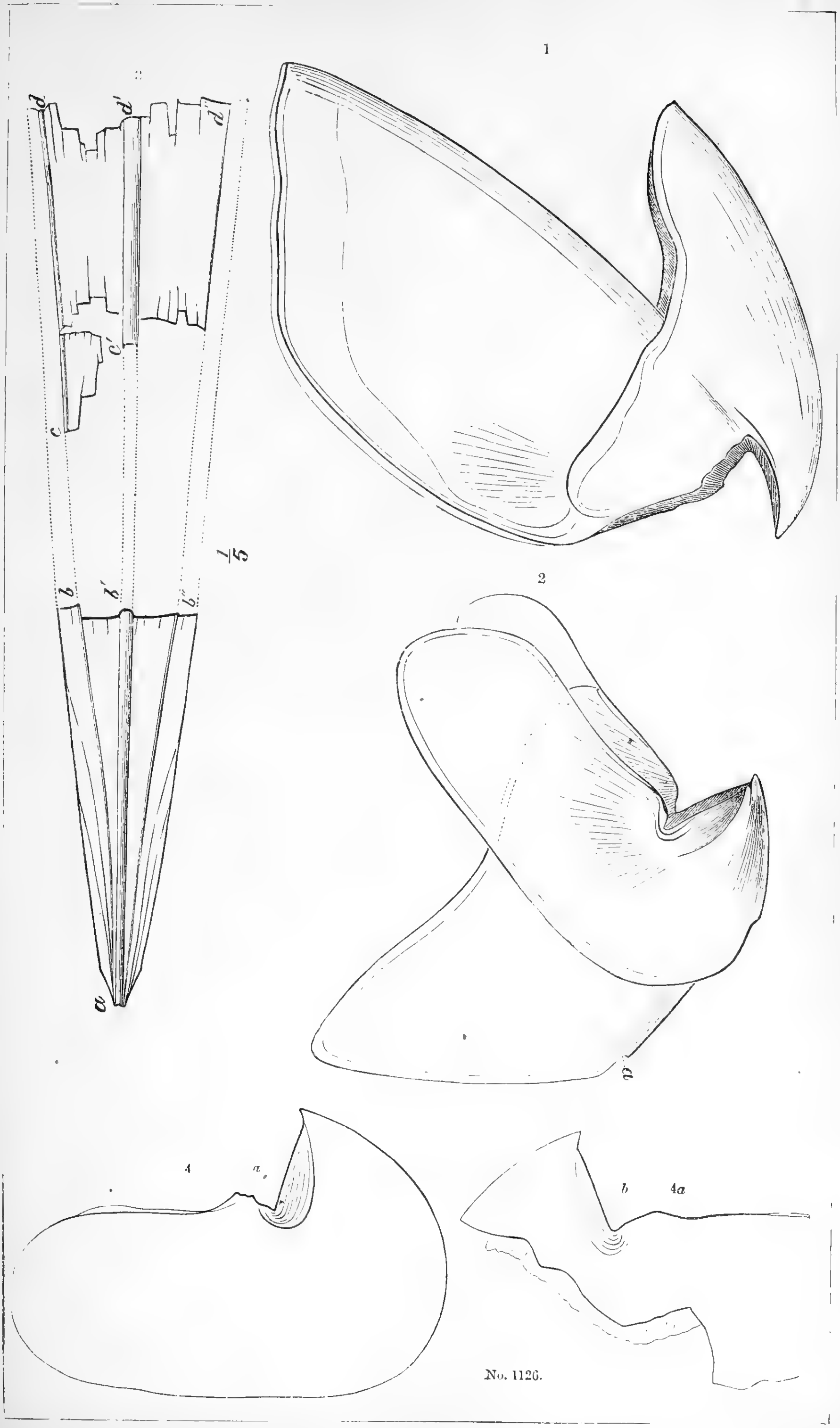
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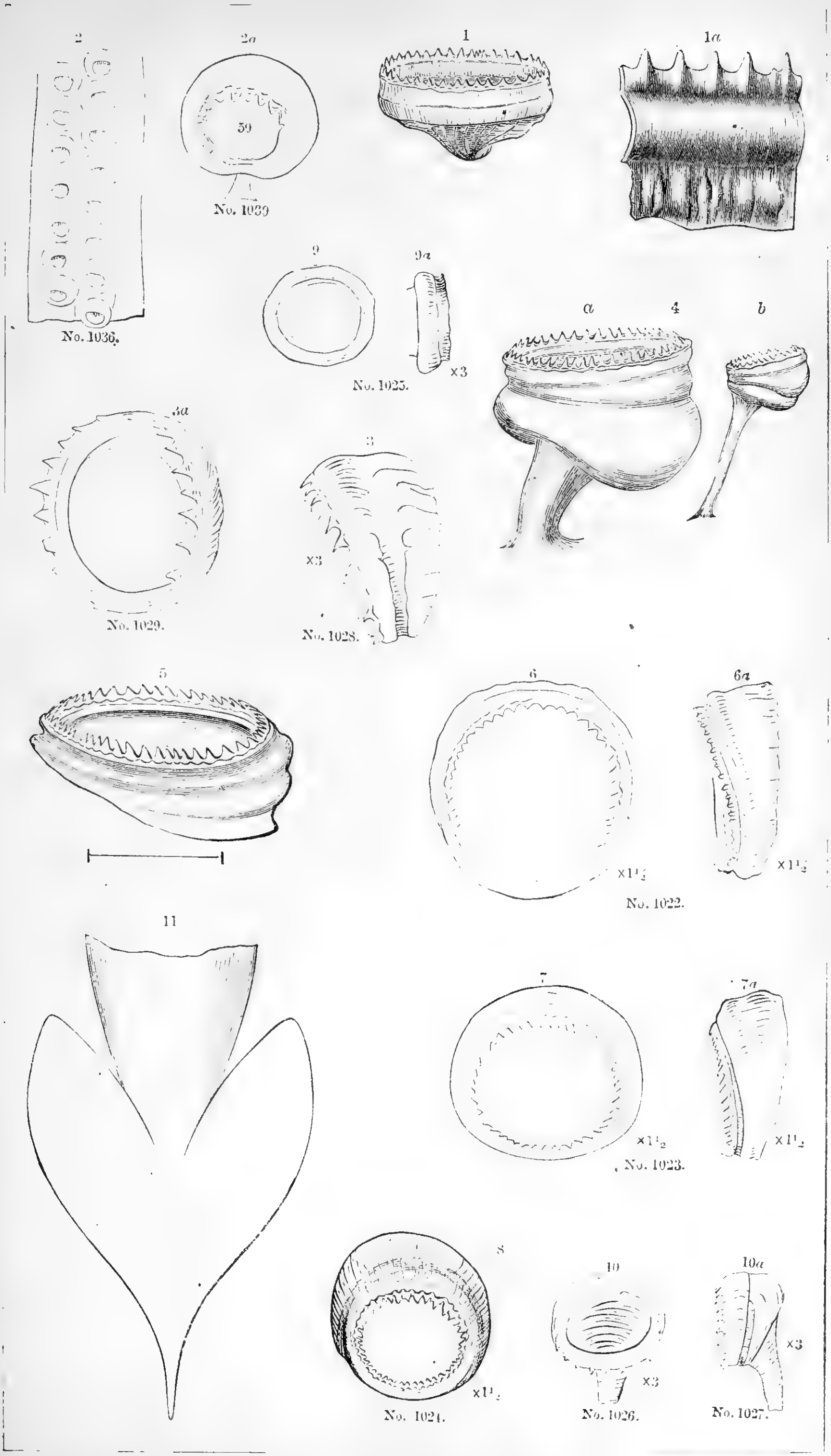
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×1½
×1½
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7
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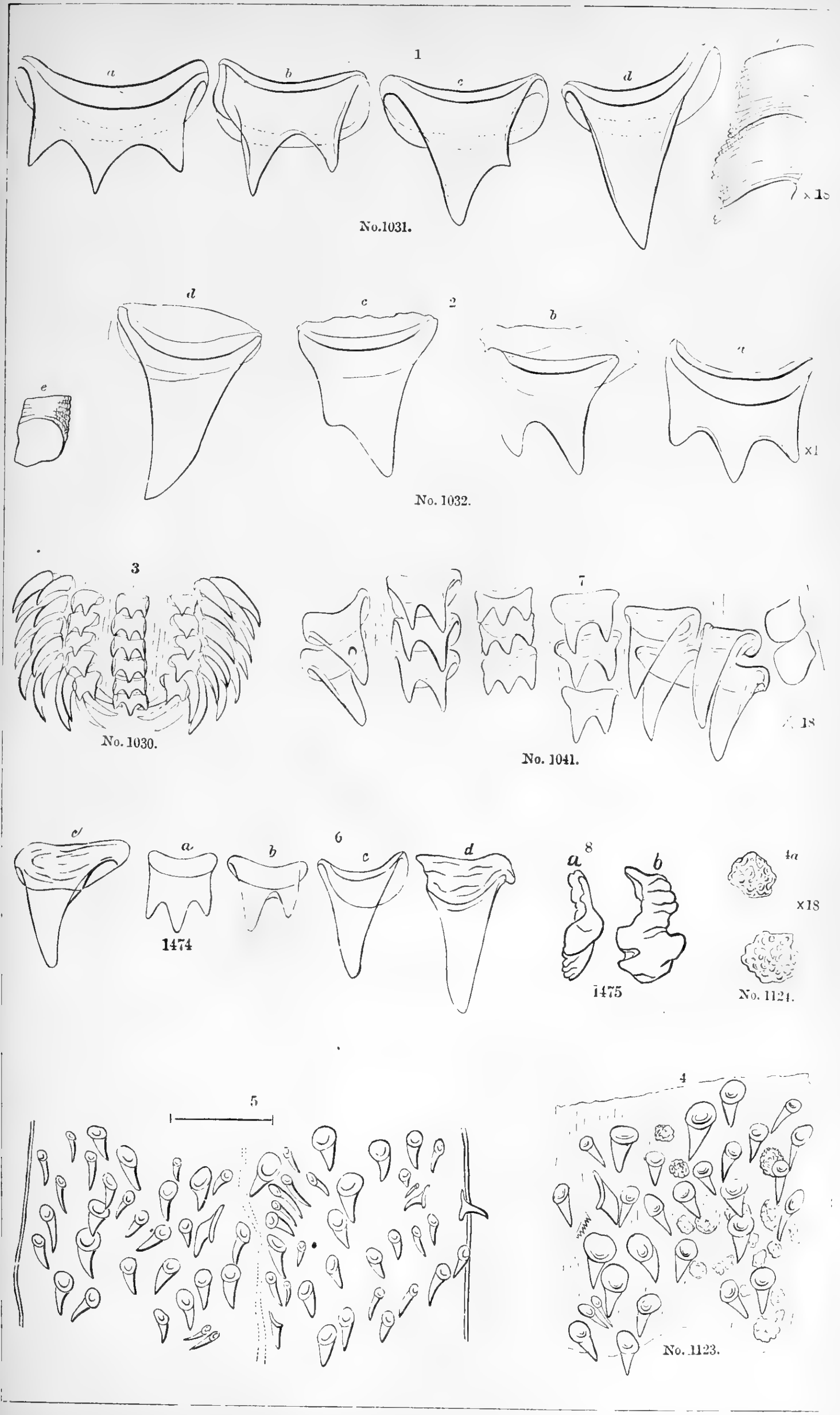
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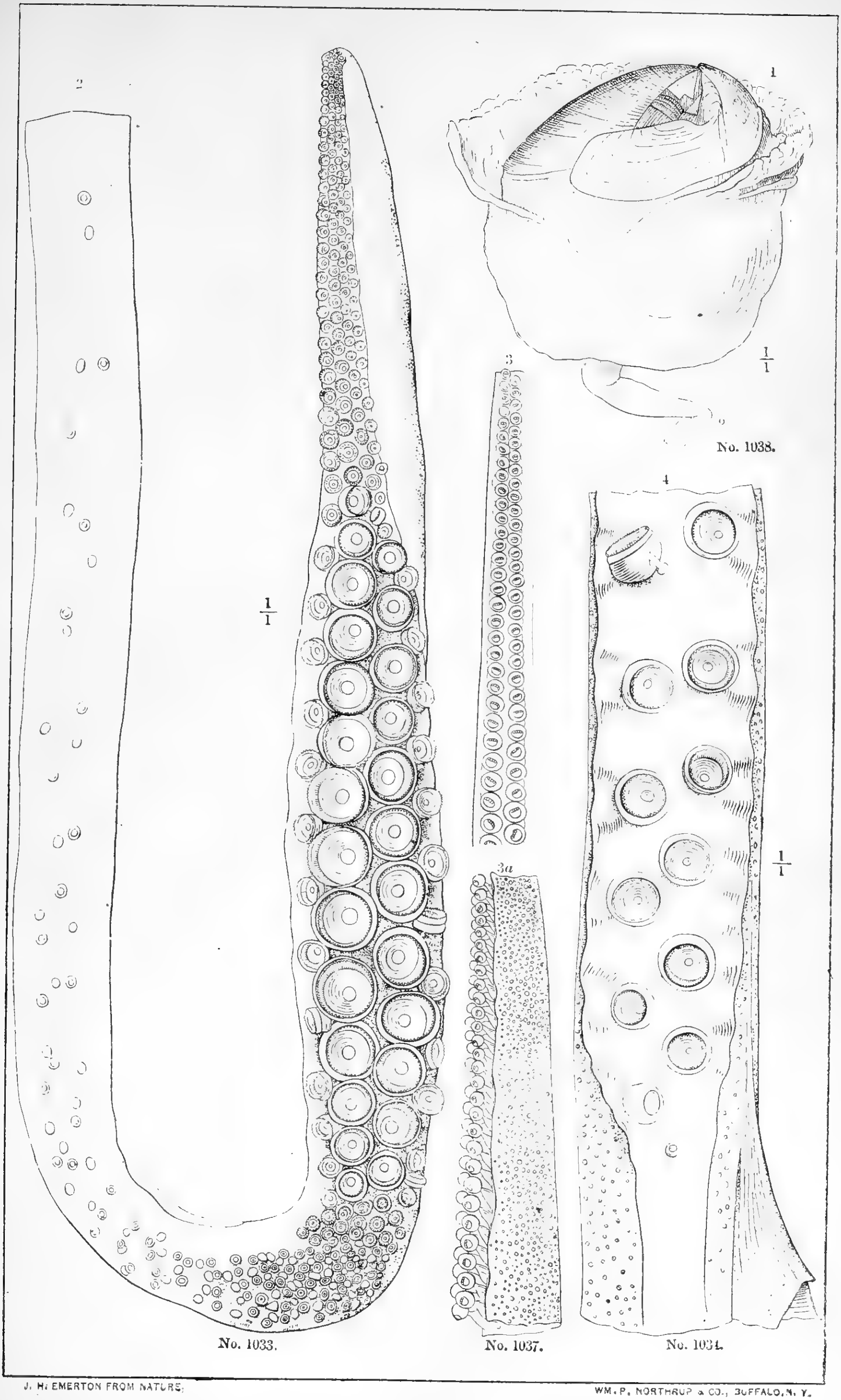

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WM. P. NORTHRUP & CO., BUFFALO, N. Y.

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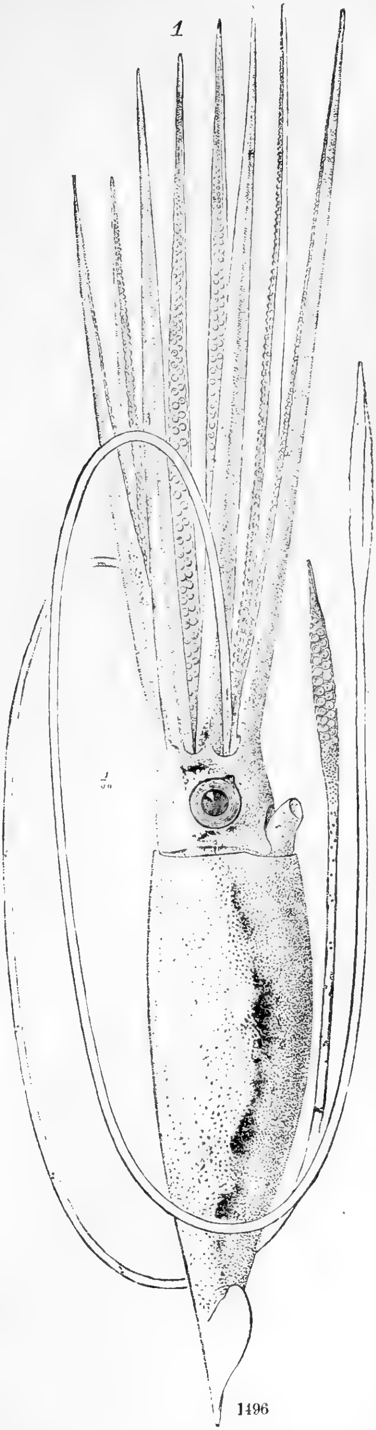

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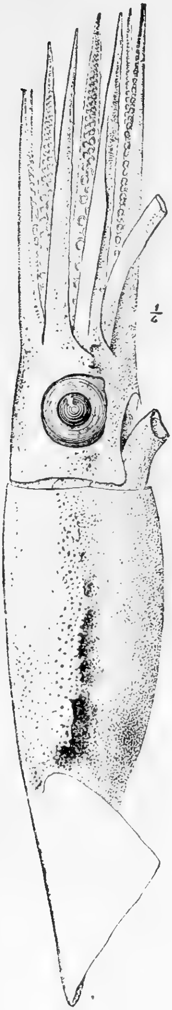

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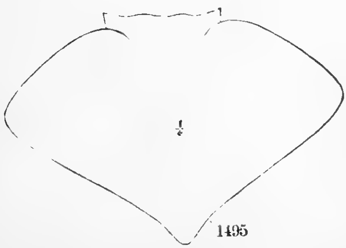

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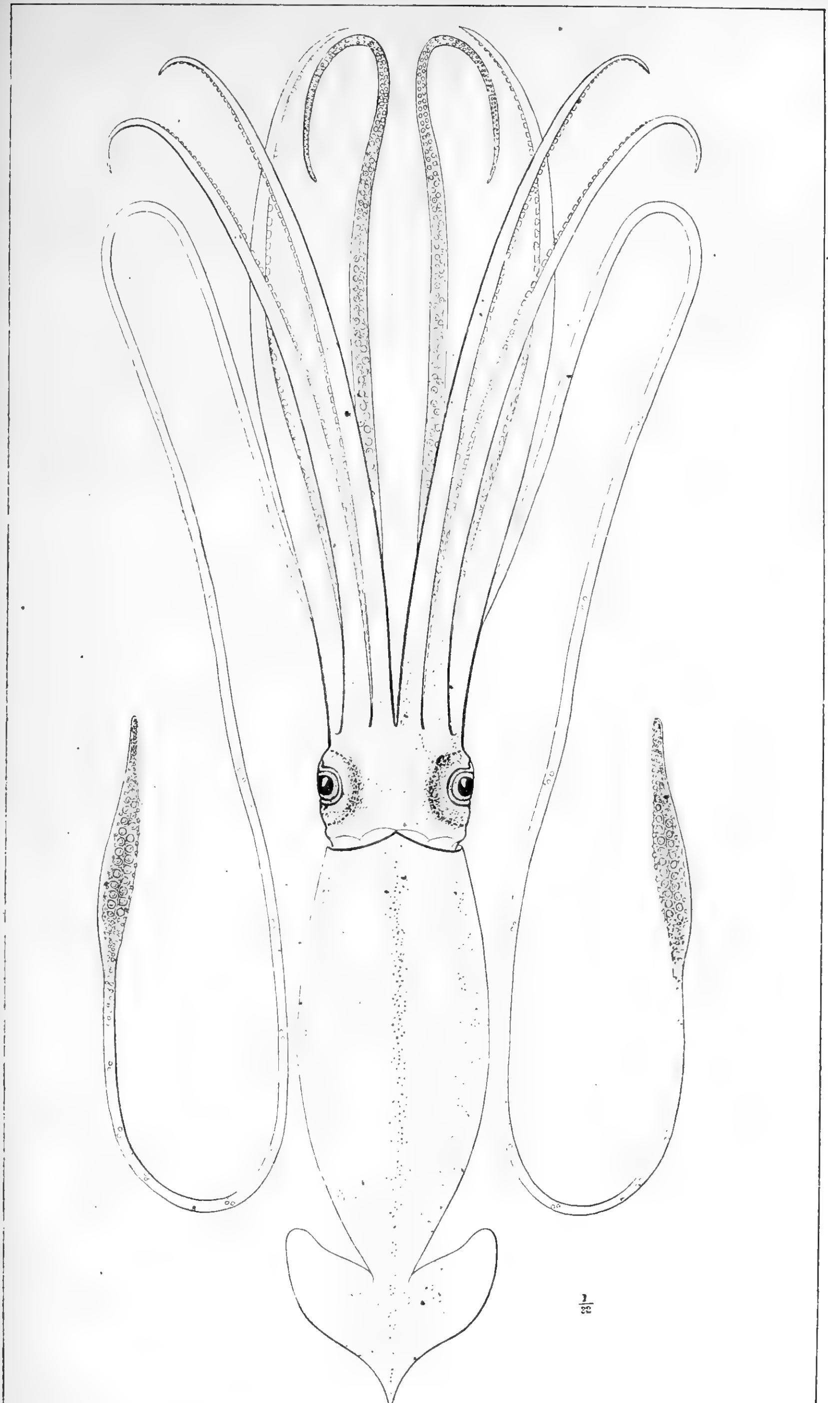

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A. E. VERRILL, FROM NATURE.

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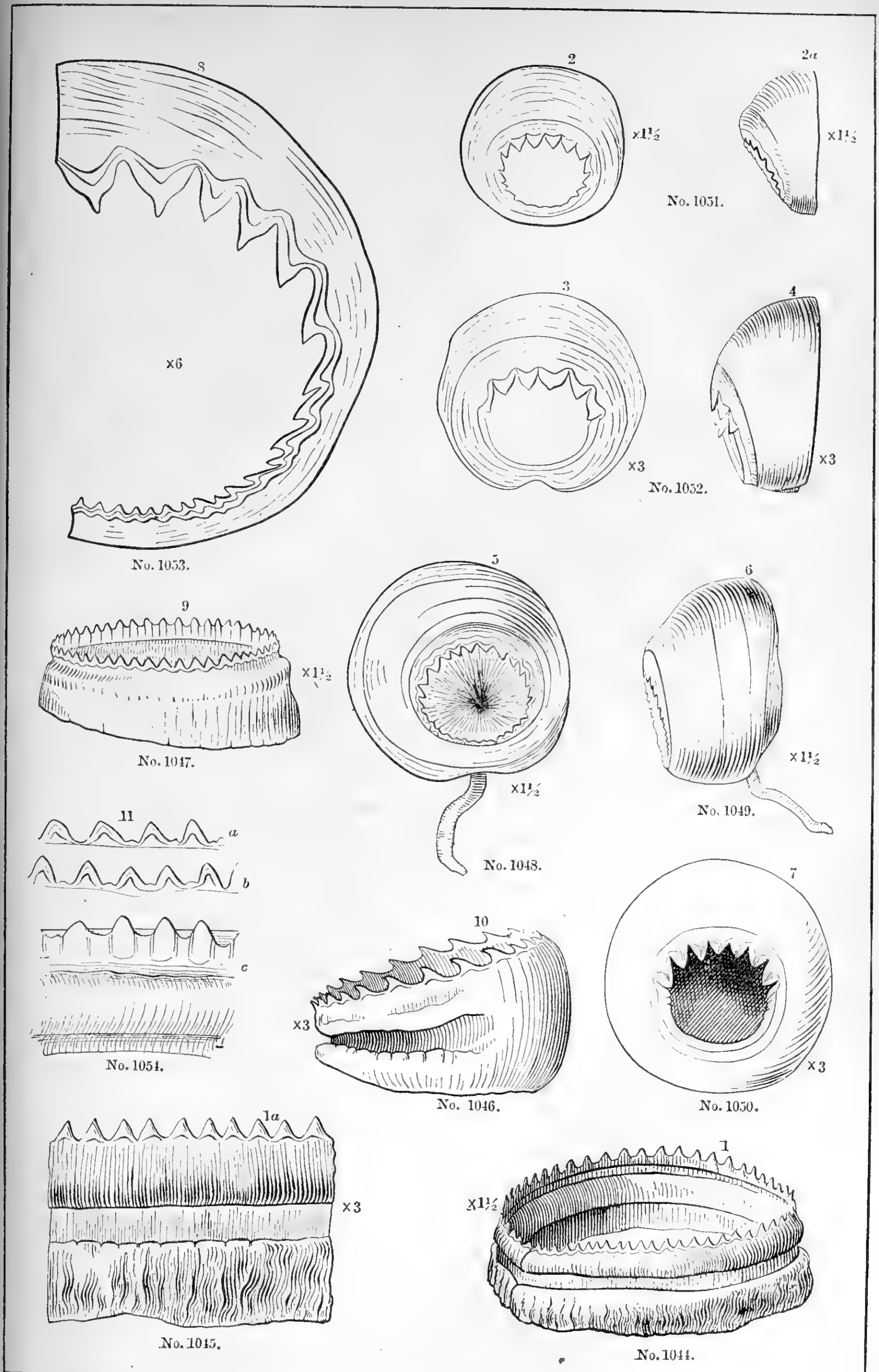
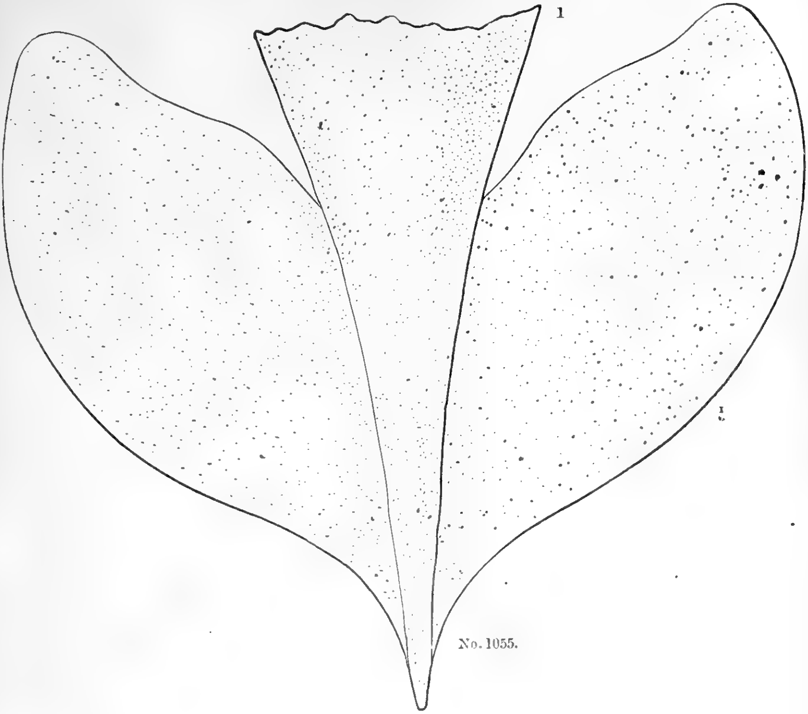


J. H. Emerton & A. E. Verrill from nature.

Wm. P. Northrup & Co. Engravers, Buffalo, N. Y.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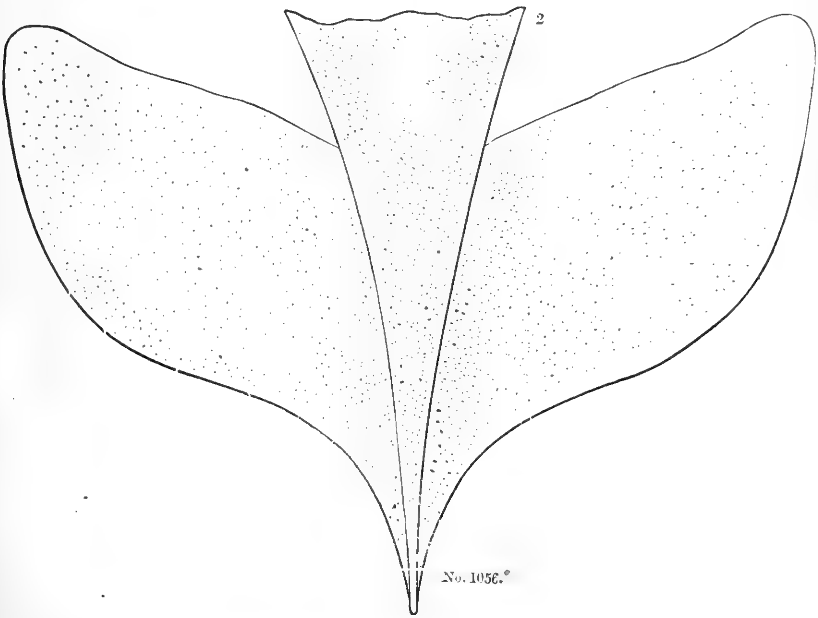
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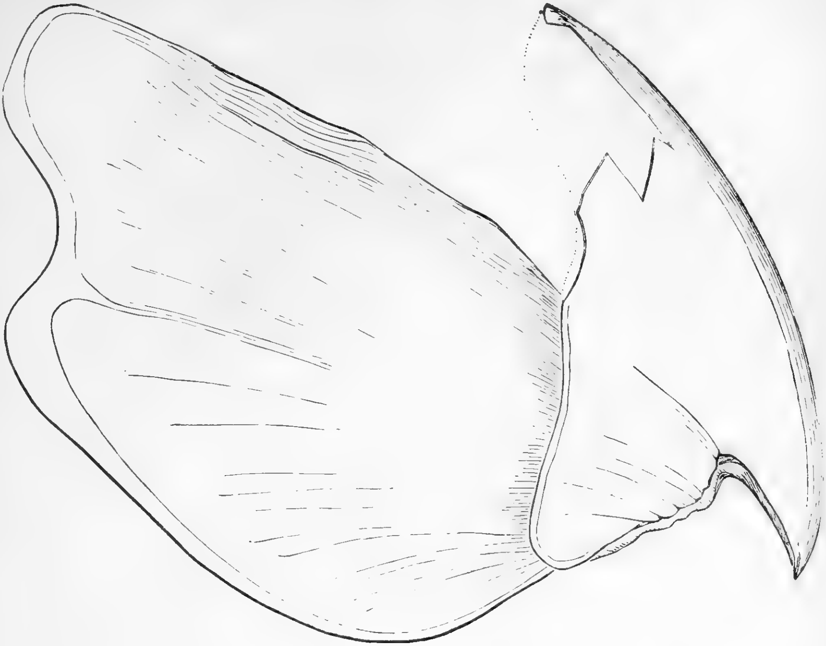

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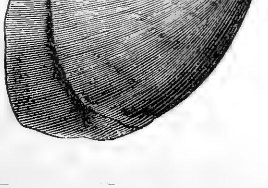

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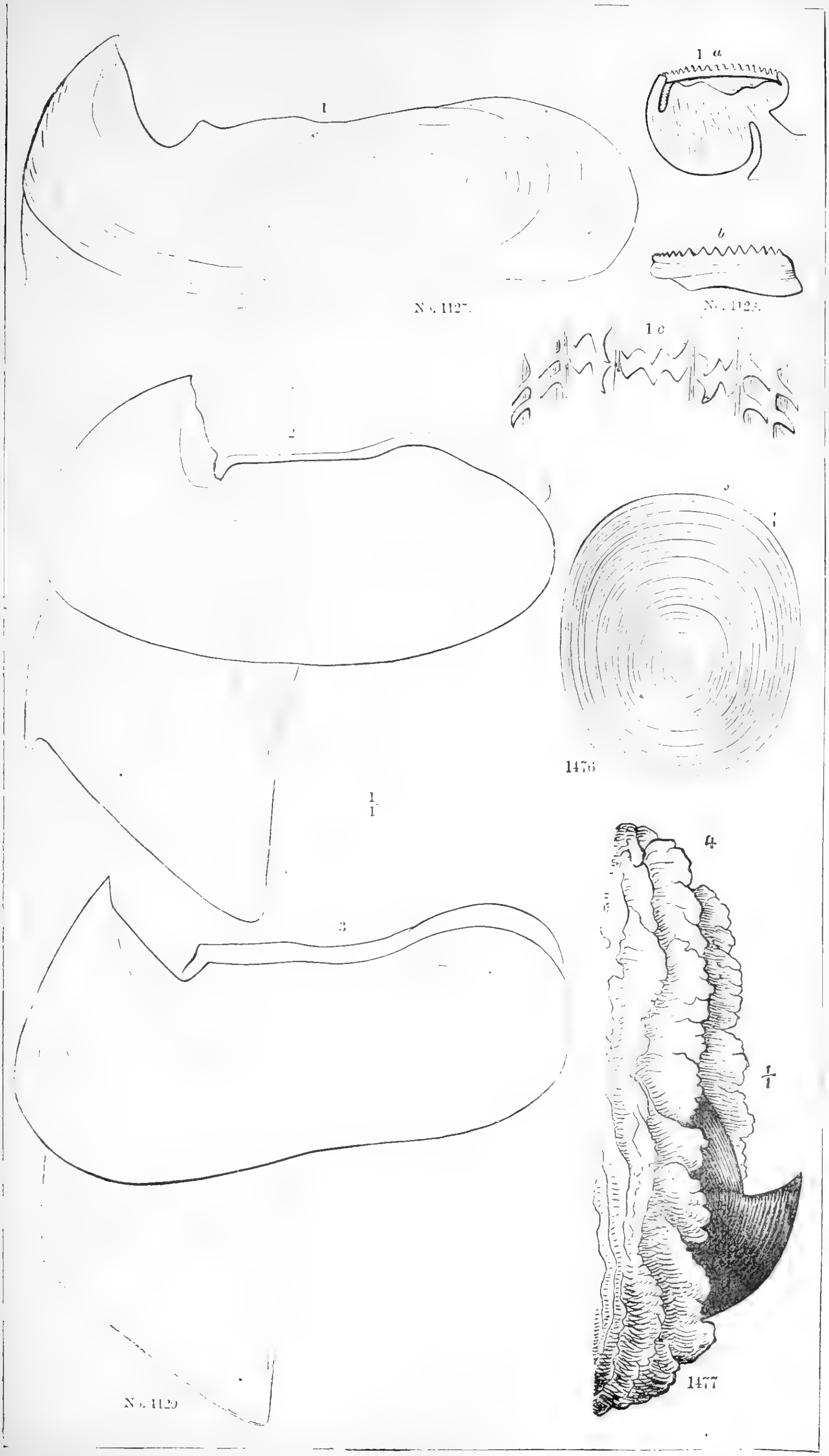
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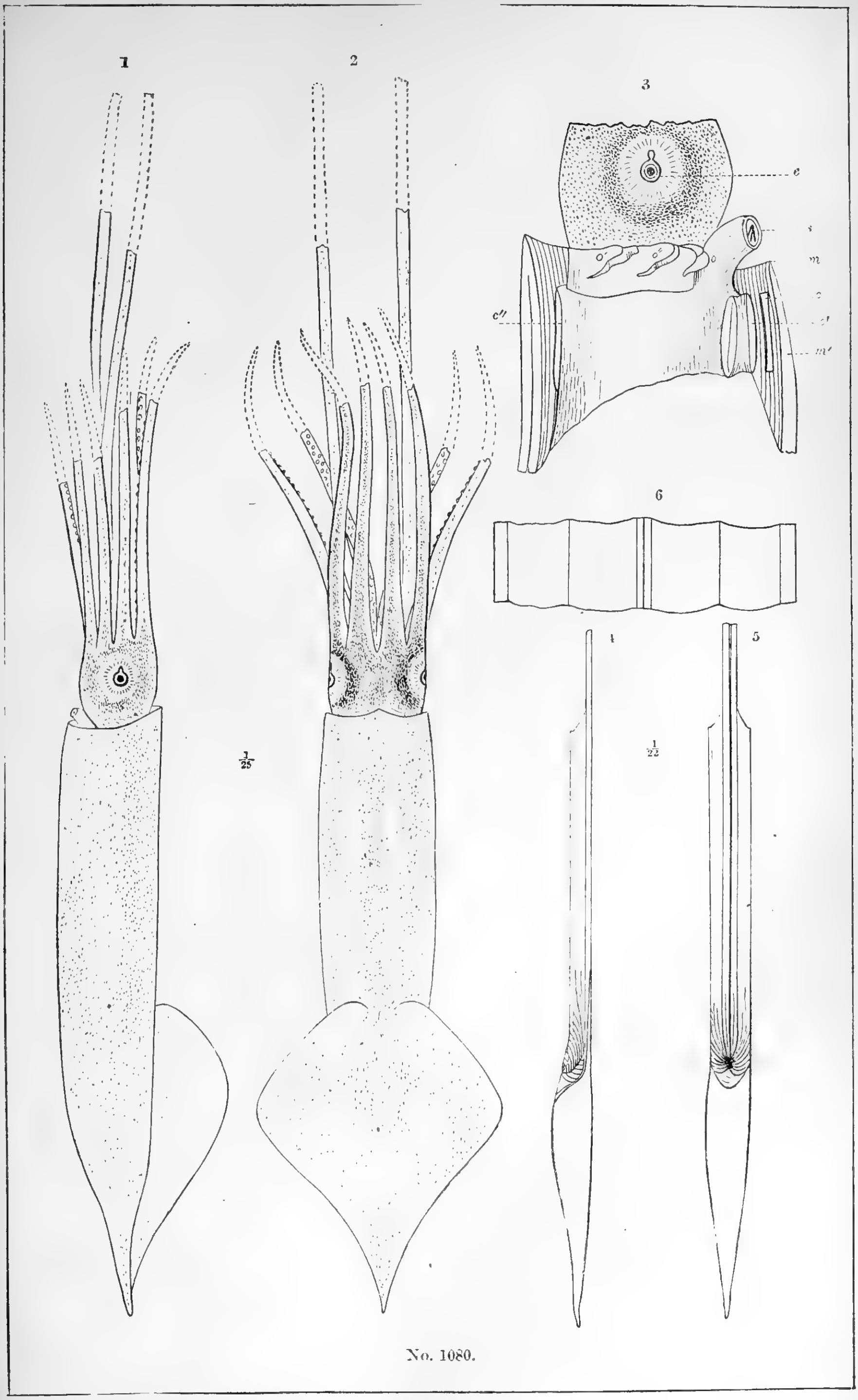
PLATE XIII.



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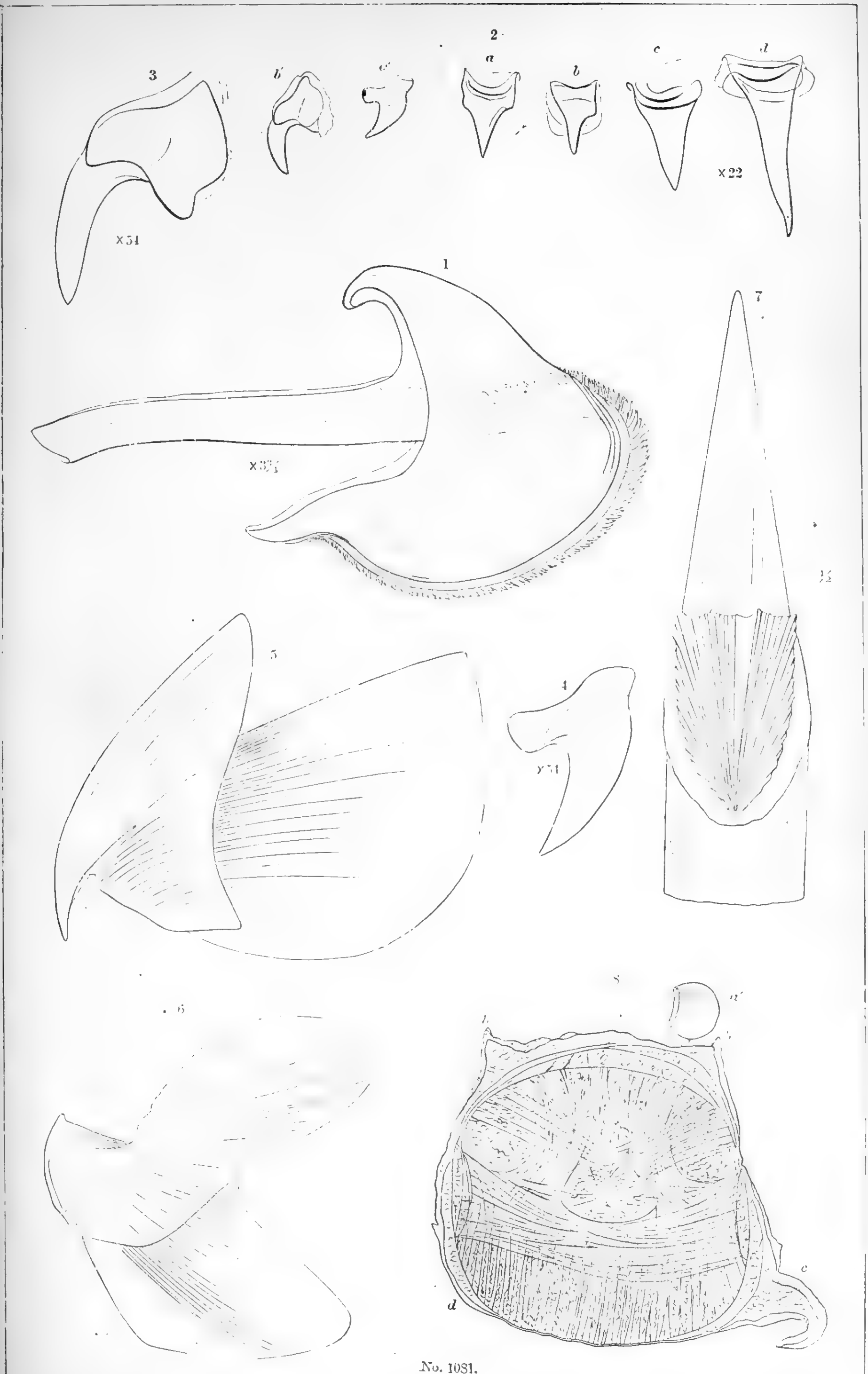

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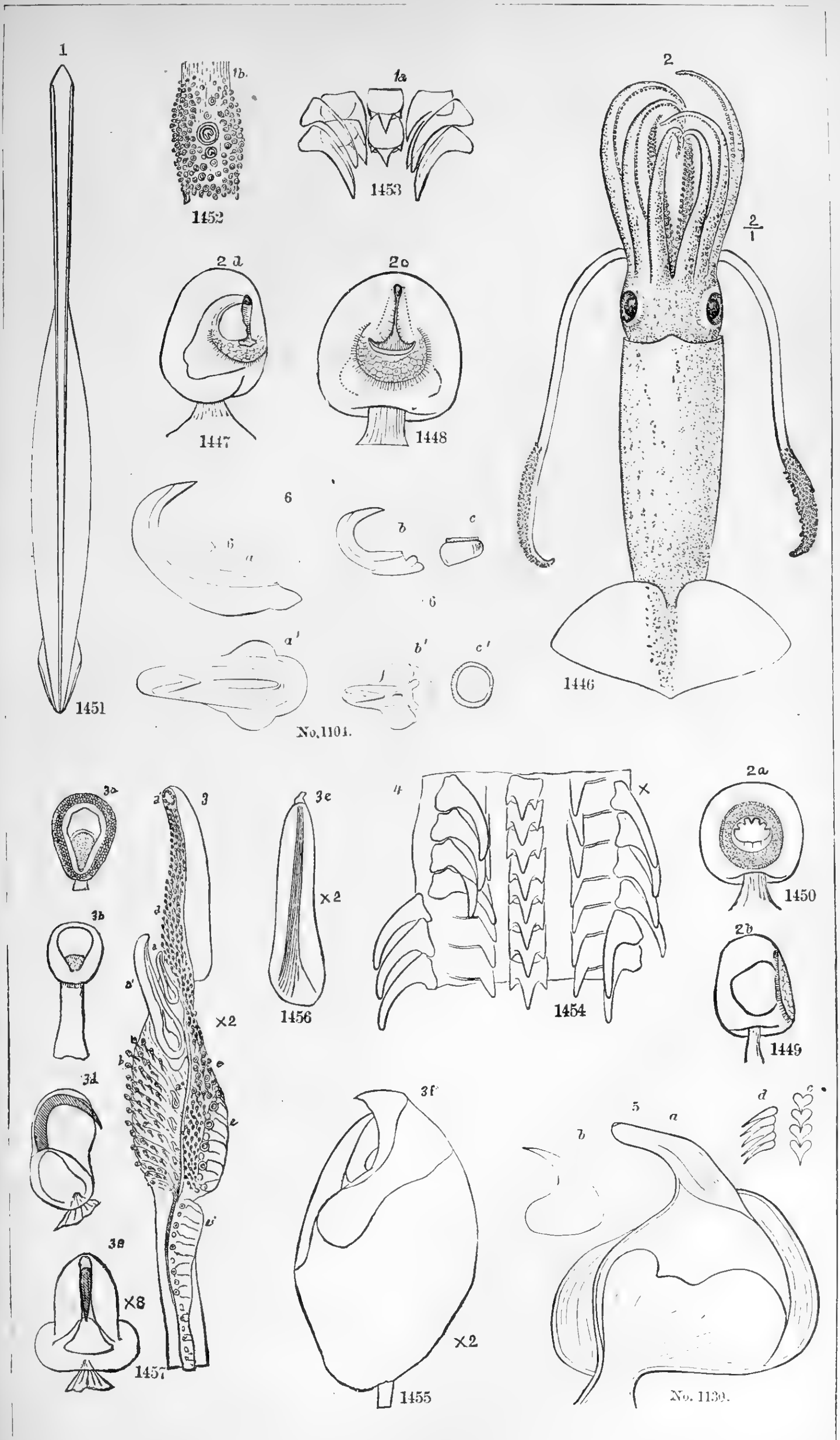
J. H. Emerton & A. E. Verrill, from nature. Wm. P. Northrup & Co., Engravers, Buffalo, N. Y.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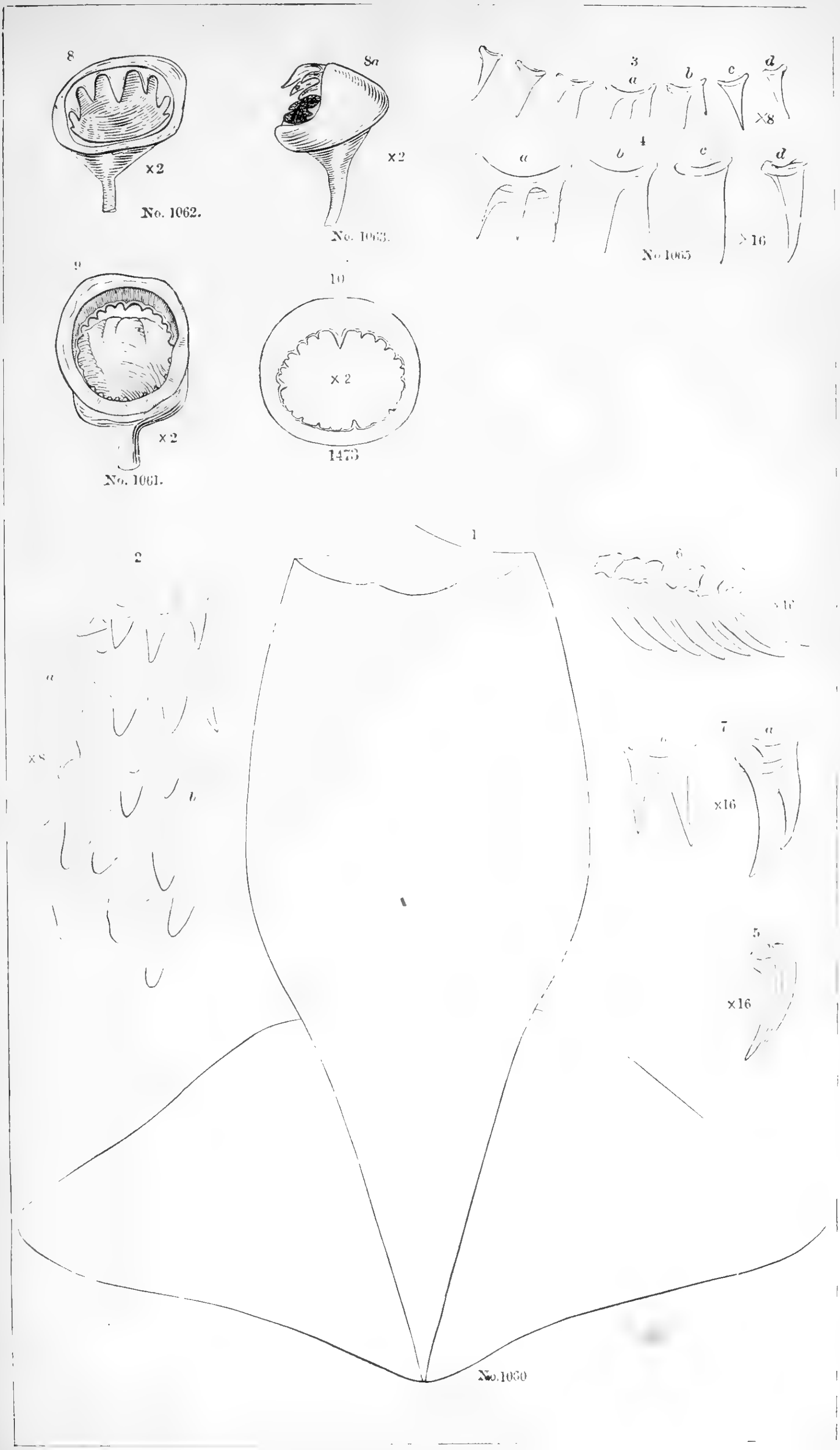
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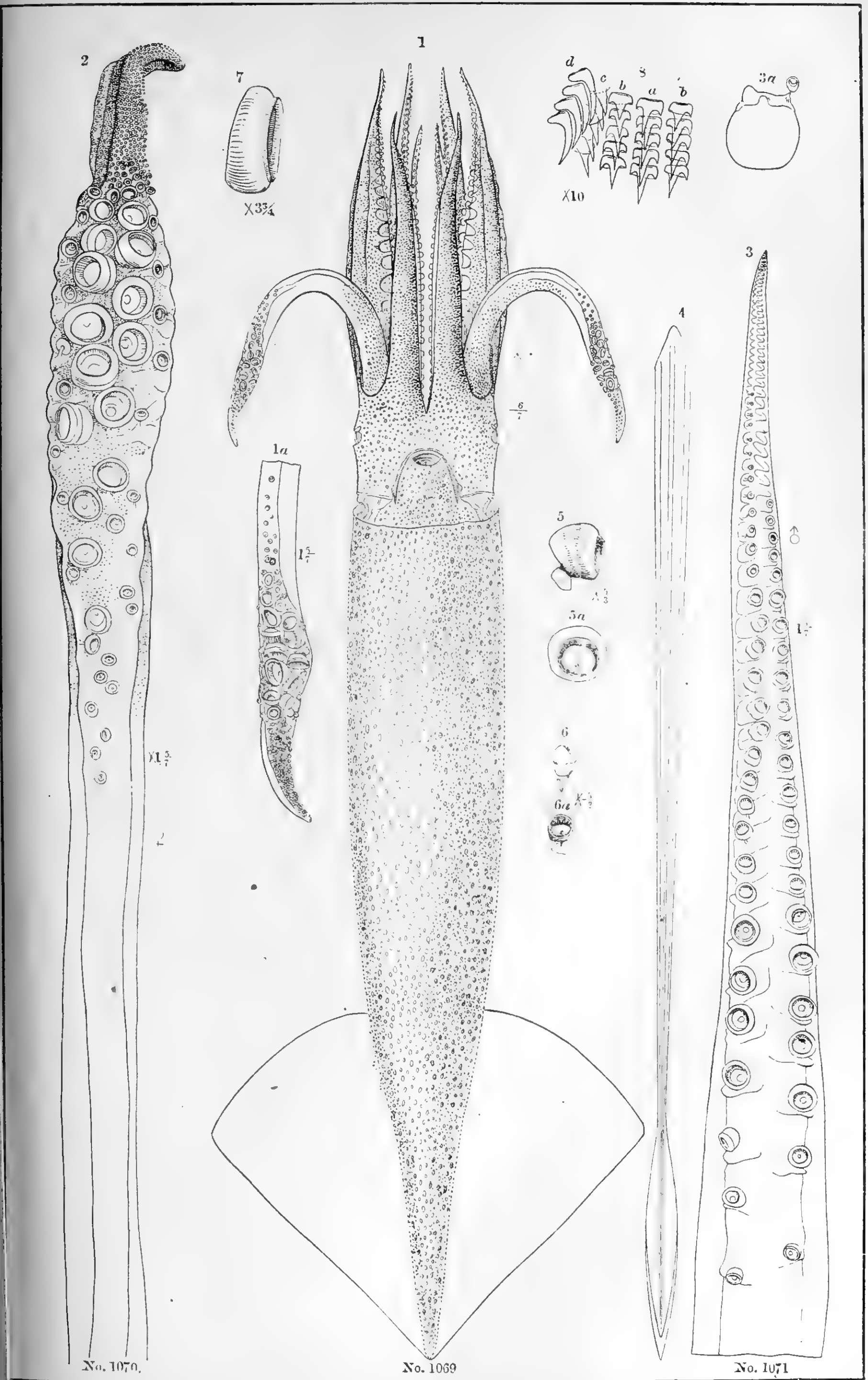

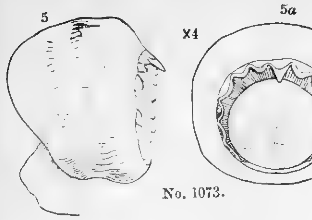

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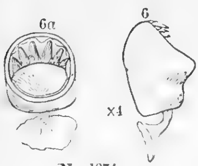

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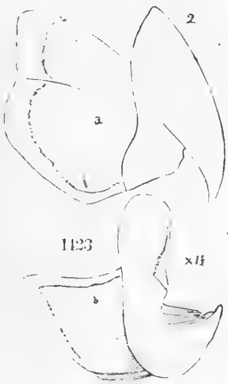

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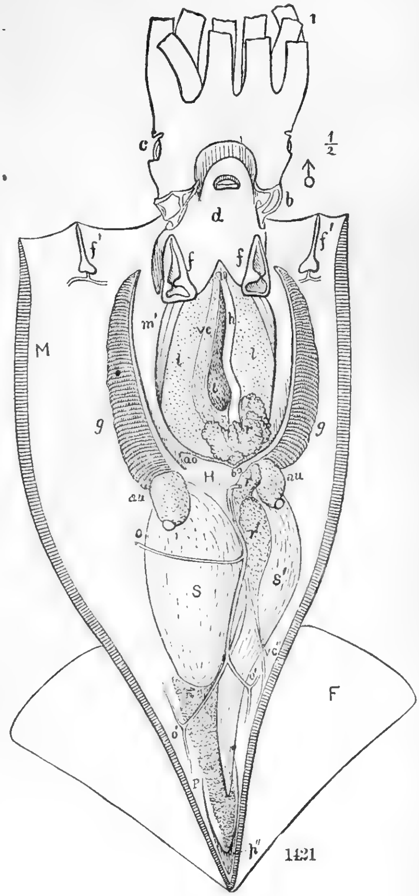

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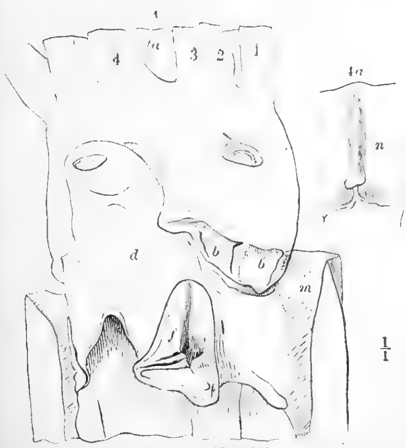

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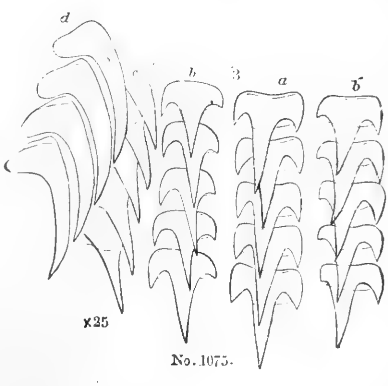

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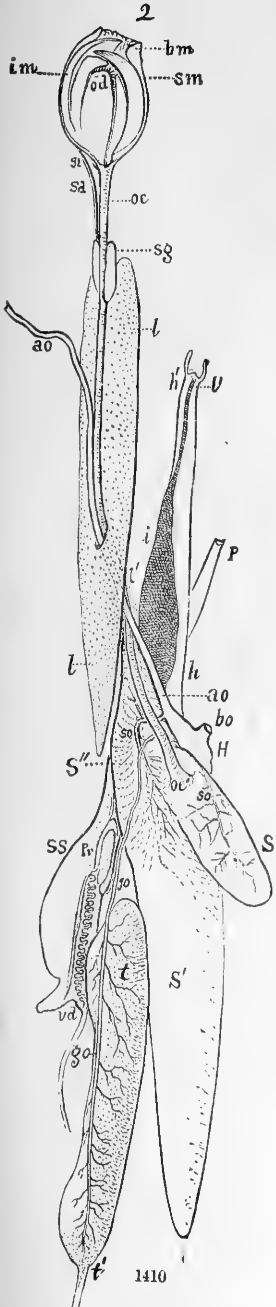
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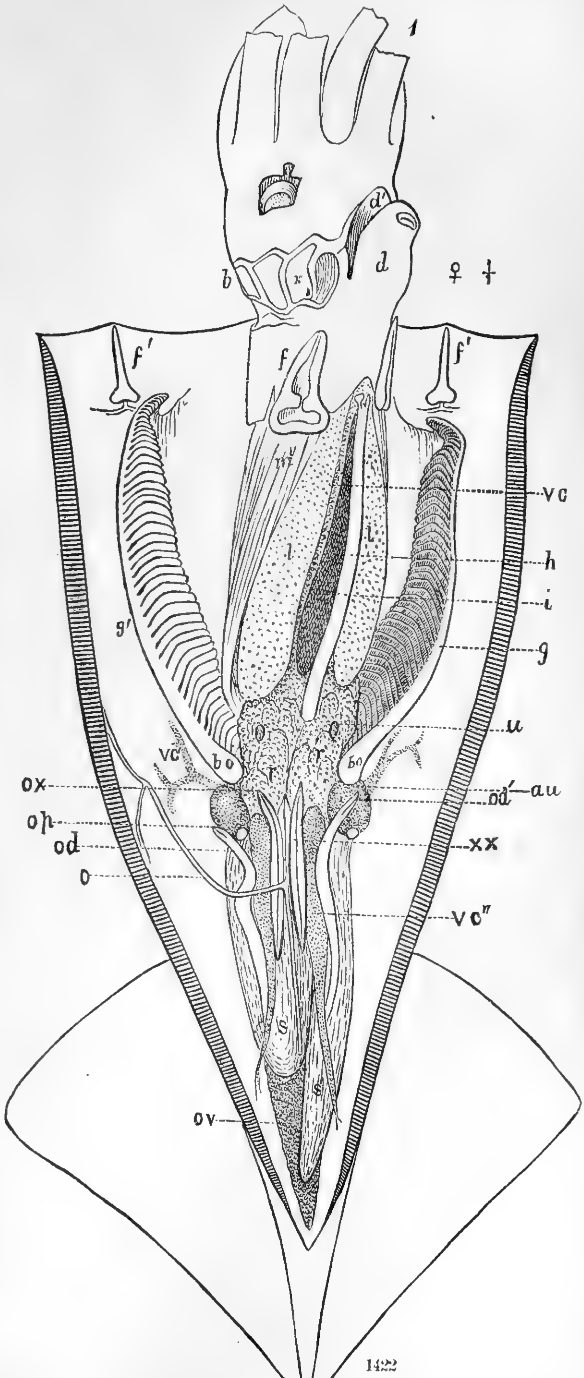
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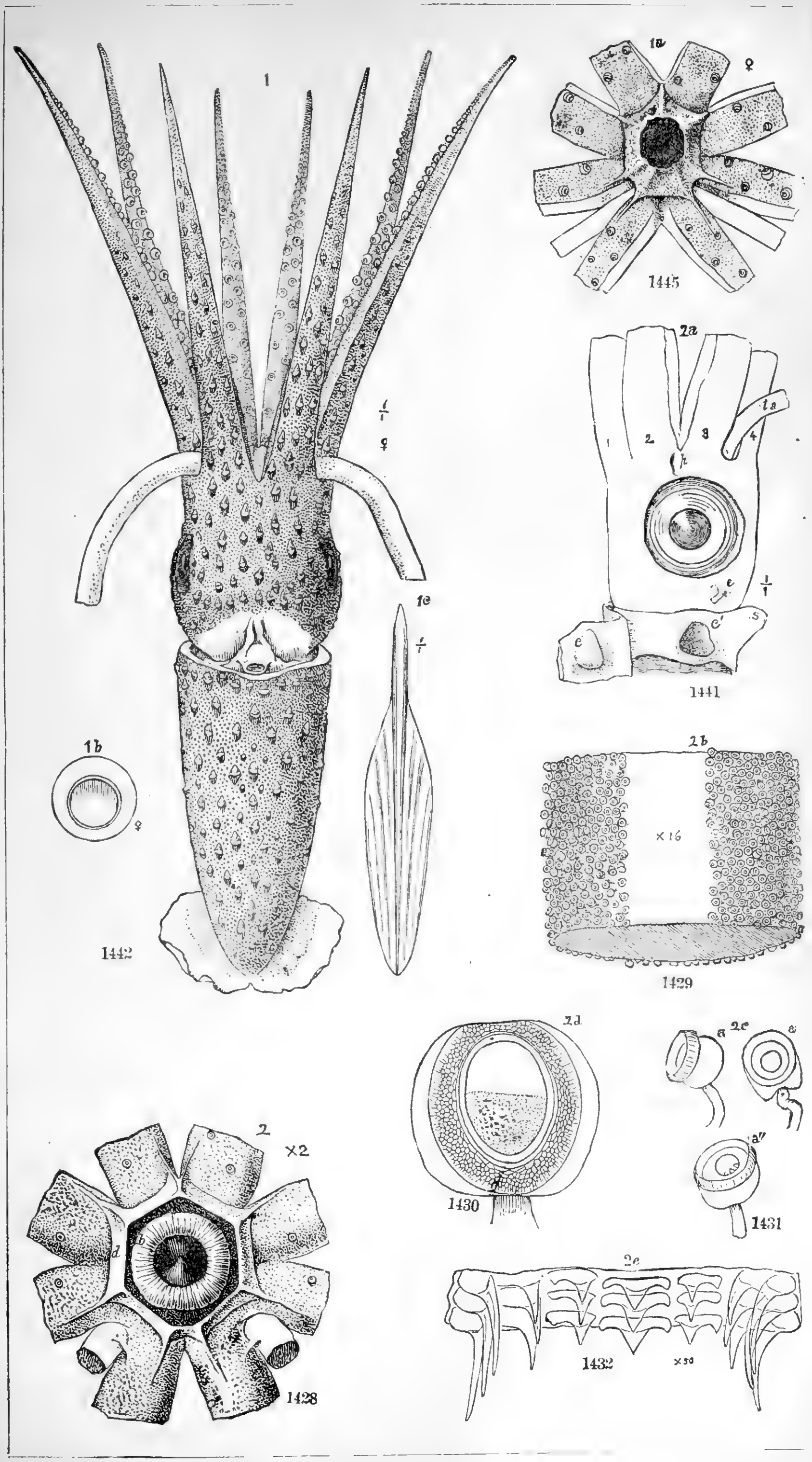

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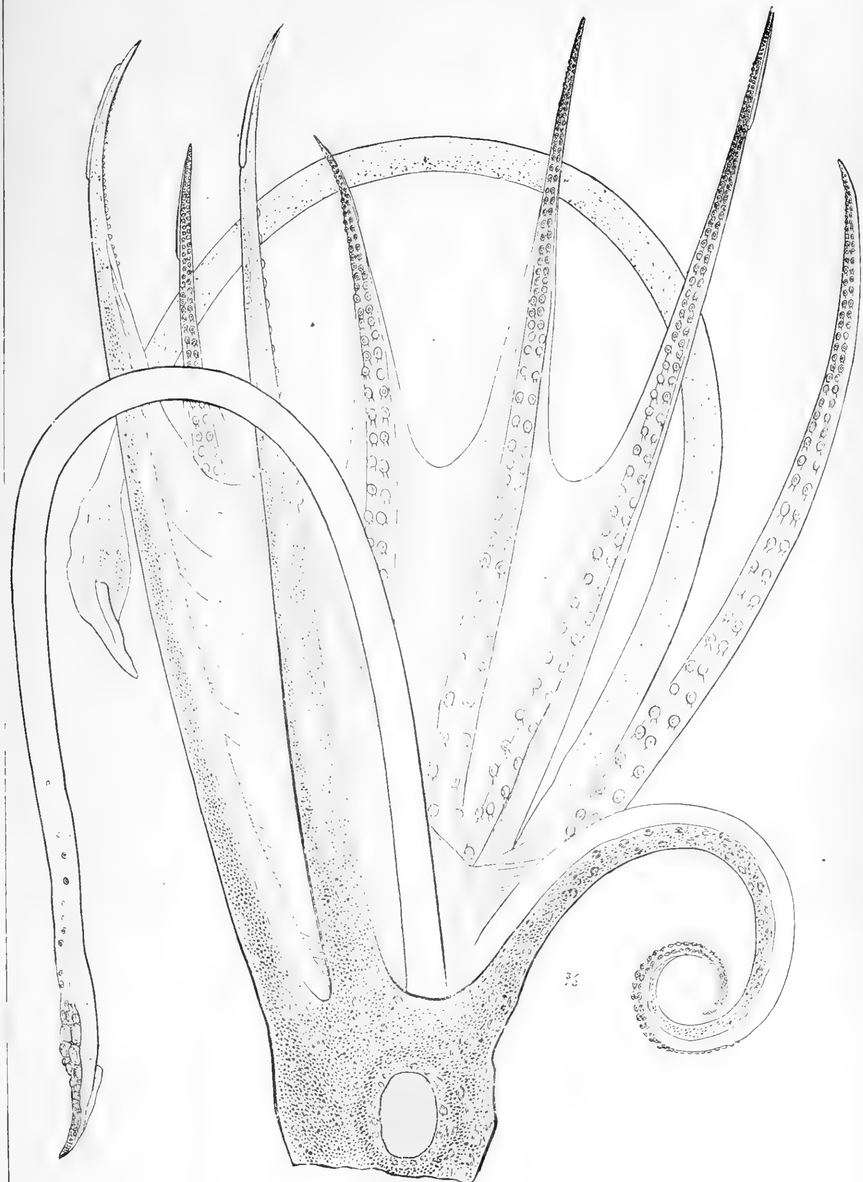

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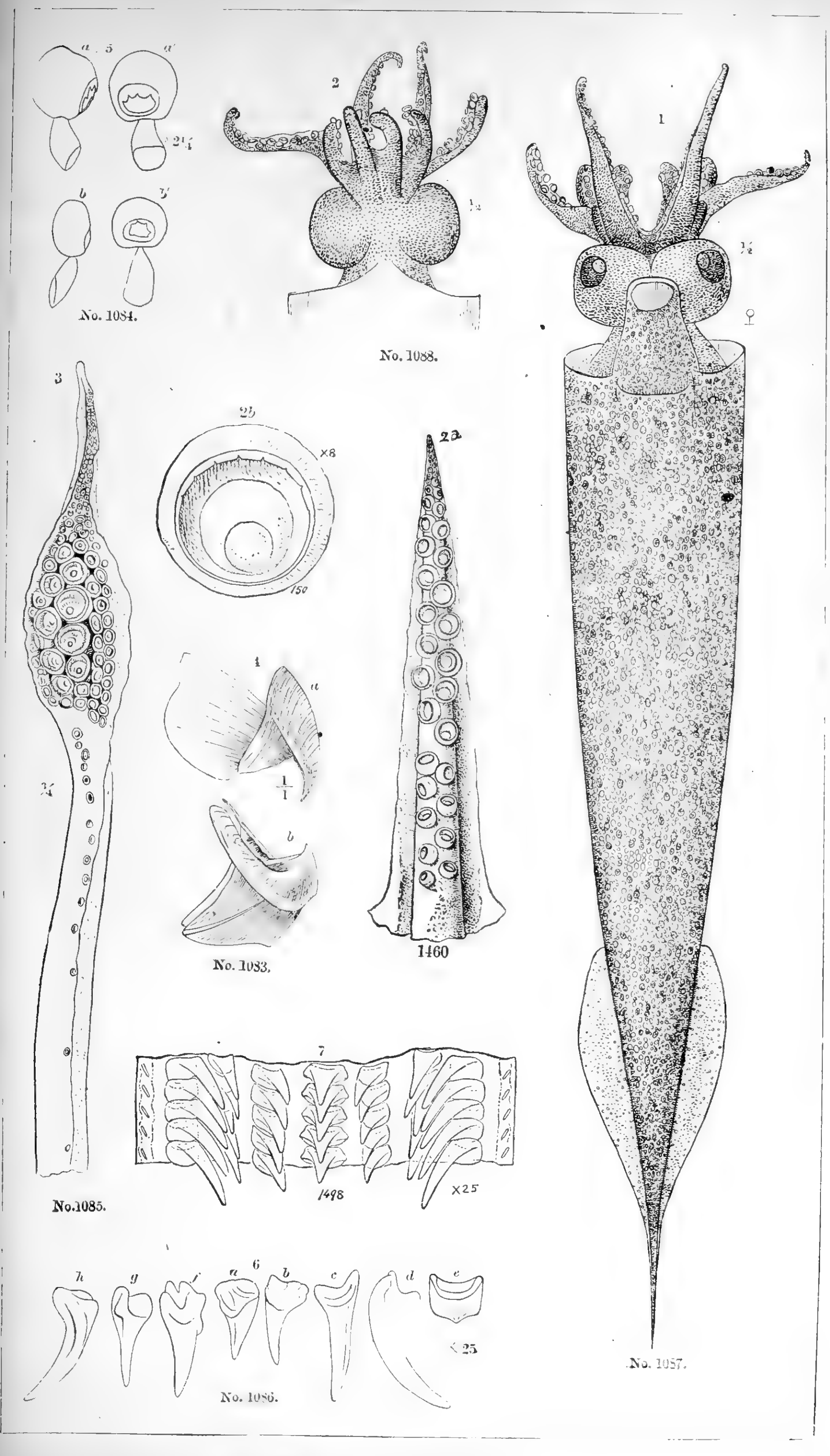
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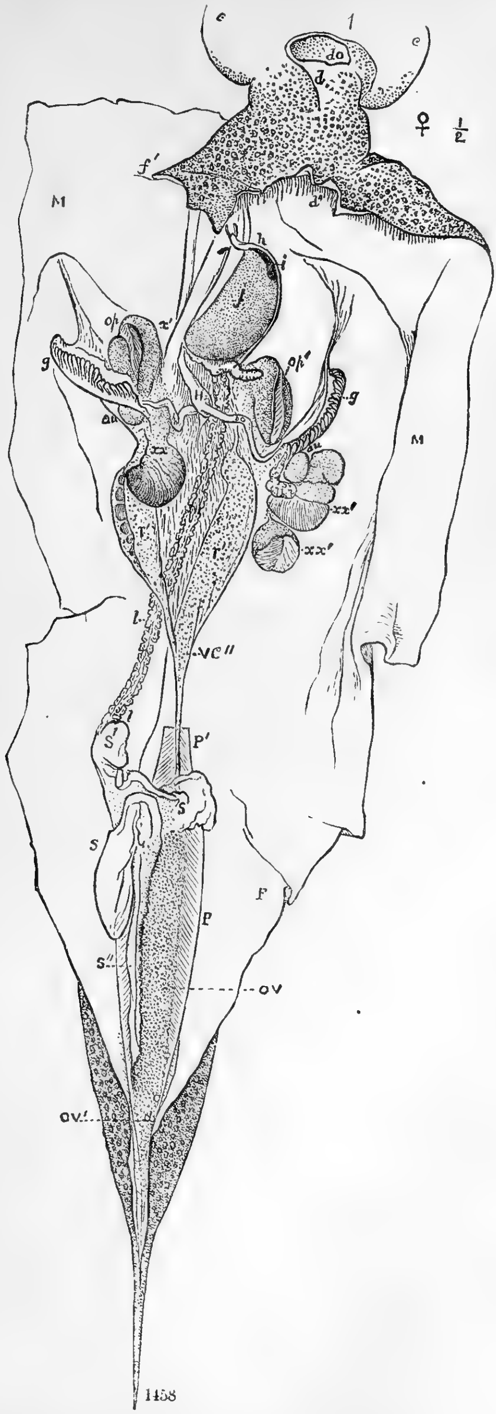
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1459

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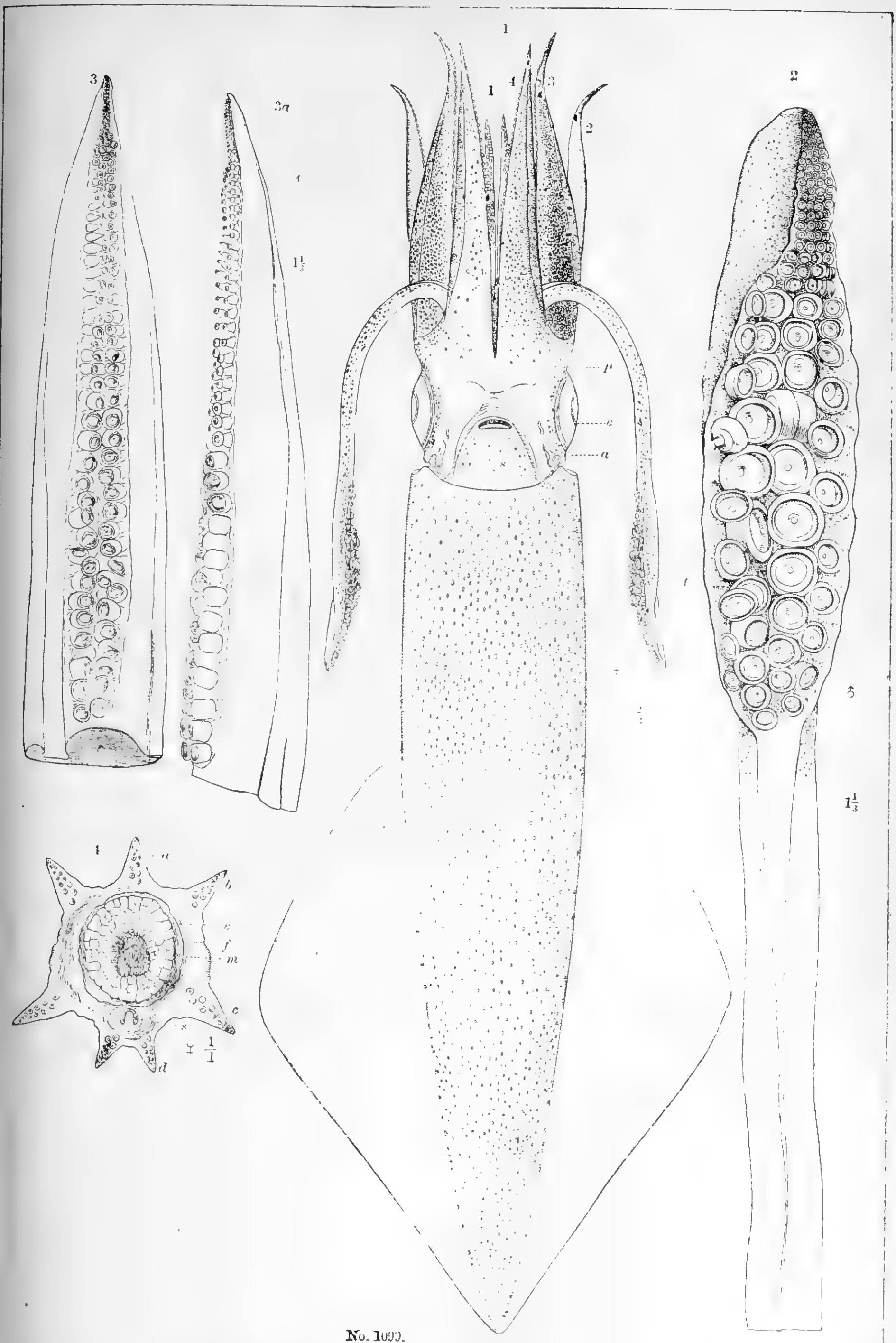

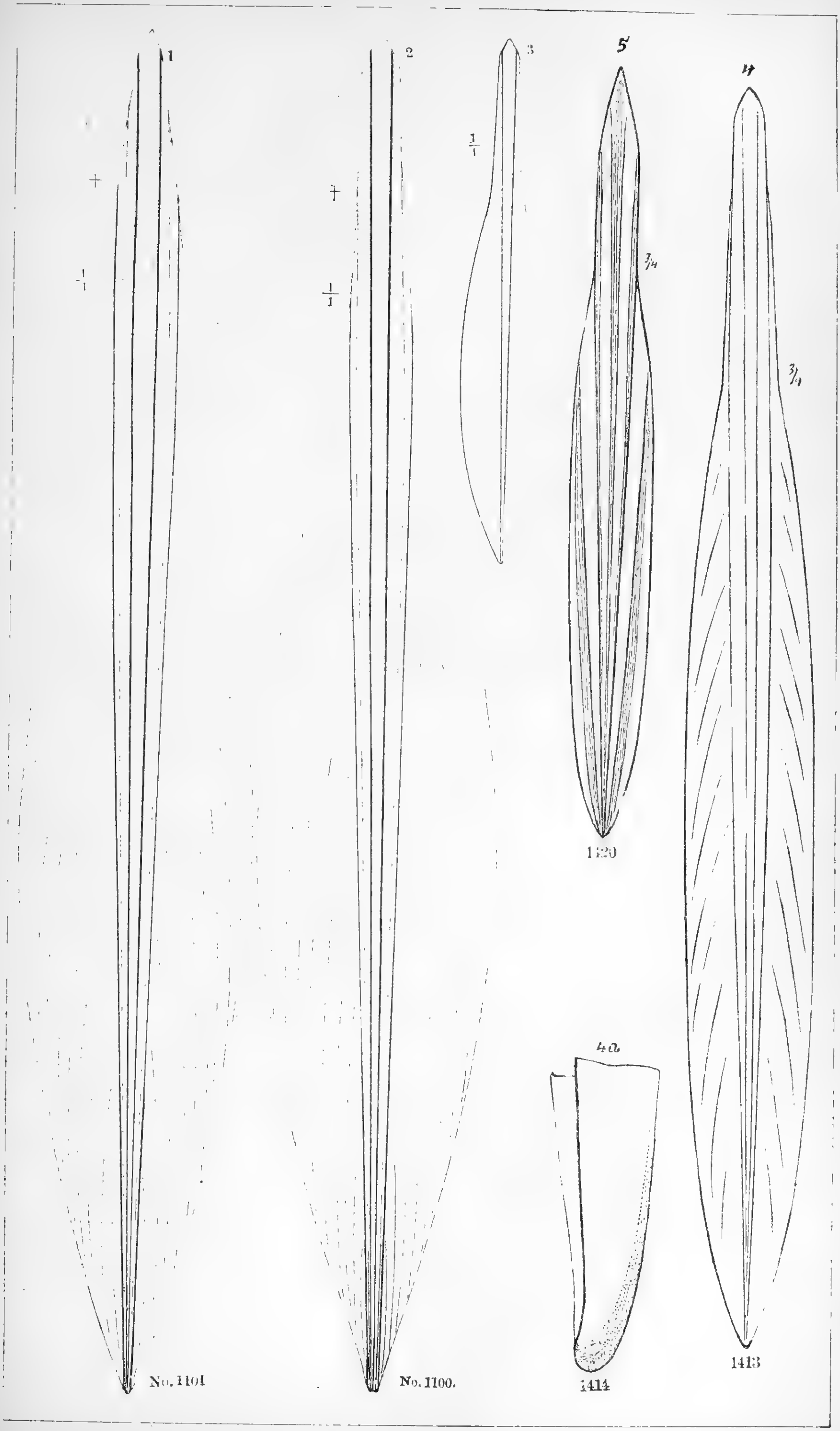
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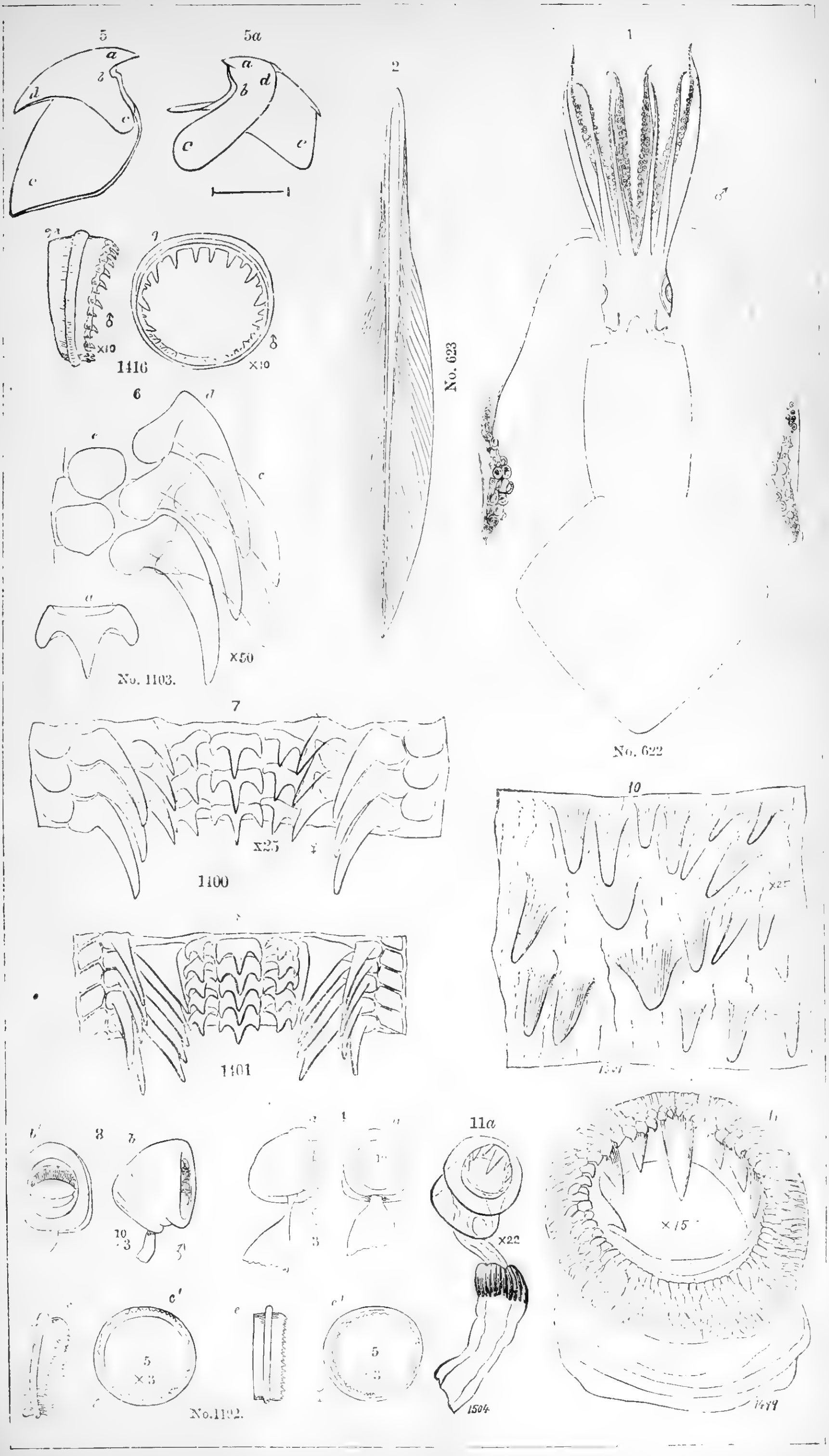
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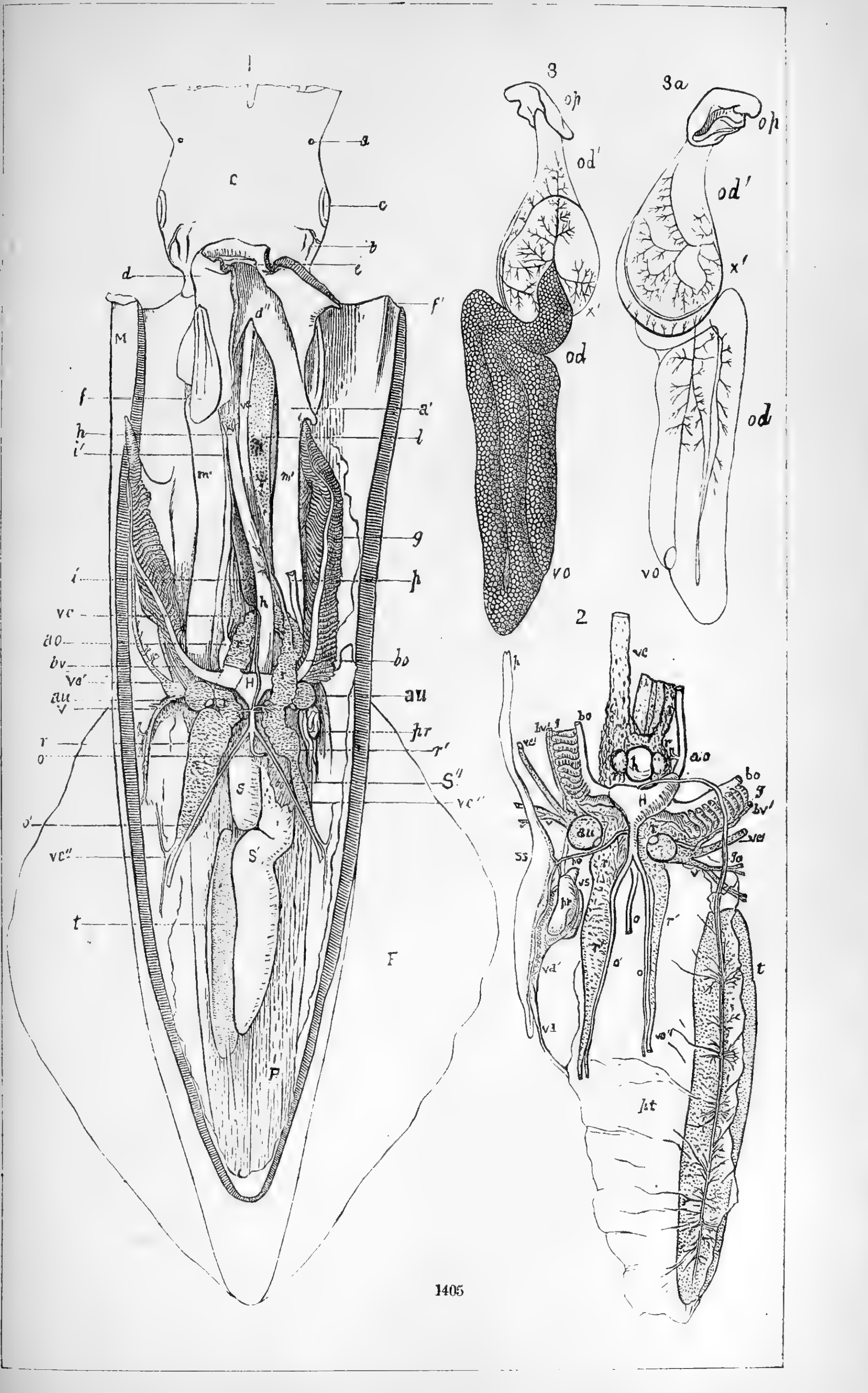

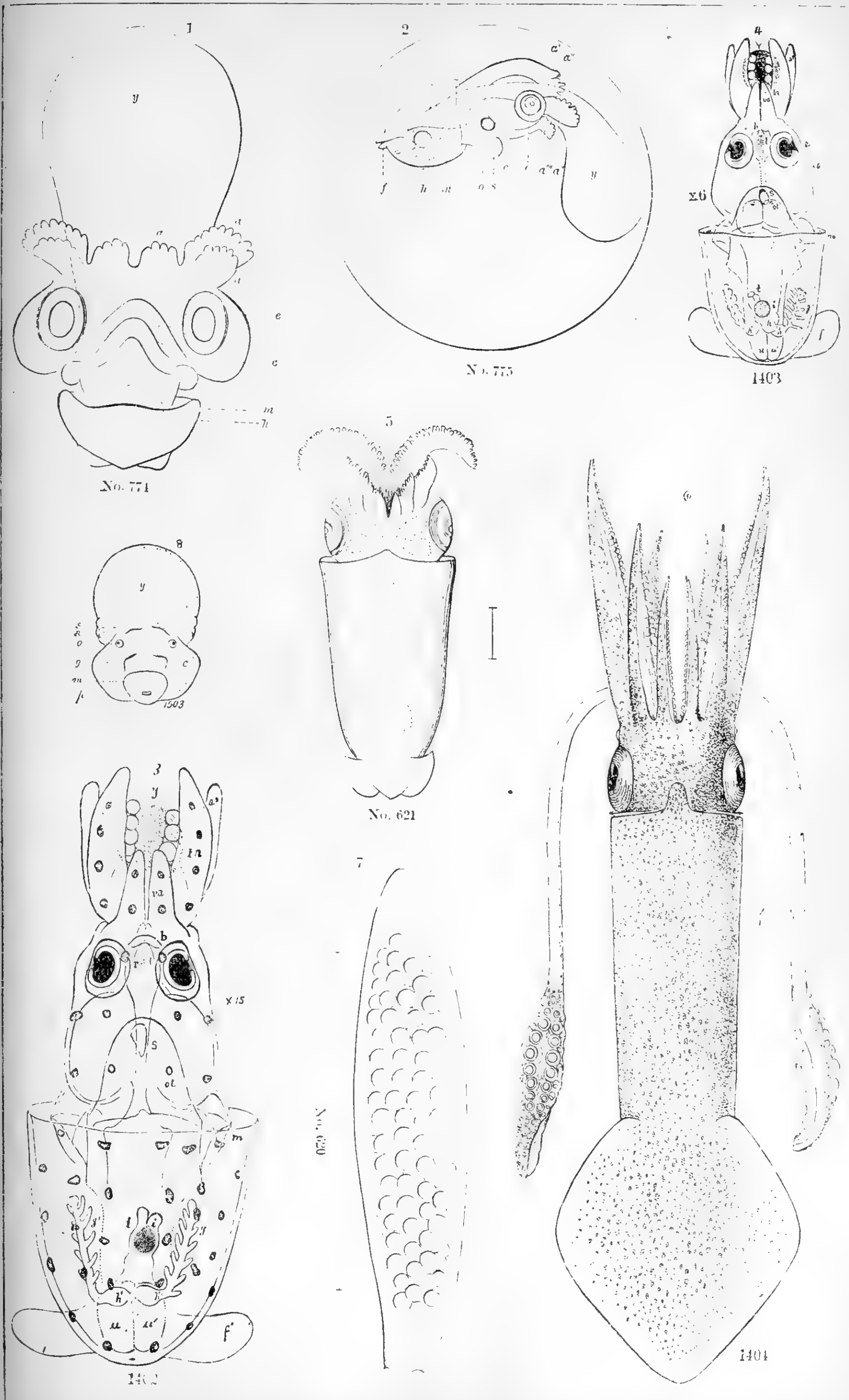
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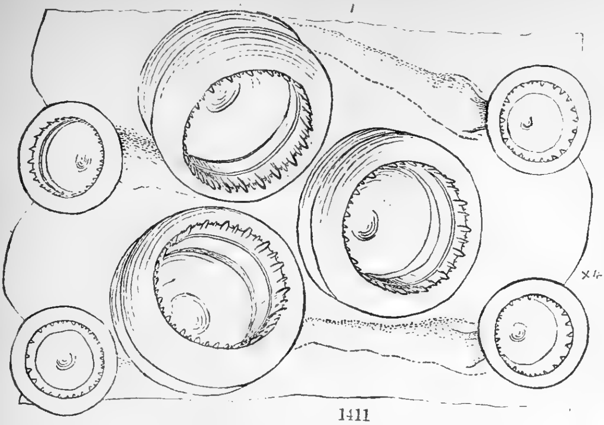

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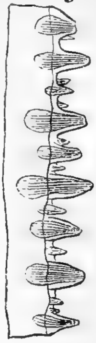

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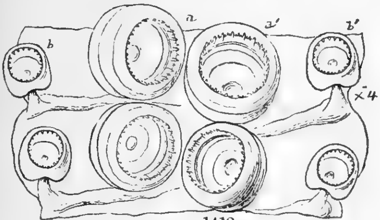

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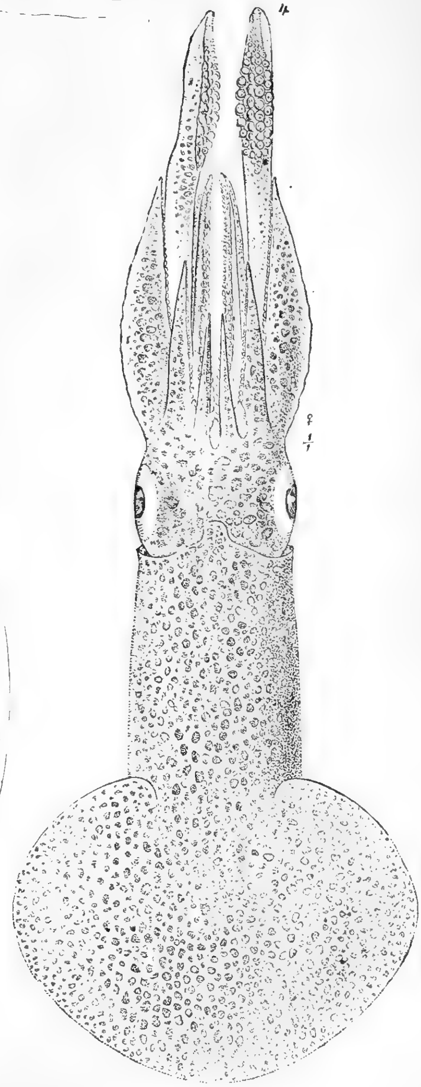

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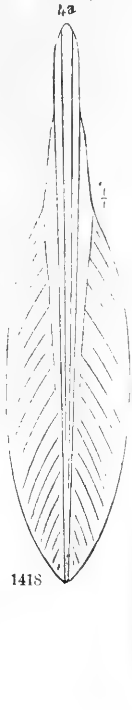

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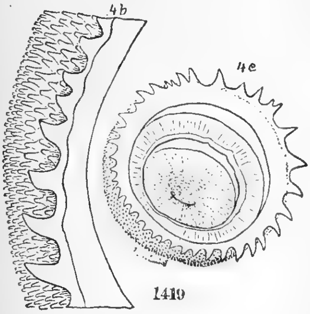

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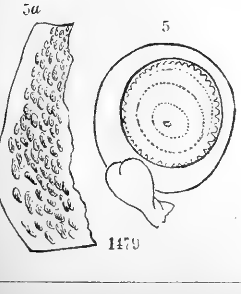

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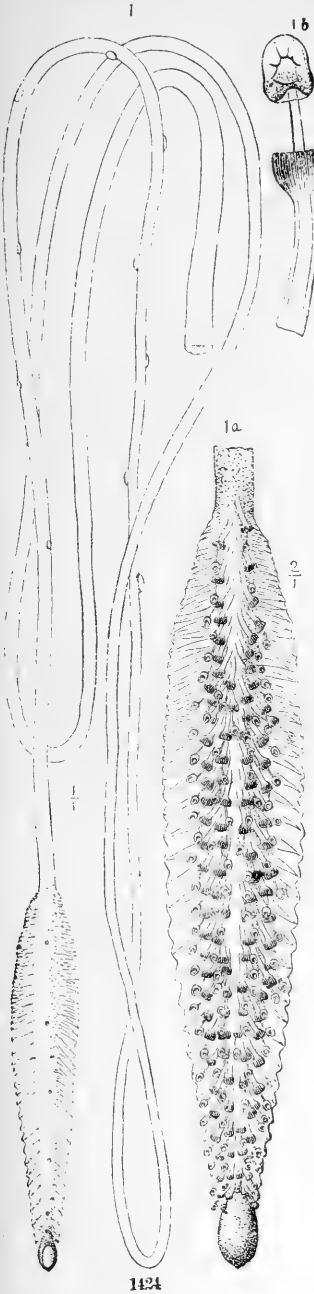

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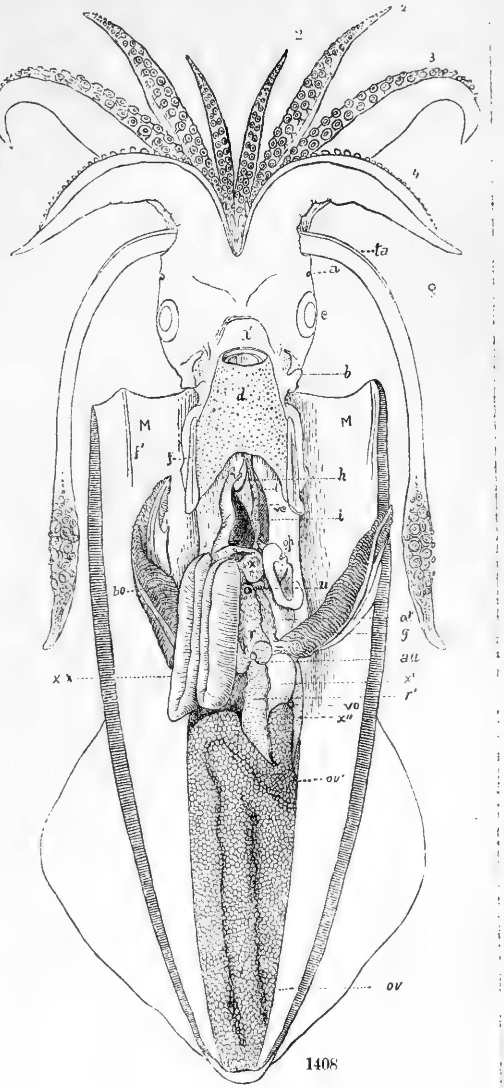

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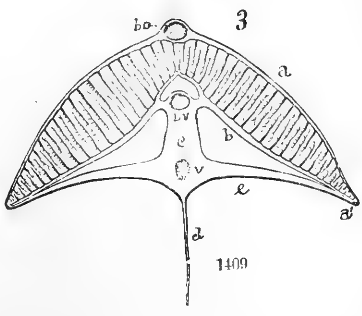

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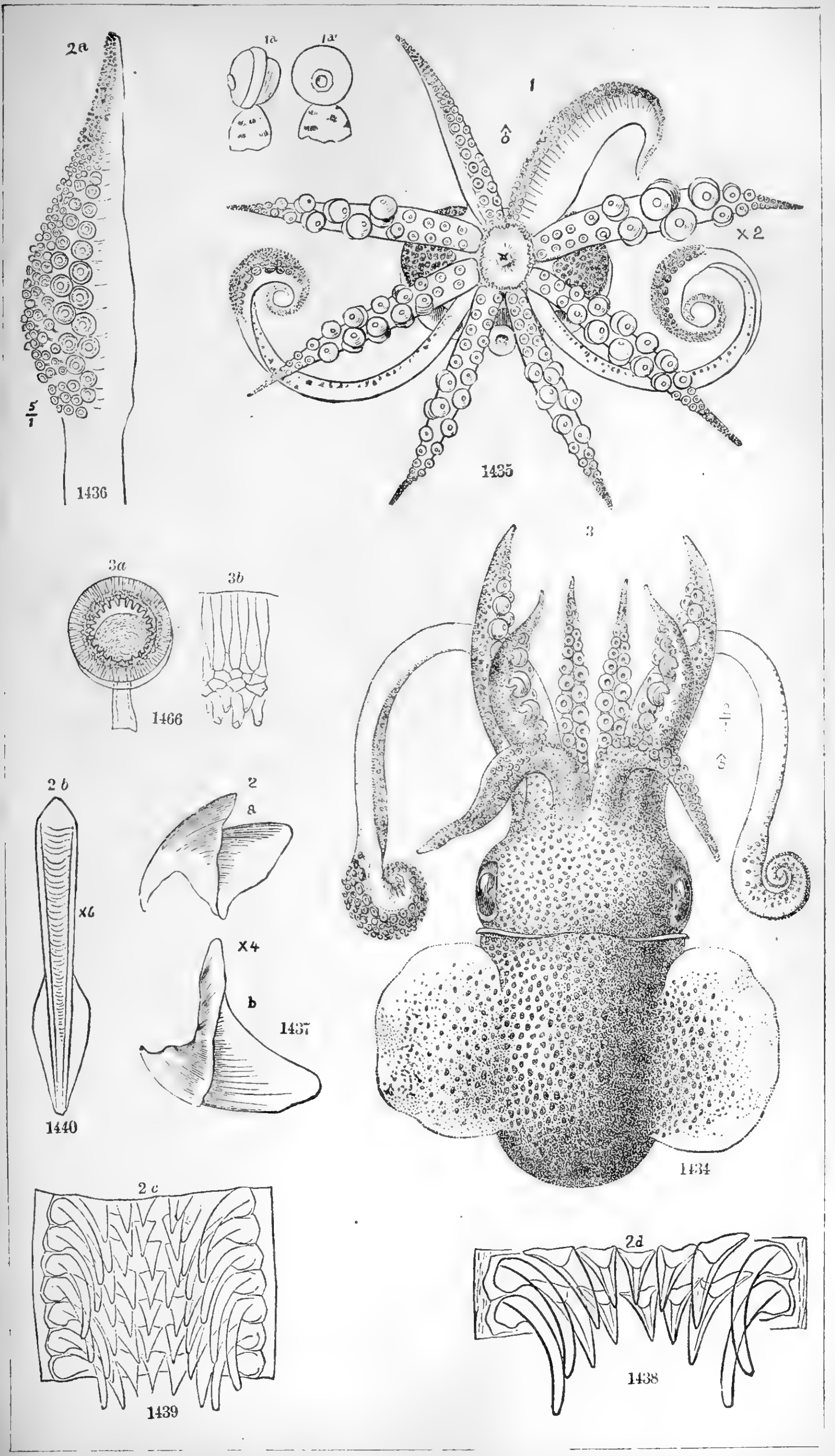
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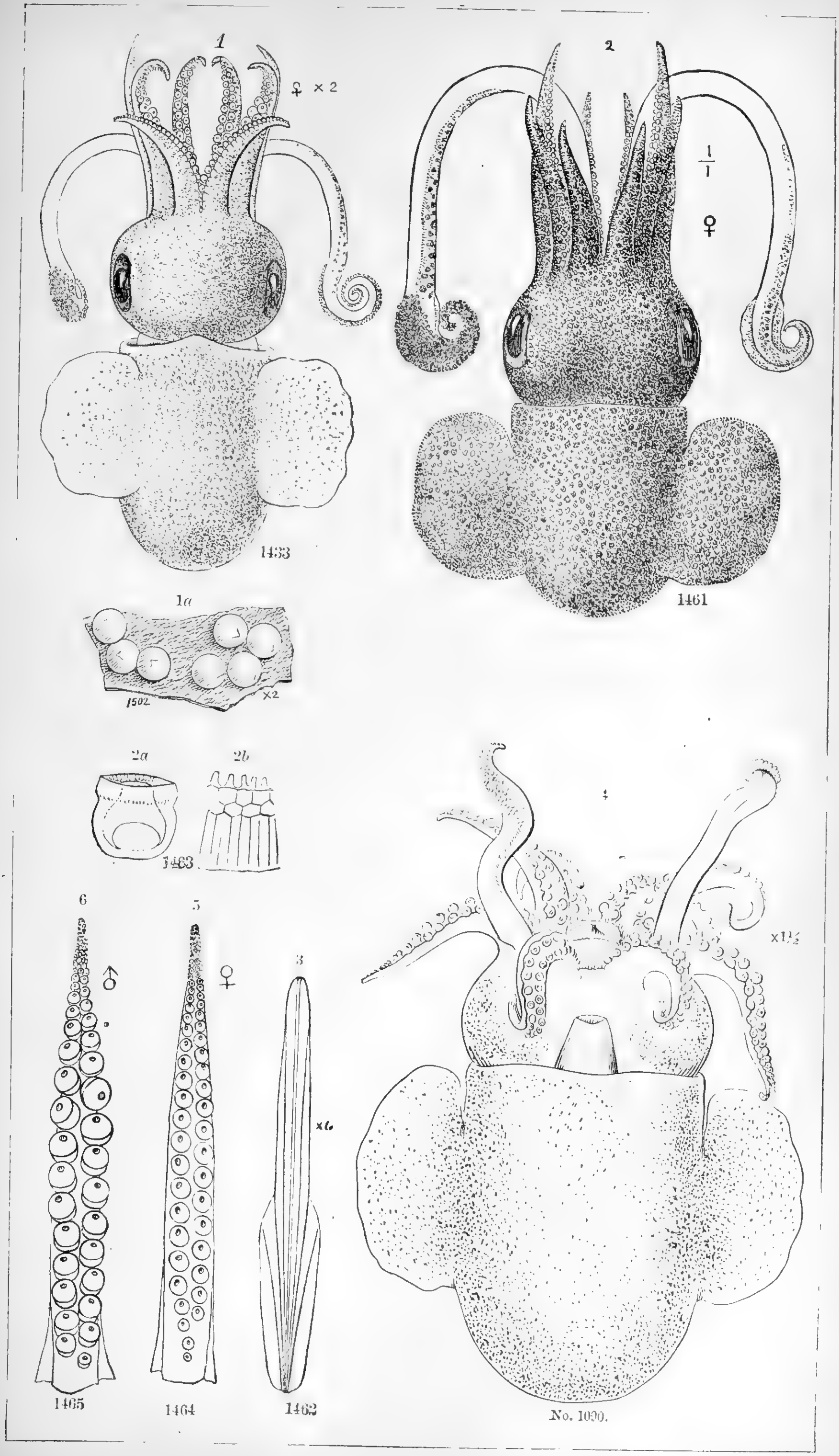
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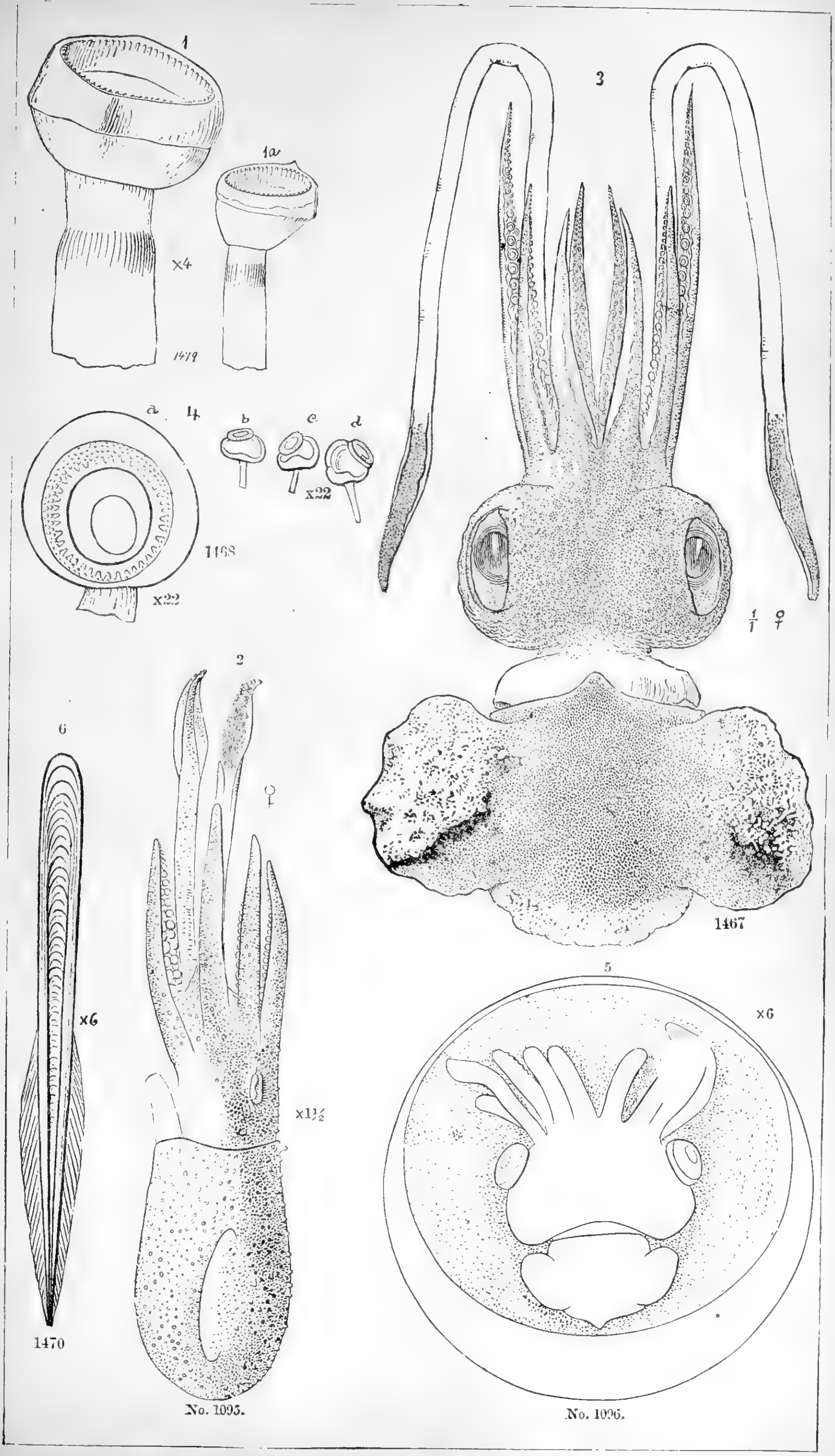
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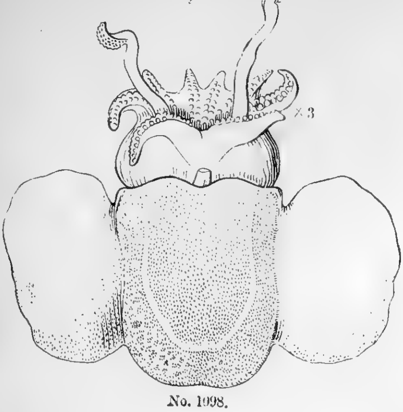

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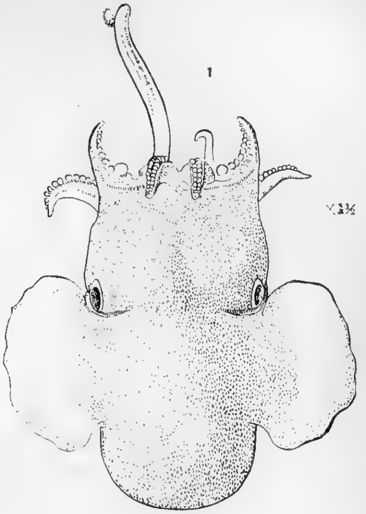

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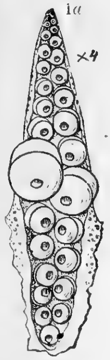

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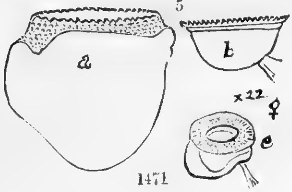

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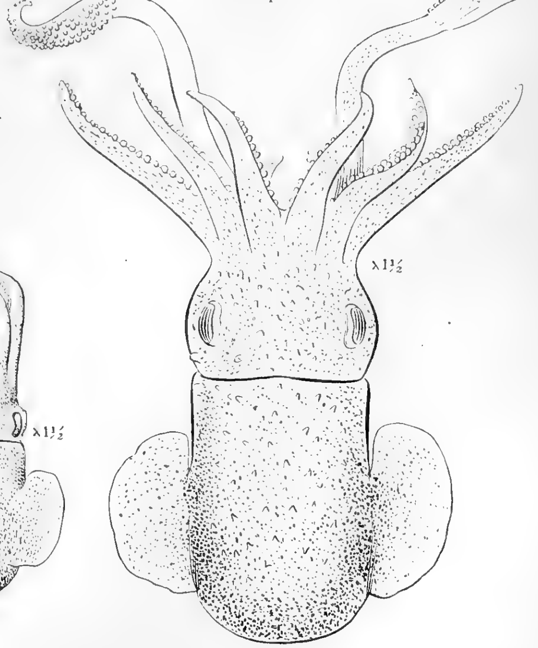

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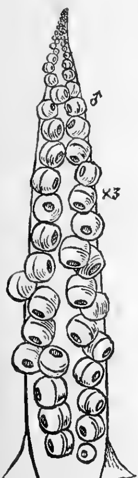

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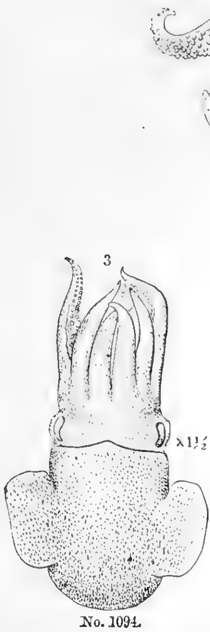

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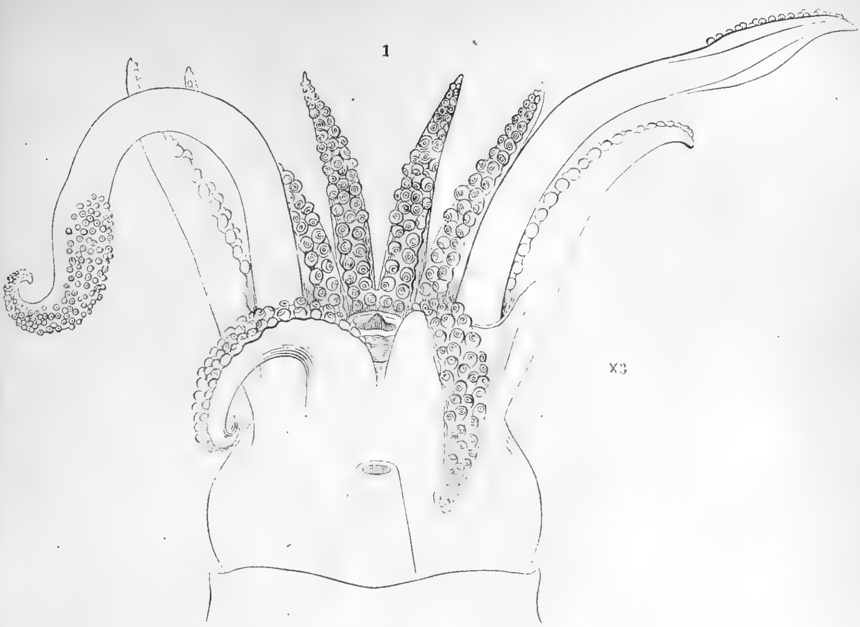

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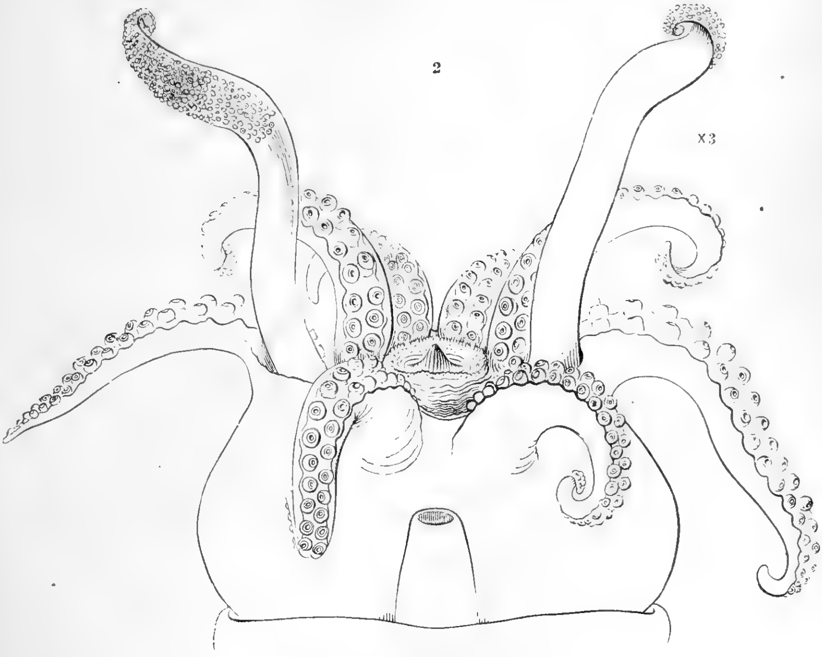

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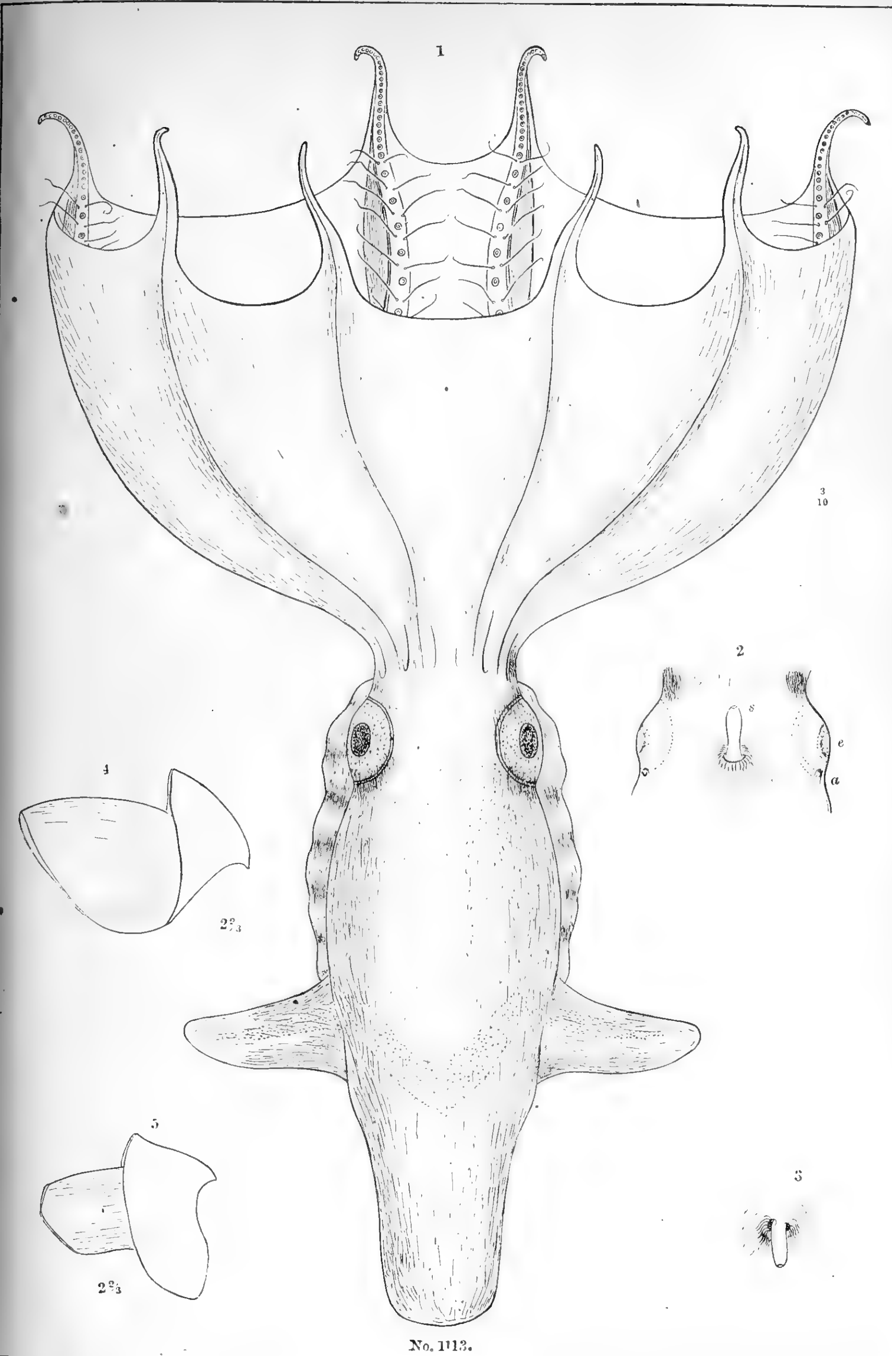

A. E. Verrill from nature. Wm. P. Northrup & Co., Engravers, Buffalo, N. Y.

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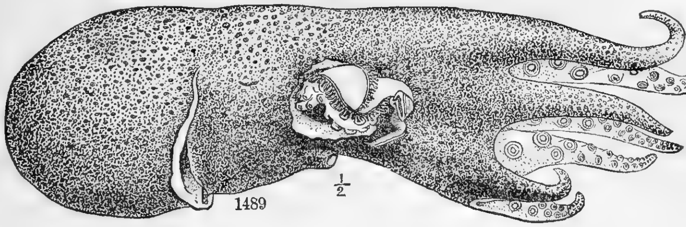

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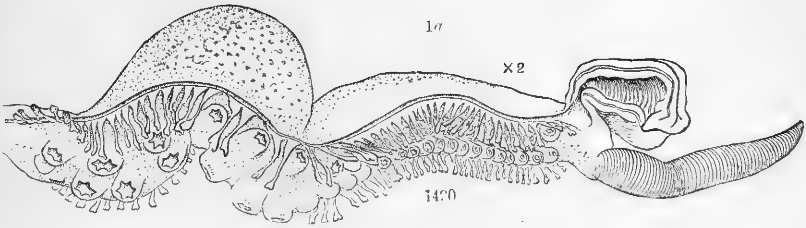

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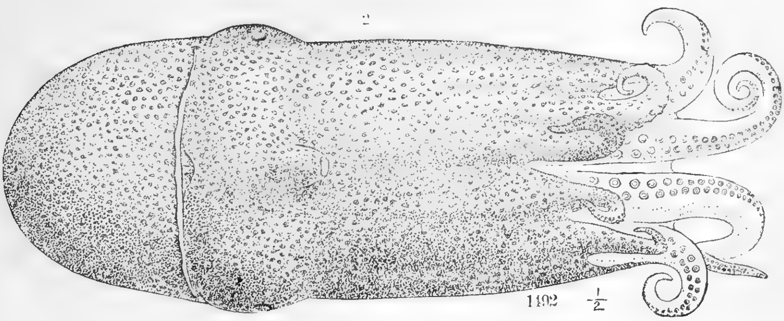

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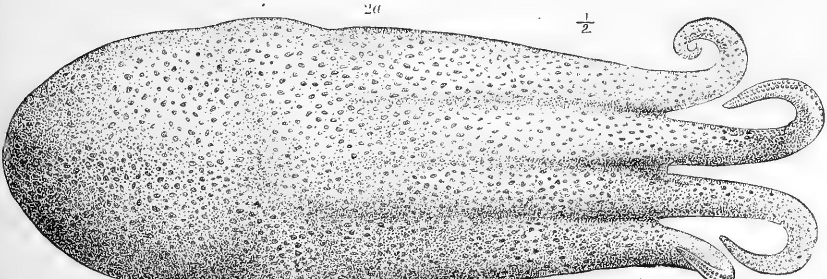

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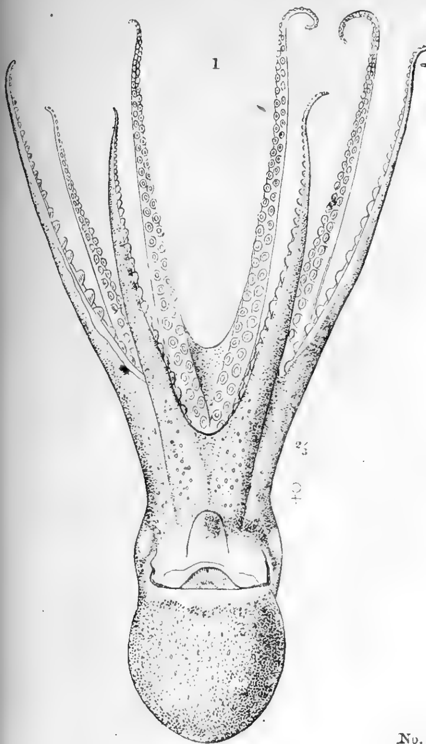

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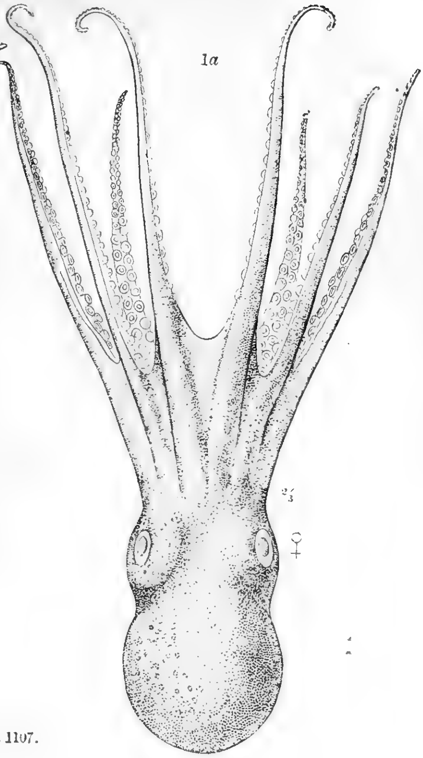

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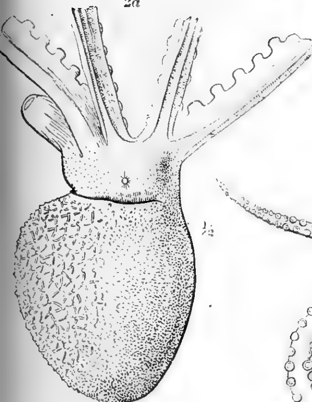

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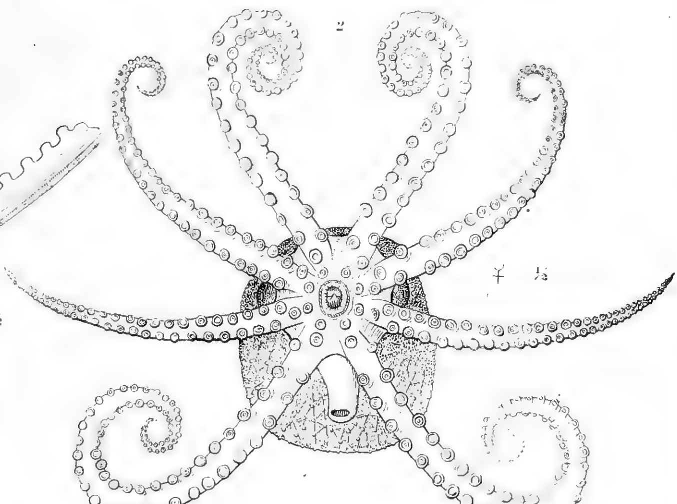

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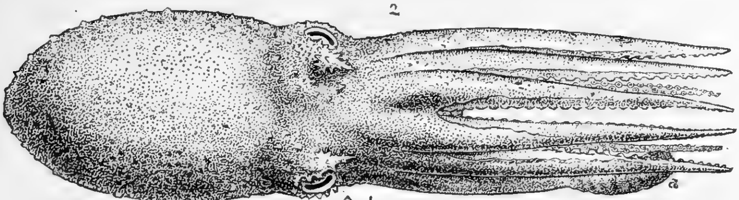

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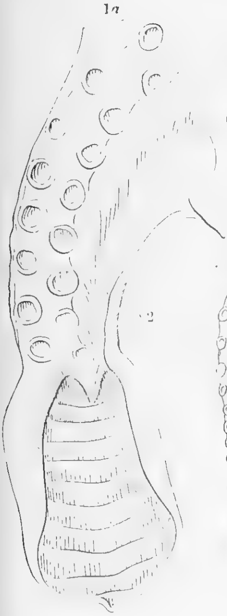

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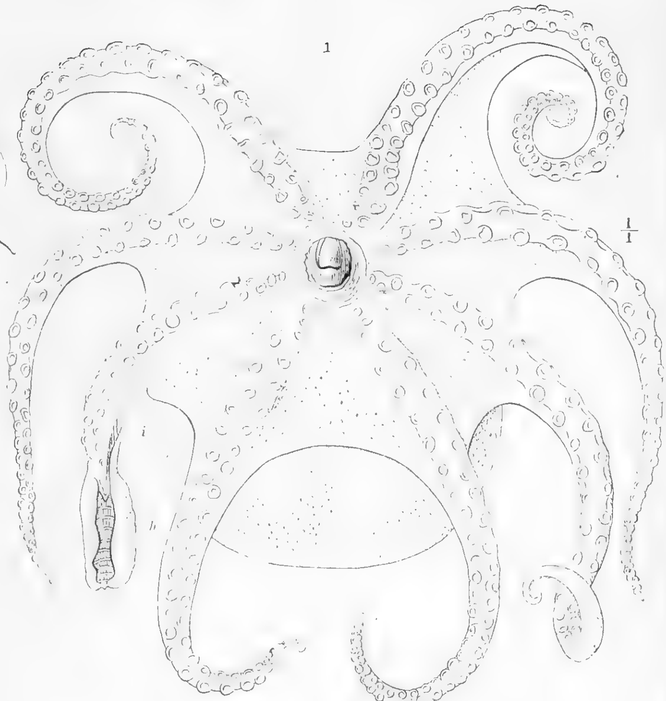

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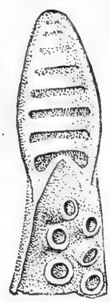

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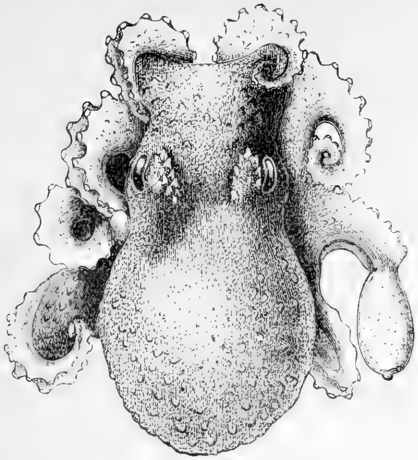

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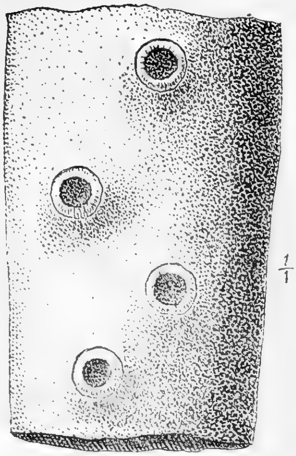

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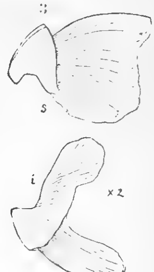

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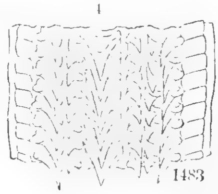

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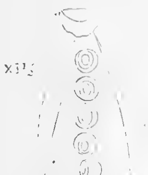

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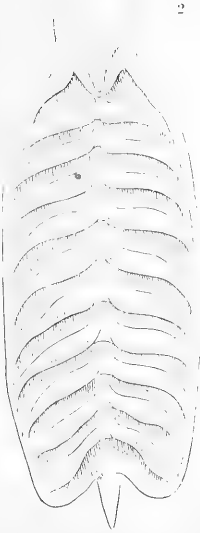

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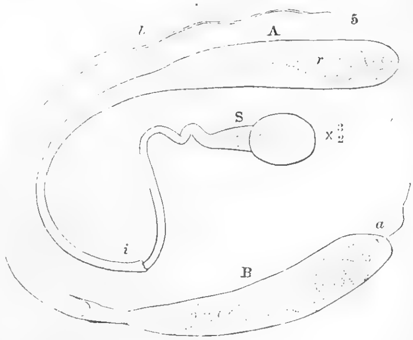

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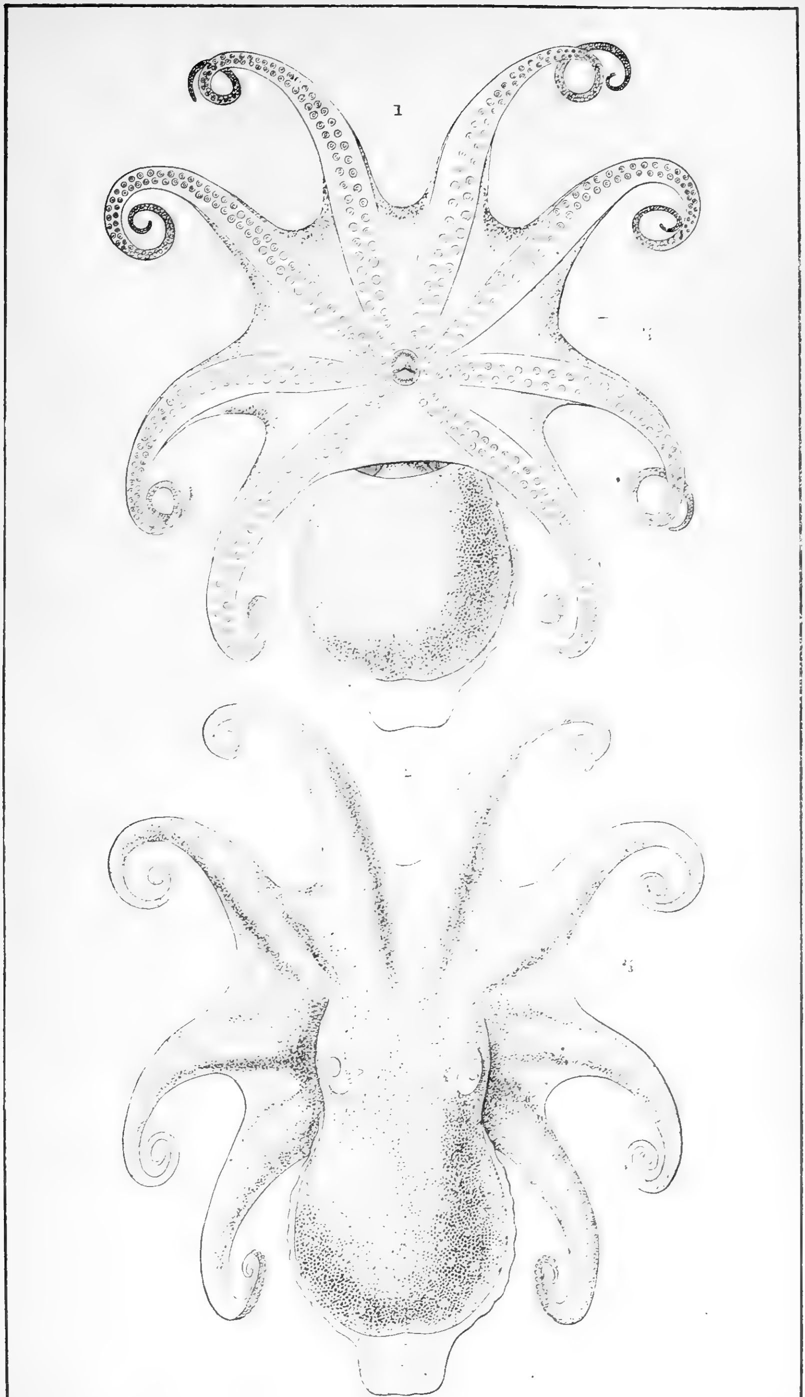

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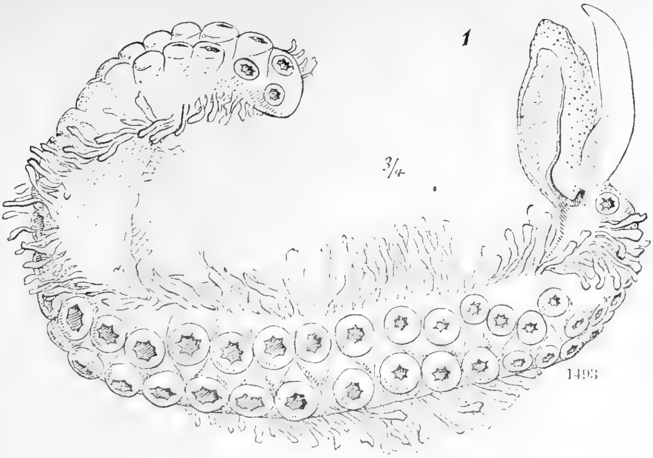
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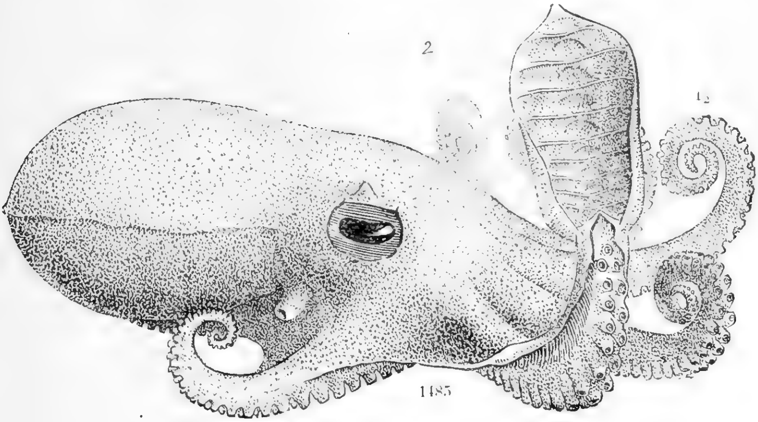
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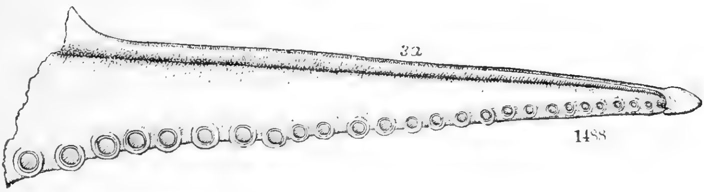
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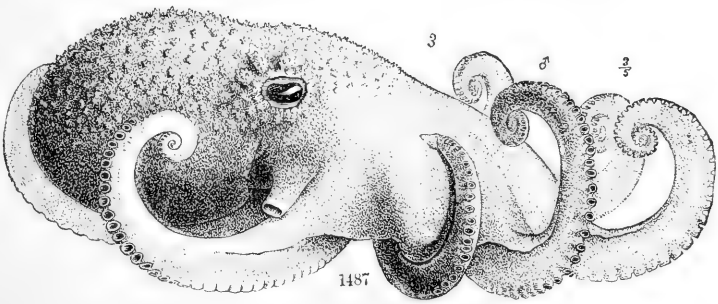
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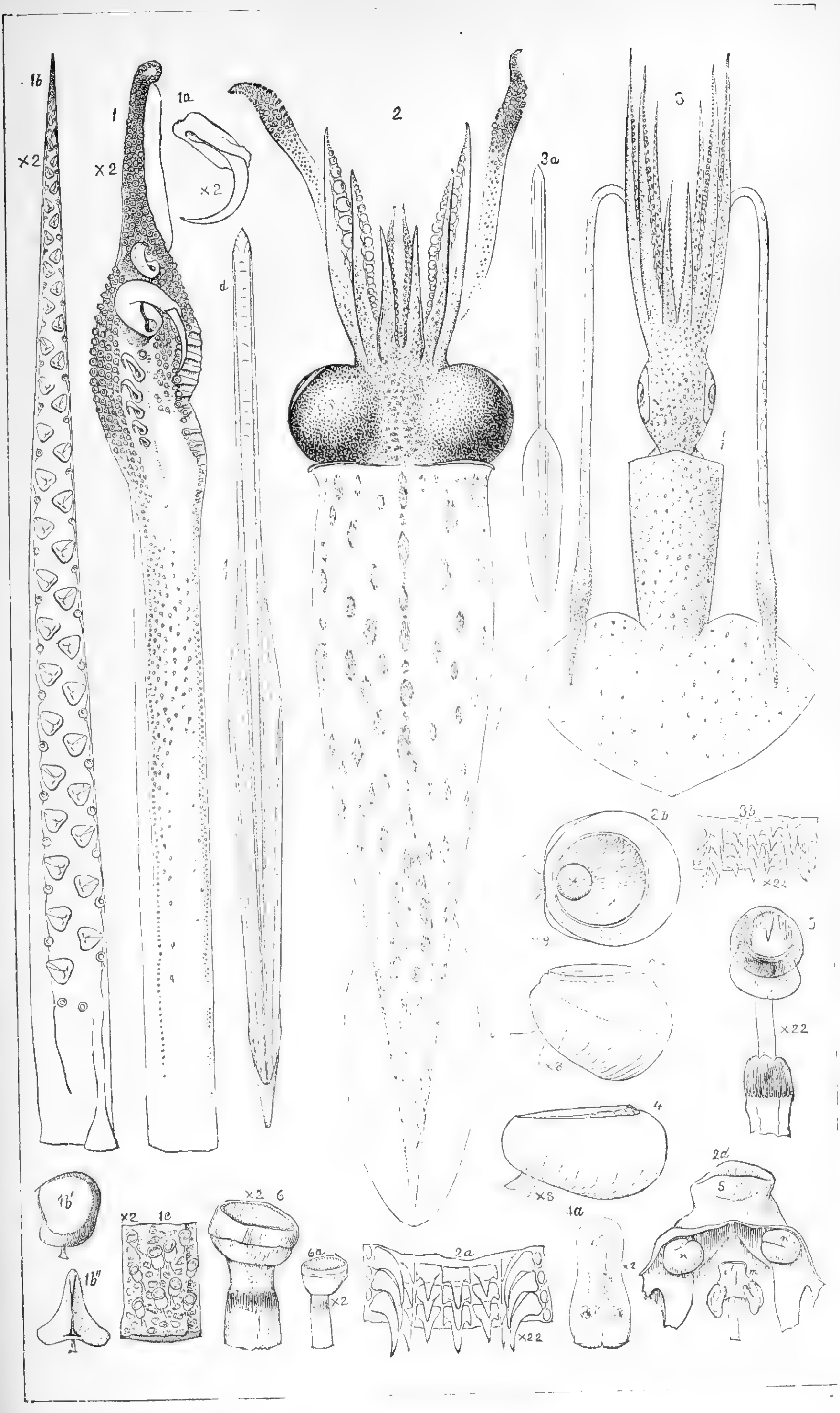
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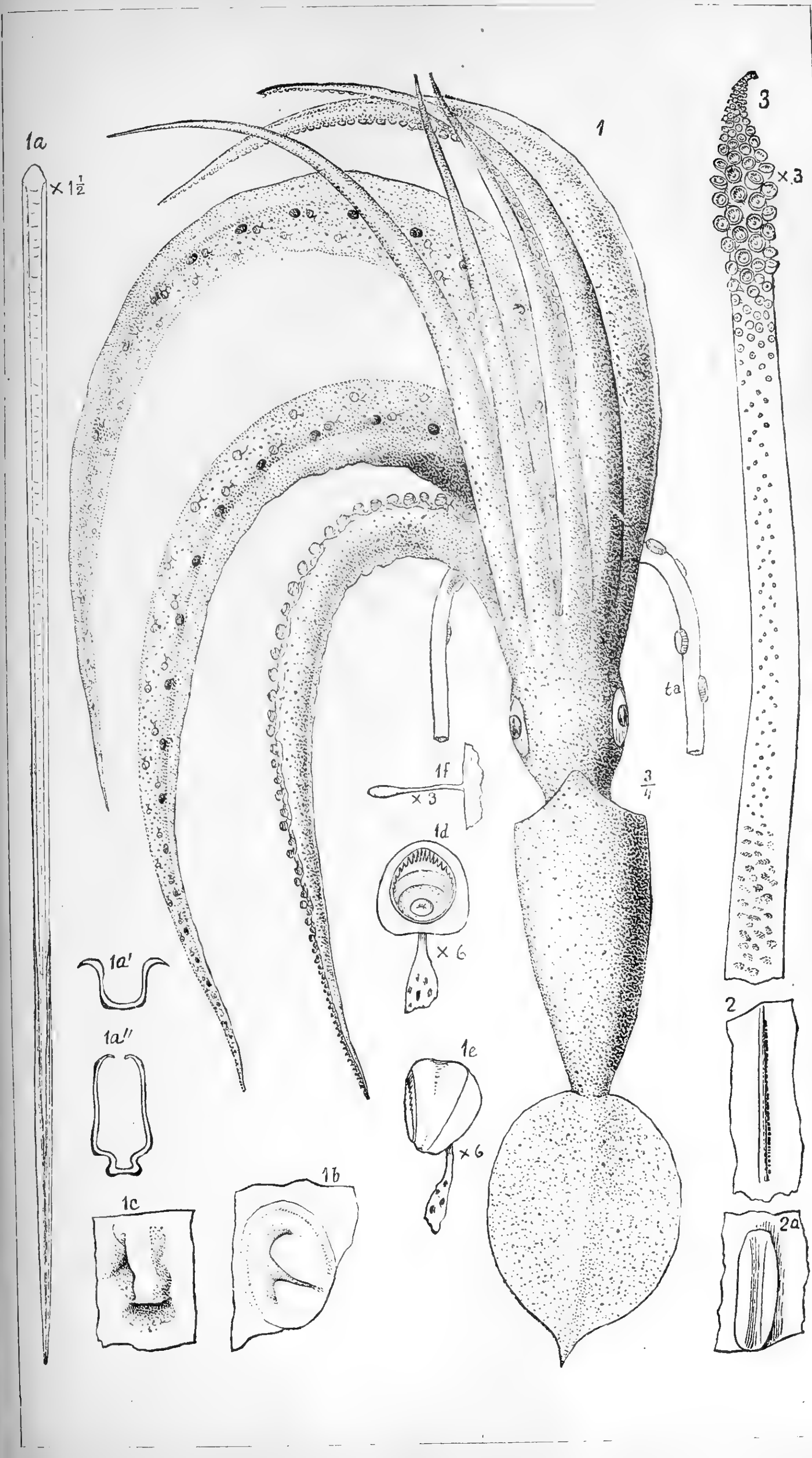
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III.—THE PROPAGATION OF THE EEL

By Dr. Otto Hermes.*

[From Circular No. 6, Berlin, November 25, 1880, of the "Deutsche Fischerei-Verein"—German Fishery Association.]

Since the beginning of last spring, when the eel fisheries in our part of the country commenced, I have given my undivided attention to the eel question (see Circular No. 1, p. 23; No. 2, p. 55; No. 4, p. 72, 1880), to dispel, if possible, the darkness which still hides the life of this mysterious fish. I do not hesitate to communicate, at the present time, the results of my investigations to the readers of the Circular, with the hope of stimulating others to make observations of this problem.

It was natural to extend these investigations to the formation and development of the sexual organs of the sea eel (*Conger vulgaris*), which so closely resembles the fresh-water eel, all the more as its sexual organs and the manner in which it reproduces its species are likewise but little known. If positive facts could be ascertained with regard to this eel, it would be tolerably safe to conclude, from the similarity of the two kinds of fish, that the same would apply to our common river eel (***Anguilla fluviatilis***).

The sea eel grows twice as long as our river eel (specimens measuring 6 feet in length are by no means uncommon), and outwardly differs from the latter by the different formation of the jaws and the dorsal fin. In the sea eel the latter begins immediately back of the pectoral fins, whilst in the river eel it is placed farther back. In the sea eel the upper jaw protrudes over the lower jaw; in the river eel the reverse is the case. The position and formation of the internal, especially the sexual, organs is very similar in both. But whilst the river eel grows up in rivers and only goes into the sea to spawn, the sea eel never leaves the sea. The sea eel stands imprisonment very well, and grows rapidly. I have had a considerable number in the Berlin Aquarium, and have examined several large ones which died. These were invariably female fish, whose ovaria had developed to an extraordinary degree. From lack of the natural conditions they could probably not spawn, and I believe that they died from this cause. I have been informed that a sea eel in the aquarium in Frankfort-on-the-Main actually burst in consequence of the unnatural development of the ovaria.

* Zur Fortpflanzung des Aales, von Dr. Otto Hermes.—Translated by Herman Jacobson.

In the autumn of 1879 I received a number of sea eels which had been caught near Havre, measuring 60 to 70 centimeters in length. They ate voraciously and grew rapidly. Only one did not develop so fast, and could easily be distinguished from the others by its smaller size. This, the smallest of all the sea eels in the aquarium, died on the 20th of June, 1879, and was examined by me the same day. I was very much surprised when I discovered that its sexual organs were entirely different from those hitherto observed in eels. When an incision was made in these organs a milky fluid oozed out. I had before me a mature male eel. A drop of this fluid, when placed under the microscope and magnified 450 times, showed a large number of live spermatozoids, whose head and tail could easily be distinguished. They moved about in a very lively manner, thus fully establishing the fact that the organs examined by me were male organs. As to my knowledge no mature male of the *Conger vulgaris* had ever been found or described, I requested Dr. Rabl-Rückhard to examine this fish with me, and had correct drawings of the organs made by a painter, Mr. Mützel, and, for the sake of comparison, placed by the side of these drawings a sketch of the ovaria of a female *Conger* measuring 84 centimeters in length. Both these drawings, reduced to half of their natural size, accompany this article.

The male sexual organs lie on both sides of the swimming-bladder, resembling long, compressed, ribbon-like channels extending the whole length of the abdominal cavity, commencing at the liver and extending beyond the anus. By a number of lateral notches each testicle is divided in several parts of different size. The right testicle has four such notches, and therefore five parts, the first section, counting from the head, measuring 45 millimeters; the second, 70; the third, separated from the second by a notch extending only half the breadth of the organ, 8; the fourth, 43, and the fifth, 38. The left testicle consists of an upper part measuring 103 millimeters, followed by a second part of 18 millimeters, and by one of 80, which by three notches, extending only one-third of the breadth of the organ, is subdivided into three parts measuring 15, 27, and 38 millimeters, respectively. The thickness of the most strongly developed upper part of the left testicle is 9 millimeters, and its breadth from the root to the free edge 18 millimeters. The attachment of the right testicle commences 11 millimeters farther forward than that of the left. The free edge of both testicles gradually grows narrower, and thus forms a border consisting of several folds measuring at most 4 millimeters in breadth and overlapping the parenchyma. If we compare these organs of *Conger* with the so-called *Syrski* organs of *Anguilla*—described in circular No. 2, 1880—the similarity of the two is very striking. In *Anguilla* we see a large number of small subdivisions or parts, and in *Conger* a small number of large parts. But if we consider that owing to the difference in the size of these two species, the parts of *Conger* must be simpler and larger, and that we examined a fully grown mature male *Conger* measuring 74 centimeters, whilst the sexual organs of the *Anguilla*—measuring 43 centimeters—were not fully developed, we may conclude with a probability bordering on certainty that the *Syrski* organs are really the male sexual organs of *Anguilla*. The male, both of *Conger* and *Anguilla*, is therefore considerably smaller than the female.

In order to ascertain the proportion of male to female river eels in our part of the country, and likewise in order to find how far up the rivers the male eels ascend, I have made a series of investigations, which, though interesting in themselves, are by no means sufficient to throw all the light we desire on the life of the eel. This requires further and more exhaustive investigations, for which I would ask the hearty co-operation of the members of the German Fishery Association.

Syrski's work,* which marks an era in the history of this investigation, throws some light on the relations between the male and female eels of the Adriatic, which has been further increased by *Jacoby's* investigations at Comacchio. The sexual relations of our North Sea and Baltic eels have hitherto been but little investigated. Mr. Cattie, teacher at the Real school at Arnheim (Holland), found among a large number of eels, measuring 30 to 45 centimeters, 25 per cent. of males. We could not learn, however, where these eels were caught.

I have examined:

(1) 72 eels caught in the Baltic, near Wismar.
(2) 72 eels from the Great Belt.
(3) 250 eels from the Elbe, near Cumlosen.
(4) 40 eels from the Havel, near Wendendorf.
(5) 137 eels caught near Neuenkirchen in the island of Rügen.
(6) 40 eels caught on the coast of Schleswig.

The length of these fish varied from 28 to 42 centimeters.

I found among those mentioned under:

(1) 8 males, or 11 per cent.
(2) 8 males, or 11 per cent.
(3) 13 males, or 5.2 per cent.
(4) No males.
(5) 61 males, or 44.52 per cent.
(6) 1 male, or 2.5 per cent.

From these figures it is apparent that Siebold's assertion that the male eels do not ascend the rivers, but remain in the sea or near the mouth of the rivers, cannot be taken in a literal sense. Cumlosen is near Wittenberge, or at least 20 (German) miles from Cuxhafen, at the mouth of the Elbe, and still we here find 5 per cent. males. How large a percentage of males there may be near the mouth of the Elbe and farther up the river I could unfortunately not ascertain, because the necessary data were wanting. From the Havel, near Havelberg, I unfortunately got only 40 eels, among which there was not a single male; but we are not justified in concluding from this that there are no male eels in the Havel.

*"Ueber die Reproductionsorgane der Aale." Vol. LXIX of the "Abhandlungen der k. k. Akademie der Wissenschaften zu Wien." Part 1. April, 1874.

In order to solve this question satisfactorily a larger number of eels would have to be examined. It would be wrong, however, to conclude, from the fact that male eels are found in rivers, that eels can propagate their species in rivers. Both male and female eels do not fully develop in fresh water, and only reach their full maturity in the sea.

The difference in the percentage of males in different parts of the Baltic is a strange phenomenon, 11 in one and 44.52 in the other. It is possible that we have to look for the spawning places of the eels in those waters where males are found in such large numbers; and here investigations should be carried on all through autumn.

The catching of such small eels as are required for these investigations is, however, attended with considerable difficulty. The fishery law prohibits the catching of eels measuring less than 35 centimeters, and even those measuring 35 to 40 centimeters are rarely seen in the market. As a general rule the fishing apparatus is not at all adapted to the catching of such small eels. In Cumlosen I had special eel baskets or traps constructed of fine wicker-work. A similar apparatus will be required in other places, if we wish to obtain light on the many dark points in the life of the eel.

The spawning places of the eels, towards which their migrations doubtless tend, will be the places where fully matured eels can be found, and from the direction in which the eels migrate the location of the spawning places can probably be ascertained.

Mr. Dallmer, superintendent of fisheries in Schleswig, who has regularly supplied me with eels from the Schleswig coast, writes me that he intends to make a thorough investigation of this coast with special reference to the eel question.

Mr. Dallmer writes: "In October and November many eels are caught in wicker baskets in the Little Belt and near Flensburg and the Island of Alsen. As these baskets are of course placed with the opening in the direction from which the eels come, this opening must indicate the direction in which the eels migrate, and if the position of the baskets in the different localities were marked on a map the course of these migrations could easily be ascertained. With this view I have drawn a map of the German side of the Little Belt and the Flensburg-Alsen waters, and have transmitted it to Mr. Hinkelmann, superintendent of fisheries at Flensburg."

If this attempt is followed by good results, Mr. Dallmer thinks the German Fishery Association should publish maps of all the German coasts where eels are caught, and have them filled out in the manner above indicated by competent persons. This proposition is thoroughly practical and promises success.

Both in the North Sea and in the Baltic eels are only caught near the coast, but never in the open sea. A man thoroughly acquainted with our western coasts, who at the same time is a very close observer—Mr. Decker, superintendent of fisheries at Blankenese—says in a letter to

Mr. Dallmer regarding the occurrence of eels in the sea, more especially in the North Sea: "Eels are found in the North Sea wherever there are islands and banks, even if these are left dry at low tide, but in the open sea they are never found. On the west coast of the island of Sylt, which is not obstructed by banks, no eels have, to my knowledge, ever been caught, whilst a great many are caught on the west coast of the island of Amrum (only a few miles distant), which is protected by a number of banks. Near Heligoland eels are frequently caught, a line and hook to which a stone is tied being thrown into the sea from the shore. Beyond the turbid yellowish water surrounding the island no eels are caught. Near Nemverk, on the Watt, I have caught many eels, but I feel convinced that beyond a line drawn from Gross-Vogelsand to Scharhörn no eels can be found. I am therefore of opinion that it may be considered absolutely certain that the Watten Sea, and the mouths or the lower parts of rivers, and not the open North Sea, are the spawning places of eels." Such observations of practical fishermen, based on accurate knowledge and experience, are exceedingly valuable, and it is to be desired that a larger number of similar observations could be made and published.

Among the outward signs by which a male eel may be recognized is a very striking metallic or bronze color, by which it can easily be distinguished from the female. Mr. Hinkelmann could thereby always beforehand inform me how many males I would find among the fish which he sent me. Among these there were several which measured 45 centimeters in length.

For a further study of the eel question it will be necessary to continue these investigations in as many rivers, bays, and coast waters as possible. Every one interested in this matter is herewith requested to send me eels. They are best packed in wicker baskets in moist sea-weeds or aquatic plants. I presume that in view of the general interest felt in this matter the German Fishery Association will gladly bear the expenses.

EXPLANATION OF THE ILLUSTRATIONS.

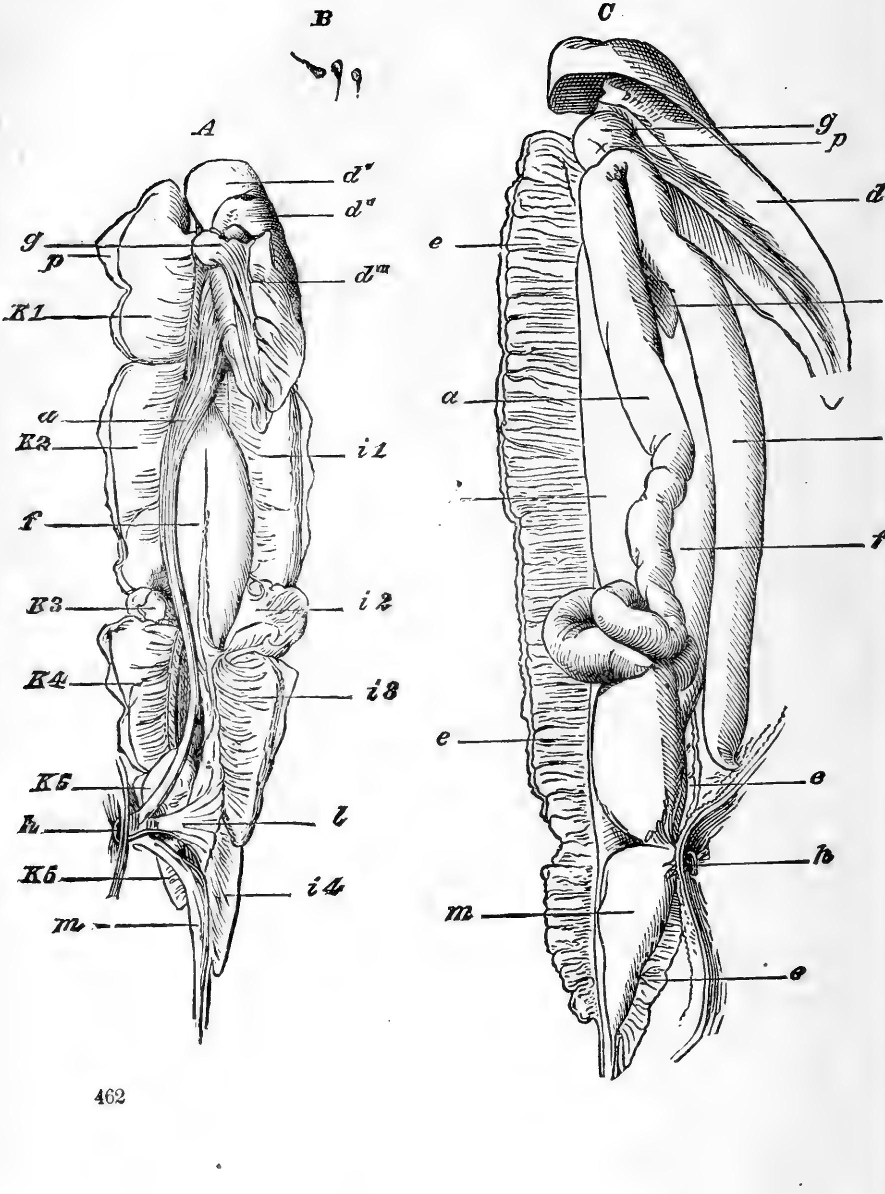
A. Fully matured male sexual organs—one-half the natural size—of a sea eel (*Conger vulgaris*) measuring 74 centimeters in length.

a, stomach; *d'*, upper; *d''*, middle; *d'''*, lower part of the liver folded back; *f*, swimming-bladder; *g*, gall-bladder; *h*, anus; *i* 1, *i* 2, *i* 3, *i* 4, the different parts of the left testicle; *k* 1, *k* 2, *k* 3, *k* 4, *k* 5, the five parts of the right testicle; *l*, *Bursa seminalis*; *m*, urinary bladder; *p*, skinny border of the testicles.

B. Spermatozoids.

C. Undeveloped sexual organs (ovaria)—one-half the natural size—of a female sea eel *Conger vulgaris*) measuring 84 centimeters in length.

a, stomach; *b*, cœcum; *c*, spleen; *d*, liver; *e*, right ovarium; *e'*, left ovarium; *f*, swimming-bladder; *g*, gall-bladder; *h*, anus; *m*, urinary-bladder; *p*, base of the left ovarium.


B
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IV.—THE EEL QUESTION.

By Dr. JACOBY.*

[From "Der Fischfang in der Lagune von Comacchio nebst einer Darstellung der Aalfrage. Von Dr. L. Jacoby." Berlin, 1880.]

I.

HISTORY OF THE EEL QUESTION.—ANTIQUITY (ARISTOTLE).—MEDIEVAL AND MODERN FABLES REGARDING THE EEL.—HISTORY OF THE DISCOVERY OF THE FEMALE EEL.—DESCRIPTION OF ITS OVARIA.

"Among all the animals that surround us the eel is the only one which has never unveiled the secret of its propagation even to the most persevering investigators." This assertion, made almost forty years ago by Martens in his work "Italien," is true to some extent even at the present day. To a person not acquainted with the circumstances of the case it must seem astonishing, and it certainly is somewhat humiliating to men of science, that a fish which is commoner in many parts of the world than any other fish, the herring perhaps excepted, which is daily seen in the market and on the table, has been able, in spite of the powerful aid of modern science, to shroud the manner of its propagation, its birth, and its death, in darkness, which even to the present day has not been completely dispelled. There has been an eel question ever since the existence of natural science.†

To the ancient Greeks the eel seems to have been a strange mystery. Even in very ancient times people were astonished to find that, whilst all other fish at certain seasons of the year contained eggs and semen—spawn and milt—such were never found in eels, although many thousands were opened for culinary purposes. A proof that the ancients at a very early time took an interest in this question is found in the jocose remark made by several Greek poets, that, since all children whose paternity was doubtful were ascribed to Jupiter, he must be considered as the progenitor of the eels.‡

*Die Aalfrage. Von Dr. L. Jacoby.—Translated by Herman Jacobson.

†"Non mediocre Philosophis ac Naturæ scrutatoribus negotium facessere semper est visa Anguillarum procreatio." (The procreation of the eel has at all times been a difficult problem for philosophers and naturalists.) With these words Cajetan Monti begins his article on the procreation of the eel in the "Transactions of the Academy of Bologna," 1783.

‡"Hæc fuit nimirum causa, cur Græci quidam poëtæ, quasi per jocum quod certus earum stirpis auctor deesset, Jove natas dixerint."—Cajetan Monti in the treatise quoted above, p. 393.

Aristotle is the first among the ancients who expressed a definite opinion regarding the origin of the eel. This great philosopher and investigator, whose knowledge concerning many questions of natural history has been corroborated by the discoveries of modern times, unfortunately expressed the most singular and primitive views regarding the eel question. In his "Natural History of Animals" he says:* "Among the articulates and among the fish there are some which in no respect show any difference of sex. Thus the eel is neither male nor female and is procreated from nothing. Those, however, who maintain that occasionally eels are found which contain worm-like objects speak without reason, because they have not seen where the eels carry these objects; for no other animal produces young without eggs; but no eel has ever been found to contain an egg." And in another place he says:† "Eels are not produced by copulation, nor do they lay eggs. No eel has ever been found to contain semen or eggs; and when eels have been opened neither seminal nor ovarian ducts have been discovered. Among all the animals having blood the eel is the only one which does not originate from copulation or eggs. It is evident that this is a correct statement, for eels will make their appearance in marshy lakes, even after all the water has been allowed to flow out and the mud has been taken out, as soon as rain-water begins to fill such lakes. In dry weather they will not be produced, not even in lakes which are full of water all the time, for they live on rain-water. It is therefore evident that they originate neither from procreation nor from eggs. Nevertheless some people think that they produce live young ones, because intestinal worms have been found in some eels, which these people think, are the young of the eel. This, however, is an erroneous opinion, for they are produced from the so-called 'bowels of the earth,'‡ which are spontaneously produced from mud and moist soil."

Considering the high esteem in which Aristotle was held among the ancients, and still more in the Middle Ages, it will not be astonishing that these marvelous statements were believed and embellished by a number of other fables and legends, many of which are current among the common people to this very day. There is in fact no other animal regarding whose origin and life so many erroneous opinions are prevalent as the eel. These opinions, some of which are entirely fabulous, whilst others are within the range of possibility, but have been proved to be wrong, may be divided into three groups.

The first comprises those opinions which, based on Aristotle's descriptions, supposed the eel to be procreated not directly from the mud of the earth, but from a slimy mass, which is said to be produced when eels, which otherwise show no difference of sex, rub their bodies against each

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*Book IV, chapter 11.

†Book VI, chapter 16.

‡Aristotle understands by these "bowels or intestines of the earth," the earth-worm (*Lumbricus terrestris* L.), as appears from his treatise on the procreation of animals.

other. This opinion was held by Pliny, by Athenæus, and Oppian, and was again taken up in the sixteenth century by Rondelet, and later by Conrad Gessner.

The second group comprises the opinions held by people who accidentally found worm-like organisms in the entrails of the eel, who described these, and therefore considered the eel as an animal producing live young ones. Although even Aristotle rejected this opinion as erroneous, and rightly supposed that these worms were nothing but intestinal worms, there have been discoverers of live young eels up to the present time. I find this opinion in the Middle Ages in the "Thierbuch"—book of animals—by Albertus Magnus, and later in the works of naturalists like Leuwenhœk, Elsner, Redi, and Fahlberg. Linné likewise inclined towards this opinion, and maintained that the eel produced live young ones. A few years ago a professor at the gymnasium (college) of Rostock published an article in the "Gartenlaube,"* in which he gave a rapturous description of the young eels discovered by him in a female eel, and the same opinion was again advanced by others during the summer of 1877. It is quite natural that persons who are not versed in natural history, and who, on opening an eel, find in its inside a more or less considerable number of live worm-like beings, are at once inclined to consider them as the young of the eel. It must be stated, however, that whenever such so-called young eels were subjected to a scientific examination, they turned out to be intestinal worms.†

The last group comprises the opinion that eels are born, not from *eels* but from *other* fish, and even from other animals. Absurd as this opinion is—which in a certain sense must also be traced back to Aristotle—it is very common, even at the present day, among all eel fishermen, especially those living on the coast near the mouths of rivers. A slimy fish—the *Zoarces viviparus* L.—owes the name by which it is commonly known—the "Eel-mother"—to this opinion. In Comacchio I have again met with instances of the inexterminable belief of the fishermen that the eel is born from other fish. They even go so far as to point out certain differences in the color and shape of the *Mugil cephalus* as the causes of the different color and shape of eels. It is a very old opinion, prevalent to this day, that eels copulate with water snakes, but it seems incredible, and is nevertheless a positive fact, that the Sardinian fishermen consider a beetle, the *Dytiscus Roeselii*, as the procreator of the eel. They very generally call this beetle "Eel-mother."

No scientific investigation of the question of the procreation of the eel could be made until, towards the end of the Middle Ages, the influence which Aristotle had hitherto exercised over the opinions of all learned men began to wane. At the revival of natural sciences in the sixteenth century naturalists took up this special question with

* Volume for 1874, p. 120.

† Most of the worms inhabiting the intestines of the eel belong to the species *Ascaris labiata*.

great zeal, and we have treatises on the procreation of the eel by the most famous naturalists of that period, such as Rondelet, Salviano, Aldrovandi. This (the sixteenth) and the following century, however, did not get beyond the discussion regarding young ones said to have been found in eels. I have already mentioned some of the naturalists who held this opinion. Franz Redi and Christian Franz Paullini, both living in the seventeenth century, were the first who, without, however, having made personal observations, expressed the opinion that eels had both semen and eggs, and that their procreation differed in no wise from that of other fish.

It was reserved for the eighteenth century at last to discover at least the female organs of the eel, and settle this part of the question definitely. It is an interesting fact that Comacchio has been the birthplace of many erroneous opinions, and of the final truth in this matter. Dr. Sancassini, a learned physician of Comacchio, who, in the year 1707, visited one of the eel-houses, found an eel whose stomach appeared considerably bloated. He opened it and found inside an organ closely resembling an ovarium, which contained what appeared to him mature eggs. He preserved this eel and sent it to his friend, the famous naturalist, Professor Vallisneri, of the University of Padua, who carefully examined the organ and rejoiced that he had at length found the ovarium of the eel. He wrote a learned treatise on the subject* and sent it to the Academy of Bologna. Strong doubts as to the correctness of this discovery were immediately raised, especially outside of Italy. These doubts seem to have been shared by Professor Valsava, the first anatomical authority of Bologna, especially when soon after another Comacchio physician, Dr. Francesco Bonaveri, author of a "History of Comacchio," sent an eel to Bologna, which in every respect resembled the one described by Vallisneri.† The discussion grew quite animated, and the Bologna scientists seemed actually possessed with a passionate desire to discover the ovaria of the eel. Prof. Pietro Molinelli had promised several fishermen of Comacchio whom he knew a large reward if they would get him a pregnant eel; and in 1752 a fisherman brought him a live eel, whose stomach was very much bloated, and which, when opened by him in the presence of a friend, was found to be full of eggs. The great hopes connected with this discovery were, unfortunately, not realized, for it turned out that the sly fisherman had previously opened the eel and stuffed it with the eggs of some other fish. The eel question entered upon another and more successful stage when, in the beginning of the year 1777, a third eel, resembling the two former ones, was caught near Comacchio. Luigi Bonafede sent it to the Academy of

*Published with illustrations at Venice in 1710, and also in 1712, under the title "De ovario anguillarum" in the "Ephemeriden der Leopoldinischen Akademie der Naturforscher."

†Bonaveri says in his "History of Comacchio" that he is fully convinced of the correctness of Vallisneri's idea and discovery.

Bologna, which handed it over to Prof. Cajetan Monti. As he was sick and could not in person superintend the investigation, he called a number of his scientific friends together for a consultation on the subject. There were present at his house, among others, the anatomists Carlo Mondini and Germano Azzoguidio, the famous discoverer of galvanism, then an unknown student, Camillo Galvani, whose eminent scientific talents are specially mentioned in the report.* The eel was examined by all the persons present at this conference, and recognized as closely resembling the one described seventy years previous by Vallisneri. It was finally unanimously resolved to request the famous anatomist Mondini to make a thorough examination of this precious fish. He entered upon his work with great zeal, and the paper which was its result was read at the academy in May, 1777. This treatise is entitled "De anguillæ ovariis," but was not published till six years later in the "Commentarii," &c., of the academy.† Mondini, first of all, showed in the most convincing manner that the supposed ovarium described by Vallisneri had been nothing but the swimming-bladder of the eel distended unnaturally by sickness, and that the small round grains which had been mistaken for eggs were only swelled glands. Mondini at the same time published an accurate description, accompanied by excellent illustrations, of the true ovaria of the eel discovered by him. This work, which contains a very fine illustration of the magnified eggs, may, both as to form and contents, be termed a standard work; and it is an act of historic justice to say that it was not O. F. Müller or Rathke, but Carlo Mondini, who first discovered and described the female organs of the eel, which for centuries had been sought after in vain.‡ Three years later, and as it seems independently of Mondini, the eminent zoologist, Otto Friedrich Müller, published his discovery of the ovaria of the eel in the publications of the Berlin Society of Naturalists.§ A peculiar

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* Monti (p. 393) calls him "præclara indole adolescens, ad naturalem historiam excolendam natus" (a young man of remarkable talents, born for the study of natural sciences).

† De Bononiensi Scientiarum et Artium Instituto atque Academia Commentarii. Tomus VI. Bononiæ, 1783, p. 406. *et seq.*

‡ Prof. G. B. Ercolani, of Bologna, and Professors Crivelli and Maggi, in articles published by them in 1872, very justly complain that the priority of Mondini's discovery had been overlooked in Germany. Neither Rathke, nor Hohnbaum-Hornschuch, nor Schlüser have mentioned his work. S. Nilsson, in his "Skandinavisk Fauna," 1855, knows nothing of Mondini. In his "Histoire naturelle des Poissons" he mentions O. F. Müller and Cuvier as the first who had described the ovaria, and Rathke as the first discoverer of the eggs. As far as I know, Th. von Siebold was the first who, in 1863, in his work, "Die Süsswasserfische von Mitteleuropa" (p. 349), mentioned that Mondini had discovered the ovaria of the eel almost simultaneously with O. F. Müller, and that the two discoveries had been entirely independent of each other. The erroneous opinion that the Italian discovery had been made after the German is easily explained by the fact that Müller's treatise was published in 1780, and Mondini's, though written and read in 1777, not till 1783.

§ "Schriften der Berlinischen Gesellschaft naturforschender Freunde," vol. i, 1780, p. 204, article entitled "Bemühungen bei den Intestinalwürmern" fate awaited the discovery of Mondini at the hands of Lazzaro Spallanzani. This famous naturalist, in October, 1792, undertook a journey from Pavia to the Po lagoons, near Comacchio, for the sole purpose of studying the eel question in that locality. He spent the greater part of the autumn in Comacchio, but did not discover anything new, whilst in the published description of his journey * he entirely rejected Mondini's discovery, and maintained that the ovaria which Mondini had described were in reality nothing but the unusually fat folds of the diaphragm. It is probably this absolutely negative result of the investigations made by so famous a naturalist as Spallanzani which deterred others for some time from any further investigations of the eel question, and which made all that had been so far discovered appear doubtful and fall into oblivion. When, therefore, Professor Rathke, of Königsberg, in his large work on the generative organs of fish, 1824,† described the ovaria of the eel as two organs resembling frills, extending along both sides of the backbone, and described them a second time‡ in an article in "Wiegmann's Archiv für Naturgeschichte," 1838, he was generally in Germany, even to the present day, considered as the discoverer of the ovaria of the eel. The first drawing of the ovaria after Mondini, and the first microscopic drawing of the eggs of the eel, were given by Hohnbaum-Hornschuch in a dissertation published in 1842,§ which will always occupy a prominent place in the literature of the eel question. The question regarding the ovaria of the eel was definitely settled by Rathke, who, in 1850, published an article in "Müller's Archiv" on a pregnant female eel examined by him, the first and only specimen of a pregnant eel which so far had been seen by a naturalist.||

It will be proper to give in this place a short description of the ovaria of the eel. If an eel be opened along its lower side from the breast to a point behind the anus, there is seen besides the entrails and stomach, and underneath the back part of the liver, the long swimming-bladder, growing narrower toward both ends, and extending on the one side as far as the diaphragm, and on the other a little distance beyond the anal opening. Along both sides of the swim-bladder there extends a white or yellowish band, tolerably broad and shaped exactly like a frill, whose inner edge is attached to the swim-bladder by a narrow skin, a duplicature of the inner skin of the abdomen, but whose other edge hangs down free in the abdominal cavity. Each of these frill-like bands extends forward

* Lazzaro Spallanzani: "Opusculi due sopra le anguille, dove singolarmente si ragiona di quelle che si pescano nelle valli di Comacchio." Opere. (Milan edition, 1826.) Vol. iii, p. 518.

† "Neueste Schriften der Naturforschenden Gesellschaft zu Danzig," vol. i, part 3, Halle, 1824. "Ueber den Darmkanal und die Erzeugungsorgane der Fische," von Dr. Heinrich Rathke, p. 122.

‡ Wiegmann's Archiv, 1838, i, p. 299.

§ "De Anguillarum sexu ac generatione." Inaugural dissertation by Reinhold Hohnbaum-Hornschuch. Greifswald, 1842.

|| Müller's Archiv, 1850, p. 203.

to the fore part of the liver, passes along the whole abdominal cavity, and ends a little distance back of the anal opening, with which, however, it is in nowise connected. In these bands, which contain a great deal of fat, numberless eggs are imbedded. By tearing a little piece of this band with a pin and carefully wiping off the small drops of fat, one can recognize the eggs with the naked eye as very small white dots. The microscope, however, will distinctly reveal their form and inner construction. They are generally round, surrounded by a skin, which forms a clear transparent ring—the *zona pellucida.* Inside of this skin there is a large mass of small grains, the yolk of the egg. In the larger eggs nothing but these grains is seen, especially when the eggs have lain in water for some time, because then the small grains composing the yolk have congealed and become opaque. But if one takes from the same ovarium the smaller and less developed eggs, one may very distinctly recognize the small and entirely colorless bladder, called the Purkinjean vesicle. There can, therefore, be no doubt that we have before us the ovaria and eggs of the eel. The fact that it took several centuries of eager search to discover these ovaria is, to some extent at least, explained by the circumstance, that up to the present day all attempts to discover larger and more developed eel-eggs have proved futile. It is well known that there were no good microscopes till about thirty years ago. Even the eel which was examined by Rathke, the only pregnant eel which has been found, although its distended ovaria filled the whole abdominal cavity, contained only very small eggs, the largest measuring .1 millimeter in diameter. Larger eel-eggs, on the point of cutting loose from the ovaria and turning to young eels, have still to be discovered.

Running alongside of each of the two ovaria, extending through the abdominal cavity of the eel, there is nearly always an irregular band of fat, with many points, developed more on one side than on the other; this is a fold of the inner skin of the abdomen.

II.

HISTORY OF THE EEL QUESTION (CONTINUED).—DISCOVERY OF THE MALE EEL.—DESCRIPTION OF THE MALE ORGANS.—OUTWARD DISTINCTIONS BETWEEN MALE AND FEMALE EELS.—THE EEL QUESTION IN GERMANY IN 1877.

No less interesting than the history of the discovery of the ovaria of the eel, is the history of the researches for the male organs of the eel, although it is not many years old.

In the above-mentioned dissertation by Hohnbaum-Hornschuch (1842) we find the opinion expressed, that certain cells discovered by the author inside the ovaria, which are said to differ from the egg cells both in shape and contents, must be considered as the seminal cells of the eel, which, therefore, would be a hermaphrodite. Six years later, Schlüser published an interesting dissertation on the sex of the lamprey and the eel,* in which he pronounced Hohnbaum's view as erroneous, and expressed the supposition that male eels were either very scarce, or that they differed in shape from the females. Till the seventh decade of our century no male eel has ever been seen, nor has any opinion been advanced regarding the shape of the male eel and its organs of generation.† By a strange accident the University of Bologna was again destined to open the discussion of the eel question and enter upon a scientific tournament with the University of Pavia. In the session of the Academy of Bologna of December 28, 1871, G. B. Ercolani, professor of anatomy, read an essay entitled, "The complete hermaphroditism of the eel."‡ Two weeks later two professors of the University of Pavia, Balsamo Crivelli and L. Maggi, also read a paper on the eel entitled "The principal organs of generation of the eel." These three scientists had, therefore, without the slightest preconcerted knowledge, again taken up the famous discussion of the eighteenth century, this time chiefly with regard to the male organs of the eel. Both parties were convinced that they had at last discovered these organs, and it must be confessed that the results of their investigations were strange enough. In Ercolani's treatise it is shown that the above-mentioned fatty band running alongside of the ovarium is the male organ (testicle) of the eel; the left band, distended by air, being the real testicle, whilst the right one had been in some way checked in its growth, and was not capable of performing its function. In Crivelli's and Maggi's essay,§ on the other hand, these fatty bands are likewise described as the testicles of the eel, but with this difference, that the right one is declared to be the only productive organ. These two last-mentioned scientists even give drawings of the spermatozoids, which they say they have observed in the fatty band extending along the right side. As these bands are invariably found

* "De Petromyzontum et Anguillarum sexu." Inaugural dissertation, Dorpat, 1848.

† Rathke, strange to say, in his above-mentioned treatise on the sexual organs of fish (Halle, 1824), also speaks of the male organs, the testicles of the eel, and always in connection with those of the lampreys (see p. 128 and p. 158); yea, he even describes the inner construction and substance of the testicles of the eel, pp. 185, 186, 187, 190, and 193. It is a positive fact, however, that Rathke has never informed the scientific world of the discovery of a male eel, although in the above-mentioned article in "Wiegmann's Archiv" (1838, p. 299) we find the following sentence: "Regarding the male organs of the eel, I hope to give further particulars at no distant period." It would be interesting to ascertain whether in the posthumous papers of the famous author some notice of or memorandum on male eels which, however imperfect, would be valuable, has been found.

‡ Ercolani's essay is entitled, "Del perfetto ermafroditismo delle Anguille," and is reprinted in the "Memorie dell' Academia delle Scienze del Istituto di Bologna," 1872, part 4, p. 529.

§ Balsamo Crivelli's and L. Maggi's essay has been published under the title: "Intorno agli organi essenziali della riproduzione delle Anguille" in the Memoire del Istituto Lombardo di Scienze e Lettere a Milano," vol. xii, 1872, part 4, p. 229. It has been translated into German in "Wiegmann's Archiv für Naturgeschichte" 1872, part I, p. 59 *et seq.*

in all eels having an ovarium, Crivelli and Maggi must, according to their own view, declare the eel as a hermaphrodite. Professor Ercolani's essay begins with this assertion, that "the author this day appears before the academy with fear and trembling, since he intends to present something new regarding a question which has been the rock on which the vessels of so many distinguished scientists have foundered." He thereupon points to the famous scientist Vallisneri, whose great mistake had exactly a hundred years ago been shown up by Mondini in this very same academy, when the latter, referring to Vallisneri's joy at his supposed discovery, had uttered the following words: "Oh, that the truth had been equal to his joy"! and Ercolani adds that when writing his essay he had often to think of these words.

We are sorry to say that this feeling of fear and trembling which the highly esteemed Bolognese savant and anatomist manifests in a manner so modest, and at the same time honorable for himself, as well as his reference to Vallisneri's mistake, were entirely justified. The organ of the eel described both by Ercolani and Crivelli and Maggi as the testicle, has, on careful examination, been shown in the most unmistakable manner to have not even the slightest trace of a testicle-like construction. The cells of this organ extending alongside of the ovarium are only simple fatty cells having all the distinguishing marks of such cells as given in manuals of histology.

Professor Rauber, of Leipzig, has carefully examined these cells; and I have also examined them in a great many eels; and nothing has ever been discovered in them but fat and the roots of blood-vessels. The supposed spermatozoids depicted in Crivelli's and Maggi's work have under a good microscope been shown to be nothing but small fatty particles or crystalline particles, such as are frequently found in fatty cells.*

Meanwhile the question regarding the male organs of the eel was to enter upon a new and highly significant stage, bringing it nearer toward its final solution. Darwin has directed attention to the circumstance that the male of nearly all fish is smaller than the female.† He says that Dr. Günther, the eminent ichthyologist of the London Museum, had assured him that he never yet met with a single instance where the male fish had been larger than the female of the same species. This utterance may possibly have induced Dr. Syrski, formerly director of the Museum of Natural Sciences at Trieste, now professor at the University at Lemberg—when commissioned by the authorities of Trieste to ascertain the actual spawning season of all the fish caught near Trieste, which of course would include the eel—to direct his attention

* In making microscopic examinations of fatty tissues the so-called "Brown's molecular movement" may easily deceive the observer and cause him to imagine that he sees moving spermatozoids; especially will this be the case in fish, of whose spermatozoids—unless they are extraordinarily magnified—only the head can be recognized, and which have an entirely globular shape.

† Charles Darwin, "The descent of Man," translated by Carus, 1871, vol. ii, p. 5.

principally to small eels. Hitherto the largest eels had been picked out for purposes of scientific examination, because people reasoned in this wise, that the larger and, therefore, the older the eel the farther developed their organs of generation must be. As early as the 2d of January, 1874, Syrski found in the second eel which he examined, and which measured 40 centimeters in length—the specimen in question has been preserved in the Museo Civico in Trieste—an entirely new organ which no scientist had hitherto discovered in an eel, although thousands and tens of thousands of eels had been examined.* Syrski published his discovery in the number for April, 1874, of the "Abhandlungen der Kaiserlichen Akademie der Wissenschaften zu Wien." The most important feature of the new discovery was, that in all those eels which contain Syrski's organ the frill-like ovarium, the female organ of generation, was entirely wanting. This proves in the first place that the eel is not a hermaphrodite. But now the question arises: Does the newly discovered organ, both as to its outward form and inner construction, differ so much from the ovarium that it is out of the question to consider it as an irregularly developed or sickly ovarium? After all the preceding investigations, it must be considered highly probable that the newly-discovered organ is really the long-sought-for male organ of generation of the eel, but as yet it cannot be asserted with absolute certainty, because the most important proof, the presence of spermatozoids, has so far not been furnished.

The first important difference between the newly-discovered organ and the ovarium, which in itself is a strong point in favor of declaring the former to be the testicles, is the presence of a seminal duct, which, when filled with air or quicksilver, can be distinctly recognized with the naked eye, and which by its base is attached to and runs along the whole length of the organ. The ovarium never has any duct of this kind, no indication even of ovarian ducts, so that the eggs when ripe fall into the abdominal cavity, and from there through two very small genital apertures, which were discovered by Rathke, into the outer world. In the second place, the outward shape of the newly-discovered organ, at any rate in eels which are not too diminutive, differs very much from the well-known ovarium. The organ which occupies the same place in the abdominal cavity as the ovarium does not show the slightest trace of the characteristic frill-like folds, but appears more like a very narrow, light band,† whose free edge, protruding into the abdominal cavity,

*If we remember that in our times Professor Münther alone has opened and examined 3,000 eels without discovering the Syrski organ, we are justified in supposing that many mysteries in the nature of the eel are still reserved for future discoveries.

† If an eel is opened with a view of finding the Syrski organ, one may easily be deceived by the two fatty bands which have been mentioned several times, and which play so important a part in the treatises of Ercolani and Maggi, who mistook them for the frill-like ovaria. Most people will then think that they are examining a female eel, and will lay it aside. A more thorough examination will leave no room for doubt as to the irregularly indented fatty fold and the frill-like organ. If the latter is not found, one has before him a Syrski eel, and the Syrski organ will be found

shows a beautiful and regularly wavy outline. By these convex indentations the whole band is regularly divided into small pieces, or little lobes, from which the organ, in contradistinction to the frill-organ of the ovarium, is called the lobe-organ ("Lappen-organ"). This organ, which in such perfection is not found in any other fish, is now generally called, from its discoverer, the Syrski organ. The inner structure and histological construction of this organ is also very different from that of the ovarium. Whilst the contents of the latter, even when only moderately magnified, appear beyond a doubt as eggs imbedded in layers of fat, the elementary structure of the lobe-organ can only be recognized when strongly magnified. Under a powerful microscope no ovarian cells can be seen, but a net-work resembling closely the histological structure of the immature testicles of other fish. Professor Claus, of Vienna, who like other German scientists, for instance, Professor Siebold, of Munich, and Professor Virchow, of Berlin, takes a very lively interest in this question, had one of his scholars, Mr. S. Freud, a student of medicine, examine histologically the lobe-organ of a large number of eels. Although this observer could not pass a definite opinion, because he was not able to prove the presence of spermatozoids, he likewise draws attention to the great difference between the ovarium and the lobe-organ, and to the probability that the latter is the testicle.* When engaged at the zoological station at Trieste, I devoted considerable time to an examination of this question. In September, 1877, I obtained an eel which had unusually large lobes, and which, at the special desire of Professor Claus, was sent to Professor Siebold, of Munich, for examination by the naturalists then in convention in that city. I had succeeded in showing in this eel a more advanced stage of development of the inner construction, namely, tube-like ducts filled with cells, exhibiting an unmistakable resemblance to the seminal cells of the testicles of other fish.

It is interesting to observe the outward difference between live eels having an ovarium and those having a lobe-organ. The most important difference is (1) that of length and size, already referred to. Syrski says that the largest eels with lobe-organs discovered by him measured 430 millimeters. I have, however, both at Trieste and Comacchio, found eels with this organ measuring 450, 460, 470, and 480 millimeters. All eels longer than this—and it is well known that they reach the length of one meter, and the thickness of a man's arm—have so far at least been invariably found to be females. The other outward differences are (2), the broader point of the snout in the female in contradistinction to the narrow, extended, or short and pointed snout of the eel with lobe-

by carefully turning over and laying back the fatty folds. The lobe-shaped band fastened to the backbone is, however, often so narrow, and its substance is so glass-like and transparent, that this organ when attached to its base can only be recognized with the naked eye when it is held in an oblique direction towards the sun.

* Published in the March number of the "Sitzungsberichte der K. Academie der Wissenschaften zu Wien." 1877.

organs; (3) the lighter color of the female, green on the back and yellow or yellowish on the lower side, the back of the male generally being a dark green, often almost black, whilst its sides have invariably a metallic glitter. I often found eels having a bronze color, which were always eels with a Syrski organ—and their lower side white; (4) a very striking difference in the height of the dorsal fin. All females have a higher and broader dorsal fin than eels with the lobe-organs of equal size; and finally (5) the generally—for it is not always the case—larger diameter of the eye in eels with lobe-organs. Eels with particularly small eyes are nearly always females, whilst eels with a Syrski organ have generally large eyes, although many female eels have also large eyes.

The following measurements are the averages of a very large number of eels which I examined, and may be of general interest; *a* is the total length of the eel, *b* the breadth of the point of the snout between the nostrils, *c* the breadth of the snout between the eyes, *d* the length of the mouth from the center of the eye to the point, *e* diameter of the eye, *f* length of the head to the gill aperture, *g* height of the dorsal fin; all these measurements are in millimeters:

	A. Eels with lobe-organs.								B. Female eels.						
	a.	*b.*	*c.*	*d.*	*e.*	*f.*	*g.*		*a.*	*b.*	*c.*	*d.*	*e.*	*f.*	*g.*
I.	480	6	13.5	15	8	52	5	I.	480	8.5	15	17	5	62	9
II.	470	6	10.5	12	7	54	6	II.	475	7.5	14.5	16	8	59	9.5
III.	445	5	11	12	6	47	6	III.	440	8	12	14	5	56	7.5
IV.	411	4	9	12	5.5	47	6	IV.	410	8	12.5	13	7.5	51	7
V.	386	4.5	9	12	5.5	46	4	V.	378	7.5	11	12	5	49	7.5
VI.	370	3.5	7	10.5	5	40	6	VI.	369	7.5	11	13	6.5	51.5	7
VII.	344	4	7.5	10	4.5	40	5	VII.	342	6	8	11	4.5	44	6.5
VIII.	319	4	7	10	5	40	4.5	VIII.	313	5.5	8	10.5	3.5	41	6

By observing these differences, and paying special attention to the height or narrowness of the live eel, eels with Syrski organs have been successfully picked out from among a large number of eels in the Trieste fish market. Absolute certainty in recognizing eels by these marks can of course not be guaranteed. If without knowing these distinguishing marks, with the exception of the first, one indiscriminately picks out eels from a large number measuring not more than 45 centimeters in length, he will on an average find among 10 eels 8 females, and 2 with lobe-organs; but if every one of the distinguishing marks are carefully observed, this ratio is reversed, and 8 eels with Syrski organs are found among every 10.

It was to be expected that Syrski's discovery would revive interest in the eel question. This was, however, not the case—at least so far as the general public was concerned—until the beginning of the year 1877. During the spring and summer of that year all German and Austrian journals and periodicals contained articles and notices regarding the eel question. Among other things the following notice made the round of the press: "In spite of all our modern aids, science has not yet succeeded in clearing up the mystery of the propagation of the eel. The German Fishery Association at Berlin, will, therefore, pay a reward of

50 marks ($11.90) to any one who will send to Professor Virchow, at Berlin, an eel in a state of pregnancy, sufficiently advanced to throw some light on the propagation of the eel." The Royal Superintendent of Fisheries, Mr. Dallmer, in Schleswig, had volunteered to forward letters and eels to Berlin, and in the January numbers, 1878, of the "Deutsche Fischerie-Zeitung," published at Stettin, he gave a long and interesting report. He says, in the course of his remarks, that he had by no means counted on having the above-mentioned notice published in nearly every German paper, from the Rhine to the Vistula, and from the Alps to the sea. At first he was delighted with the number of letters he received; next he was astonished, and finally he was horrified, and had to refuse to forward any more letters. At the same time an equally large number of letters, &c., had been sent direct to Berlin, to Dr. Virchow, from all parts of Germany. Dozens of so-called young eels, all said to have been cut out of grown eels, were sent to him, and invariably turned out to be intestinal worms; the most incredible statements were made in letters, especially by ladies, regarding large eggs which they said had been found in eels. .... Finally, Mr. Dallmer was compelled to publish the following notice in the "Schleswiger Nachrichten": "Since the German Fishery Association has promised a reward for a pregnant eel, the desire to obtain this reward, as well as inquisitiveness and a sincere desire for knowledge, have greatly excited a large number of people. I had offered to forward letters, &c., to Berlin, but the enormous increase of my expenses for postage has induced me to ask all senders henceforth to send everything direct to Berlin to Professor Virchow. I am compelled to direct the attention of the public to a few matters in this connection. The reward will only be paid for a pregnant eel, and not for its contents alone, for if the latter alone are sent, there is no guarantee that they really came from an eel. The eel should therefore be sent in all cases. Most of the senders have sent me only the intestines, or also the supposed young of the eel, which invariably turned out to be intestinal worms. Most of the senders had eaten the eel, and nevertheless requested to have the 50 marks forwarded to them, often by return mail." By directing the unceasing current of letters, packages, &c., to Professor Virchow's address, Mr. Dallmer had not rendered a service to the professor; for very soon a notice appeared in several papers, by Professor Virchow, urgently requesting people not to forward anything more. Some Berlin funny papers thereupon published a notice that henceforth all eels sent to scientists should be smoked. This episode will show, however, how great and how general an interest was taken in the eel question.

In January, 1879, the "Zoologische Anzeiger," published at Leipsic by Victor Carus,* contained a notice that a Mr. Edwards, of New Bed-

*In No. 18, January 13, 1879. The notice has been taken from Putnam in the "Proceedings of the Boston Society of Natural History," and communicated by Prof. A. S. Packard. The eels were said to have been caught in brackish water near Providence.

ford,* Mass., had, in December, 1878, discovered male eels of the variety *Anguilla bostoniensis*, having fully developed seminal cells with spermatozoids, which, under the microscope, could be seen moving about in a lively manner. Unfortunately, this glorious news was soon proved to be incorrect. In No. 26, April 21, 1879, of the "Zoologische Anzeiger" there was a notice to the effect that the American observer had been deceived by Brown's molecular movement of the particles, and had mistaken the grains of the yolk of the egg for spermatozoids.†

III.

THE EEL QUESTION (CONCLUDED).—JOURNEY OF THE AUTHOR TO COMACCHIO, AND RESULTS OF HIS INVESTIGATIONS.—COMPARATIVE STATEMENT OF ALL THE DOUBTFUL QUESTIONS AND DIFFERENT OPINIONS REGARDING THEM.

Late in the autumn of 1877 I undertook a journey to Comacchio, going from Trieste by sea via Ravenna. Convinced by my own experience of the difficulty of the questions which had yet to be solved, I did not set out with very sanguine expectations as to the prospect of finding fully-matured eels, both pregnant females and males containing semen. My chief object, from the very beginning, was to find out—

(1) Whether among the eels which in autumn migrate to the sea any sign could be discovered pointing to a preparation for the act of propagation;

(2) Whether, and if so to what degree, eels with the Syrski organ participate in these migrations; and, finally,

(3) If possible, to catch some eels which had migrated to the sea, with a view of comparing their organs of generation with those of the lagoon eels.

With regard to the first two questions I was able to solve the problem which I had set myself, and I have succeeded in discovering a new and interesting fact; but as to the last question, all my eager endeavors have proved futile.

I found, first of all, that the eels which migrate to the sea in autumn take no food during this period. The stomachs of the many hundreds of eels which I caught during their migration were, on examination, invariably found empty. All the fishermen and officials of the Comacchio lagoons are well acquainted with the fact that the eels take no food during this period. In contradistinction to this the stomachs of those eels which do not migrate but remain in the lagoon, both of those which are

[* These eels were taken by Mr. Edwards at his home, Woods Holl, Mass.—Ed.]

† "Zoologische Anzeiger," by J. V. Carus, No. 26, April 21, 1879, p. 193, under "Literature": Packard, A. S. "The breeding habits of the eel." "A correction in the 'American Naturalist,' Vol. XIII, February, pp. 125, 126: the motile bodies were not spermatozoa but yolk particles."

not yet able to migrate and of those which never go into the sea but spend their whole life in the lagoons, were more or less filled with remnants of food.

In Comacchio, and doubtless wherever large masses of eels live in brackish water near the sea-coast, a certain variety of eels exists which I found were barren females of the common species. They are female eels whose ovarium shows an entirely anomalous condition. On opening such an eel one finds, instead of the well-known, yellowish-white, and very fatty, frill-like organ, a frothy, thin band, without any fat, and having but few folds, often as transparent as glass, otherwise of the same breadth and length as the frill-like organ, varying, of course, according to the size of the eel. If this band is examined under the microscope the eggs appear entirely transparent, containing but very few grains of yolk or none at all. This band, therefore, appears to be an anomalously-developed barren ovarium. The outward distinguishing marks of these barren females, which I found of all lengths to upwards of 70 centimeters, are very striking. They show all the above-mentioned distinguishing marks of the female intensified. Their snout is broader, often—especially the point of the lower jaw—extraordinarily broad, the dorsal fin generally higher, the eyes decidedly smaller—in large specimens astonishingly small—and the color is generally a light, almost yellowish green; the back is of a lighter green, and the belly of a brighter yellow than in the common female eels. The flesh of these barren eels has a very delicate but different flavor from that of the other eels. I was surprised at its delicious flavor when I, for the first time, ate such eels at Comacchio; the flesh actually melts on the tongue. Even in the live eels one can, in feeling them with the hand, distinguish their soft flesh from the hard, firm, and muscular flesh of other eels.*

In Comacchio this eel is called "pasciute." Coste, who has not paid any attention to the scientific side of the eel question or to the distinction of the sexes, called them "priscetti," and characterized them as eels which had not yet reached maturity, but weighed at least one pound.† The name "priscetti" is certainly incorrect, and I became convinced of this by repeatedly questioning the superintendents of the fisheries and by listening to conversations of the fishermen.‡ "Pasciuto" means pastured, and lagoon fishers by this expression understand, first of all, those eels which do not migrate, which do not enter the basins where eels are caught during autumn, but which feed all the year round, and therefore keep in the lagoon, which is their pasture ground. But they further-

*The author of the "History of Comacchio," Francesco Bonaveri, who wrote during the last century, already considered this eel, which he called "Buratello," a very interesting fish. He thought it must be a variety peculiar to the Comacchio Lagoon.

†M. Coste: "Voyage d'exploration sur le littoral de la France et de l'Italie." Paris, 1861, p. 49.

‡Spallanzani, in his above-quoted work: "Sopre le anguille" (Opere, vol. iii, Milano, 1826, p. 518), calls them "presciutte."

more designate by this name the above-described variety of eel with broad mouth, small eyes, bright green color, and tender flesh. The use of this word "pasciuto" for two totally different categories of eels, the one comprising both those which have not yet reached maturity, the normally developed females which migrate later, and the eels with the lobe-organ, and the other comprising the barren females, which never migrate, and which, as I remarked above, are found of all sizes, is apt to create some confusion, which will make scientific investigations in the beginning somewhat difficult. When Spallanzani, a hundred years ago, visited Comacchio he encountered the very same difficulty, although he had no knowledge of sexual differences in eels.*

The second part of the problem was of special interest, namely, to prove the occurrence in Comacchio of eels with lobe-organs and to show what sort of life they led. I can state that among the 1,200 eels (more or less) which I dissected at Comacchio (including in this number the larger eels, which are invariably females), I found that on an average 5 per cent. had the Syrski organ; but that of all the eels which measured less than 45 centimeters on an average 20 per cent. had it; the result was therefore the same as in Trieste, whose fish market is, for the greater part, supplied with eels from Chioggia, a comparatively small portion only coming from Comacchio. I found at Comacchio the largest eel with a lobe-organ which has so far been discovered, measuring 48 centimeters, and also the smallest, measuring 24 centimeters. All these were

* Several of the older naturalists have already stated that there are some eels which never migrate to the sea; *e. g.*, Risso, in his "Histoire naturelle de l'Europe méridionale," vol. iii, p. 198; also S. Nilsson, in his "Skandinavisk Fauna," vol. iv, p. 663. Nilsson calls the variety of the eel which does not migrate "grass-eel," and makes special mention of its yellowish-green color and its tender and delicate flesh. Both these naturalists, however, strange to say, describe this very variety as having a more pointed snout than the others; and Risso, who gives it as a special variety—the *Anguilla acutirostris* (the eel with the pointed snout), describes it as dark-colored on the back and of a light silver color on the belly. This statement differs in every particular from the appearance of the non-migratory eel of Comacchio. I must state that all the "pasciuti" which I found to be barren females, and which from this reason do not migrate, are distinguished by a broad snout. It will be interesting in this connection to compare the following measurements taken in Comacchio; *a* means the whole length of the body of the eel, and *b* the breadth of the point of the snout between the nasal tubes, in millimeters:

A.			B.			C.		
Barren females. "Pasciuti."			Normal females.			Eels with lobe-organs.		
	a.	*b.*		*a.*	*b.*		*a.*	*b.*
I.	508	10	I.	511	8	I.	....	....
II.	480	8.5	II.	497	7	II.	480	6
III.	458	11	III.	465	9	III.	470	6
IV.	443	9	IV.	447	7	IV.	445	5
V.	426	8.5	V.	425	6	V.	428	5
VI.	408	8	VI.	407	6	VI.	403	5
VII.	395	11	VII.	396	7	VII.	396	5.5

among eels which had been caught during their migration to the sea, and like the female eels which were migrating showed an entirely empty stomach, containing only a small quantity of slime. A farther advanced development of the lobe-organs, in contradistinction to those caught during summer near Trieste, could not be noticed in any of them.

Before entering upon the third and concluding portion of this treatise on the eel question, I must describe and determine scientifically the varieties of eels found in the lagoon of Comacchio. As I could not discover an actual difference of species, they must all come under the common designation of *Anguilla fluviatilis* (Fleming). I give the distinguishing marks of the different varieties according to Siebold.*

Distinguishing marks of the species.—Lower jaw longer than the upper jaw; dorsal fin begins far behind the head, anal fin begins the length of a head back of the beginning of the dorsal fin; body, as far as the anus, cylindrical; from there to the tail, compressed.

Of this species the following sexual varieties can be distinguished:

(1.) *Anguilla fluviatilis, Femina vera.*—The fully developed female eel: Snout generally broad, dorsal fin comparatively high, color on the whole light, back brownish green—never intensely black; belly whitish yellow; little or no metallic glitter; flesh coarse and firm; grows more than one meter in length; the frill-like ovarium contains much fat, and the eggs contain many yolk-grains. Migrates to the sea in autumn, and during that time ceases to eat.

(2.) *Anguilla fluviatilis, Femina sterilis.*—The barren female eel, called in Comacchio "pasciuto": Snout decidedly broad, dorsal fin high, eyes remarkably small, color green—almost yellowish, back green, belly yellow, no metallic glitter, flesh soft and tender, grows three-quarters of a meter in length; the ovarium contains no fat, and is, near the edges, frothy, thin, and bright, often as transparent as glass; the eggs contain few or no yolk-grains. Never migrates to the sea and feeds all the year round.

(3.) *Aguilla fluviatilis, Mas.*(?)—The eel with a lobe-organ (the male eel?): Snout either attenuate and pointed, or short and pointed; dorsal fin narrow, eyes generally large, color decidedly dark, the back a dark green, often quite black; belly bluish or silvery white with little or no yellow, has a metallic glitter, often a bronze color; flesh coarse and firm; so far no specimens have been found measuring more than 48 centimeters. Instead of the frill-like ovarium, it has an organ resembling a narrow band divided into many lobes, probably of the nature of testicles. Migrates to the sea in autumn, and during that time does not take any food.

According to size and weight the Comacchio fishermen distinguish the eels by different names. The young eels, thin as threads, which in spring come from the sea they call "*Capillari*," those weighing less than

* With his usual ingenuity Siebold as far back as 1863 (Süsswasserfische Mitteleuropas, p. 352), asked the question, whether those eels which never migrate could be barren eels, whilst the migrating eels were the fully developed males and females.

3 pounds "*Anguille*," those between 3 and 4 pounds "*Anguillaci*," from 4 up to 6 pounds "*Rocche*," and the largest, weighing 5½–6 pounds and more "*Miglioramenti*." During autumn eels are frequently caught near Comacchio weighing 10 and even 15 pounds.

As regards the third aim which I had set myself, and which brings us to the most important point of the whole eel question, namely, to catch in the open sea eels which had got there on their migrations, in order to obtain in this way a fully matured milter and spawner, I have, as far as my modest means would allow, done everything which would bring me nearer to the solution of this problem. I have gone to sea in Chioggia fishing vessels, both from Magnavacca and from Codigero; I have accompanied the fishermen on their expeditions to the open sea; I have fished with them, and by offering them rewards I have urged them to catch eels out at sea. I have arrived at the conviction that this problem can only be solved by employing extraordinary means. Sensible old Chioggia fishermen, who know every nook and corner of this part of the Adriatic,* have assured me that during a long life-time they have never yet caught a fully-grown river eel at any distance from the coast. The eels which were handed me in the harbor of Magnavacca, which were said to have been caught in the open sea, and which I found to be common female eels, or eels with lobe-organs, had invariably been caught in the immediate neighborhood of the coast, or even in the Palotta Canal. There was no lack of attempts to deceive me; fishermen would take eels along from the shore, and on their return exhibit them to me as having been caught in the sea. Near the coast eels are frequently found, as I have mentioned above, in the sea, and differ in no respect from the lagoon eels. I found both female eels and eels with lobe-organs with the same immature organs of generation as in Comacchio; these eels had evidently just entered the sea from the lagoon by way of the Palotta Canal. At some distance, however, 1 to 2 nautical miles from the coast, none of the many thousands of grown eels which have migrated to the sea are seen; every trace of them is absolutely lost.† Inexplicable as this phenomenon appears at first sight,

*The inhabitants of Chioggia are the boldest fishermen and sailors on the whole coast of Italy, and are famous as such under the name "*lupi di mar*"—sea-wolves It is a great pleasure, especially when the waves are high, to watch their maneuvers, which they execute shouting and singing. Two Chioggia vessels with reddish-brown sails set out on their expedition. One sails far ahead, and at a suitable place casts the net; thereupon both vessels rapidly sail towards each other; it looks as if they must run into each other. When very close to each other a fisherman holding the line of the net in his hand leaps from the first into the second vessel, amid the shouts and laughter of his companions. In a few moments both vessels are again far from each other, and haul in the net.

†Wherever the coast has long and shallow bays, like near Goro, north of the Po di Volano, as also in Schleswig and Denmark, eels are found at a considerable distance from the coast. I have seen eels speared at a great distance from the coast in the Bay Sacca di Goro. The difficulty or impossibility only begins in deep water, and this is the very place from which eels are desired. After my experiences I must contest the

it is easily explained when one thinks of the method of fishing, and the nets employed by the sea fishermen. These nets, which, like those used in the lobster fisheries, are intended to be dragged along the bottom of the sea, have very wide meshes, much too wide to retain an eel, which can slip through a very small hole. And those nets which have narrow meshes never reach to the bottom of the sea; the eels, however, can only be brought up from the bottom of the sea. The drag-nets which the fishermen employ are, moreover, deficient in this respect, that they do not have an apparatus to dig up the mud which is the favorate habitation of the eel, but glide over it gently. The fishermen would very justly fear for their expensive nets if they were to make an attempt at digging up the bottom. To catch a river eel in the open sea, which is an essential condition of solving the most perplexing question of the eel problem, will therefore remain an impossibility as long as we do not possess vessels and apparatus specially adapted to this purpose.

When one, as I did, has spent weeks in the company of the fishermen and officers of the lagoon, superintendents of fisheries, and private fishermen, who year after year and during the fishing season by day and night think and talk of nothing else but of the eel, on which their prosperity depends, which was fished for by their ancestors centuries ago, so that their power of observation of the mode of life of this fish has naturally been sharpened, it will not be surprising to find that the more intelligent fishermen have quietly formed some opinions regarding this mysterious fish and its procreation, which, laying aside the common fables, are calculated to give some hints to the naturalist as to the way and direction in which he should pursue his investigations. Such opinions I have heard expressed by some of the more intelligent of the fishermen, and the opinion which I had formed concerning some of the unsolved problems of the eel question has thereby been confirmed. These problems, which are intimately connected with each other, are the following:

(1) How can it be explained that no fully-developed males and females—milters and spawners—of the eel have ever been found?

(2) When and where do the organs of generation of the eel develop to that degree of maturity which is necessary for the procreation of young eels?

(3) Where do eels spawn, and where are their eggs impregnated?

(4) What becomes of the fully-grown eels after the spawning season; why do they never return to the rivers, but disappear altogether?

Drawing rational conclusions from our present knowledge of the eel question, these questions should be answered as follows:

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assertion made by Professor Ercolani, that the eels which were sent to him from Ancona had been caught in the open sea. I am convinced that they had never seen the open sea; the fishermen, however, described them as "caught in the sea," which, of course, was true in a certain sense, although, no doubt, they had caught them near the coast. Through the kindness of Mr. von Littrow, harbor-master at Fiume, I received a large number of eels which the lobster-fishermen had caught in the harbor of Fiume, and which in no respect differed from the common lagoon eels.

(1) For the development of their organs of generation eels need salt water.* As has now been ascertained beyond a doubt, the eels leave the rivers and brackish lakes when their organs of generation have scarcely begun to develop, and enter the sea that these organs may there reach their full development. That this migration to the sea is undertaken for the purpose of spawning is fully proved by the fact that in spring the young eels come from the sea, and this view is further strengthened by the circumstance that when the eels commence to migrate they cease to eat, just like other fish do, during the spawning season.

(2) The development of the organs of generation takes place in the sea, not near the coast, but farther out in deep water. Considering the immature condition of the eels when they begin to migrate, the development is exceedingly rapid. In a few (five to six) weeks they reach maturity, according to the time when they enter the sea. Near Comacchio the eels migrate from the beginning of October till the end of December.

(3) The river eels have their settled spawning places in the sea.† These are mud-banks which the eels visit in large numbers for the purpose of spawning. The young fry develop on these banks, and go to the mouths of the rivers in the beginning of spring, about eight to ten weeks after their birth.

(4) The old eels, both males and females, die soon after the spawning season. The extraordinarily rapid development of their organs of generation exhausts them to such a degree that they die soon after having spawned. This is the reason why they are never seen to return.‡

It is hoped that this short treatise on the eel question may do its share in giving a new impetus to its scientific investigation and may aid in

* Some peculiarity in the chemical composition or the organic contents of the water of the Black Sea must be assigned as the reason why there are no eels in the whole territory of the Black Sea nor in the Danube and its tributaries.

† The Chioggia fishermen have pointed out to me several of these mud-banks in the Adriatic.

‡ Siebold was the first to express this opinion (see farther below). An intelligent Chioggia fisherman, owner of a vessel, in answer to my question, what became of the old eels, replied: "They die on the mud-banks after they have made young ones." This view finds its scientifically proved analogy in the lamprey. Panizza in describing the sea lamprey (*Petromyzon marinus* L.) remarks that both the males and females of this kind of lamprey are invariably found dead after the spawning season. (See Panizza: "Memoria sulla lampreda marina" in the "Memorie dell' Instituto Lombardo di scienze," vol. ii, Milan, 1845, p. 48.) Regarding the river-lamprey (*Petromyzon fluviatilis* L.) Statius Martens, the translator of Linné's System of Nature, says (vol. iii, 1774, p. 232), that after it has finished spawning it gradually declines and finally dies. Concerning the small lamprey (*Petromyzon Planeri*, Bloch), the discoverer of its larva (the *Ammocœtes branchialis*), August Müller, who had observed the spawning process of this fish in the river Panke near Berlin, says that he had witnessed the very same phenomenon. (See A. Müller, "Vorläufiger Bericht über die Entwickelung der Neunaugen" in "J. Müller's Archiv," 1856, pp. 323, 324.) Theodor von Siebold (in his "Die Süsswasserfische Mitteleuropa's," p. 378) says: "A very interesting fact, discovered by A. Müller in the course of his observations, is the complete dis-

leading us to its final solution. Would that all who possess the necessary means might constantly remember Spallanzani's words, uttered by him a century ago after his many vain attempts to solve the eel problem: "Our still prevailing ignorance regarding the procreation of the eel, instead of deterring us from further investigations, should spur us on to strain every nerve to dispel this dark cloud of ignorance, having ever before us the examples of seekers of truth in other fields of natural science, who by careful and persevering search at last succeeded in removing the seemingly impenetrable vail from many a mystery of nature." (Opere di Lazzaro Spallanzani, vol. iii, pp. 561, 562, Milan, 1826.)

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appearance of the small lampreys after the spawning season is over. In spite of the most diligent search A. Müller could not find any trace of them except a few dead ones floating about in the water. As moreover the ovaria of these lampreys never contained eggs in different stages of development, as is the case with other fish, but after the spawning season contained nothing but the empty cells, A. Müller was justified in concluding from this that the organs of generation of these small lampreys are after the spawning-season completely exhausted, and that the fish consequently die. By personal observation I have convinced myself that after the spawning season the ovaria of the small lampreys are entirely void of eggs, and I must therefore agree with Müller that the supposition seems very natural that the same is the case with *Petromyzon marinus* and *Petromyzon fluviatilis*. I even go a step farther and ask the question whether, perhaps, such a generative activity, only occurring once during life and followed by death, is the reason why the eels which have migrated to the sea never return from there." It may not be out of place to point to the striking similarity between the generative organs of the lamprey and the eel, to which Rathke has directed attention in his treatise on the organs of generation in fish, not only as regards the female, but, strange to say, also the male eel.

V.—THE FOOD OF MARINE ANIMALS.

By Prof. K. Möbius.*

[From "*Tageblatt der* 53. *Versammlung Deutscher Naturforscher und Aerzte in Danzig*, 1880." Journal of the 53d Conference of German Scientists and Physicians, held at Danzig, 1880. No. 6, September 22, 1880.]

All the known forms of animals may be divided into 155 orders; of these 52 live on land, 67 in fresh water, and 107 in salt water. The sea, therefore, is richer in animal forms than the fresh water and the land, and also produces more individuals than fresh water and land combined.

As the number of domestic animals on a farm depends on the extent and quality of the land belonging to it, in the same way the number of animals in the different domains of nature, both on land and in water, depends on the quantity of food.

As no animal is able to form the organic combinations of its body direct from water, air, and mineral substances, all animals of our earth depend on the quantity of organic matter produced by the vegetable kingdom; and the number of animals inhabiting the different seas, therefore, likewise depends on the quantity of organic nutritive matter which the water, either directly or indirectly, receives from the vegetable kingdom.

To prove this let us first of all cast a glance at our own seas, the Baltic and the North Sea.

Large meadows of green sea-weeds extend in the shallow waters near the coast, wherever the bottom does not consist of shifting sand, in which no plant can take root. Wherever the bottom is stony, brown algæ (*fucoids*) grow, and further away from the coast, at depths of 60 to 80 feet, the bottom is in many places covered with red algæ (*florids*). At a still greater depth there are few or no plants; but aquatic plants torn loose from the places where they grew are often brought up in dredges from a depth of several hundred yards. After the gases filling their tissues have escaped, such plants sink towards the bottom, fall to pieces, and finally form the principal component part of the mass of dark, soft mud forming the bottom of many bays of the Baltic and North Sea. When such mud, brought up in dredges, is put into a barrel,

* *Die Nahrung der Seetiere. Vortrag von* K. Möbius, *Professor in Kiel.* Translated by Herman Jacobson.

it does not appear to contain any animal life; but if it is put through a fine wire sieve, which cleans out all the mud, a large number of diminutive mollusks, worms, crustaceans, and other marine animals may be seen.

If we could dive down to the mud bottom without touching its surface, we would find it full of worms, shells, and other marine animals protruding from the mud, all busy absorbing with their mouths the particles of mud nearest to them; and we would also see flounders, codfish, eels, and other fish digging themselves into the soft mud for the purpose of devouring its inhabitants.

In the great depths of the Baltic, 90 to 95 fathoms, east of the island of Gottland, where the bottom consists of plastic clay containing but very few organic substances, I found very few worms during the summer of 1871. In the greatest depths of the Mediterranean southeast of Sicily (1,700 fathoms), where the bottom consists of yellowish clay, the British exploring expedition of 1870 found no traces of animal life.

In the southern part of the North Sea the muddy bottoms, at a depth of 20 to 25 fathoms, are literally alive with small crustaceans, worms, snails, mollusks, echinoderms, and polyps, and are therefore very rich in fish.

Enormous masses of dark mud, formed from vegetable matter which has sunk to the bottom, lie at the bottom of the deep fiords of Norway, and furnish excellent food for their numerous fish and other marine animals.

Besides the sea-weeds, which in all latitudes grow at a depth of 25 fathoms on level bottoms, the sea produces different kinds of floating algæ, which furnish food to marine animals.

During the summer a floating microscopic alga (*Melosira costata*) appears in the Bay of Kiel, and probably also in other parts of the Baltic, in such enormous masses that the water becomes turbid.

Clean plates of glass which I fastened to some poles in the Bay of Kiel one meter below the surface of the water were, after 8 to 14 days, completely covered with diatoms, among which infusoria were crawling about, the stomachs of which contained diatoms. Diatoms live in every sea, and when dead form the principal component part of the finer portions of the bottom.

Late in summer the Baltic near the mouths of the Oder, Vistula, and other rivers assumes a peculiar green color, from great masses of floating microscopic algæ, so-called "water blossoms." The commission for the scientific investigation of the German seas, which during this month has examined the Bay of Danzig, on the 10th of September found a herring-net which, east of Zoppoh, had been left at the bottom of the sea for one night, covered with a greenish slime, which principally consisted of such microscopic algæ.

In the Red Sea, the Atlantic, Indian, and Pacific Oceans, navigators and scientists have often observed floating microscopic algæ of a reddish color (*Trichodesmium erythræum*) covering the sea for miles and miles.

In the middle Atlantic Ocean large masses of algæ (*Sargassum bacciferum*) are floating about, which furnish food not only to the animals living on and among them, but also, after they have decayed and sunk to the bottom, to animals living in the depths of the sea.

Plants growing on land likewise furnish food for the animals of the sea. All rivers carry organic matter into the sea, which, with the fine mineral substances of the river water, sink to the bottom near the mouths of the rivers and form layers of rich mud.

In the Caribbean Sea, A. Agassiz found masses of leaves, pieces of bamboo, and sugar-cane at a depth of 900 fathoms, and at a distance of 16 to 24 kilometers from the shore, and wherever this was the case the deep-water fauna was particularly rich.

At the greatest depth of the ocean, below 900 fathoms, both the number of species of animals and individuals decrease, evidently because the quantity of food is smaller. Decaying plants and animals which either sink to the bottom perpendicularly or gradually glide down the incline of the coast, are either devoured by marine animals or dissolve entirely before they reach the deepest bottoms.

Flat, sandy bottoms, on which the constant motion of the waves allows nothing to rest, be it alive or dead, are almost void of animal life.

Firm coral reefs, on the other hand, towards which wind and breakers carry vegetable and animal life from the open sea, both by day and night, are among the most densely inhabited portions of the sea, especially on their outer edges, because these receive the greatest quantity of nutritive matter (Murray).

As the growth of young marine animals, just as much as that of land and fresh-water animals, depends on the quantity of food, large numbers of young fish and other marine animals, which were hatched within a limited space, must spread over a larger extent of water, if many of them are not to perish from want of food. To find this food, they swim in large schools from one place to another, and continuing in the direction in which they find the most food, they gradually get to migrating, without the slightest idea or purpose of finding a more pleasant place of sojourn. Thus the schools of herrings enter the bays of the Baltic, following those portions of the sea which are richest in copepods. The herrings are followed by the codfish, which feed on the former, and near the coasts of Norway large numbers of whales follow the herring and devour many thousands (O. Sars).

The migrations of marine animals are therefore caused by the periodical appearance of food within certain parts of the sea, just as the migrations of the South African antelope, the North American buffalo, and the Siberian reindeer are produced by the same causes.

Food-fish, by seeking their food in different parts of the sea, thus furnish us with wholesome food from numberless small marine animals, which without them would be of no use to us.

The periodical increase and decrease of nutritive matter in the different parts of the sea depend on the degree of warmth and light which, during the changing seasons, they receive from the sun.

Food and temperature exercise a powerful influence on the development of the eggs of marine animals.

The eggs of many invertebrate marine animals develop simultaneously with the eggs of fish which come in large shoals; the young fish therefore find numerous microscopic embryos in the same water in which they were hatched. By inhaling this water when breathing they at the same time get the food which is most suitable for them. The water flowing through their gills is in a certain sense their mother's milk. If the water does not contain the food which is absolutely required by the young fish they perish as soon as the nutritive yolk of the egg has been consumed, for on water alone no marine animal can live.

Though it is therefore an easy matter to develop young salt and fresh water animals from healthy eggs in small vessels, because the eggs contain all the substance which is necessary for such development, it is very difficult to raise the young fry in aquaria, because these but rarely contain the necessary food.

There is no doubt that many young fish and other marine animals do not attain to maturity simply because the water where they were born does not contain a sufficient quantity of suitable food.

The average quantity of sunlight and warmth, repeating itself from year to year, develops a certain quantity of nutritive matter for the animal life of the sea, and the total mass of mature animals of one part of the sea is as large during every period of development as the quantity of food in that part allows, for during every breeding-period all the animals living together in one region produce a much larger number of eggs than the number of mature animals developed from them. The germinating faculty of all species of animals is greater than their maturing faculty.

One of the most obvious reasons why the maturing faculty of animals decreases is the destruction of eggs, embryos, and young fry by other species or by larger individuals of the same species. Thus, the *Coregonus lavaretus* eats the eggs of its own species; large codfish devour small codfish, and eels fill their stomachs with the spawn of different fish.

In certain localities man exercises a considerable influence on the maturing faculty of marine animals. In Greenland the whale (*Balæna mysticetus*) is at present a very rare animal, because Dutch, Hamburg, British, American, and other whalers have caught old and young whales for centuries.

In nearly all the fishing villages on the coasts of the Baltic and the North Sea the fishermen complain that the former wealth of fish is disappearing. It is unfortunately impossible to ascertain from comparative statistics in how far these complaints are justified; but there is scarcely a doubt that in most of our coast waters more fish are caught within one year than in former times. The number of consumers of salt-water fish in our inland provinces has, since the introduction of railroads, increased so much that the quicker and larger sales of fish have induced the fishermen to bring more small fish to market than formerly; thereby they of course reduce the productiveness of the food-fish in their waters. They follow the same course as large fish of prey, and do their share in reducing the maturing faculty of valuable fish. The invertebrates found in such waters then serve as food for other worthless fish, or at best they only serve to develop a larger number of young immature food-fish, whose total weight has much less value than the same weight of fully grown fish, which moreover could do something in the way of propagating the species before they were caught. If fishermen, therefore, wish to permanently reap an average reward of their labor, the fish which spawn in coast waters should not be caught at all ages, but should be protected especially during the period of their youth and during the spawning season.

In no part of the sea has fish-food decreased, as has been the case in many fresh waters of highly cultivated countries, causing a decrease of fresh-water fish. In many countries our modern civilization has destroyed the *natural communities* (Cenobitisms) of plants and animals, and substituted those plants and animals which were most profitable to man. But the natural communities of the sea human agencies can only change to a certain degree in the coast waters. In the open sea the natural communities of plants and animals will continue to live and sustain each other as long as the waves of the eternal ocean continue to roll.

APPENDIX B.

THE SEA FISHERIES.

VI.—THE ICELAND HERRING-FISHERIES.*

By W. Finn.

[From "Deutsche Fischerei-Zeitung," 3d year, No. 54. Stettin, December 21, 1880.]

Towards the end of last year (1879) a market report received from Gottenburg by the "Deutsche Fischerei-Zeitung" mentioned the fact that a new article had been introduced into the Gottenburg market, viz, Iceland salt herring, which on account of its superior quality had commanded a very high price. Some time later the same kind of herrings was mentioned in reports from other places. Quite recently news was received from Elmshorn (Holstein) that a vessel which from that place had gone to Iceland in spring to engage in the herring-fisheries had returned with a full cargo. These communications aroused my interest, and as in the Danish official reports I found but very few data regarding the Iceland herring-fisheries, I applied to Norway for further information, for, strange to say, neither the Icelanders nor the Danes, but the Norwegians, have begun herring-fisheries on a large scale near Iceland, and they are rapidly developing them to an extent which cannot fail to exercise an important influence on the world's commerce. The information relating to these fisheries which I received from Norway, and which in the highest degree deserves the attention of our ship-owners and capitalists, is given in the following:

It is now eleven years since an association called the Iceland Fishing Company was formed in Mandal, Norway. A mere accident furnished the occasion for forming this association. The captain of a Norwegian vessel, who often visited Iceland, had his attention directed to the large schools of herrings in the Sejdis fiord on the east coast of Iceland. He communicated his observations to the owner of the vessel, a Mandal merchant, Mr. Albert Jacobsen. This gentleman, one of the most energetic business men of Mandal, resolved to make an attempt to establish regular fisheries on the coast of Iceland, although he hardly looked for favorable results, as neither Icelanders nor Danes had hitherto attempted anything in this direction. Mr. Jacobsen bought a piece of land in a favorable location on the shore of the Sejdis fiord, and sent a vessel to Iceland well furnished with everything required for fishing. This first

* *Die Häringsfischerei bei Island.* Translated by Herman Jacobson.

expedition was successful, and the vessel returned with a full cargo of herrings of the finest quality. This result created quite a sensation in Mandal business circles, and seven other merchants associated themselves with Mr. Jacobsen in the above-mentioned company. Alongside of the land near the Sejdis fiord bought by Mr. Jacobsen, another and larger piece of land was bought by the company, and a large and somewhat expensive establishment, answering to the great expectations entertained with regard to this enterprise, was started on the Sejdis fiord. During the first year these expectations were not disappointed, for about 2,000 tons of herrings were sent to Mandal. But now there followed a number of poor years. The herrings did not make their appearance, and the heavy expense of keeping up the establishment caused serious losses to the stockholders. The consequence was that the company was dissolved and the whole establishment sold for a mere song to a new company rising from the ruins of the old one. Among those who had not yet given up all hope was Mr. Jacobsen, who was also one of the stockholders of the new company. But as the enterprise did not flourish, and did not seem to promise any profits in the future, the number of stockholders gradually decreased until only two were left, Mr. Jacobsen and another merchant, Mr. Carl Lund. These two men, not discouraged by temporary failures, and able, by reason of their pecuniary circumstances, to stand the pressure for some time, bought up the shares of all those stockholders who desired to withdraw from the company. At last, in 1877, the herrings again made their appearance in the Sejdis fiord, and came again in the following year. But in spite of the moderately successful fisheries the net profits were not large, owing principally to the low price of herrings. Last autumn, however, the sensational news reached Mandal from Iceland that such an enormous number of herrings had entered the nets that there were not enough barrels and salt. These articles were sent out at once, but nevertheless a considerable number of herrings was lost. In spite of this loss, however, the result was very satisfactory, no less than 8,000 barrels of herrings having been salted, and as prices were high (in Mandal 26½ crowns—$7.12—wholesale price, were paid for a barrel; and in Gottenburg and Stockholm the retail price was 36 to 40 crowns ($9.64 to $10.72, per barrel), the two stockholders were fully rewarded for their perseverance, and amply repaid for former losses and disappointments. During the last few years the company has every year sent two vessels with a crew of 28 men to Iceland. Barrels, salt, food, &c., are of course taken along from Norway. Last year's expedition unfortunately closed with a very sad occurrence. In December the Dutch steamer Anna was to take the remainder of that year's yield of herrings—2,117 barrels—and the officers and workmen of the Sejdis fiord establishment back to Bergen. At Feiosen, near Bergeln, the steamer ran against a rock and immediately sank to a depth of 8 fathoms. Besides the first mate, the pilot, and two coopers, Captain Abrahamsen, the director of the Sejdis fiord establishment, also met his death in the waves. His death was a very serious loss to the company, for he was an exceptionally able and energetic man, whose place it will be difficult to fill. Of the cargo only a small portion was saved.

The magnificent results obtained last year by the "Iceland Fishing Company" had a magic influence on all the ship-owners on the west coast of Norway. Every vessel which could be spared was in the beginning of last summer fitted out and sent to Iceland to engage in the herring-fisheries. From Mandal alone 30 vessels, with a total burden of about 2,000 tons, are said to have sailed for Iceland. In June last an "Iceland Fishing Company" was organized in Aalesund, with a capital of 20,000 crowns ($8,040).

To obtain the right to fish in Iceland waters, a foreigner must be naturalized, which is done in a very simple way, by taking out an Iceland citizen's paper (cost about 4 crowns, $1.75), swearing an oath of allegiance to the King of Denmark, and settling down on the island. This settling down, however, generally only consists in putting up in some favorable location on the shores of the fiord the frame house which has been brought ready-made from Norway. Although, according to a circular of the governor of Iceland, addressed to all officials in the island, these regulations are to be strictly observed, it is a fact that many Norwegian fishermen who have taken out Icelandic citizen's papers, never think of settling permanently in Iceland.

Last summer the herring-fisheries carried on by Norwegians were chiefly confined to the east coast of the island, although a few vessels also fished in the Oe fiord and the Ise fiord. Both during this and last year the Eske fiord was the principal place for herring-fishing during summer, whilst the richest autumn fisheries have taken place in the Sejdis fiord. During last summer 28,000 tons of herring were caught in the Eske fiord (6,000 of these by a Bergen company—J. E. Lehmkul), whilst during the same period scarcely 1,000 tons were caught in the Sejdis fiord. In this last mentioned fiord, however, upwards of 40,000 tons were caught during the third week in October, whilst the quantity of hrrings left in the nets was estimated at 20,000 tons. As according to the last reports from Iceland fishing was still going on, we are not prepared to give any absolutely reliable information as to the total yield, but in all probability the Norwegian fishermen will this year bring home from Iceland about 100,000 tons of herrings. If such harvests should prove the rule,* ship-owners fitting out vessels for Iceland will do well to remember this.

We shall doubtless soon be in possession of all the data regarding the Iceland herring-fisheries.

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* During last summer the herring-fisheries on the coast of Norway have been very poor, whilst all reports from Iceland speak of the Iceland herring-fisheries as being remarkably successful. See "*Die Norwegische Nordsee-Expedition*, 1877" (the Norwegian North Sea Expedition), p. 181, volume for 1878 of this journal.

To the Norwegian merchant, Albert Jacobsen, belongs all the honor of having inaugurated these fisheries; and other nations owe him a debt of gratitude, if in the future this enornous wealth of fish, which its rightful owners have hitherto neglected with inexplicable short-sightedness, proves a practical benefit, not only to Norway, but also to many other countries (let us also hope Germany).

VII.—CONTRIBUTION TOWARDS SOLVING THE QUESTION OF THE SECULAR PERIODICITY OF THE GREAT HERRING FISHERIES.

By AXEL LJUNGMAN.*

There is doubtless no phase in the history of our Scandinavian sea-fisheries which has attracted more general attention and has been of such far-reaching consequences as the periodical stoppage and return of our great herring fisheries; but, at the same time, there is scarcely a question whose solution has offered greater difficulties. For six years I have been engaged in scientific investigations of the herrings and herring fisheries on the west coast of Sweden, chiefly with a view of improving the fishery laws. During these investigations I have necessarily been confronted with the above-mentioned difficult problem, and after having given it some attention I have from time to time published the results of my investigations.[1]

The old, and doubtless erroneous opinion that the last great Bohuslän herring fisheries came to an end on account of the reckless manner in which they were carried on, formed the leading scientific thought in the old fishery law, which has not yet been completely abolished, and one of whose principal features is the prohibition to catch herrings with large seines. When this whole question was subjected to a more thorough investigation, it became clear that a scientific tribunal would condemn this law. But even from a purely economical standpoint this question is of such importance to the fisheries that no trouble should be considered too great in solving it. All the works which have so far been published on the subject will show clearly that the problem is so vast, that it will require a long time and the labor of more than one person to reach a satisfactory conclusion. The following little treatise will fully show the truth of my remarks:

As an introduction to this new attempt to solve the problem in question, I shall give a brief and systematic review of all the attempts at solving it which have hitherto been made.

In reviewing all the causes, which from time to time have been assigned,

*Axel Ljungman, "*Bidrag till lösningen af frågan om de stora sillfiskenas sekulära periodicitet.*" Copenhagen, 1880. [Translated by HERMAN JACOBSON.]

[1] *Preliminär berättelse för* 1873–'74 *öfver de beträffande sillen och sillfisket vid Sveriges vestkust anstälda undersökningarna*, Upsala, 1874, p. 23–29.—United States Commission of Fish and Fisheries, III. Report of the Commissioner for 1873–'74, and '74–'75, Washington, 1876, p. 137–141. Northern Ensign, Wick, October 18, 1877, No. 1429, p. 4. *Några ord om vårt stora bohusländska sillfiskes upphöranda och återvändande* in *Göteborgs Handels och Sjöfarts-Tidning*, January 26, 1878. *Bohusläns hafsfisken och de vetenskapliga hafsfiskeundersökningarna*, II. Göteborg, 1878, p. 24, 65–99.

of the disappearance of the herrings from our coasts, we shall soon find that they may be divided into three groups: the *first* embracing explanations of a mythical or purely accidental nature; the *second*, human agencies; and the *third*, natural causes.

A. Under the first head there would come:

1. The wrath of God manifested on account of the abuse of his gifts, or on account of the wickedness or indifference of men, Sunday fishing, denying the priests their tithes, dissatisfaction with the laws made, or the taxes imposed by the government.
2. Sorcery.
3. Shedding of blood.
4. Cruelty towards the herring.
5. Using herring as manure.
6. Occurrences which by mere accident were simultaneous with the disappearance of the herrings, *e. g.*, the burning of sea weeds, the establishment of new light houses, &c.
7. The failure of the whales and other so-called herring-hunters to drive the herrings toward the coast.
8. Caprice of the herrings, or their natural instinct.

All these causes, which doubtless were very popular among the common people, imply the going away of the herrings to another place which proved itself worthier of such a blessing.

B. Under the *second* head come all those causes which may be assigned to human agencies:

1. The herrings have been gradually destroyed, their schools becoming smaller and smaller towards the end of the fishing period. This result has been brought about—
   a. By excessive fishing, and more especially by catching the young herrings with seines having narrow meshes.
   b. By preventing the herrings from reaching their favorite spawning-places.
   c. By destroying the roe.
   d. By disturbing those places where the young herrings were in the habit of seeking food and shelter.
2. The herrings have slowly but surely been driven away by—
   a. Noise.
   b. By unsuitable fishing-apparatus, by fishing with seines during daytime, or by using drag-nets too early in the season.
   c. By disturbing the spawning-process.
   d. By disturbing the spawning-places by seine-fishing or by throwing refuse in the water.
   e. By leaving dead herrings at the bottom of the sea, or by throwing guts and gills into the water.
   f. By throwing fish-oil refuse in the water.
   g. By preventing the schools of herrings from reaching their accustomed spawning-places.

h. By reckless fishing, thus depriving the herring of his necessary food.

C. Under the *third* head would come all natural causes:

1. The herrings have been destroyed by the unfavorable condition of the weather, by an unusual number of fish of prey and birds of prey, by lack of food, &c., by various natural causes hurtful to the roe, the young fish and the fully-grown fish.
2. The herrings were obliged to leave the coast in consequence of—
   a. Changes in its physical condition both meteorological and hydrological (accidental or periodical), as likewise changes in the nature of the bottom, principally at the spawning places.
   b. Changes of a biological nature, *e. g.*, an increase in the number of fish of prey or birds of prey; lack of food, or changes in the character of the local fauna and flora, occasioned by overwhelming masses of herrings flocking towards one point.
   c. A secular periodicity in the natural condition of the whole region where herrings occur, thus obliging the large schools of herrings to change their spawning-places and their places of sojourn during the early part of their life.

Of all these explanations only the last mentioned shall form the subject of further remarks, and it will be our object to find out whether there is really any secular periodicity in nature sufficiently strong to cause the disappearance of the herrings from certain coasts.

In the year 1843 the well known astronomer, Mr. S. H. Schwabe, at Dessau, succeeded in proving that the solar spots known since the second decade of the seventeenth century were periodical in their occurrence; and in 1852 it was found that "the daily variation of the magnetic needle lasted exactly as long as the period of the solar spots, and that this variation reached its utmost limit at the time when the solar spots were most numerous, and was scarcely noticeable when the solar spots were fewest in number." The average length of the solar-spots period was by Wolff found to be 11.11 years; Schwabe had previously put it at 10 years, and Lamont, in Munich, at 10.48; whilst Wolff, Fritz, and others proved conclusively that there were longer solar-spots periods, comprising about fifty-five and one-half years. Other scientists, however, put the length of the longer periods at a different figure, *e. g.*, Köppen at forty-five years, Lemström fifty-eight, Klein sixty-seven, and Hornstein seventy. In 1862 Fritz, and in 1873 Köppen showed a correspondence in the occurrence of northern lights and the changes in the solar-spots periods.* Thus evidence was constantly accumulating to prove the great influence which the solar spots exercise on our earth. Among the evidence bearing more directly on our question the most important is doubtless the correspondence between the occurrence of the northern lights and the solar spots discovered by Fritz, and the fact

*The periodicity of the northern lights had already been spoken of during the last century by *Mairan, Wargentin, Th. Bergman,* and others.

of there being periods in these phenomena embracing twenty periods of the lower order, and extending over two hundred and twenty-two years.

We will now endeavor in the same way as the changes in the weather, the harvests, the migrations of the grasshoppers, &c., have been compared with the solar spots periods, to compare these latter with our Bohus län herring-fishery periods, and we shall find that there is such a remarkable correspondence between the two that it can scarcely be considered accidental. Starting from the last of the above-mentioned fifty-five and one-half years' periods, viz., the one extending between the minima of solar spots, 1810–1867, we will give a series of fifty-five and one-half years' periods, and with each of these we will mention briefly whatever is known regarding the "genuine sea-herrings" periodical occurrence on the coast of Bohuslän, and when we have no data whatever we will mention such occurrences as can possibly be supposed to have some connection with the herrings' periodical occurrence; for from the time previous to the year 1300 we have scarcely any information regarding our Bohuslän herring fisheries.

1867–1922. (Rich fisheries began in 1877.)

1811–1866. (No good fisheries.)

1755–1810. (Rich fisheries 1748–1808, which, especially during the last quarter of the eighteenth century, assume enormous dimensions.)

1699–1754. (No specially good fisheries till near the end of the period from 1747 or 1748.)

1643–1698. (Good fisheries, at least between 1660–1680.)

1587–1642. (No good fisheries.)

1531–1586. (Particularly good fisheries, at least between 1556 and 1587.)

1475–1530. (No good fisheries.)

1419–1474. (Good fisheries, at least about the middle of the century.)

1363–1418. (No good fisheries.)

1307–1362. (Particularly good fisheries, at least during the first thirty years of the century, which probably already commenced towards the end of the preceding century.)

1251–1306. (At the beginning and about the middle of the period no good herring fisheries, although probably the fisheries were good towards the end.)

1195–1250. (Probably there were good fisheries, judging from the fact during this period Gullholmen, Öckerö, and other desert islands were colonized, and the convents of Marstrand and Dragsmark were founded.)

1139–1194.

1083–1138. (Probably there were good fisheries, during which Konungahella became the most important commercial city of the north.)

1027–1082.

971–1026. (Good fisheries, at least during the reign of Olaf the Saint.)

915–970. (No good fisheries, at least during the beginning of the reign of Gunhild's sons.)

859–914.

From this series of fifty-five-and-a-half-years' periods, it will be seen, first, that large numbers of sea-herrings came to the coast of Bohus län during every other one of these periods, producing good fisheries and consequent wealth; second, that unusually good fishery periods changed about with less good ones. Thus, the herring fisheries during the fifteenth and seventeenth centuries were far less important, and probably did not last as long as those of the fourteenth, sixteenth, and eighteenth centuries. In the above series this change has been indicated by putting some of the figures in heavy-faced type. The Bohus län herring-fishery cycles seem therefore to correspond exactly with Professor Fritz's great Northern lights' periods of about two hundred and twenty-five years each, and to include one very good and one less good fishery period, as well as two intermediate periods when the sea-herrings staid away from the coast. From what we know concerning our periodical herring fisheries, it appears that the interval between the good fisheries of the fourteenth century and those of the sixteenth century was longer than the interval between those of the sixteenth and eighteenth centuries, and that the interval between the good fisheries of the thirteenth and fourteenth centuries, and between those of the seventeenth and eighteenth centuries was probably shorter than might be supposed, for between the two last mentioned it is said to have been only fifty years.[3] Such differences in the length of the periods are also known in the periods of the solar spots, those whose average length is 11.11 years often being only eight to fifteen years long. It is probable, however, that these differences indicate still longer periods, during which they recur with a certain regularity. Thus, in the series given above, the differences following each other make it probable that there is a larger period of four hundred and forty-four and one-half years, with which the former rich herring fisheries on the coast of Skåne and Zealand may correspond.

It is also a strange phenomenon that the most flourishing fisheries of a herring fishery period coincide with or occur about the same time with the liveliest formation of solar spots, and the most numerous northern lights during a fifty-five-and-a-half-years' period,[4] and that a peculiar

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[3] O. Lundbeck., *Anteckningar rörande Bohusländska Fiskerierna i synnerhet Sillfisket.* Göteborg, 1832, p. 36.

The fact that the interval between two Bohus län herring-fishery periods is as high as seventy years may be explained by the small alternating fishery periods having only occupied a part of the fifty-five-and-a-half-years' period; even the unusually rich herring-fishery periods do not seem to have always occupied the whole of that period, although in some cases, *e. g.*, during the eighteenth century they may have been even a few years longer.

[4] By comparing the different statistical data regarding the revenue derived by the government from the herring fisheries during the present and the last century with Wolff's relative figures, I have not been able to find any very striking coincidence between the occurrence of solar spots and good fisheries; but it seems that, *e. g.*, in the Scotch herring fisheries the best fisheries occur generally two to five years after the maximum number of solar spots, and the smallest, one to three years after their minimum number. A more striking coincidence may possibly be shown between the

change took place in the relation between the solar spots and the temperature during the last decade of the eighteenth century, when Bohus län, as is well known, had the richest herring fisheries which have ever occurred. As there are also traces of such a change during the latter part of the seventeenth century, it is not improbable that such a change always coincides with the frequent occurrence of the sea herrings on the coast of Bohuslän.

It is self-evident that this little treatise can by no means claim to have answered satisfactorily the question regarding the causes of the secular periodicity of the great herring fisheries, and more especially of the Bohus län fisheries, but it may serve to direct attention to a hitherto not yet attempted way of explaining this dark problem, and to decrease the belief in the old explanation of the periodicity of the herring fisheries of mans disturbing the household of nature by the fisheries. In order to show more fully the coincidence between the herring fisheries and the solar-spots periods, scientists and historians should work hand in hand. It cannot be expected of scientists that for the sake of a few data they should go through the immense collections of documents in our archives or through the whole range of historical literature, and thus gather all the necessary facts from former times; but these facts should be obtained by persons who have made a life work of the study of history. By such work done by the officers of the Royal Norwegian Archive, it became possible for Axel Boeck to furnish quite a number of new and interesting contributions to the history of the Bohuslän fisheries.

As regards the manner in which a coincidence between such vastly different phenomena as the solar spots and northern lights and the herring fisheries is brought about, we can only point to the influence of the solar spots on the weather and thereby on the currents of the sea. Here we therefore find a rich field for long-continued observations by which the necessary hydrological material should be gathered for proving the actual occurrence of such regular periodical and secular changes in the direction and intensity of the currents of the sea, by which a change in the occurrence of herring food and the consequent migrations of the large schools of herrings could be explained. It is probable, however, that ere long science will have obtained all the necessary data, so that the greater portion of what is still wanting can be supplied by careful calculations.

In looking at the advantages which our new method of explanation affords we shall, by comparison with the other attempts in this direction mentioned above, find very soon that it is the only way of explaining both the temporary and local regularity in the secular periodicity of the

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solar spots and the mackerel fisheries, as the mackerel are, according to the observations of many fishermen, most frequent when the sky is full of cirro-cumuli, or so-called "mackerel clouds," which are known to be in some way connected with the solar spots. As soon as I have gathered more material I hope to be able to give fuller information on this interesting subject.

great herring fisheries, and their varying length and importance. It not only explains the varying occurrence of the herrings during the period and their final disappearance, but also their regular return; and it does this in a manner which offers far less difficulty than the older explanations, not even excepting my own explanation of these phenomena by changes in the cenobitic condition of the spawning-places produced by the disproportionately large size of the schools of herrings.

The theory which I have advanced throws new light on the herring fisheries and on the nature of the herring which at some future time may be the subject of another treatise.

VIII.—CONTRIBUTIONS TOWARDS A MORE CORRECT KNOWLEDGE OF THE HERRING'S MODE OF LIFE.

By Axel Ljungman.*

The following may be considered as a continuation of my former treatise "On the propagation and growth of the herring and smell-herring,"[1] and will comprise a résumé of all we know so far regarding the general condition and mode of life of the herring, and its bearing on the herring fisheries on the daily life and the yearly and secular migrations of the herring.[2]

In compiling this treatise I have consulted my own experience and all the old literature on the subject which was accessible, and likewise the information which I have gathered from many a conversation with fishermen. In going over all the literature on the subject I have met with many difficulties, as the peculiarities in the herring's mode of life are often described in provincial terms which are sometimes unintelligible. By publishing this *résumé* I hope to have in some measure obviated this difficulty.

For comparison's sake, I shall also give a few observations on the small-herring (*Clupea sprattus* L.), concerning which much less is known, but whose mode of life in many respects agrees with that of the herring.

The *food* of the herring belongs exclusively to the animal kingdom, but varies a great deal in different seas and during different seasons. It chiefly consists of small crustaceans, especially of the copepod species, but also includes worms, young fish, roe, &c., and in some places the larvæ of gnats, &c. In fact, the herring devours any small aquatic animals which it can get, and does not even spare its own offspring. Boeck and L. Agassiz have said that the character of the herring's teeth proves that it is not confined to any special kind of food.

As in many places herrings are principally caught during the spawning-season, when, as is well known, they do not eat much, the idea has, especially in former times, been quite prevalent among fishermen that the herring lived on nothing else but water,[3] an idea which is found in

* Axel Ljungman, *Bidrag till Kännedommen om sillens lefnadsförhållanden.* Copenhagen, 1880. [Translated by Herman Jacobson.]

[1] *Nordick Tidsskrift for Fiskeri*, V., pp. 193–194.

[2] Compare my treatise: "*Kortfattad framställning af den nutida Kännedoman om sillens gång och flyttningar samt dessas beroende af physikaliska och biologiska förhållanden,*" in "*Bohus läns hafsfisken och de vetenskapliga hafsfiskeundersökningarna,*" II Göteborg, 1878.

[3] "*Ex puro aquæ elemento vivit, sicut salamandra ex igne.*"—Another explanation of the origin of this idea has been given by *Neucrantz* (*De harengo*, p. 28).

several of our older authors, *e. g.*, Rondelet, although Albertus magnus has already pointed out the impossibility of this statement.

In the Skagerak, where I have made many observations, the favorite food of the herring consists of small copepods, which are often found in enormous quantities. During the warm season these little animals are very numerous, and herrings during this time are much less valuable. The same is the case in Norway, where three kinds of herring food are known, viz, the "red food," which according to H. Ström, Rathke and others consists of small crustaceans; the "yellow food," which according to Axel Boeck consists of annelida larvæ; and the "black food," which, according to Rathke, consists of larvæ of mollusks. In olden times laws were given in Scotland and other parts where herring fisheries are carried on to counteract the influence of this food on the herring. In Norway herrings which have gorged themselves with such food are called "*aated*," and in Scotland "*gutpoke*."

Professor Möbius has published some data regarding the quantity of food which a herring can devour. These data are based on exact observations. Thus, there were found no less than 60,000 tails of copepods in the stomach of a single herring which had been caught in the Bay of Kiel.

As regards the food of the young herring but little can be said, as we do not as yet possess a sufficient number of observations from different localities. Prof. C. J. Sundevall says that on the Stockholm coast the young herring when measuring little above an inch feed on small copepods; and Prof. G. Lindström states that even in a smaller herring caught on the same coast he has found larvæ of a *tergites*. Axel Boeck maintains that the young herring immediately after it has lost the umbilical bag begins to snap after small crustaceans. Quite recently Dr. H. A. Meyer has communicated the result of his extensive observations, according to which the food of young herrings in the Bay of Kiel consists of larvæ of *Rissoa*, *Ulva*, *Lacuna*, *Tellina*, *Cardium*, &c., and occasionally of larvæ of *Nauplius*, whilst when they grow somewhat larger they will eagerly devour full-grown copepods.[4]

The herring only in exceptional cases bites a baited hook and line, but may be caught with floating hooks. Whenever we find it mentioned that herrings were caught with hooks, this doubtless refers to floating hooks.

The herring often consumes small and generally very oily aquatic animals in such enormous quantities that its whole inside is filled with a putrefying stinking mass of animal matter, so that it is not fit to become an article of human food. And this condition of the herring has by some authors been considered as a sickness; as such even that certain faintness has been explained which sometimes overcomes the herring after spawning to such a degree that it is helplessly tossed about

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[4] *Nordisk Tidsskrift for Fiskeri*, V., p. 154, 200.

by the waves.[5] This very circumstance was mentioned in the dispute regarding our fishery laws, when it was used as proof of the assertion that the sea-herring had been driven away from the coast of Bohus län. This faintness has doubtless been much exaggerated, but cannot be denied entirely, although it has not been observed in all places where herrings are found. It may possibly be ascribed to the diminution of vital strength produced by spawning or by a long period of scanty food, or (according to Gisler), by long and violent storms and otherwise unfavorable weather. It is likewise supposed that the herrings, like other fish, occasionally suffer from destructive epidemics.

Both the herring and the small-herring are troubled with several kinds of parasites, among which, doubtless, those are the most dangerous which attack the floating roe or the young fry.

In connection with the sicknesses of the herring, we must here mention its tenacity of life even when outside of its native element and its power of endurance, which has been viewed and described so differently from time immemorial. It has been said that the herring breathed its last immediately when taken out of the water, and as the cause of this its wide gill-openings were assigned. Neucrantz already opposed this view, and more recent authors have proved conclusively that the herring can live out of the water for several hours, if it is not exposed to the heat, pressure, or any violence. Herrings caught in nets are generally dead when the net is hauled in, and this circumstance has probably given rise to the opinion that the herring dies as soon as taken out of the water. Herrings caught in large seines live longer, and those caught in bottom-nets or fish-pots live longest. The herring cannot stand any strong pressure, and in seine-fishing care should be taken to avoid it, as it may cause the death of many herrings and by increasing the weight may make the hauling in of the seine difficult or impossible. On the whole the herring must be counted among the least hardy fish, and this applies in a still higher degree to the small herring. Under favorable circumstances, however, even the small herring may live for half an hour after it is taken out of the water. Other fish of the herring species seem to be still more tender.

There are few animals which are more defenseless and more persecuted by numerous and dangerous enemies than the herring; and if it was not so extraordinarily prolific it would surely have died out, or would, at any rate, have ceased to appear in such large numbers as to form the object of fisheries of a vast economical importance. The principal enemies of the herring are, among fish, the cuttle-fish, the cod, the salmon, and the shark; among birds, the puffin, the sea-gull; finally the whale, the seal, and above everything man, who, on account of the great variety of means by which he can pursue the herring, is by many considered its most dangerous enemy. Great dangers, however, threaten not only the grown herring, but also the roe and young fish. Among the

[5] F. BUCKLAND., *familiar history of British fishes.* London, 1873, p. 102.

enemies to the roe must be mentioned parasitic algæ, infusoria, star-fish, large crustaceans, the cod, the whiting, the flounder, and other fish. The young fish are also violently persecuted by the cod, the whiting, and other fish.

As an enemy of the herring we must finally mention the so-called "sea-blossoms," a kind of lover of salt water algæ (*Oscillatoriæ*), which are quite frequent in the Baltic, and which often force the herring to seek deeper water.[6]

The herring and the small herring, although closely related, cannot well live together, but must rather be considered as mutual enemies. They keep in separate schools, and if both kinds are caught in one and the same seine, as will sometimes happen, this is doubtless caused by the seine's enveloping two different schools, either whole or in part.[7] When these two fish meet the small herring has invariably to give way to the stronger herring; and when large herrings begin to appear in the seines this is considered an unfavorable sign for the small herring fisheries. The large migratory herring is considered dangerous to the young herring, and when occurring in large numbers it is said to chase the small herring away; the fishermen on the northern coast of Bohus län, therefore, do not like to see this herring make its appearance.

After having thus briefly given an account of the food, the sicknesses, and the enemies of the herring, we must make a few remarks regarding its general mode of life.

As regards its life during the tenderest age C. J. Sundevall says: "As long as the fish still have the umbilical bag they move about in a very peculiar way. By violent contortions of the body, which occur every second, and even oftener, they work themselves up to the surface of the water (at least when inclosed in vessels 1 to 2 feet deep); as soon as they touch the surface they keep still for a little while, and then again sink to the bottom. This movement is constantly repeated." "As soon as the umbilical bag has been consumed, which takes place in a week's time, the young herrings begin to swim about in dense schools and with a worm-like movement."[8]

When the herrings are not disturbed, they generally move in a straight line or in more or less curved lines, and like most other fish, do not turn round abruptly. On this peculiarity fishing with bottom-nets and fish-pots is based.

The herring is a lively fish and prefers a strong current. It has often been observed to go straight against the current, which, however, may

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[6] C. J. SUNDEVALL, *Stockholms läns Kgl. Hushållnings-Sällskaps Handlingar.* VI. Stockholm, 1855, pp. 152, 153. V. SKRYDSTRUP, *Nordisk Tidsskrift for Fiskeri,* II, p. 40.

[7] Violent storms, however, may occasionally cause the small herring to mingle with the larger herring.

[8] *Stockholms läns Kgl. Hushållnings-Sällskaps Handlingar,* VI, Stockholm, 1855, pp. 195, 196. *Kgl. Svenska Vetenskaps-Akademiens Handlingar,* I, Stockholm, 1858, pp. 17, 18. Compare also A. BOECK, *Om Silden og Sildefiskerierne,* Christiania, 1871, p. 14, 15.

be caused by its desire to catch the small crustaceans which are carried along by the current.

The herring is easily scared, and at any sudden noise quickly changes its course, no matter whether it is going with or against the current, but generally returns very soon to its old place. Fishermen, therefore, are not afraid that noise could entirely scare the herrings away from a coast.

In seine-fishing the herrings generally exhibit great terror of the seine, and it is often very difficult to catch them in this manner. By saying this we do not wish to convey the impression as if seines did drive the herrings away from the coast; for one seine after the other may often be hauled in successfully in one and the same place. The more or less transparent character of the water has a great deal of influence on seine-fishing. This mode of fishing can, on the coast of Bohus län, be only carried on by daytime on the southern part of the coast, where the many rivers and streams make the water muddy, so the herring cannot see the seine until escape becomes impossible. During the last great Bohus län herring fisheries in the eighteenth century, fishing was generally carried on by daytime, but already during the second half of that fishing period the fishermen were obliged to fish by night. The rich herring-fisheries of the last two winters have, however, shown a tendency to return to more favorable conditions. The herrring, which is a much less daring fish than the small herring, does not make any vigorous attempt to fly from the seine[9]; the small herring, on the other hand, boldly rushes against the sides of the seine, especially whilst it is being hauled in, endeavoring to push through the meshes, and in this respect it resembles the pilchard. If in seine-fishing small herrings are caught among the larger ones, they are generally found sticking in the meshes of the seine. The small herring does not, like the herring, try to escape the seine by going into deeper water, except during day-fishing in very clear water. If, however, there is the least chance of escape, they will all rush out as fast as possible. Gisler, from reports received by fishermen, relates that it is possible for the herring to disentangle itself from the seine; and G. C. Cederström maintains, also, according to fishermen's reports, that the herring possesses the faculty of swimming about and above the seine, especially when coming in towards the coast or when rising from the deep, so that it can only be caught when going out. All such reports, however, lack confirmation from scientific authorities. This also applies to the report common among the fishermen, that the herring could lift up portions of the seine and go underneath. This explanation probably has had to serve as an excuse for mistakes made during fishing.

The herring often changes its depth very suddenly; and especially during calm weather it has been observed to come to the surface and suddenly head foremost to rush to the deep, whilst the small herring,

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[9] When a codfish accidentally gets into a seine with the herrings it creates such a terror among them that they rush against the sides of the seine with the fury of dispair and often burst it.

according to the observations of old and experienced fishermen, never does this.

The herring generally goes deeper than the small herring, which is more of a surface fish. During the rich fisheries in the Norwegian boundary-waters, fishermen have reported that large herring and small herring were caught alternately by lowering and raising the seine.

It has been observed during seine-fishing that the larger herrings keep nearer the bottom than the small ones, which always love to keep near the surface. It has also been observed that after spawning the herring goes deeper than previous to it, so that in drag-net fishing most fish are caught in the lower part of the net. In some cases this may be explained by the fact that the herring after spawning seeks to devour the floating roe. According to other reports, however, the herring goes to the surface after spawning and to the deep previous to it.[10]

Several authors, one of them living in the latter half of the last century[11], relate that "fishermen have observed in different places," that the herring at times hides near the bottom ("in the mud, among the algæ and other aquatic plants, as also in holes made by itself both in bays and sounds and farther out at sea"), and it is in this respect compared to the launce, the eel, and the stickleback.[12] Although the herring has certainly been observed occasionally "to bore with its snout among the sand and stones of the bottom," as old authors already have observed, we are scarcely justified in the supposition that the herring, like the eel, hides on the bottom for any length of time. It is not probable that the herring has a regular period of winter sleep, as some old authors have maintained.

It is well known that the herring emits air-bubbles, and Gisler has given a description of this phenomenon which we will quote in his own words: "When the herrings are closely huddled together, they breathe heavily, and gape after every breath like a person in a close room; from the anus a string of small air-bubbles is emitted, whilst water spurts from the mouth.

The herring is even said to possess the faculty of producing sounds, as the Scotch fishermen say, "squeak," and without sufficient reason, however, it has been said that it breathed its last with an audible sigh or sound.[13]

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[10] Compare "*Bohus läns hafsfisken och de vetenskapliga hafsfiske-undersökningarna*, II, p. 34; *Nordisk Tidsskrift for Fiskeri*, V, p. 209.—Report on the herring fisheries of Scotland, London, 1878, p. 76.

[11] DUHAMEL DU MONCEAU, "*Traité général des pêches*, II, Paris, 1772, section 3, p. 339.

[12] G. C. CEDESTRÖM, *Svenska Östersjö sill-och strömmings-fiskerierna naturhistorisk betraktade*." Stockholm, 1873. Prospectus, p. 7; appendix, pp. 4, 12; supplement, p. 1.

[13] Compare F. BUCKLAND, Report on the herring fisheries of Scotland, London, 1878, p. 167. HUGH MILLER according to W. BRABAZON. The deep-sea and coast fisheries of Ireland, Dublin, 1848, p. 32. P. NEUCRANTZ, "*De harengo exercitatio medica*," Lubecæ, 1654, p. 23. VALENCIENNES, "*Histoire naturellé du hareng*," Paris, 1847, pp. 65, 89.

The mode of life of the herrings when gathered in schools finally de-rerves some remarks.

The herring is one of the most gregarious fish; from its tenderest age it gathers into schools, and only in very exceptional cases lives in solitude.

Between the spawning seasons the herrings certainly scatter a little more, and generally go farther away from the coast to seek their food, but it is an erroneous idea that during this period the schools are entirely broken up. When the spawning season approaches, the smaller schools gather into larger ones, which finally assume such enormous dimensions as to deserve the name of "herring mountains." When such an enormous mass of herrings approaches the coast, it gives a peculiar color to the water, and when near the surface creates a considerable commotion in the water.

When a large mass of herrings are gathered in one place, many air-bubbles rise to the surface, which circumstance doubtless contributes its share towards coloring the water. The Norrland fishermen say that the herring "is milling," and from the size of the air bubbles draw their conclusions as to the depth at which the herrings are. The smaller the bubbles the deeper the herrings are supposed to be. Also on the coast of Bohuslän these so-called "herring bubbles" form an important mark for the fishermen, who thereby judge not only of the approach of the herrings, but also of the depth at which they will be found. If the bubbles burst when reaching the surface, the herrings are in deep water; if they float for some time on the surface, the herrings are nearer the surface. These air bubbles can best be observed during day fishing with large seines, and they will then by their greater or smaller number indicate in how far the haul will be successful or not.

French and English authors say that according to the observations of many fishermen the location and size of a school of herrings are indicated by an oily substance ("*graissin*" "*smelt*") floating near the surface, which is considered a favorable sign for the fisheries. The French Channel fishermen say when they see this that the water is "*pouilleuse*." Some authors explain this phenomenon as being caused by herrings which have been torn to pieces by sharks (*Squalus acanthias L.*), and say that it is a sure indication that sharks are near. Bartlett's explanation, however, seems better, according to which this oily substance is formed from the numerous excrements of the herrings.[14] Strange to say, this phenomenon has both in old and modern times been by some confounded with the whitish substance floating about near the surface during the spawning season of the herring.

It is also said that the large and dense schools of herrings when spawning, or when swimming near the surface in large schools, produce a peculiar odor, which has often been observed by the Norrland fishermen.

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[14] Report on the herring fisheries of Scotland. London, 1878, p. 169.

Schools of herrings when swimming near the surface are said by their movement to produce a rushing sound, which ceases immediately when, scared by some sudden noise, the herrings go into deeper water. In this connection we will also mention the old fable that the herrings when gathered in large schools produce a sharp cracking noise, whereupon they disappear.[15]

When a large number of herrings move about rapidly, a peculiar glitter is produced on the surface, which our fishermen call "herring light." Some old authors have maintained that the herrings themselves are phosphorescent, and that the "herring light" is therefore not produced by the numberless small crustaceans floating near the surface; but this is probably an erroneous idea. In olden times these herring lights were thought to be the cause of the frequent sheet lightning occurring late in summer and in the beginning of autumn, and such lightning was termed "herring lightning." When the herrings turn about in the water their sides, which shine like metal, reflect the light, and produce a very pretty effect, but much fainter than the "herring light."

Herrings of different age and size do not generally go together in one and the same school, although there are exceptions to this rule (thus the so-called "May-herring," which towards the end of spring are caught, especially on the southern coast of Bohus län, are often found in company of two- and even one-year-old herrings). Cases are also said to have been observed where the two sexes went in separate schools.

In every school the larger and stronger fish precede the smaller and weaker ones. This circumstance may possibly have given rise to the well-known fable, that the herring schools are led by a so-called "herring-king," who always swims at the head of the school and whose death by violence was thought to injure the fisheries. The herrings often swim in the same order as the old northern heroes used to march, viz, in the form of a wedge whose point forms the head of the column.[16] A similar order has been observed among other fish and likewise among birds.

The herrings always follow their leaders, and when these change their course the whole school changes. If through some violent cause a school of herrings is scattered and broken up into smaller schools, each one of these swims in the same order as the large school used to do. Like the single herring, the schools move either in a straight line or in slightly-curved lines, and unless disturbed they do not change their course. Like some of our small fresh-water fish, the smaller herring schools, principally composed of young herring often move about in a circle, gliding gently along. Occasionally a school of herrings will describe circular movements with extreme rapidity; those in the center will then remain almost stationary, while those on the outside will move round with great velocity, such velocity increasing from the center to-

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[15] VALENCIENNES, "*Histoire naturelle du hareng.*" Paris, 1847, p. 88.

[16] A. BOECK, "*Om Silden og Sildefiskerierne,*" pp. 53, 54.

wards the circumference. The Bohuslän fishermen say that the herrings are "milling," and the Dutch fishermen say they are "grinding."

Gisler says that the herrings, especially during the spawning season, push against each other with such violence that many of their scales come off and float about near the surface. This phenomenon has also been observed by the Bohus län fishermen.

Owing to outward causes the herring schools swim at very different depths under the surface, and at times even rise to the surface, which they do more frequently when out at sea than when near the coast. The herrings have thus been observed immediately after the close of the spawning process to rise to the surface and remain there for some time, quietly floating about with a scarcely perceptible movement; in clear weather the herrings may often be observed sporting about near the surface and beating the water with their dorsal fins, producing quite a shower of spray. British fishermen call this "the play of the herrings," and French fishermen, "*le jeu des harengs*," and the same name is given to it by our Bohus län fishermen,[17] although the word "*lek*" (play) is used by them in a different sense from the one employed by Swedish naturalists. When the herrings are thus joyfully sporting about in the water it is considered as a favorable sign for the fisheries.

The small herrings may also at times be seen moving about quickly near the surface and beating the water with their dorsal fins.

On the Stockholm coast[18] the herrings are said to "bathe" in the still water, which expression is probably intended to describe a gentle movement of the herring when hunting for small crustaceans. C. J. Sundevall describes this peculiarity of the herring and some other fish as follows: "*Bathing fish* so called are schools of fish which in summer keep near the surface to enjoy the warmth of the sun. This term is very expressive, and we recommend its adoption."

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[17] See *Nordisk Tidsskrift for Fiskeri*, v, p. 211.

[18] C. J. SUNDEVALL, *Stockholms läns Kgl. Hushållnings-Sällskaps Handlingar*, vi, pp. 84, 96, 126. H. WIDEGREN, *Några ord om sillfiske, Stockholm*, 1871, p. 3; *Tidsskrift for Fiskeri*, vi, p. 66.

IX.—THE FISHERIES ON THE WEST COAST OF SOUTH AMERICA.

By H. G. Kruuse.*

[From "*Nordisk Tidsskrift for Fiskeri,*" Vols. V and VI. Copenhagen, 1879.

Although the following communication leads us far away from those countries which are generally spoken of in our journal, I hope that it will prove interesting, as giving us an insight into the fisheries on a portion of the great Pacific coast. They will be doubly interesting to those of our readers who are personally acquainted with the author, whose upright character commanded universal respect, and whose genial temperament gained him many friends.

Our countryman, *Hans Gunner Kruuse*, originally a fisherman, later captain of a vessel and owner of a factory in Korsör (island of Zealand, Denmark), was, in the spring of 1877, by the force of circumstances, compelled to leave his home, and, with his numerous family, emigrated to Callao, Peru, which place he had often visited in former years, believing that his knowledge of the country and its customs would enable him to earn a living. He was not successful, partly on account of local difficulties, partly owing to want of capital; and he was obliged again to become the captain of a vessel. His constant activity on the western coast of South America, however, gained him an intimate acquaintance with the fisheries in those distant regions: and, with his consent, I give the following extract from a recent letter of his. His clear insight into all matters pertaining to the fisheries, and his general trustworthiness, will be sufficient guarantees for the correctness of his descriptions.

H. V. FIEDLER,
Editor of Tidsskrift.

Russian Bark Ruria,
On the Atlantic, July, 1879.

When leaving Denmark in the spring of 1877, I promised you to write from Peru and give you some idea of the fisheries on the west coast of South America. Various causes have, so far, prevented me from fulfilling my promise; but during the two years which have elapsed since it was made I have seen a good deal, and visited a large number of places on the coast. I shall, therefore, be able to give you a fuller and more reliable account than if I had written soon after my arrival.

Before describing the fish of this coast and the way in which they are

* H. G. Kruuse, *Nogle Meddelelser om Fiskeriet paa Vest-Kysten af Sydamerika.*—[Translated by Herman Jacobson.]

caught and used, I think it proper to give a short description of its nature. My personal observations were confined to the coast of Peru, nearly every point of which I visited, from the 3d to the 22d degree southern latitude; but my remarks will, in a great measure, also apply to the coast of Chili, Ecuador, and Colombia as far as the Isthmus of Panama.

This whole coast is bounded on the west by the South Pacific. The mountain range of the Andes follows the coast-line in its whole extent, and at a distance of only seventy miles reaches its greatest height, 15,000 to 20,000 feet. A great deal of water flows from these high snow-clad mountains, especially during summer, but on account of the very steep incline no rivers have been formed. The little stream and brooks, of which there are a great many, rush so violently over their stony beds towards the coast, that no plants can thrive and no fish live in their waters. There are, consequently, no fresh-water fish, and all the fish which occur in Peru are salt-water fish.

The Pacific is richer in fish than any other sea, and this is caused by its peculiar natural conditions. A current runs along the entire coast, from south to north, beginning as a surface-current on the west coast of Patagonia, near Cape Horn, and bringing the cold waters of the Antarctic Ocean as far as the northern boundary of Peru. At this point the current leaves the coast and runs in a westerly direction to the Gallapagos Islands, where it loses itself. This cold current, which has a temperature of not more than 12° to 14° Réaumur, produces the remarkably temperate climate on these coasts which lie within the tropic zone, but which have seldom any greater heat than we have in Denmark during summer; and as the air is drier the heat is not near as oppressive. But what is of more interest to us is the circumstance that this cold current of the sea contains an almost incredible wealth of fish. The fish which occurs in the most surprising numbers is the herring; but the coast waters swarm with innumerable other fish, *e. g.*, the mackerel, the cod, and others. Rich oyster-beds are found in many places, and oysters of the most excellent quality are so plentiful that they sell for 18 to 26 cents a barrel in Callao and Lima.

The enemies of fish, however, are just as numerous, especially among the aquatic animals. An incredible number of seals, sea-lions, porpoises, sharks, and other large fish chase the schools of smaller fish; and the seals particularly gorge themselves among the dense schools of herrings. Seals and sea-lions are found everywhere at a distance of about two miles from the coast, rarely farther out; their places of retreat are inaccessible rocks on the coast or out at sea. Here they lie or sit sunning their enormous bodies, when they are not engaged in hunting fish. They are so tame that scores and hundreds of them will follow a boat at a distance of only 2 to 3 fathoms and often closer, and hold their inquisitive heads close up to the side of the boat. As they are of no special value, no one chases them.

I would like to give you a description of those species of fish which are most common on this coast; but as this will be somewhat difficult, I will endeavor to describe those fish which have some similarity to ours. The specimens which I had collected and preserved in spirits of wine were unfortunately spoiled from some cause or other, and the only kind of fish of which I can this time send you a few specimens are herrings, which put up in brine seem to have kept very well. I shall, therefore, begin my account with the herring.

As to size and looks the *herring* of the South Pacific does not differ much from that found in the northern seas, but it is undoubtedly of a much inferior quality. It is found along the coast and close to the land all the year round, but even at a distance of fifty miles from the coast the sea is full of them, whilst farther out they are not so frequent. On calm, warm days dense schools of them rise to the surface and hold their heads above the water, often covering the surface of the sea for hundreds of fathoms.* This is the time for the seals to gorge themselves, and they certainly do not neglect their opportunity. As many herrings as you want can then be caught with nets and seines; but as they are hardly ever used as food it seems perfectly useless to catch them. During the night their dense schools may be seen farther out at sea, and the rapidly moving phosphorescent light produced as they fly from porpoises and other enemies presents a beautiful spectacle.

But very few of these herrings are ever used as an article of food, as there is such an abundance of better fish; the only use which is made of them is to serve as bait for other fish. They can be salted, and their flavor is then better than when fresh, but the climate is not favorable to salting. Smoked they form a very good article of food.

The *mackerel* is also found in large quantities, but its quality is inferior to our northern mackerel. In size and shape these mackerel resemble ours, but the color, which is so beautiful in ours, is very faint. They are not as fat, and their flavor is not near as agreeable, having a sort of bitter taste, produced, as some think, by the coppery nature of the bottom. It is but rarely eaten, and therefore does not form an object of fishing. The horse-mackerel also occurs here, but it is absolutely worthless.

The *codfish* is not near as common as the above-mentioned species, but of all the Peruvian fish it resembles our northern fish most, and is considered the best and most valuable fish on this coast. In looks and size it differs considerably from our northern codfish, and rarely weighs more than 8 to 10 pounds. It is fat, has a good flavor, and fetches a good price, both fresh and salted (about 13 cents per pound salted). It lives in deep water where there is a rocky bottom, and is caught exclusively with hook and line. It is really the finest fish found on this coast.

Flounders are also found, but not in any considerable number. They

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* The same phenomenon I observed in the North Sea during the summer of 1840, though probably not on such an extensive scale.—H. V. FIEDLER.

vary in size, and sometimes reach a weight of 10 pounds. They have a tolerably good flavor, but nothing like our flounders. They fetch a good price.

Eel are often found close to the coast, and between the rocks where the breakers are not too strong. They say that large-sized eel are found near some of the outer islands at a depth of 50 to 80 feet, but I never had an opportunity of seeing any.

These are about the only fish which bear any similarity to ours; but there are a large number of excellent fish which we do not have, and which, to a great extent, form an article of food. It is useless to give their names and to describe them, as long as I cannot send you specimens. One kind, called *Raballes* or *Corobinas*, weighs from 20 to 80 pounds, and somewhat resembles the salmon, but its flavor is not quite as delicate. Owing to the want of fresh-water streams, there are no salmon on this coast, while large quantities of excellent salmon are caught on the coast of California and farther north. These are put up in brine, and sold all along the west coast of South America, and salted, canned, and packed in ice, they are sent to the Atlantic coast of North America. On the west coast of South America the water has often, during calm weather, a brownish color, and it seems at first sight as if the water was shallow. But on closer examination we find that this brown color is produced by another cause, viz, by very diminutive animals, which cover the surface of the sea for many miles. They are so small that they cannot be seen with the naked eye; but when you let this colored water stand for some time in a glass, a brownish sediment will soon form. I have not had the instruments nor the opportunity to observe this matter closer, but I refer you to *Ch. Darwin's* observations, made during Her Majesty's ship Beagle's voyage around the world. These little animals are also found on the coast of Norway, and it is interesting to hear what an authority like Darwin has observed in this line during his voyage in the South Pacific:

"On the coast of Chili, a few leagues north of Concepcion, the Beagle one day passed through a large extent of muddy water, and the same phenomenon appeared, in a still more marked degree, a few days later south of Valparaiso. We were more than fifty miles from the coast, but still I believed at first that this muddy water might possibly come from the river Maypo. But Dr. Sullivan, who had collected some of this water in a glass, thought he could see little spots moving about in it. The water looked as if a quantity of reddish dust had been put into it, and when left undisturbed this dust collected at the bottom. Through a magnifying-glass these little spots could be seen moving about very rapidly, and quite frequently they would burst. When placed under the microscope, it appeared that their form was oval, and surrounded by a ring, from the middle of which small fibers protruded, which served as means of motion. One end of the body was narrower than the other. It was very difficult, however, to observe them, for suddenly the motion would cease, and the body would burst. Sometimes one end broke off, and then the other; often both ends would break off at the same time, and a dark brown substance would ooze out. The ring with the fibers would, for a few moments after the body had burst, keep up a wriggling motion. It took about two minutes to extinguish all life in a drop of water poured in a saucer. The motions of the little animals were exceedingly rapid, and could not be seen with the naked eye, as each animal only measured $\frac{1}{1000}$ of an inch in length. Their number was prodigious, every drop of water containing vast quantities. One day we passed through two places where the water was colored, one of them extending over several square miles. What an enormous number of microscopic animals! The color of the water, seen from a distance, was like that of a river which has a red clayey bottom, whilst nearer the ship it was dark brown, like chocolate. The line of demarkation between the brown and the blue water could be traced very distinctly."

I will only add that the largest quantity of these microscopic animals which I observed was farther north, in the 6th and 7th degree of southern latitude, but there is no doubt that they are found all along the coast.

The bottom of the sea has scarcely any vegetation. The vast ocean rolls its strong waves towards the coast over a stony or sandy bottom, and this character of the bottom extends far out. How different from the bottom of the sea on the colder coasts farther south, *e. g.*, of Patagonia and the Falkland Islands. But where the gigantic algæ grow, the coasts, like those of Norway, are surrounded by many rocky islands, which moderate the violence of the breakers; but there are scarcely any such slands on the coast of Peru, and the sea breaks against the shore with such violence that it is always difficult to land in boats.

I shall now say a few words regarding the *fishermen*, their *apparatus*, and *method of fishing*. Fishing is carried on almost exclusively by two classes, the native population, the so-called "cholos"—a mixed race of Spaniards and old Peruvians—and by Italians, who are a thrifty and energetic people. The "cholos" go out fishing in their canoes, and nearly always use hooks and lines. Only for catching shrimps and small fish for bait they use a small net. The Italians, on the other hand, always fish with nets, and, according to the custom of their native country, in well-built boats with lateen sails. The natives generally go fishing early in the morning, either far out at sea or close to the rocky coast, where their boats may often be seen tossed about by the terrible breakers. Bottom lines form their principal apparatus, and they certainly know how to use it. They often catch a very considerable number of codfish, mackerel, and other fine fish during the forenoon. About noon they go on shore, and their day's work is done. Floating lines with a number of baited hooks cannot be used, as the seals would disturb them. But when the above-mentioned fish of the salmon kind, the *Raballes* and *Corobinas*, come near the coast, the natives employ another method of fishing. They row out to sea early in the morning, before the sea wind arises, and go a good way to the leeward, and when there is sufficient wind they go with it, having a long, stout line floating about a fathom behind the canoe. This line is furnished with hooks and glittering tin floats; and as the above-mentioned fish are very greedy they soon bite. As soon as the man in the boat notices a bite he quickly hauls in the line and endeavors to bring the fish close to the canoe, where it is secured with a large hook.

The *boats* used by the natives deserve some mention. I have already mentioned that the breakers on this coast are very violent, and with the exception of a few sheltered landing-places, it is impossible to land anywhere with a boat or even a canoe. In order to meet this difficulty to ferry people from the coast to ships or for fishing, the natives use the so-called *balzas*. In some localities, especially in Southern Peru and Chili, these *balzas* consist of two sea-lion skins, joined by two boards, on which there is a little platform; each skin is furnished with a tube through which it can be filled with air. On these *balzas* the *cholos* cross the most terrible breakers, which throw the *balzas* high on the coast; the very moment where the breakers recede, the cholos leap up out, and standing on the dry land firmly hold their fragile vessel. They possess an extraordinary dexterity in handling these vessels. In many places the cargoes of ships must be taken on *balzas* to and from the boats which are at anchor outside the breakers. On other parts of the coast five, seven, and nine boards, of light wood, measuring 8 to 12 inches in diameter, joined lengthwise and furnished with a similar platform, are used, and on the northernmost coast of Peru the *balzas* only consists of a bundle of reeds tied together in the shape of a cigar, 10 to 12 feet long, 2 feet broad at the stern, and with a pointed prow slightly inclined upward. This *balza* the fisherman takes on his back, after it has been used, and dries it in the sun. It must be borne in mind that it never rains in these latitudes. On the board *balzas*, which are often of considerable size, the native fishermen go far out to catch codfish, frequently out of sight of land.

Such are the apparatus, boats, and methods of fishing of the natives. The Italians, however, employ a more rational method of fishing. They all live in or near the large cities on the coast, where they find a good market for their fish, whilst the *cholos* are found everywhere along the coast. The Italians always use boats 16 to 22 feet long, 6 feet broad, and having a deck like our boats in the Great Belt. They always use nets, and fish during the night. Their boat is their home, where they live, cook, and sleep. I have already mentioned that the Italians are thrifty, frugal, and economical, and are far superior to the lazy Spaniards and the mixed race. They always keep their boats and their apparatus in good order; they are out early and late, and shun no trouble to earn a living. They go out early in the evening, when it is nearly always calm, and row many miles till they reach their fishing-places. At dusk they cast their nets, and are then obliged to keep a constant watch for the seals; when these approach, they haul in the net, take out the fish, and cast again. Thus the night is passed; towards morning the fishermen go on shore, sell their fish, mend their nets, and then first can think of taking a little rest in iteir small cabin.

This is the way in which these men pass their lives; and it may well be called a hard way of earning one's bread, for, although they generally catch a good many fish, the profits are very small. Some of them, however, have prospered, own several boats, and go in partnership with others. There is never any lack of such, as there are always many Italian sailors in the principal seaports of the west coast of South America; and all of them have a great liking and talent for fishing. Their nets are made of the strong hemp which grows in these regions, and whose threads are almost too thick, according to our notions. The size of the meshes varies according to the kind of fish which they wish to catch. They always make their own nets and furnish them very prettily with round floats. Everything must always be in good order on account of the frequent casting and hauling in, owing to the danger threatened by seals. Everything in the boat is prepared with this view. The shipboard is furnished with rollers over which the lines of the net may be drawn with great ease, and these men possess an almost incredible dexterity in casting and hauling in their nets. They generally have a gun in their boats to shoot or scare off the seals and sea-lions; but this is not of much use, as these animals are too numerous and care very little for shooting. The best way is to haul in the net and take out the fish as soon as seals are in sight. Old people, and those who can only afford to have a small boat, occasionally fish by day-time quite close to the coast, generally with nets having very narrow meshes, which they place in a serpentine line as near as possible to the breakers. As soon as one end of the net, measuring about 60 fathoms in length, has been put in position, they row immediately to the other end and begin to haul it in; and thus they go on a whole day; for the seals come close to the coast and are on the alert both day and night. Near the coast they catch a beautiful little transparent fish, which is in great demand, and which we do not have in Denmark. It is called "*pega-rej*," *i. e.*, "the fish-king," and is so transparent that every bone can be distinctly seen; it has a beautiful shining silver color. Oyster-fishing, as far as I know, is only carried on near the island of St. Lorenzo, which forms the bay of Callao, but there is no doubt that rich oyster-beds are found in many other places along the coast. As I have mentioned before, their number is enormous, but the price which oysters fetch is very small. The Italians continually use long poles, partly for chasing the fish into the nets and partly for keeping off the seals and sea-lions. These poles resemble those which our fishermen use in the Limfiord.

As is the case everywhere these fishermen have to work hard to earn their daily bread, and their enjoyments are few in number. But I must mention some of them. I lived for some time in a little sea-town which serves as a watering place to the inhabitants of Lima, and which is connected with that city by a railroad of about thirty miles. This town is situated in a very arid part of the coast, but on a beautiful bay which offers a fine opportunity for fishing; consequently a good many fisher men live in this town. In these out-of-the-way places the Roman Catholic priests still exercise a powerful influence, which is decidedly waning in the large cities with a mixed population. On a certain day in July the fishermen have their festival, and on that day about a dozen priests and monks come from Lima to add to the proper observance of the sacred day. In the morning, images of St. Peter and the Virgin Mary, surrounded by banners, are, amid the thunder of artillery, carried through every street of the little town; at the head of the procession are seen the monks and priests, the alcalde, and the harbor-master, followed by all the fishermen with their wives and children, bareheaded in spite of the burning rays of the sun, and carrying lighted candles, all marching with a slow measured step. After the procession has passed through every street they go to the wharf and into gaily decorated boats. The priests solemnly bless the fish and address sermons to them This ends the religious part of the festival, and the fishermen spend the rest of the day in boisterous merriment, dancing, drinking, cock-fighting, &c. The priests do not fail to make this day as profitable to themselves as possible. They placed the images inside a tent, and by paying a small sum every true believer—I was the only unbeliever in the town—could go in and have the extreme pleasure of kissing the foot of either St. Peter or the Virgin Mary. As far as I could observe, St. Peter had the larger number of worshippers. The festivities were continued till late at night, but on the following day everything went again its usual course.

Respectfully, yours,

H. G. KRUUSE.

APPENDIX C.

DEEP-SEA RESEARCH.

X.—POPULAR EXTRACTS FROM THE INVESTIGATIONS OF THE COMMISSION FOR THE SCIENTIFIC EXAMINATION OF THE GERMAN SEAS.

[Published by the Royal Ministry of Agriculture, Domains, and Forests.*]

PREFACE.

The following treatise has been prepared at the special request of the Minister of Agriculture, &c., with a view to making some of the more important results of our investigations accessible to *practical fishermen*, and for the purpose of encouraging them to aid us by all the means at their command in continuing our work in the interest of the salt-water fisheries.

[The Ministerial Commission for the scientific examination of the German waters: H. A. Meyer, K. Möbius, G. Karsten, V. Hensen.]

A.—THE PHYSICAL CONDITION OF THE BALTIC AND THE NORTH SEA.

At first sight the knowledge of the condition of the sea-water seems to be of small importance for the practical salt-water fisheries. Fishing has been carried on by men for a long time without any special regard to the temperature, saltness, and currents of the sea; experience and accident taught men the seasons and places where fishing could be carried on with hopes of good results. No one thought of inquiring whether the success of the fisheries, varying every year, had something to do with the changes in the condition of the sea-water; and yet it is an undoubted fact that an intimate connection exists between the two. It is not purely accidental that many plants and animals found in a belt extending from the eastern shores of the North Sea to the western shores of the Baltic vary greatly in size and strength, according to the more or less plentiful food or the larger quantity of solid particles in the sea-water; nor is it accidental that the changing condition of the water in one and the same place produces a varying development of plants and

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* *Gemeinfassliche Mittheilungen aus den Untersuchungen der Commission zur wissenschaftlichen Untersuchung der deutschen Meere. Herausgegeben im Auftrag des Königlichen Ministeriums für Landwirthschaft, Domänen und Forsten. Kiel,* 1880.—Translated by Herman Jacobson.

animals. Warmth, which furthers the rapid development of plants and small animals which serve as food for fish; currents, which carry plants and embryonic animals in constantly varying quantity to the fishing-places, are some of the causes which necessarily must exercise an influence on the migrations of fish to such places.

No one will expect that fishermen should go to sea with thermometers and areometers; but the fishermen will be benefited if the above-mentioned conditions of the sea-water are regularly examined and compared with the results of the fisheries. The fishermen, without making any scientific investigations, may aid greatly in extending our knowledge of these matters, and may benefit their trade by paying close attention to such easily recognizable circumstances as high or low temperature, currents, and to various phenomena connected with the spawning of fish, the greater or less quantity of fish at different places and seasons, &c., and by making their observations public.

These considerations induced the Ministry of Agriculture, &c., in the year 1870, to appoint a commission at Kiel for the purpose of making scientific examinations of the German waters, which might aid in gaining a better knowledge of those conditions on which the success of the salt-water fisheries—their improvement and extension—depends. For this purpose a number of stations have been established where the condition of the sea-water is regularly examined, whilst, at the same time, similar observations are made by several vessels following a certain regular course. At some of these stations observations are also made with a view of ascertaining (in exact figures) the result of the fisheries. A beginning has also been made in making observations regarding the spawning places and seasons, the development of fish, &c.

Our knowledge is still quite limited, and so far, at least, the practical result of these investigations has not been very great; but we must take into consideration the fact that but a short time has elapsed since these investigations were commenced.

No year resembles another in its atmospheric conditions, and meteorology, although studied for several centuries, has not yet been able to fix with absolute certainty the rules from which for some time in advance the condition of the weather could be calculated. The sea has likewise its atmospheric changes, dependent on many different circumstances, and many years will pass before we shall ascertain the causes of these changes observable in different years. The conditions of life and the habits of salt-water fish have scarcely begun to be studied. Fishermen themselves know but little with absolute certainty regarding the spawning places and seasons of the more important salt-water fish of their own familiar waters. It may as well be acknowledged that so far we only know a few facts regarding the spawning places and seasons and the development of one species of fish—a very important one, to be sure—the herring; but even these observations have reference to only a few localities. But what we know is highly important, because it has plainly demonstrated the intimate connection existing between the development of this fish and the condition of the water.[1]

Here is the point at which the fishermen themselves can aid and further the fishing interests, if they will give careful attention to the spawning of all the more important fish and to the accompanying general conditions of the sea.

In the following we shall endeavor to give all the results which have been gained by observations of those conditions in the Baltic and the North Sea which probably exercise a considerable influence on the fisheries.

2. There are three conditions of the sea-water which exercise a decided influence on animal and vegetable life, viz: (1) *temperature*, (2) *saltness*, (3) *currents;* and all three are influenced by the atmosphere and the nature of the bottom. Another important fact as regards the condition of the water of the Baltic and the North Sea is their varying connection with the ocean, and the varying quantity of fresh water flowing into them from different streams and rivers. The conditions of these two waters are so different that we must treat of them separately.

A. THE BALTIC is a very shallow sea. If we except the deep waters east and southeast of Gotland we rarely find a greater depth than 100 meters. The three channels leading into the North Sea, the Sound and the two Belts, are shallow. Large streams flow into the Baltic, carrying into the sea rain and snow water from a territory three times the size of that from which the North Sea is supplied. When two masses of water of different weight meet, the heavier of the two will generally sink lower down; the heavier water from the Kattegat will therefore enter the Baltic and form its undercurrent, whilst the lighter water of the Baltic flowing into the Kattegat will become its surface water. On account of the very large quantity of fresh water flowing into the Baltic (especially in spring, when the ice and snow begin to melt, and in summer during continued rainy seasons), the upper current which flows out of the Baltic is much more powerful than the undercurrent which enters it.

The saltness of the Baltic therefore decreases from west to east, but not uniformly; but, influenced by the wind, sometimes quick and at other times slow, and also influenced by the nature of the bottom, quicker in one direction than in another.

Continued east wind favors the flowing of the water of the Baltic into the Kattegat; the upper current containing but little salt, becomes stronger in the Sound and the Belts, and the salt Kattegat water is forced back. Continued west wind, on the other hand, drives the water east and favors the entering of salt water. The advance of the last-mentioned water from west to east varies considerably, according to the

[1] Compare: Dr. H. A. MEYER, "*Biologische Beobachtungen bei Künstlicher Aufzucht des Herings der westlichen Ostsee.*" *Berlin*, 1878. (Biological observations made during the artificial rearing of herrings in the Western Baltic.)

nature of the bottom. On the German coasts on the west of the Baltic the heavy water enters far into the fiords, whilst the undercurrent entering through the Sound and the Great Belt is broken by the shallow places known as the "Rönne-bank" and the "Oder-bank," between the islands of Reizen and Bornholm, and advances with no great force after it has passed this line, decreasing rapidly in saltness as it goes farther east. Between Bornholm and the Swedish coast the depth of the sea is greater, and this explains the circumstance why the heavy water can here advance farther east, making the water in the Gulf of Finland saltier than that of the Bay of Dantzig or that of the Baltic near Memel.

The following figures, the result of observations made at different stations, will fully prove all that has been said in the above regarding the *saltness of the Baltic:*

	Average per year.	Spring.	Summer.	Autumn.	Winter.	Maximum.	Minimum.
SONDERBURG.							
Surface water:							
Specific weight	1.0131	1.0122	1.0123	1.0139	1.0138	1.0214	1.0100
Per cent. salt	1.72	1.60	1.61	1.82	1.81	2.80	1.31
Bottom water:							
Specific weight	1.0141	1.0137	1.0136	1.0146	1.0233	1.0233	1.0108
Per cent. salt	1.85	1.79	1.78	1.91	3.05	3.05	1.41
KIEL.							
Surface water:							
Specific weight	1.0124	1.0115	1.0117	1.0137	1.0117	1.0201	1.0043
Per cent. salt	1.62	1.51	1.53	1.79	1.66	2.63	0.56
Bottom water:							
Specific weight	1.0146	1.0147	1.0144	1.0147	1.0152	1.0220	1.0115
Per cent. salt	1.91	1.93	1.89	1.93	1.99	2.88	1.51
WARNEMÜNDE.							
Surface water:							
Specific weight	1.0089	1.0085	1.0082	1.0095	1.0095	1.0132	1.0060
Per cent. salt	1.17	1.11	1.07	1.24	1.24	1.73	0.79
Bottom water:							
Specific weight	1.0103	1.0102	1.0093	1.0107	1.0109	1.0146	1.0068
Per cent. salt	1.35	1.34	1.22	1.40	1.43	1.91	0.89
LOHME (RÜGEN).							
Surface water:							
Specific weight	1.0071	1.0071	1.0068	1.0070	1.0077	1.0104	1.0032
Per cent. salt	0.93	0.93	0.89	0.92	1.01	1.36	0.42
Bottom water:							
Specific weight	1.0075	1.0073	1.0072	1.0073	1.0081	1.0112	1.0050
Per cent. salt	0.98	0.96	0.94	0.96	1.06	1.47	0.66
HELA.							
Surface water:							
Specific weight	1.0057	1.0055	1.0058	1.0056	1.0058	1.0066	1.0014
Per cent. salt	0.75	0.72	0.76	0.73	0.76	0.86	0.18
Bottom water:							
Specific weight	1.0058	1.0057	1.0059	1.0058	1.0059	1.0068	1.0014
Per cent. salt	0.76	0.75	0.77	0.76	0.77	0.89	0.18

From these figures the following rules may be deduced:

1. The weight and saltness of the water of the Baltic decrease from west to east, the entry of the heavy water into the depths of the sea ceasing near the island of Rügen.

2. The surface water is invariably lighter, and contains less salt than the deep water; the difference between the two decreases in the direction from west to east.

3. On an average the water is heavier and contains more salt in autumn and winter than in spring and summer; this difference likewise decreases in the direction from west to east.

4. The variations of the specific weight and the saltness of the water, that is, the differences between the temporary variations of the water, are also much more considerable in the west than in the east. Near Sonderburg, and even near Kiel, the deep water occasionally contains so much salt that it differs very little from the North Sea water in this respect, whilst near Lohme, and still more near Hela, the heaviest water contains little more than the average quantity of salt.

As regards the second important condition of the water, viz, its temperature, the Baltic shows the following phenomena:

On account of its comparative shallowness, and because it cannot exchange its warmth with that of the oceanic water through wide open channels, the temperature of the water of the Baltic will mainly be regulated by the temperature of the atmosphere, and will in different years be more or less dependent on the atmospheric temperature of those years. As the water absorbs warmth slowly, and likewise cools off slowly, the water will grow warmer or cooler somewhat later than the atmosphere, and the deeper the water the slower will be this process. The warmth and cold of the atmosphere will be the same in the water, only it will occur later in point of time and will decrease in the direction of the deep water.

The temperature of the water, which is dependent on the local temperature of the atmosphere, is somewhat changed by the currents. The cold water, which in spring flows into the Baltic in enormous quantities from the north and east, and which is chiefly produced by the melting of the snow, creates a cold upper current flowing in a westerly direction; and this current delays the warming of the water by the atmosphere, and even tends to make the atmosphere cool (the cold days of May!). The more or less powerful undercurrent from the North Sea will communicate to the deep water in the Western Baltic the warmth of the North Sea water. As these undercurrents are strongest in autumn and winter, and as the North Sea water is warmer during those seasons than the water of the Baltic, the temperature of the deep water is raised as far as the influence of these currents extends.

The observations relative to this question made at the different stations show the following result:

Warmth of the surface water (t) and the bottom water (T) in degrees C.

Stations and depth in meters.	January.		February.		March.		April.		May.		June.		July.	
	t.	T.	*t.*	T.	*t.*	T.	*t.*	T.	*t.*	T.	*t.*	T.	*t.*	T
Sonderburg, depth 36 meters	1.9	2.2	1.0	1.4	1.5	1.6	4.8	4.3	8.8	7.5	13.9	10.3	15.8	13.0
Kiel, depth 58 meters	2.3	3.9	1.7	3.7	2.4	3.2	6.5	3.8	10.5	5.0	15.7	5.4	18.7	6.5
Warnemünde, depth 18 meters	1.9	2.1	1.1	1.2	2.0	2.0	5.2	4.7	9.3	8.4	14.9	14.2	17.7	17.1
Lohme, depth 36 meters	1.6	2.1	1.4	1.8	2.8	3.0	6.0	5.1	9.1	7.3	14.6	11.9	16.8	15.6
Hela, depth 42 meters	1.9	3.9	1.0	1.7	2.4	2.2	5.6	5.3	9.6	9.1	15.0	12.6	18.3	16.4

Stations and depth in meters.	August.		September.		October.		November.		December.		Year.	
	t.	T.	*t.*	T.	*t.*	T.	*t.*	T.	*t.*	T.	*t.*	T.
Sonderburg, depth 36 meters	17.0	15.1	14.7	14.4	11.1	11.6	6.7	7.2	3.0	3.3	8.4	7.7
Kiel, depth 58 meters	18.6	9.1	16.2	12.1	12.1	12.5	7.3	9.8	2.8	6.0	9.6	6.8
Warnemünde, depth 18 meters	18.6	17.9	15.7	15.7	12.3	12.6	6.9	7.6	3.3	3.8	9.1	9.0
Lohme, depth 36 meters	16.7	16.0	14.5	14.0	10.4	10.4	5.6	6.8	2.5	3.0	8.5	8.1
Hela, depth 42 meters	18.3	16.7	15.6	15.9	11.4	11.8	5.8	5.7	2.5	3.8	9.0	8.8

From an analysis of this table it appears: 1. The warmth of the atmosphere is followed by the warmth of the surface water with some slight delay, so that in the water, February is the coldest month, and not January, as in the atmosphere. 2. In the deep water the influence of the atmospheric warmth is delayed, and this is most noticeable in deep water where there are no strong currents, for example, in the deep water near Kiel, October is the warmest and March the coldest month.

The spawn which, during the first months of the year, is by the fish ejected in shallow water would therefore first be in cold water, but would soon find the temperature rising, whilst the spawn ejected in autumn in deep water would find a high temperature which would favor a rapid development.

In the surface water, which in winter may reach as low a temperature as zero, and even lower, the fish could not live, whilst in deep water they find warm places of retreat during winter.

We must mention another important circumstance which is caused by a remarkable quality of the water.

Like all other bodies, water becomes specifically heavier the colder it gets; but in water there is a limit to this. When fresh water has cooled down to a temperature of 4° it grows continually lighter until it freezes. The water having a temperature lower than 4°, therefore, continues to float above the heavy water of 4°, and the deep water of deep fresh-water lakes, consquently, never reaches a temperature lower than 4°.

This quality of fresh water is somewhat changed by the salt contained in the sea water, and the extreme limit of density is found in water having a low temperature. Thus, water containing $\frac{3}{4}$ per cent. salt, such as is found in the eastern portion of the Baltic, reaches its greatest density at a temperature of $+2°$, whilst water containing $1\frac{1}{2}$ per cent. salt would reach its greatest density at a temperature of about zero. Water containing 2 per cent. salt would be heaviest at a temperature of $-1°.1$; water containing $\frac{3}{4}$ per cent. salt freezes at a temperature of about $-0°.6$, and $1\frac{1}{2}$ per cent. at $-1°$, and 2 per cent. at $-1°.2$.

From these figures the following rules may be deduced as regards the water of the Baltic: In the eastern part, where the saltness of the deep water is not very considerable, the temperature will always be above zero, whilst in the western part it may happen that the water with a high degree of saltness and a low temperature of the atmosphere shows a temperature considerably below zero.

From this quality of the water many phenomena may be explained. If, for instance, the western part of the Baltic in some year, through the influx of a considerable quantity of North Sea water, receives a large number of animal germs from the North Sea, these may develop and flourish for a time, until the unfavorable temperature of a single winter destroys them; so that such animals cannot be permanently acclimatized in the Baltic. On the other hand, the above-mentioned quality of the water will explain the circumstance that in the northern and eastern parts of the Baltic, on account of the more favorable temperature of the deep water containing but little salt, the spring spawning season, and the migration of the fish connected with it, begin much earlier than in the western and southern parts.

B. The North Sea.—The conditions of saltness, temperature, and currents are entirely different from those of the Baltic. In the North Sea three parts may be distinguished by their different depth: *First*, the southern and shallowest part, with a depth of about 35 meters, connected with the ocean by the narrow British Channel. To this part belong the Doggerbank and the coast waters of the Schleswig-Holstein and Jutland coasts. *Second*, the central part, extending northward as far as a line drawn from Peterhead, in Scotland, to Cape Skagen (Jutland), with a depth of about 100 meters. *Third*, the northern part, with much greater depths. This last-mentioned part has free communication with the Northern Atlantic. All three parts meet in the Skagerack, and through its waters are connected with the Baltic.

The North Sea, therefore, freely mingles its waters with those of the Atlantic, but the manner in which this is done differs in its different parts. The mingling of the waters takes place most freely in the northern part, but on account of its connection with the Baltic, the North Sea receives from the former some of its water containing less salt. Several large rivers also tend to decrease its saltness, which is therefore less than that of the Atlantic.

As regards the saltness of the North Sea, we therefore arrive at the following result: that it is less near the German and Danish coasts where the influence of the Baltic and the rivers is strongest, than in the central and northern parts, although the strong tide of the North

Sea tends to mix the waters. The following figures are the result of actual observations:

List.	Year.	Spring.	Summer.	Autumn.	Winter.	Maximum.	Minimum.
ISLAND OF SYLT.							
Surface water:							
Specific weight	1.0235	1.0231	1.0247	1.0235	1.0227	1.0263	1.0208
Per cent. salt	3.08	3.03	3.24	3.08	2.97	3.45	2.72
Bottom water:							
Specific weight	1.0238	1.0234	1.0249	1.0237	1.0230	1.0266	1.0215
Per cent. salt	3.12	3.07	3.26	3.13	3.01	3.48	2.82
WILHELMSHAFEN.							
Surface water:							
Specific weight	1.0249	1.0247	1.0251	1.0249	1.0247	1.0271	1.0203
Per cent. salt	3.26	3.24	3.29	3.26	3.24	3.55	2.66
Bottom water:							
Specific weight	1.0250	1.0247	1.0252	1.0251	1.0249	1.0272	1.0205
Per cent. salt	3.28	3.24	3.30	3.29	3.26	3.55	2.69
HELIGOLAND.							
Surface water:							
Specific weight	1.0255	1.0251	1.0249	1.0260	1.0261	1.0279	1.0188
Per cent. salt	3.34	3.29	3.26	3.41	3.42	3.65	2.46
Bottom water:							
Specific weight	1.0256	1.0254	1.0249	1.0261	1.0261	1.0280	1.0215
Per cent. salt	3.35	3.33	3.26	3.42	3.42	3.67	2.82
OUTER LIGHTSHIP, RIVER WESER.							
Surface water:							
Specific weight	1.0256	1.0253	1.0250	1.0256	1.0264	1.0271	1.0203
Per cent. salt	3.35	3.31	3.28	3.35	3.46	3.55	2.66
Bottom water:							
Specific weight	1.0256	1.0253	1.0250	1.0256	1.0264	1.0272	1.0205
Per cent. salt	3.35	3.31	3.23	3.35	3.46	3.56	2.69

The annual average saltness is therefore much more uniform at every place above mentioned than in the Baltic. The occasional fluctuations, especially the lower figures, are caused by a large influx of fresh water, and they consequently occur more frequently in surface than in deep water. If the water at times is heavy, this is a sign that water from the ocean has entered the North Sea, whilst if it is light, it shows a considerable influx of river or Baltic water. The same influences are at work as regards the remarkable temperature of the North Sea.

The southern part of the North Sea resembles the Baltic; it is shallow, and its nearest communication with the ocean is a narrow channel. In this part of the North Sea the temperature of the water, like that of the Baltic, is controlled by the temperature of the air. The only perceptible differences are caused by the influx of warm water from southern latitudes through the channel and by water from the rivers Weser and Elbe, as well as by water from the Baltic, varying in its temperature according to the seasons, entering the North Sea.

The central part receives water from the south and north at a greatly varying temperature during the course of the year. In summer the surface water coming from the south, from rivers and from the Baltic, is warm, whilst the water from the north, passing by and over shallow places, is cold. In winter this condition of things is reversed, as the shallow southern part then grows cold; the same applies to the Baltic and river water, whilst in the north the branch of the Gulf-stream which enters the North Sea is comparatively warm.

The northern part, as far as its temperature is concerned, entirely depends on the currents of the ocean, the above-mentioned branch of the Gulf-stream, and a deep, cold under-current coming from the north. Thus the distribution of warmth is constantly changing throughout the year; as far as the surface water is concerned, an attempt has been made to represent these changes graphically in the small maps found at the end of this pamphlet. These maps have been prepared in the following manner: A large number of observations made at coast stations or on board ships were collected from different parts of the North Sea, and from these figures the average temperature has been calculated. All points having an equal average monthly temperature are connected by a line. Blue indicates the lowest and scarlet the highest temperature, and the transitions from blue to scarlet are indicated by green, yellow, and orange lines. In examining these maps the above statements will be found correct. In January the water is warm in the north and in the extreme south, in the former region on account of the Gulf-stream, and in the latter on account of the warm water from southern latitudes. Along the German coast the water is cold on account of the Elbe and Baltic water. February closely resembles January; and even in March the water on our coast is cold. In April this condition begins to be reversed, and the water on our coast grows warmer; in May and June the temperature of the water is low as far as the Doggerbank, whilst during these months the shallow southern part and the coast waters, which receive much Baltic and Elbe water, are much warmer.

From July to September the water keeps warm in the southern and southwestern parts of the North Sea, a circumstance well known in our North Sea watering places, which are frequented till far into September. In October the water begins to cool off, beginning at the Baltic, and continues to grow cooler during November and December.

These graphic representations are, of course, only in the nature of a first attempt, which will have to be improved and supplemented by future observations, especially in deep water; but even the little we know regarding these changes in the temperature of the water is sufficient to show that they must exercise a decided influence on the migration and life of the fish. The appearance of the herring first in the north, then gradually farther south, the wealth of fish near the Doggerbank, which is washed by cold water during the months of April, May, and June, are hints pointing to the intimate connection existing between the temperature of the sea and its animal life.

To further investigate this connection should be the first object of scientists during the next few years; and practical fishermen can greatly aid in solving the problem, if they will watch those natural conditions which either rewarded their toil by rich hauls of fish, or which failed to crown their most earnest endeavors with success.

G. KARSTEN.

B.—SCIENTIFIC INVESTIGATIONS UPON THE FISHES PROFITABLE TO THE FISHERIES.

How can we explain the circumstance that our knowledge of the many salt-water fishes which form the chief support of our fishermen on the coasts of the Baltic and the North Sea is exceedingly limited, in spite of the fact that for several centuries millions of these fish have been caught by experienced fishermen, and that one generation of fishermen has transmitted to the other all they had either heard concerning these fish or had themselves observed?

We believe that our fishermen are acquainted with the nature and life of their fish as far as their eyes and instruments, as well as their education and the age in which they live, will permit.

If we wish to go beyond the very considerable and important knowledge of the fishermen, as regards the nature and conditions of life of food-fish, we must use other means. We must investigate fish with all the means which science places at our command. We must not be satisfied with observing fish at those seasons when fishermen are catching them for the market, but we should follow them at all seasons, and carefully examine them at all stages of their life. When the fish no longer congregate for the purpose of spawning, we must, with suitable instruments, hunt them up in their retreats. We must find out their spawning places and endeavor to ascertain what peculiarities attract the fish to these places during the spawning season. We must not rest satisfied with knowing various outward characteristics, but we must study the internal structure of every species of fish; we must dissect their stomachs and entrails to see what kind of food they use.

In order to learn the internal structure of fish it is not sufficient to dissect them with knife and scissors, but every portion of their organism, even their eggs during the time that the young fish develop in them, should be examined under powerful microscopes.

The use of all these means for entering the mysterious life of fish has to be learned just as much as fishing. Practical fishing and the scientific investigation of fish have their own peculiar difficulties, and a special talent is required for each.

The highest aim of the trained ichthyologist is to learn to know as thoroughly as possible the nature and mode of life of fish. He rejoices whenever his labor is rewarded by an increase of knowledge, and he values these achievements higher than any other result of his observations. By making his observations known to others he gladly increases the pleasure and profits of his fellow-beings.

The more thorough the knowledge of the ichthyologist, and the farther he advances in it, the greater will be the profit which the practical fisherman will derive from his teachings. No intelligent fisherman of our day would therefore do without the scientific ichthyologist.

Experienced fishermen who have recognized the value of scientific investigations for their trade, who appreciate such investigations, and who have a keen eye for the life of fish, are the best aids to the scientific investigator.

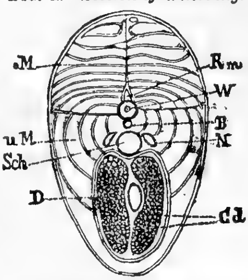
People who wish to communicate to each other details of one and the same subject must converse in a language which both of them understand.

The ichthyologist will quicker learn the language of the fisherman than the fisherman the language of the ichthyologist, for the latter will speak of matters connected with the life of fish which the fisherman either does not know at all, or very imperfectly, because he knows the fish only by the various characteristics exhibited by them during the fishing season, and by their flavor and market price. The fisherman, however, can easily understand everything in the language of the ichthyologist which is necessary for aiding the latter in his endeavors to gain an insight into the life of fish, provided the scientist makes his descriptions of the fish of such a nature that a practical man, without any higher education, can easily understand them. We will make this attempt by giving some information regarding the nature and mode of life of the herring. What we are going to say will not have as its immediate consequence a considerable increase in the number of fish caught by the fishermen or higher market prices; but we are of opinion that every fisherman who is proud of his trade, and who takes pleasure in it, will gladly embrace every opportunity of becoming better acquainted with that class of animals with which he comes in constant contact, and which are the support of himself and his family. By all new information regarding them his attention to their life and its various phenomena becomes sharpened. He learns to observe them from new points of view, of which he had never thought before, and thereby he gains a firmer basis for a better and more profitable way of carrying on his trade.

1.—Observations on the structure of the herring.

The herring is a good swimmer, and, like all fish having a broad back, can move forward very rapidly. This broad back is produced by the thick masses of flesh on both sides of the body, which are separated by the backbone and the ribs. In Fig. I these masses of flesh and the large side-muscles are shown cut across. Every side-muscle consists of two portions, an upper one (oM) and a lower one (uM), composed of fine fibers, which can easily be observed in eating a smoked herring. These fibers exercise collectively the strong motive power which the herring exercises when swimming. If the fibers of the left side-muscle are shortened, the back part of the body bends towards the left; whilst if the right side-muscle is shortened, the back part of the body bends towards the right. And if these bending movements

FIG. I.—*Section of a herring.*



B, large artery underneath the backbone; D, intestinal tube; G d, ovaries; o M, upper portion of the large side-muscle; u M, lower portion of the large side-muscle; N, kidneys; Rm, spinal marrow; Sch, swimming bladder.

follow each other in rapid alternation they impel the body forward, just as a boat is propelled by an oar turned right and left at its stern.

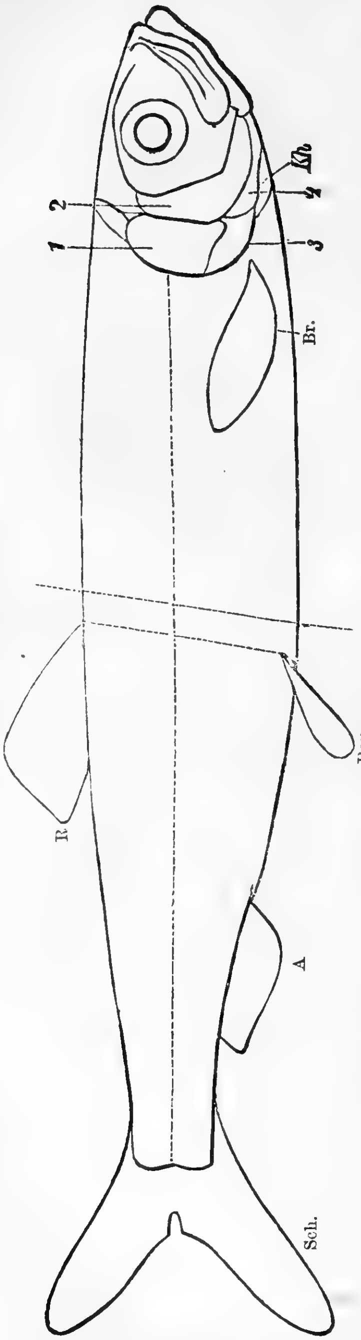


FIG. II.—*Outline of a herring from the North Sea.*

A, anal fin; Bau, ventral fin; Br, pectoral fin; Kh, gill-membrane; R, dorsal fin; Sch, caudal fin; 1, 2, 3, 4, the gill covers or opercles. The dotted lines in front of the dorsal and ventral fins indicate the places where these fins are found in the Baltic herring.

The fins aid but little in propelling the body of the fish. Their chief object is to keep the back upward, and to give to the body the direction which it is to follow. The herring has two pectoral fins (Fig. II, Br), two ventral fins (Bau), one dorsal fin (R), one anal fin (A), and one caudal fin (Sch), whose lower lobe is somewhat longer than the upper one. The skin of the fins is extended between the thin bones, termed the rays of the fins, at whose roots there are small muscles, by means of which the fins can be moved. Every fin has its certain number of rays. The scales of the herring adhere to the skin so loosely that in hauling in the net they come off very easily. The opercles or gill-covers at the sides of the head, back of and below the eyes, are alternately opened and closed by the fish, in order to draw in water for breathing through the mouth over the gills to be discharged through the gill-opening. Each opercle or gill-cover consists of four bony plates. In Fig. II these are marked 1, 2, 3, 4. The folds of the herring differ in shape from those of the sprat (Figs. II and III). Below there is joined to the third and fourth plates a skin or membrane kept extended by means of small bones (the gill or branchiostegal rays, Kh, in Fig. II), which contributes towards making the covering of the gills fit closely. The herring has four pairs of gill-arches (Fig. IV, B.) To these are fastened at the back two rows of gristly gill-leaflets (Fig. IV, B), which are covered with so thin a skin that in the live fish they look dark red from the blood passing through them.

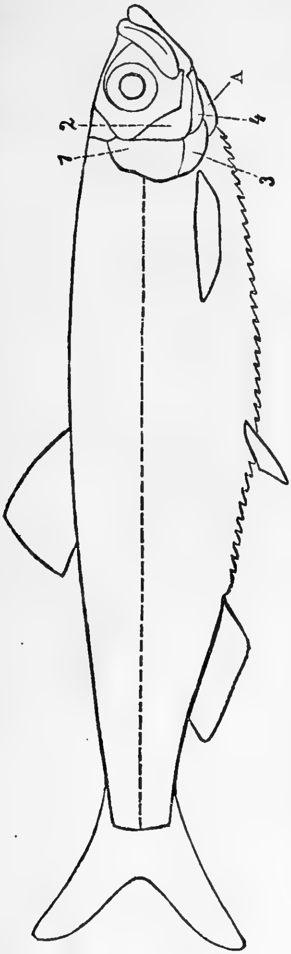
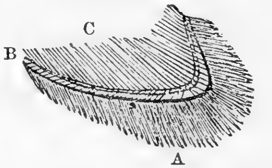


FIG. III.—*Outlines of a sprat from the Baltic.*

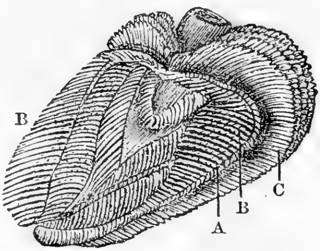
A, gill-membrane; 1, 2, 3, 4, the four plates of the gills or opercles. The points of the scales on the lower side of the fish are drawn somewhat more prominently than they appear in nature.

FIG. IV.—*The arch of a gill of the herring* (*natural size*).



A, leaves of the gills (blood red in live fish); B, arch of the gills; C, gill-rakers or slender appendages on the anterior border of the arch.

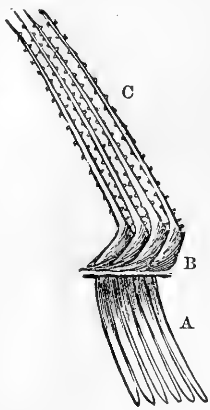
FIG. V.—*The gills of a herring* (*natural size*).



A, arch of the gills; B, the anterior border of the gills, garnished with the rows of gill-rakers; C, leaves of the gills. The tube protruding between the four rows of leaves is the beginning of the œsophagus.

In front the arches of the gills have a dense row of slender appendages, technically called gill-rakers, on each side of them (Fig. IV, C; Fig. V, B, and Fig. VI, C.) All water which the herring takes in its mouth to let it flow out again over the gills in breathing must pass through the fine grating formed by these spinous points. By this process all small animals which, with the water, enter the mouth and gill-cavity are retained in it, and accumulate till they are swallowed. This enables the herring, whenever the water is full of small life, to fill its stomach in a short time with thousands of them. In February, 1872, I found in the stomach of one herring 15,000 small crustaceans, in another 19,000, and in a third one even 60,000. These small crustaceans are only about 1 millimeter long. Fig. VII shows one of these crustaceans mag

FIG. VI.—*Part of the arch of the gill of the herring* (magnified five times).



A, leaves of the gills (blood red in the live fish); B, part of the arch of the gills; C, gill-rakers covered with small spines.

nified 50 times. These crustaceans are the best food for herrings and sprats. By feeding on them they become fatter and get a better flavor than from any other food. Whenever herrings feed on these crustaceans their excrements have a reddish color; when they eat many small worms they are yellowish, and of a dark color when the herrings feed chiefly on floating snails or mussels. In the abdominal cavity of fully grown herrings the sexual organs, the ovaria, and spermaries take up the largest room (Fig. VIII). As soon as the eggs and milt are fully

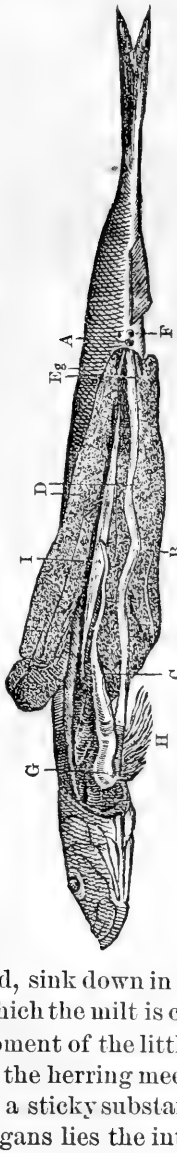


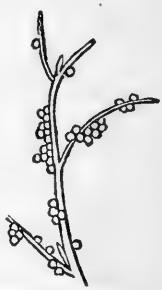
FIG. VIII.—*Opened herring, half its natural size.*

A, anus; B, intestinal canal; C, canal connecting the stomach and swimming-bladder, the pneumatic duct; D, sexual organs; E, emissory canals of the sexual organs, which open at F, opening back of the anus; G, stomach; H, appendages of the stomach; I, swimming-bladder.

FIG. VII.—*A male crustacean* (*Temora longicornis*), from the Bay of Kiel, magnified 50 times. Below it is given in its natural size.

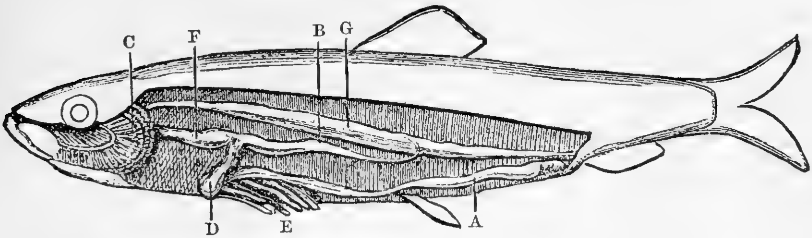
FIG. IX.—*A spermatozoan* (from the milt) *of the herring*, magnified 375 times.

FIG. X.—*Herring eggs, natural size* (from the Schlei), sticking to *Potamogeton pectinatus.*



matured they pass from their envelopes through a narrow tube toward an opening which is immediately back of the anus (Fig. VIII, F). In spawning the milters swim by the side of the spawners and emit their milt. Whilst the eggs, after having been emitted, sink down in the water, the fine thread-like particles, spermatozoa, of which the milt is composed (Fig. IX), enter the eggs and cause the development of the little fish from the egg to commence. As soon as the eggs of the herring meet with plants or touch the bottom they adhere by means of a sticky substance which covers them (Fig. X). Between the two sexual organs lies the intestinal canal (Fig. VIII and Fig. XI, A). It starts from the stomach (Fig. XI, D), at whose back there are hollow tubes (Fig. VIII and Fig. XI, E) which, when food is plentiful, are filled with a fatty juice. In front of the stomach there is a short and wide cavity (Fig. XI, F).

FIG. XI.—*Entrails of the herring.*



A, intestinal canal; B, air-passage between stomach and swimming-bladder; C, gills; D, stomach; E, appendages of the stomach; F, œsophagus; G, swimming-bladder.

From the stomach a tube, the pneumatic duct (Fig. XI, B), passes to the swimming-bladder (Fig. VIII and Fig. XI, G), which shines like silver, and has the shape of a spindle. On either side of the swimming-bladder are the kidneys (Fig. I, N), and between these and close below the spine there is a large blood-vessel (Fig. I, B) in which a large portion of the blood which has passed through the gills is conveyed to the lower part of the body.

2.—On the differences between the sea-herring and the coast-herring.

The opinion that the herrings come to our shores from the northern seas, and that all which are not either devoured by other fish or are caught by fishermen return to those seas after the spawning season is over, cannot be correct, because the different parts of the ocean are inhabited by herrings differing in shape and size.

The herrings which are caught in the North Sea and in the Baltic have grown up in those seas. They may be divided into two varieties, the coast-herring and the sea-herring. The coast-herring of the Baltic spawns in spring in the shallow coast waters, where the bottom is covered with a rich vegetation. The sea-herring spawns in deep water, and its principal habitation is the North Sea. The sea-herring of the Baltic spawns at a depth of 4 to 5 meters.

Sea-herrings only make their appearance a short time before the spawning season, as migratory fish, coming in dense schools, and soon afterwards disappear again.

Coast-herrings, on the other hand, stay near the coast all the year round, in greater or smaller numbers. In placing a coast-herring by the side of a sea-herring (both being of the same length), the fore part of the body of the sea-herring appears longer and more slender (Fig. XII) than the fore part of the body of the coast-herring (Fig. XIII), because in the latter the dorsal fin (D) extends a little farther forward than in the sea-herring.

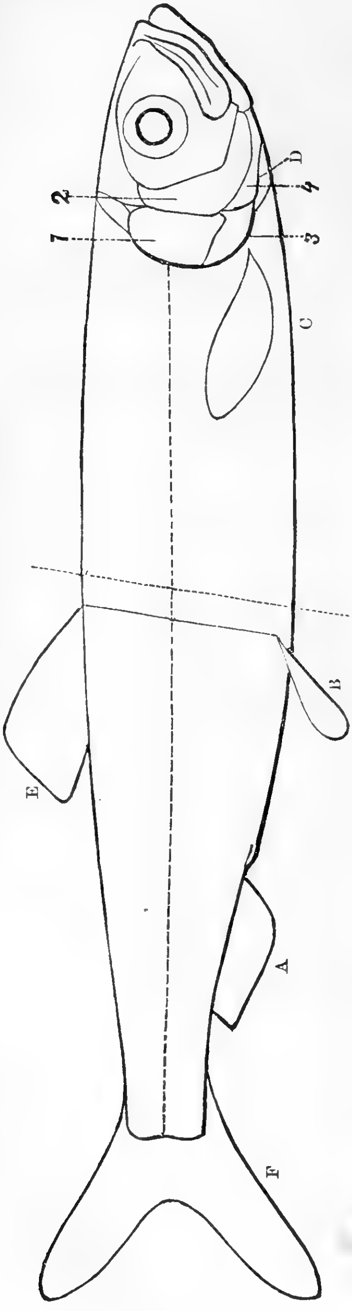


FIG. XII.—*Outline of a sea-herring from the North Sea.*

A, anal fin; B, ventral fin, C, pectoral fin; D, gill membrane; E, dorsal fin; F, caudal fin; 1, 2, 3, 4, the four plates of the gill-coverings, or opercles. The dotted line to the right of the dorsal and ventral fin shows the places where the roots of these fins are in the Baltic herring.

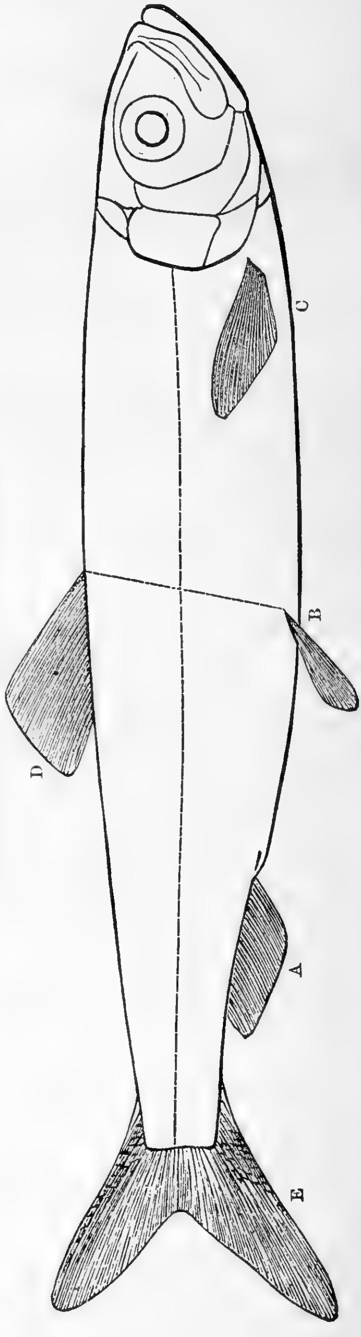


FIG. XIII.—*Outline of a coast-herring from the Baltic.*

A, anal fin; B, ventral fin; C, pectoral fin; D, dorsal fin; E, caudal fin.

3.—The different ages of the herring.

When the young herring leaves the egg it does not have the shape of an old herring; it is much more slender than the old herring (Fig. XIV) and almost as thin as a ribbon. Its dorsal fin is proportionately long, and is placed far back. At this stage of its life the herring may be said to be a larva. The fish retains this shape until its length exceeds 30 to 40 millimeters. As soon as the sexual organs begin to grow rapidly, indicating the approach of the spawning season, other changes in the shape of the body can be noticed.

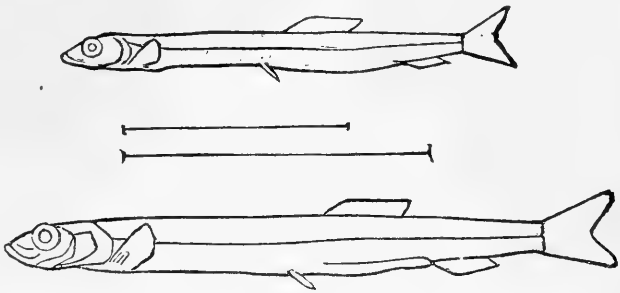


Fig. XIV.

The upper figure shows the outline of a spring-herring larva from the *Schlei*, magnified twice. The lower figure shows the outline of an autumn-herring larva from the Bay of Eckernförde, magnified twice. The lines between the two figures show the natural size.

The sexual organs of small herring, measuring less than 210 millimeters in the Bay of Kiel, are but little developed. In herrings measuring 210 to 290 millimeters in length, the sexual organs grow from October till the spawning season in spring.

As the spermaries grow faster from October to December than the ovaries, the male herrings are during these months thicker than the female ones, whilst from January to April the female herrings look thicker, because during that period their ovaries increase more rapidly than the spermaries of the male fish.

When the spawn and the spermatozoa approach maturity, the herrings decrease in size as their quantity of fat diminishes, although even then we occasionally find herrings which in spite of the strong development contain a large quantity of fat.

In April the larger herrings whose spawn and milt have been fully matured generally leave the Bay of Kiel and go into the shallow brackish waters of the Schlei, and their places in the Bay of Kiel are occupied by smaller herrings, measuring less than 200 millimeters in length.

The Schlei herring which is caught in spring is therefore not a different race from the Kiel herring, but simply a fully-matured herring of the kind found along the whole eastern coast of Schleswig-Holstein. In this Schleswig-Holstein race of coast herring the following stages of age and size may be distinguished:

1. The larval form, measuring at most 40 millimeters in length (Fig. XIV). It is much more slender than the juvenile form of the herring. A larva measuring 33 millimeters in length is only 2 millimeters high, whilst the height of a herring which has already assumed its juvenile

form when measuring 40 millimeters, is 6 to 7 millimeters. The larvæ are transparent. The juvenile form has transparent scales glittering like silver.

2. The young form, measuring 40 to 120 millimeters in length. It appears in the Bay of Kiel in autumn and winter, whilst in the Schlei it is found all the year round, but principally from July to January.

3. The middle form, measuring 120 to 140 millimeters in length. At this age the herrings are generally very fat. The sexual organs are as yet undeveloped. Herrings of this shape and size are frequently caught in the bays of Kiel and Eckernförde in March and April, and often in February. They compose more than half the number of all the herrings caught in these bays.

4. The sexually mature form, measuring 210 to 290 millimeters in length. Herrings of this shape and size are found all through the winter in the bays of Kiel and Eckernförde. Towards the end of March they disappear and go to the Schlei.

In the Kattegat along the Swedish coast the smallest fully-matured herring measure 200 to 210 millimeters in length. In the North Sea on the coast of Scotland they measure 215, and on the west coast of Norway 225 millimeters.

It is probable that the herring does not reach its full size till its fourth year, but the observations made hitherto have not yet led to any absolutely certain result.

As soon as the herring has entered its juvenile age, the number of rays in all its fins (excepting the anal fin) does not change any more. At that period the pectoral fin has 17 rays, the ventral fin 9, and the dorsal fin 19. After the juvenile age has been reached the positions of the dorsal and anal fins and of the anus do not change any more, but remain henceforth at a comparatively uniform distance from the point of the lower jaw.

The length of the head, however, and the height and breadth of the body do not hold a fixed relation to the length of the whole body, but change with its size. Thus the length of the head increases with comparative suddenness, when the herring leaving its larva period enters the juvenile period. But the growth of the head in length remains behind the growth of the body, after the body of the young herring has exceeded a length of 70 millimeters.

The large and fat yellowish herring, measuring 210 to 290 millimeters, which in autumn are caught in drag-nets near Korsör (Denmark), belong to the variety of sea-herrings. They spawn in autumn probably near the coast of Langeland.

The so-called "Bund-garn" or "Reusen" herring of Korsör, which measure 150 to 200 millimeters, have in autumn but little developed sexual organs and a blue color, and are more slender and thinner, and do not possess the delicate flavor of the fat herrings caught in the same waters. They belong to the coast herrings.

4. What causes the herrings to migrate and to gather in schools?

Profitable herring fisheries can only be carried on in places where the herrings gather in schools.

In February, 1872, 240,000 herrings were caught every day in seines in the inner Bay of Kiel. To take so many fish out of the water in one day would have been an impossibility if they had been scattered over the whole bay; for even the largest seine is small compared with the area of the Bay of Kiel.

The principal causes why the scattered herrings gather in schools and migrate to certain parts are the desire for food and the desire to propagate the species.

The herrings which live outside the bays of Kiel and Eckernförde and the Schlei cannot know whether they will find sufficient food in these bays, not even when they have been there during their early youth; but they enter these bays, gradually proceeding towards the inner parts, because there they find more food than outside. Whenever these bays contain a great quantity of good food as, for example, in February and March, 1872, when the waters of the Bay of Kiel were literally swarming with small crustaceans (Fig. VII), an unusually large number of herrings will enter the bay. So many herrings had not been caught before in the Bay of Kiel within the memory of the oldest inhabitant as were taken during the winter of 1871–'72. During the same period an extraordinarily large number of large codfish were also caught. The codfish followed the schools of herrings, and feeding on them soon grew large and fat.

The second cause why the herrings gather in schools is the desire to propagate the species. The rapid growth of the sexual organs must necessarily awaken hitherto unknown desires which mutually draw the milters and spawners together, and keep them near each other even after the desire for food no longer unites them.

In the Western Baltic the mature herrings gather in spring, especially in shallow places where the bottom is covered with sea-weeds and other plants, and where the water contains but little salt and is easily warmed by the rays of the sun.

It would be a mistake to suppose that the herrings go into these waters because they have some knowledge of their condition, and because they think that they are best suited for receiving and developing the spawn. Without having the slighest knowledge of the purpose of their gathering, they nevertheless gather in schools, because they are all animated by the same desires and instincts.

It is probable that at the time when the sexual organs approach maturity, the less degree of saltness and the greater warmth of the shallow coast waters is pleasanter for them than the cold and strong saltness of the deep waters; and they consequently swim in the direction in which the saltness decreases and the warmth increases, and pursue their course until they finally meet at the time when the spawn and milt are fully matured, in places which resemble their own birth-places.

As soon as the sexual organs have been emptied, the desire which led the herrings of both sexes to the spawning-places dies out. The large schools do not permanently find sufficient food in these confined waters. The desire for food therefore compels them to scatter again. Swimming hither and thither in search of food, they find more towards the open sea than in the direction of the coast, because most of the small marine animals (crustaceans, &c.) on which the herrings feed could increase and develop more undisturbedly in the open sea, as long as the whole host of their inveterate enemies (the herrings) staid in the bays.

Not only old, fully-grown herrings, but also the young ones migrate. From the Schlei many young herrings, measuring only 60 to 70 millimeters, go to the Baltic in August.

The migration of the herrings from the open sea into the bays and back again to the open sea is a means employed by nature in order to raise large numbers of fish; for because the herrings wander, they always have plenty of food; and their migrations are generally brought about by the fact that they continue to swim in that direction where they find the most food.

When the herrings come from the open sea into our bays, and are caught, they furnish us with healthy food which has been formed by small marine animals, which, without the herrings, would be of no use whatever to us.

In the Western Baltic there are two seasons of the year when herrings spawn, namely, spring and autumn.

In the Schlei most herrings spawn in April and May, and but few of them in March and June.

In the Kattegat the herrings likewise spawn in March, April, and May, whilst on the west coast of Norway they spawn as early as February and March.

The herrings which spawn in autumn are not the same which have spawned in spring.

Autumn spawn is ejected by the herrings in the western and eastern parts of the Baltic from September to November.

The herrings which reach their maturity in autumn spawn in deeper waters than those which spawn in spring. As in autumn the water is warmer in the deep places than near the surface, it is probable that the fully matured herrings which spawn in autumn are, just like those which spawn in spring, compelled to congregate in deeper waters by the difference of temperature in the different depths of water.

In the western part of the Baltic the saltness of the water increases the deeper we go. The autumn spawn, therefore, is developed in much salter water than the spring spawn which has been deposited in shallow brackish bays. The eggs of the herring can stand a great difference of degree of saltness.

In the North Sea they develop in water whose percentage of saltness is 3.5, on the eastern coast of Rügen in water containing 0.8 per cent. of salt, and on the coasts of Prussia and Scotland in water having an even smaller percentage of saltness.

In the northern part of the North Sea the herrings which spawn in autumn reach maturity much sooner than in the southern part. On the east coast of Scotland they spawn as early as July and August, on the east coast of England in September and October, and in the neighborhood of the Channel even late in autumn.

The autumn eggs are generally deposited in warmer water than the spring eggs; but whilst the young spring herrings grow up with increasing warmth of the water, the autumn herrings develop in water whose warmth is decreasing.

The herring eggs can stand a great difference of temperature. Their development is not interrupted when they are cooled off by a temperature approaching zero, nor by a temperature rising as high as 15° C. In cold water their development is slower than in warm water. With a temperature of 3°.5 the young Baltic herring leaves the egg after forty days, at 7° to 8° in fifteen days, 10° to 11° in eleven days, and with a still higher temperature in six to eight days.

The development of eggs which have been laid in November or December, therefore, generally takes somewhat longer than the development of eggs laid in spring. This explains the circumstance why the larvæ which have come from November or December eggs do not have the same length in April as the larvæ which have come from the October spawn.

Autumn larvæ from the Bay of Eckernförde (Fig. XIV, lower figure) differ from spring larvæ from the Schlei (Fig. XIV, upper figure) in the following particulars: In the autumn larvæ the ventral fins do not begin to appear until they have reached a length of 33 to 34 millimeters, whilst in spring larvæ they appear when the little fish are only 25 to 26 millimeters long.

The autumn larvæ have comparatively smaller heads than the spring larvæ; they do not leave the larva stage until they have reached a length of at least 44 millimeters, and even when they measure 60 millimeters they are frequently not yet fully covered with scales.

5.—Comparison of the herring and the sprat.

The sprat resembles a herring of the same length to such a degree that a person who is not thoroughly acquainted with the differences between the two kinds of fish cannot easily distinguish the one from the other.

In carefully comparing the two we shall find the following differences (Fig. III and Fig. XIII):

The shape of the body of the herring is more slender, whilst the sprat is thickset. Corresponding with this the height of body is, in proportion to the length, greater in the sprat than in the herring. And this height is greater in the sprat from the point of the head to the root of the caudal fin.

The side-length of the head is about the same in both, and is one-fifth of the length of the body. The length of the top of the head from the point of the lower jaw to the point where the scales commence is the same in both. The lower length of the head, from the point of the lower jaw to the hindermost point of the gill-membrane (Fig. II, Kh, and Fig. III, A), is greater in the sprat than in the herring. The height of the head is a little greater in the sprat at the end of the upper length of the head, but a little smaller at the joint of the lower jaw.

The lower jaw of the sprat is shorter than that of the herring. This, and the difference in the height of the head, make the head of the sprat appear more thickset, and the snout more pointed, than that of the herring. When the mouth is closed the point of the lower jaw of the sprat is about as high as the center of the eye, whilst that of the herring is higher.

At the top of the head, between the eyes, the sprat is broader than the herring.

The bony plates of the gill-coverings or opercles are differently shaped in the two kinds of fish.

The principal plate (Fig. III, 1) of the sprat is broader than that of the herring, and its lower front corner extends lower than in the herring.

A straight line drawn from the upper root of the pectoral fin towards the lower front corner of the principal plate (1) of the gill-covering, if extended would, in the herring, go through the eye, and in the sprat, below the eye, towards the point of the upper jaw.

The upper portion of the gill-membrane (Figs. II and III) below the middle plate (4) of the gill-covering is longer in the sprat than in the herring. In the herring the hinder edge of the gill-membrane and the lower edge of the gill-covering (3) form a distinct angle, whilst in the sprat they almost run in the same direction.

The ventral fins of the herring are longer and broader than those of the sprat, and have generally 9 rays, whilst those of the sprat have only 7.

The dorsal fin of the sprat has 17 rays, and is placed farther back than that of the herring, which has 19 rays. In the herring it is placed in front of the center of the whole length of the body, whilst in the sprat it is set back of this point.

The ventral fins of the herring are found at a considerable distance behind the origin of the dorsal fin, whilst those of the sprat are in front of it.

The anal fin of the sprat has 19 rays, and has a much longer line of origin than the anal fin of the herring, which has only 17 rays.

The pectoral fin of the herring has 17, and that of the sprat only 16 rays.

The lower edge of the body of the sprat, in the direction from head to tail, is much sharper to the touch than that of the herring, because the ventral carinated scales of the sprat are much larger, and have more projecting points than those of the herring (Fig. III). From the head to the ventral fins the herring has 31 ventral scales, and the sprat only 22.

6.—The larval form of the flat-fish.

As very young flat-fish are comparatively little known, we give a picture of one caught in the Bay of Kiel. Like other fish it has one eye on the right side and the other on the left (Fig. XV); has the same color on both sides, and possesses a small swimming-bladder, which is wanting in fully-grown flat-fish. These small flat-fish are found swimming in a perpendicular position near the surface of the water, where they can easily be caught with fine nets.

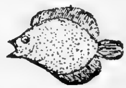


Fig. XV.

A *young flat-fish*, natural size, caught in the Bay of Kiel. One eye lies on the right and the other on the left side of the head.

7.—Something concerning the food of fish.

The North Sea and Baltic can furnish large numbers of food-fish, because they are inhabited by enormous numbers of other marine animals. The following kinds of marine animals compose the greater portion of the food of fish: crustaceans, worms, snails, mussels, and echinoderms. As most of these animals live at the bottom of the sea, the fish will generally seek their food there.

Herrings, sprats, and mackerel often find large quantities of small crustaceans near the surface of the water. For the young fish which have just left their eggs small microscopic animals, which can scarcely be seen with the naked eye, are of the highest importance. At the very time when the fish leave their eggs, the sea is full of larvæ of crustaceans, worms, snails, mussels, echinoderms, &c., so that the fish receive a number of small animals with the water which at every breath they inhale through their gills. Young fish when kept in aquaria generally die very soon, because they do not get the food which they need, namely, the larvæ of the above-mentioned small marine animals. These animals on which the fish feed live partly on other living or dead animals. The last sources of their food, however, are aquatic plants and those particles of organic matter which the rivers carry into the sea.

During the autumn and winter months large masses of sea-weeds and algæ are torn out by the waves, lose the air which during life had kept them floating, and sink to the bottom. Here they gradually decompose, and finally form the principal component part of the dark mud from which innumerable mussels and worms derive their food.

8.—SOMETHING CONCERNING THE CULTIVATION OF THE MUSSEL (MYTILUS EDULIS).

The cultivation of the mussel can be profitably carried on in all the sheltered bays of the western part of the Baltic. The best method is to use trees with all their branches, about 6 meters high. The lower end of the trunk is pointed and rammed deep into the bottom of the sea, so that the waves cannot uproot it. The tops of the trees must not protrude above the surface, even at low water. The latest time to set them is the middle of June, as during the second half of this month the young mussels leave their eggs, swim about in the water, and soon stick to any hard object they find. After three to five years the mussels are large enough for the market. During the winter months the mussel-trees are lifted. After the harvest has been gathered in they are set again as long as they last.

K. MÖBIUS.

C.—THE SPAWNING PROCESS OF SALT-WATER FISH, AND ITS IMPORTANCE TO FISHERMEN.

The object of the coast fishermen is of course to catch as many fish as possible, because the amount of their annual income will chiefly depend on this. This object they have in common with the river fishermen, but their method of reaching this object is different, and is not equal to the one employed by the river fishermen.

The river fishermen, like the coast fishermen, endeavor to catch the largest possible number of fish by means of their knowledge of those localities where the fish congregate, and by means of good nets, but they are less dependent on wind and weather than the latter; they can to some degree select the time when they want to have fish for the market, and can therefore obtain higher prices for their fish. The coast fishermen, on the other hand, have the advantage that their fishing area is larger, but not even taking into account the circumstance that the sea does on the whole not contain as many fish as an equal area of coast water, the fishing on the high seas requires a greater outlay of material and strength than the coast fisherman has at his command. The difference is more important as regards the cultivation of fish. This is carried to perfection as far as the carp is concerned, for not only are its eggs hatched artificially, but it is nursed and tended like a domestic animal. Even on fish living in a state of liberty a certain amount of care can be bestowed by protecting the fish during the spawning season, either by voluntary regulations made by the owners of the respective waters or by legislative measures. Every fisherman knows that a twofold harm is done by catching fish during the spawning season by destroying an enormous number of eggs about to be laid, and by catching too large a number, comparatively speaking, of fish, because at no time is it easier to catch fish than whilst they are spawning. To this must be added the injury done by destroying eggs which have been laid and young fry. No intelligent fisherman would therefore violate the rule of protecting the fish during the spawning season, if necessity did not compel him, or if the alternative were not placed before him either to catch the fish himself or to let others catch them, and thus deprive him of a benefit which he might have enjoyed. In such cases the excuse is made that the fecundity of fish is large enough to neutralize all losses by the eggs of the remaining fish.

These are all well-known facts, which have only been mentioned here with a view of urging a consideration of the question whether more could not be done than is done at present to further and protect the propagating process and to shelter the young fry. In considering this question it should be distinctly understood that there can be no limitation of fishing, for the fishermen are, as a general rule, by no means in a position to submit to such limitations.

The consideration of this question should be of special importance to the coast fishermen, for quite a number of fish are only caught in large numbers because they approach the coast for the purpose of spawning. But with regard to these matters most fishermen are grossly ignorant, as they know neither the spawning places nor the places where the young fry stay. This ignorance is so great that it is absolutely necessary to spread a better knowledge.

An example may serve to illustrate this. In answer to many requests to establish a season of protection for plaice and flounders, the provincial government of Schleswig some time ago determined to obtain certain information on the subject, and sent extensive question-sheets to many fishing associations. Numerous answers were returned, but with the least possible results. Only one small fishing village pretended to know any spawning places, but the places which were mentioned were many miles distant and located near much larger and more important fishing stations, where nothing concerning them was known, and the time of spawning mentioned in the answers was entirely incorrect. No other place, not even Eckernförde, where most of the extensive flounder fisheries on the whole Prussian coast are carried on, knew of those spawning places. There was the greatest difference in determining the time of spawning, which is easily ascertained, because at the beginning of the spawning season the spawn may be seen to flow from the fish which have been caught, whilst at the end of this season the fish are quite empty. According to the data obtained by the above-mentioned question-sheets the spawning season would be either in December and January, or in March and April. The fact of the matter is that this year the spawning season of the flounders in the Western Baltic commenced about the end of February, and had almost finished in the beginning of April. If fishermen make such erroneous statements, no other cause can be assigned for it than their utter indifference to this important question. The young fry has been observed by nearly all fishermen, but although there were great complaints that the number of flounders was decreasing, no one had thought to observe whether the young fry was more numerous in one year than in another, and still the fisheries of the coming years depend entirely on the young fry.

What can the authorities do in view of such a condition of affairs? As nothing is known with absolute certainty, no sure steps can be taken, and nothing remains but to let things go on until the complaining fishermen show that they are well enough acquainted with the matters about which they complain to prove the correctness of their assertions.

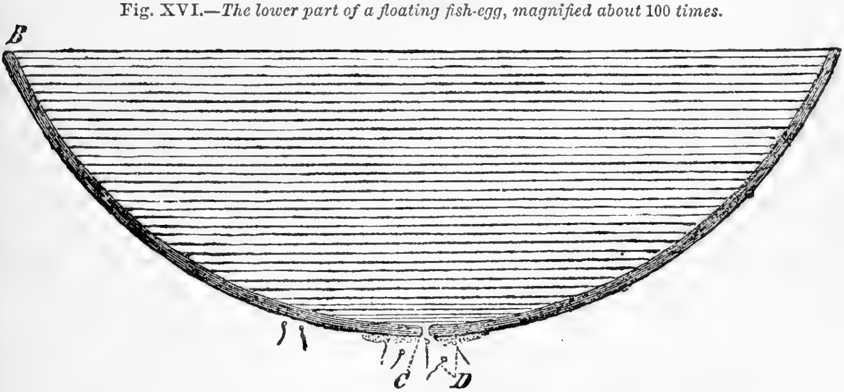
From this example from recent times it will be seen that a knowledge of how to take care of the fish during the spawning season is important to the fishermen in more than one respect. It may be said that there will scarcely be a single case where fishermen have raised complaints in which a knowledge of the spawning places and of the young fry would not be of vast importance. Even if in an exceptional case the knowledge of the spawning of fish were of no importance, the statements of those fishermen would deserve and receive the greatest attention who could give reliable information regarding the spawning places within their fishing area and regarding the life and habits of the young fry.

The following pages are intended to aid the fishermen in gaining the necessary knowledge. Scientific investigation has so far only extended to the history of the development of a few species of fish, but it may be said that as to general principles all fish will more or less resemble each other in this respect, whilst, of course, they will greatly differ as to the details, which are comparatively little known. We know that in laying their eggs the fish empty their sexual organs so completely that they appear quite small, and that the diminutive eggs of the next spawning period can only be recognized by means of a microscope. These eggs gradually mature till the next spawning period, and the sexual organs finally occupy the largest part of the abdominal cavity. At that time many eggs may be seen in the ovaries which are as large as ripe eggs, but besides these many smaller ones, less transparent, which are still growing. A person not acquainted with these matters would believe that the large eggs are ready for laying, whilst in reality this is not the case. The fishermen know this very well, for only when the eggs are ejected from the sexual opening of the fish at the slightest pressure (compare the preceding treatise by Professor Möbius) are they ready for development, and the fisherman declares that the spawning season has come.

At this period most of the eggs in the sexual organs are large, lie very loosely in the glands, and come out at the least pressure, often by the mere motion of the fish. From the abdominal cavity they pass outside through the ovarian tubes. This complete maturity of the eggs seems to be very sudden. Some fish with almost mature eggs roam about for weeks without any perceptible change in their ovaria, until on their arrival at the spawning places the eggs begin to loosen very rapidly and the ovaries are emptied in a short time. Of many fish, such as the stickleback, the pike, and others, it is known that they lay their eggs very rapidly, because they either, like the first-mentioned fish, deposit them in a sort of nest, which could be observed, or because the spawning season, after it had once fairly commenced, was finished in about two weeks. Other fish probably require a longer time for spawning. The spawning season may be either delayed or accelerated by about a month, according to difference in temperature. After the eggs have been laid they must be immediately impregnated. The semen of the male fish, inclosed in a white sexual organ (the spermary), matures at the same time as the eggs, and when fully matured is ejected by the male fish as a milky-white fluid. With the naked eye no compact particles can be discovered in this fluid, but seen through the microscope, the milky condition of the fluid is proved to be caused exclusively by the so-called semen threads, spermatozoa composing about one-half of it. These particles (see Fig. IX) consist of a head, which is generally round and flat on the top, and a long thread termed the tail; this thread moves vehemently to and fro and propels these particles quite rapidly. As at least one-half of the entire semen of a fish is composed of these small particles, thousands of which do not weigh as much as a single fish-egg, the male fish ejects millions of them. If an egg is to be impregnated, it is necessary that at least one of these particles should enter it. This process has frequently been observed.

When, for example, the codfish lays its eggs, they float on the surface because they are a little lighter than the water. A somewhat marked

Fig. XVI.—*The lower part of a floating fish-egg, magnified about* 100 *times.*



A, the yolk; B, the skin of the egg; C, a small orifice, the micropyle; D, semen threads (spermatozoa), one of which is just entering the micropyle.

portion of the egg is turned downward, because the egg is a little heavier in that place than in others. Such an egg consists of a transparent mass, containing in some fish a few drops of oil and of a skin, the egg membrane (Fig. XVI, B) which protects the egg and keeps it together.

On the lower side of the floating codfish egg there is a very small opening in the membrane, and this opening is surrounded by a sticky matter, such as is frequently found on eggs just after they have been laid, and which causes some other fish-eggs to stick to any object with which they come in contact. In the codfish eggs the floating spermatozoa enter this matter, some of them reach the small opening in the shell of the egg and through it enter the body of the egg. What becomes of them has not been observed in the codfish egg, but from observations made on the eggs of other animals it is known that the spermatozoa dissolve inside the egg and assimilate with it. When this has been accomplished, the egg is impregnated, and the young fish begins to make its appearance. If there is no impregnation the egg rots.

It has also been observed that spermatozoa only enter newly-laid eggs. Even if only half an hour or less has elapsed, the water has produced changes in the egg which make it impossible for the spermatozoa to impregnate the egg. But even the spermatozoa do not retain their fructifying power for any length of time after they have been in the water. On this circumstance depends a peculiar and, to the fisherman, very important practice of the spawing fish. Fish spawn either by couples, or groups of three, or whole schools. In the first-mentioned case the male keeps quite close to the female, in order to squirt the milt upon the eggs immediately after the female has spawned. In some fish, for instance the stickleback, this is very noticeable. The male stickleback builds a nest of vegetable fiber among the algæ, and when this is finished fetches the female, which enters the nest and lays her eggs. The male impatiently waits till the female is done, and finally pushes her out, so that he may enter the nest and impregnate the eggs. This practice can easily be observed during the months of May and June, for these nests are only a few feet below the surface of the water.

Other fish do not take such good care of their eggs, but simply lay them and let them sink and stick to the bottom, like the herring, or float about in the water like the codfish. If in this case eggs are to be impregnated, it is necessary that the water be full of freshly emitted spermatozoa. This is probably the reason why these fish are always found in large schools during the spawning season. All through this school the male fish emit their semen, so that the water, as I have myself observed (see Annual Report of the Commission, 1874–'76, p. 26), looks, if not white, at any rate quite muddy. In this water the eggs are laid, and are copiously covered with the spermatozoa. If the fish were to swim near the surface in couples the impregnation would be very uncertain, but the larger the school of fish the more evenly will the spermatozoa be distributed in spite of wind and current. Fish which spawn in this manner must therefore first of all gather in schools. It seems that on reaching the coast they move to and fro for some time (weeks or months), and during this time gather in schools, all of the fish which compose them having about equally-developed sexual organs. This is the reason why the herring fisheries yield such a good income. The fish are so closely massed together that large numbers can be caught with little trouble and loss of time. When passing over so-called codfish banks, such as are formed by the codfish whilst spawning, the plummet will scarcely reach the bottom, because it falls from fish to fish. When the herrings on their way to the spawning places pass through narrow channels like the Schlei, they can be easily speared or caught with a hook, as the water is completely filled with them. If the herrings spawned in pairs, the method of fishing would have to be different from what it is now, and the fisheries would scarcely be profitable.

The dangers to which the eggs are exposed differ according to the manner in which they are laid. Eggs floating about in the water run the risk of being cast ashore and perishing there. The eggs are therefore laid not too close to the coast, and as the waves move floating objects but very slowly, and as the wind does not hurt the eggs, which are so heavy that they protrude but little, and not at all during stormy weather, fewer eggs than might be thought perish from this cause. The eggs are the favorite food of numerous animals. Among the fish the eel and stickleback are notorious for their voracity. Eggs which float about freely have not much to fear from such enemies, for they swim about singly, and are so transparent that they cannot easily be seen. Large animals cannot fish for such eggs, and only occasionally they are pierced and devoured by the small crustaceans which float near the surface. The case is very different with those eggs which lie at the bottom. If the fish spawn in pairs the eggs lie in heaps in different places, and if an eel or stickleback finds them, he will devour all or leave but very few. But as the fish spawn in different and widely scattered places the eggs are hard to find, and whole heaps of them thus escape their enemies.

Mold is a dangerous enemy to fish-eggs. It will go through the eggs, and going from egg to egg quickly destroy their life. Whenever attempts have been made to develop fish-eggs in aquaria, the eggs have almost without exception grown moldy before the young fish were ready to leave the eggs. In the open air, or in water which has waves, this danger is not so great; it seems that the germs of the mold, of which there are always many in the water, find no time to stick to the eggs, but are constantly washed away by the waves. I have occasionally observed moldy fish-eggs in shallow places near the shore where there was stagnant water, but on the whole this kind of destruction is not of very frequent occurrence in the sea. If the eggs are scattered, as is the case with the herring eggs, they are distributed all over the bottom of the sea, and cling to any objects or plants which come in their way. Here is a rich harvest field for egg-devouring animals, and the only drawback is that the eggs are so scattered. But on this very account it is difficult to destroy large masses of them, and some will invariably escape. I am astonished that I have never seen it mentioned that eels are frequent in such places, for it would certainly seem highly probable that such an "egg-field" would attract them. The fishermen do not at all observe such places, and in the rare cases when they know of them they will hardly fish there. I am inclined to think that a considerable number of herring eggs are devoured by other fish and marine animals, because I have found great masses of freshly laid eggs sticking to aquatic plants in the Schlei, whilst I found but few and scattered developed eggs. It would certainly be important for the fisherman to observe the destroyers of fish-eggs a little more closely than is done at the present time.

Imperfect as our knowledge of the spawning process is, we can nevertheless get a general idea of it. This will be, however, of little practical use, for in questions of practice the location of the spawning place, its depth, the nature of its bottom, its vegetation, &c., would have to be considered. It might, however, be possible to favor in this respect certain food-fish, and to increase their number, by protecting the vegetation in the spawning places, by not removing the stones in such localities, or by even adding a few stones, and by setting eel-traps, or by catching the sticklebacks with a fine net a short time before the spawning season. The experiment would have to be made whether such measures, if simultaneously pursued on different parts of the coast, would have a favorable result. All we wish to do is to hint that these questions may probably be of considerable importance to fishermen. But all such experiments presuppose that our knowledge of the localities where the fish spawn is not, as now, confined to a few scattered places, but extends to many places.

No one but the fishermen can aid us in gaining this extensive knowledge, and if they were to give the desired aid it would certainly be to their own immediate profit. If it were so easy to find the spawning places they would have long since become generally known, but as the difficulties in the way of finding them are manifold, we take the liberty to give some well-meant advice.

A good deal depends, in the first place, on keeping books and noting down every observation. It is useless if one or the other fisherman reports that here and there he has seen one or another fish during its spawning process. He may mistake; he may have forgotten the place, or he may have taken one fish for the other, and even at best such things soon escape the memory. If such observations are to be valuable and of practical use, suitable for a basis of scientific investigations and decisions, the first thing to be done is to procure a little note-book, which can be bought for about two cents, and one of the older fishermen, or anyone else suited for it, should undertake to "keep account." On the cover should be written, "Observations on the spawning of fish, commenced in 1880."

In this book one page should be devoted to every kind of marketable fish. Thus the first page, for instance, should be headed "Plaice," the second "Codfish," the third "Sturgeon," &c. Below the name of the fish a few lines should be drawn and columns arrranged as follows:

Herring.

Containing mature spawn.		Empty.	Place where the mature fish is caught.	Remarks on the weather.
1880.	First	First		
	Last			
1881.	First	First		
	Last			
1882.	First	First		
	Last			
1883.	First	First		
	Last			
1884.	First	First		
	Last			
1885.	First	First		
	Last			
1886.	First	First		
	Last			
1887.	First	First		
	Last			
1888.	First	First		
	Last			
1889.	First	First		
	Last			

The fisherman who keeps accounts, and whom we will designate as the "bookkeeper," will have to inquire when fish containing mature spawn were caught first and when last, understanding thereby fish with flowing spawn. The date when such fish are caught is to be entered on the book, as well as the place where they were caught, and the date when the first empty fish were caught. Some remarks on the weather, as far as, in his opinion, it has had any influence on the spawning season, should be added. To do this involves so little trouble and expense that it is to be hoped that such books will soon be kept in many fishing stations.

It is, of course, to be expected that objections will be raised. Some will say: "Such and such fish do not spawn in our waters; we can, therefore, make no observations regarding them, and consequently we cannot keep such a book." Others again will say: "What is the use of putting down all this. We know most of what is going to be entered on the book, and new things, such as where the fish-eggs are lying, where the young fry stay, on what they live, &c., are not to be entered; these things the learned people should find out for themselves." The consequence will be that no book will be kept; in fact, no matter what objections are raised, the result in all cases will be the same, namely, that nothing will be done!

The only answer to all these objections is simply that some time or other a beginning must be made, for it is time that some attention be paid to the increase of fish, and not merely to the increase of fishing apparatus. When measures shall have been taken for increasing and protecting the fish on our coasts, and such measures will undoubtedly be inaugurated at no distant period, it will make a great difference whether fishermen are *able* to pronounce an opinion on this subject, and can corroborate their assertions by written statements from their books, or whether they know nothing about it. If they can pronounce an opinion they will be heard, and the most correct and suitable measures will be selected and carried out. If, on the other hand, they cannot prove their assertions by facts or written statements made from actual observations, and without keeping books they cannot possibly do this, the measures introduced for protecting and increasing the food-fish will be much less certain of a favorable result, and it is probable that more harm than good will be done.

The usefulness of putting down observations is, however, by no means exhausted by what has been said. On the contrary, it is to be expected that here and there a fisherman will show more talent for making such observations than he could hitherto display, or than he knew himself. If any one can be found who will enter his observations in a book and preserve them for future times, so that a naturalist, in looking over the book, can extract from it all the more important observations, the observer will take an increasing interest in fish and their life, and will put down everything that he deems important.

With the means at their command, fishermen can make many important observations, and do it much easier than scientific investigators. As has been said before, it is extremely difficult to develop the eggs of salt-water fish in aquaria, and at best we do not know whether the young fish leave the eggs just as quick or just as slow in the aquaria as in the open sea. The fisherman can either place artificially impregnated eggs in suitable places on the coast and observe how soon the young fish are hatched, or he can make observations on the spawn which has been laid and impregnated in a natural manner. This is, however, somewhat difficult, because it is not always easy to find the spawn. Artificial impregnation is on the whole so easy a process that by it our knowledge of the fish-eggs and their development will probably be increased most rapidly. All that is required is to procure a live milter containing mature milt (that is, a fish from which the milt flows), and a live spawner containing mature spawn (a fish from which the spawn flows). Some eggs, about 100 to 1,000, are then allowed to flow into a flat empty vessel, which has just been washed with salt water. Upon these eggs a few drops of the milt are squeezed from the live milter, they are stirred two or three times with the hand, and sea water is added. The vessel must not be warmer or colder than the water which is added. The eggs thereupon become impregnated and begin to develop. If the vessel is covered with a piece of gauze, so the eggs cannot be destroyed by fish and other marine animals, and placed in the sea in some suitable location, the eggs will develop just as well as if they had been laid by the fish. By keeping a close watch over the vessel, and by occasionally taking out a few eggs and examining them at home, it will be possible to obtain exact data regarding the gradual development of the fish till the time of hatching, and regarding the nature and mode of life of the young fry. But few, if any, such observations have been made; but, to judge from the experience of the piscicultural establishments, the result of such observations, if properly made, can scarcely be doubted, although a few experiments may probably prove failures.

The development of the egg can easily be observed with the naked eye. As soon as the little fish begins to form inside the egg, the two eyes are distinctly seen in the otherwise transparent egg like two black dots (see Fig. XVII), and some time—according to the slower or more rapid development of the fish, days or weeks—before the fish is hatched the eyes are seen so distinctly that there cannot be the slightest doubt that they are really the eyes of the young fish. Of the body of the fish nothing can as yet be seen with the naked eye, because many fish, as long as they are in the egg, are as transparent as water. Other young fish, for instance the pike, have even in the egg a somewhat brownish color, so that the whole fish can be distinguished. When the eggs have reached this stage, some of them should be taken home in a flat vessel containing water, which should be kept in a cool place. If it wants only two or three days till the hatching, the observer will succeed in observing how the little fish act on leaving the egg. As soon as an empty egg is noticed it will be easy to find the little fish which has left it, as it will betray itself by its black eyes. Note is taken of the time which elapses from the impregnation of the eggs till the fish are hatched. This time of course varies according to the temperature of the water, but as the temperature of the water at the bottom at the same time in different years does not differ very much, the time which has been observed will very nearly be the right time.

FIG. XVII.

A *fish-egg*, on a dark background, magnified twice its natural size. In the transparent egg the two dark eyes are seen. In their center is the light lens. When the little fish is almost ready for hatching, the eyes are seen still more distinctly.

As regards the actions of the young fish we know too little to give any details. When being hatched the abdominal cavity of most fish is still filled with the matter contained in the egg (the yolk), and their abdomen therefore looks somewhat bloated. As long as the fish feed on this matter they take no other food, and move about very little, generally staying quietly on the bottom. As soon as the yolk has been consumed they begin to seek their food. Many fish at this period of their life stay in quiet waters near the surface, and have the advantage that on account of their transparency they can hardly be seen by their enemies. Gradually they begin to scatter in different directions, although some kinds, such as the herrings, keep together. Gradually the scales begin to appear, and the body begins to assume some color. The fish then seek shelter, and are able to take coarser food, such as the small animals and plants floating near the surface of the water. For some time they stay in the shallow places near the coast, and finally seek those localities where the older fish live.

All the details, on which after all the correct views as to the possibility of furthering the development of food-fish will depend, can only be ascertained by more accurate observations. The proper persons to make such observations at the right time will principally be found among fishermen.

V. HENSEN.

XI.—LISTS OF THE DREDGING STATIONS OF THE UNITED STATES FISH COMMISSION FROM 1871 TO 1879, INCLUSIVE, WITH TEMPERATURE AND OTHER OBSERVATIONS.

[Arranged for publication by SANDERSON SMITH and RICHARD RATHBUN.]

The following lists include all the recorded dredging stations made by, or in connection with, the United States Fish Commission, from its organization up to date. The stations are, for the most part, arranged chronologically, and are designated by four series of numbers or letters, as follows: One series of numbers, from 1 to 87, with letters appended, represents the stations for 1871. The 1872 stations (in the Bay of Fundy) are designated by letters from *t* to *z*. Those for 1873 are indicated by a second series of numbers, from 1 to 212, with B. (Bache) or Bl. (Bluelight) added, according as the dredgings were carried on from the steamers Bache or Bluelight. In this series, however, are also included the stations of the Bache for 1872 and 1874, as well as those for 1873. The last series combines all the stations from 1874 to 1879, inclusive (omitting 1876, during which year sea-work was suspended), in numbers running from 1 to 769. For the sake of obtaining greater uniformity in recording the stations on charts, as explained further on, the stations for 1874 and 1875, originally numbered separately, have been united with those from 1877 to 1879, and given numbers following 1879. The numbers for these later years run as follows: 1874, from 400 to 580; 1875, from 600 to 769; 1877, from 1 to 128; 1878, from 129 to 238; 1879, from 239 to 378.

A chart has been prepared by Mr. Smith to illustrate the dredgings of the Commission north of Cape Cod, exclusive of those of 1872 in the Bay of Fundy; those of the Bache, on the Banks, in 1872; and of the Speedwell, off the coast of Nova Scotia, in 1877. On this chart the stations of the Speedwell for 1877, 1878, and 1879 are indicated by numbers only, and are readily distinguished from those of the Bache and Bluelight, which have B. or Bl. affixed to them. In such of the following tables as refer to this chart, the localities given are taken from the original record books, whenever such exist (*i. e.*, for all the work of the Speedwell and much of that of the Bluelight—101 Bl. to 166 Bl.), with some other notes added to facilitate the finding of the localities on the chart. In many cases the positions were marked, at the time, on the steamers' charts by the commanding officer, and all such positions have been adopted, even though differing somewhat from those given by the record books. From the nature of the operations of dredging and trawling, it becomes almost impossible to estimate exactly the changes of position caused by currents, &c., especially when out of sight of land, and in a few cases the positions were not placed on the charts at the time, and the bearings given do not suffice to fix them very accurately. It is believed, however, that but few positions laid down on the chart are rendered uncertain to any great extent by either of these causes. A large part of the positions determined by the Bache were originally given by latitude and longitude. The other latitudes and longitudes given in the tables are taken from the accompanying chart, and are intended to serve as the readiest means of finding the localities, all of which are either thus designated or are referred to as being near others, which are so. Of the dredging stations *north of* Cape Cod, Nos. 79 B to 97 B, 37 to 123 are outside of the limits of the chart. These, and all others of the *northern stations*, not placed upon the chart, are marked with + before the serial number. The bearings given for the Speedwell's work in 1879 are true; the others, with a few (unrecognizable) exceptions, are magnetic.

In the last column of the tables the letter indicates the apparatus employed in dredging: D., Dredge; Ag. D., Agassiz Dredge; R. D., Rake Dredge; T., Trawl; Ag. T., Agassiz Trawl; O. T., Otter Trawl; Tan., Tangles.

STATIONS FOR 1871, IN AND ABOUT VINEYARD SOUND, MASSACHUSETTS.

During this, the first year of the Commission, the dredgings in shallow water were made partly from a sail-boat, and partly from a steam-launch, and those in the deeper waters, from the United States revenue-cutter Moccasin, Capt. J. G. Baker. The dredging stations numbered in all about 250, but to avoid confusion in laying them out on the chart, they were combined into 87 groups or lines, each including from 2 to 9 stations, the lines being designated by numbers, the stations by letters. In this manner they were represented on the large chart accompanying the Report of the United States Fish Commissioner for 1871–'72. In making up the present list the same arrangement has also been followed, and where all the stations of a group were of the same nature, they have been located collectively; otherwise the exact position of each station has been given.

Dates are not prefixed to all of the inner groups, as many of these include stations made on different days. Temperature observations (with Miller-Casella self-registering thermometers) were taken at most of the outer stations, as recorded in the list, but were omitted at the inner ones. The dredge was the implement most commonly used for scraping the bottom, but the beam-trawl was also frequently employed on the smooth inner grounds. The rake-dredge was worked a few times off Gay Head, and the tangles very rarely, in only a few places. The characters of the many localities gone over in 1871, as well as the species of animals found inhabiting them, are fully discussed in the "Report upon the Invertebrate Animals of Vineyard Sound and the adjacent waters, with an account of the physical characters of the region," by Prof. A. E. Verrill; contained in the Report of the United States Fish Commissioner, Part I, for 1871–'72.

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Temperature.		
					Air.	Surface.	Bottom.
	1871.						
1		*a, b.* Off Little Harbor, Wood's Holl	1⅓–2	Covered with eel-grass			
2	June 30	*a, b.* Off Little Harbor, Wood's Holl, between Nobska Point and Nonamesset Island.	2–3¾	Rocky, small stones			
3	July 11	*a, b, c.* Off Great Harbor, Wood's Holl, from south of buoy R. No. 4 to Great Ledge.	2½–9¾	Rocks, gravel, &c			
4	June 30	*a, b, c, d, e.* Beginning nearly the same as No. 3 and extending to beyond buoy R. No. 2.	3½–12¼	Rocks, small stones, &c			
5		Wood'sHoll:					
		a, b. Southeast of Nonamesset Island	3¾–5¼	Sand, gravel			
		c, d. Between Nonamesset Island and Great Ledge.	3¾	Rocks, stones, dead shells.			
		e. Off Mink Point, Nonamesset Island	8¼	....do			
		f, g. Mouth of Great Harbor	5¾–9¾	....do			
6	July 20	Vineyard Sound:					
		a, b. Between Nobska Point and Falmouth.	2–3	Covered with eel-grass			
		c. Between Nobska Point and Falmouth.	3–5	Gravel and shells			
		d. About ⅝ mile south of Falmouth	4¾	....do			
		e, f. Between Falmouth Harbor and Western end of L'Homme Dieu Shoal.	5½–9	....do			
7		*a.* Lackey's Bay, Vineyard Sound		Covered with eel-grass			
		b, c, d. Lackey's Bay, Vineyard Sound		Gravel			
8	June 30	*a, b, c, d, e, f, g.* Vineyard Sound, off Nonamesset Island and Wood's Holl.	7–10	Rocks, gravel, small stones.			
9	June 29	*a, b, c, d.* Vineyard Sound, south of Little Harbor, Wood's Holl, ½ to 1⅝ miles from Nobska Point.	7–12	Rocks.			
10	July 24	Wood's Holl:					
		a, b, c. Passages between Nonamesset and Naushon Islands.	1⅓–2⅔	Soft mud			
		d. Hadley Harbor	3¼	....do			
		e, f. Between Long Neck and Nonamesset Island.	3–6¼	Hard gravel			
11		Wood's Holl Passage:					
		a, b, c. Off Nonamesset Island	3¼–4½	Fine gravel, dead weeds.			
		d, e, f, g. Off Uncatena Island	3½–5	Sand, stones			
12		*a, b, c.* Wood's Holl Passage, between Long Neck and Nonamesset Island.	2½–5¾	Sand, gravel			
13		*a, b.* Mouth of Great Harbor, Wood's Holl, from off Bar Neck wharf to midway between Mink Point and Parker's Neck.	1⅙–7	Gravel, &c			
14		Wood's Holl, in the passage-way to the east and south of Ram and Bluff Islands:					
		a, b	3¼–5¼	Rocky			
		c, d	2½–5¼	...do			
		e, f, g. In Great Harbor	5–10	Rocky, sand			
15		*a, b, c.* Wood's Holl, buoy No. 3, Middle Ledge to Lone Rock Spindle.	⅔–2½	Gravel, small stones, shells			
16		*a, b, c.* Great Harbor, Wood's Holl, near buoys No. 12 and 14.	1⅓–14	Rocks			
17		Mouth of Great Harbor, from Bar Neck to east of Nonamesset Island.	1⅔–14¼				
		a, b		Mud and eel-grass			
		c, d, e, f		Rocks, &c.			
18	July 24	*a, b, c, d.* Mouth of Great Harbor, from off Bar Neck wharf to midway between Parker's Neck and Nonamesset Island.	2½–12¼	Hard gravel.			
19		*a, b.* Mouth of Great Harbor, between Parker's Neck and Lone Rock Spindle.	1–8¾	Gravel, mud, weeds			
20		*a, b, c.* Mouth of Great Harbor, between Nonamesset Island and Parker's Neck.	1⅙–6¾	Gravel, &c			
21	June 27 } June 28 }	*a, b, c, d, e.* Vineyard Sound, southeasterly from Nobska Point about ⅝ mile; all near together.	6–10	Rocks, gravel, small stones.			
22		Vineyard Sound, between Nobska Point and Falmouth Harbor.	4–5¼				
		a, b, c		Stones, dead shells			
		d		Sand, gravel			

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.
	1871.						
23	June 30, July 3, July 8	*a, b, c, d, e, f.* Between Nobska Point and Falmouth, and south of Falmouth, about 1 mile.	4½–10	Gravel, small stones, shells.	....	....	....
24	....	Vineyard Sound:					
		a, b. About 1⅝ miles south of Falmouth.	5½–10	....	....	....	....
		c, d. North of west end of L'Homme Dieu Shoal.	5–13	....	....	....	....
25	....	*a, b, c, d, e.* Vineyard Sound, between Waquoit Bay and Falmouth.	3–5	Sand, shells, eel-grass.	....	....	....
26	....	*a, b, c, d, e.* Vineyard Sound; a line of dredgings parallel to No. 25, and from ⅜–¾ mile further south.	5–13	Gravel, shells	....	....	....
27	....	*a, b.* Vineyard Sound, about midway between the western part of L'Homme Dieu Shoal and the mainland.	5¼–13	Sand, shells, eel-grass .	....	....	....
28	July 20	Vineyard Sound:					
		a, b. Off western entrance to channel between L'Homme Dieu Shoal and Hedge Fence.	5–6	Sand, stones, sea-weeds	....	....	....
		c, d, e, f. South of western end of Hedge Fence.	10–12	Sand, gravel, small stones.	....	....	....
29	....	*a, b, c.* Vineyard Sound; a line parallel to, and just south of, eastern half of Hedge Fence.	5½–12	Gravel, &c	....	....	....
30	....	*a, b.* Mouth of Vineyard Haven, between East and West Chop.	5–7	Sand, eel-grass, algæ...	....	....	....
31	July 20	Vineyard Sound:					
		a, b. Between Hedge Fence and East Chop.	10–13	Sand, gravel, small stones.	....	....	....
		c, d, e. North of East Chop and off Vineyard Haven.	9–11¾	... do	....	....	....
32	....	*a, b, c.* Vineyard Sound; line running east and west, north of eastern half of Hedge Fence.	11–12¼	Gravel, &c	....	....	....
33	....	Vineyard Sound:					
		a, b. South of eastern end of L'Homme Dieu Shoal.	5¼–13¾	....do	....	....	....
		c, d. Southeast of same shoal	5–8½	....do	....	....	....
34	....	*a, b, c, d, e, f.* Vineyard Sound, between eastern end of L'Homme Dieu Shoal and Wreck Shoal.	5–7	Gravel, hard mud, sand.	....	....	....
35	....	*a, b, c, d, e.* Vineyard Sound; line running east and west between Wreck Shoal and 1 mile off Waquoit Bay.	4–7¾	Gravel, shells........	....	....	....
36	....	*a, b, c, d.* Nantucket Sound, between Wreck Shoal and Horse-Shoe Shoal.	4¾–15½	Astrangia, sponges, &c	....	....	....
37	....	Vineyard Sound, off north side of Martha's Vineyard and nearly parallel with the shore, distant from shore ¼–½ mile:					
		a, b, c, d. Between Martha's Vineyard and Middle Ground.	5–11	Gravel, stones, rocks..	....	....	....
		e, f, g. Off West Chop..................	9–13	Rocks, sand..........	....	....	....
		h, i. Off East Chop....................	4¼–9	Sand, stones	....	....	....
38	....	Vineyard Sound:					
		a. About ⅝ mile north of center of Middle Ground.	10–14	Gravel...............	....	....	....
		b, c. Just off center of Middle Ground..	9½–13½	....do	....	....	....
39	June 29	*a, b.* Vineyard Sound, about midway between Nobska Point and Middle Ground.	12–13¼	Stones, gravel........	....	....	....
40	....	*a, b, c, d.* Vineyard Sound, between Wood's Holl and Middle Ground.	10–13	Gravel, stones, sand...	....	....	....
41	....	Vineyard Sound:					
		a. About 1¼ miles east of Nobska Point.	4½–6½	Small stones	....	....	....
		b. About 1⅞ miles southeast of Nobska Point.	10–12	....do	....	....	....
42	July 17	*a, b.* Vineyard Sound, off Tarpaulin Cove.	10¾–15¾	Gravel...............	....	....	....
43	....	Vineyard Sound:					
		a, b, c. Line of dredgings off northern half of Naushon Island, parallel to shore, distant about ½ mile.	10¼–13¾	Gravel, hard sand.....	....	....	....
		d. Continuation of same, ⅝ mile off Nonamesset Island.	10¾–11½	Gravel...............	....	....	....

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.
	1871.						
44		*a, b, c, d, e.* Vineyard Sound; line about parallel to last, off northern half of Naushon Island, about 1 mile from shore.	10½–15¾	Gravel			
45		*a, b.* Vineyard Sound, off Quick's Hole	6¼–8¾	Coarse gravel, shells			
46		Vineyard Sound, off the Elizabeth Islands.	7–14¾				
		a, b. Off Pasque Island		Sand, shells			
		c. Off Robinson's Hole		...do			
		d, e. Off south end of Naushon Island		Sand, shells, and gravel			
47		*a, b, c, d, e.* Vineyard Sound, off west side of Martha's Vineyard, between Menemsha Bight and Cedar Tree Neck, ½ to 1¼ miles from shore, and nearly parallel to it.	10–17¾				
		a, b, c, d		Black mud, dead mussels, &c.			
		e		Sand			
48		*a, b, c, d.* Vineyard Sound, same as last, ¼–½ mile from shore, and extending about 1½ miles both north and south of Cape Higgon.	4¾–11	Sand, gravel, shells			
49		Vineyard Sound:					
		a. About northeast of Gay Head, 4¼ miles.	7¾–13				
		b. About west of Lucas Shoal, 1½ miles	5–6				
50		*a, b.* Vineyard Sound, Menemsha Bight	4–8				
51		Vineyard Sound, Menemsha Bight:					
		a, b, c	1⅔–2½	Mud, fine sand			
		d	4¾	...do			
		e	6–9	...do			
52	July 14 } July 17 }	*a, b, c, d.* Vineyard Sound, north of southwestern extremity of Martha's Vineyard, ½–1 mile from shore (*c, d,* off Menemsha Bight).	10–12	Sand			
53	July 14	*a, b, c, d, e.* Vineyard Sound, north and northeast of Devil's Bridge, Gay Head, ⅝ to 1 mile from shore.	5–12	Sand, rocks			
54		Vineyard Sound, north of Gay Head:					
		a. About 1½ miles from shore	16½	Mussels			
		b. About 2¼ miles from shore	14–15½	...do			
55	July 22	*a, b, c.* Vineyard Sound, north of Devil's Bridge, Gay Head, ¾ mile.	6¾–13¼	Rocky, dead mussels, &c.			
56	July 22	*a, b, c, d.* Vineyard Sound, northwesterly from Gay Head, about 1 mile.	5–11	...do			
57		*a, b, c, d, e.* About same position as last, forming a line about ½ mile further off.	5–13¼	Rocky			
58		*a, b, c, d, e.* Vineyard Sound, northwesterly from Gay Head, 1¾–2 miles.	10–16				
		a, b, c		Rocky			
		d		Mud, dead mussels			
59		*a, b, c.* Vineyard Sound, northwesterly from Gay Head, ½–1⅝ miles.	5¾–11¼	Rocky			
60		*a, b, c.* Vineyard Sound, northwesterly from Gay Head, 1–2 miles.	6–11½	...do			
61		*a, b, c.* Vineyard Sound, northwesterly from Gay Head, 1–2 miles; more easterly than 60.	5½–13¾	...do			
62		*a, b, c.* Vineyard Sound, northwesterly from Gay Head, 1–2 miles; more easterly than 61.	5½–16½	...do			
63		*a, b, c, d.* Vineyard Sound, north of Devil's Bridge, Gay Head, ⅛–¼ mile.	6–8¾	Rocks, sand, shells			
64	July 12	Buzzard's Bay, Cataumet Harbor:					
		a. In harbor	3¼	Sand, eel-grass			
		b. At mouth of harbor	3½–4¾	...do			
65		*a, b.* Buzzard's Bay, off Cataumet Harbor.	4¾				
66		*a, b.* Buzzard's Bay, between Long Neck and Quamquisset Harbor.	5–6¼	Hard sand			
67	July 24	*a, b.* Just outside of 66	5–6¼	Sand, mud			
68		Buzzard's Bay, west of Quamquisset Harbor:					
		a. About 2 miles	7¼	Fine sandy mud			
		b. About 1 mile	7¼	...do			
		c. About ¾ mile	6–7	Mud			
69		*a, b.* Buzzard's Bay, west of Quamquisset Harbor, about 1½ miles.	5¾–7¼				

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Temperature. Air.	Surface.	Bottom.
	1871.						
70		*a, b, c, d.* Buzzard's Bay, westward of Quamquisset Harbor, about 1¾–2⅛ miles.	7¼	Sand, gravel, stones			
71		*a, b.* Wood's Holl Passage, between Long Neck and Uncatena Island.	3¾–6¼	Fine gravel			
		c, d. West of Long Neck, ⅕–⅗ mile	3¾–6¼	Rocks, hard sand			
72		*a, b, c, d.* Buzzard's Bay, northward from Woepecket Island, 1¼–2 miles, forming a line running about northeast and southwest.	7½–8¼				
73		Buzzard's Bay, north of northern part of Naushon Island:					
		a, b, c. Parallel and near to shore from Uncatena Island to south of Woepecket Island.	6½–10¼	Sand, mud			
		d. About west of Woepecket Island, ¼ mile.	6¾	Rocks			
		e, f, g. Northwesterly from Woepecket; *e*, ½ mile; *f*, 1 mile; *g*, 1½ miles.	7¼–8½	Sand and muddy sand.			
74		*a, b.* Buzzard's Bay, northward of Woepecket Island, 1¾–2¾ miles.	7½	Mud			
75		Buzzard's Bay, forming a line of dredgings parallel to the Elizabeth Islands and distant from them ⅜–¾ mile.	7–9				
		a, b, c. Off Naushon Island		Blue mud			
		d, e. Off Pasque Island		do			
		f, g, h. Off Cuttyhunk Harbor	3¼–5				
76		*a, b, c.* Buzzard's Bay, between Quick's Hole and Lone Rock.	3¼–8¼	Gravel, dead weeds, &c			
77		*a, b, c, d, e, f.* Quick's Hole, between Pasque Island and Nashawena Island.	5¼–8¼	Rocks, gravel, sand			
78		*a, b, c, d, e.* Buzzard's Bay, off northern entrance to Robinson's Hole.	3¾–7¼				
		a		Mud, eel-grass, and dead weeds.			
		b		Black mud			
		c		Blue clay			
79		In channel between Chappaquiddick Island, Martha's Vineyard, and Hawe's Shoal:					
		a. Northern part of channel	3¼–4¼				
		b. Southern part of channel	4½–5				
80	Sept. 12	Southeasterly from Martha's Vineyard, 3½ to 9 miles:					
		a. 10 miles south from Cape Poge	16½	Sand and silicious sponges.		64	60
		b. 13 miles south from Cape Poge	18½	Sand		64	59
		c. 1½ miles west of *b*	21	Sandy mud		61.5	59
81	Sept. 12	South of Martha's Vineyard, 5 to 8 miles:					
		a. Southeast of Gay Head, 12½ miles	16½	Sand			
		b. Southeast of Gay Head, 8 miles	16½	do			61
82	Sept. 9	South and southwest from Gay Head, about 5 miles; northwest of No-man's Land:					
		a. 5 miles south-southwest of Gay Head.	8–12	Gravel and stones			
		b. 5 miles south of Gay Head	16	do			62
83		*a, b, c, d.* Vineyard Sound, off Gay Head, parallel to No. 58, and slightly more distant from shore.	10–16	Rocky			
84	Sept. 11	South and southwest of Gay Head:					
		a. 1½ miles southwest of Gay Head	13	Rocks, gravel			
		b. 4 miles southwest of Gay Head	16½	Sandy mud			
		c. 2¼ miles a little west of south of Gay Head.	12	Rocks, gravel			
		d. 3½ miles a little east of south of Gay Head.	7	do			
85	Sept. 9	West of Gay Head, 2 to 5 miles:					
		a. 3 miles; *b*, 3½ miles; west of Gay Head.	15½	Sand		67	63
		c. 4 miles west of Gay Head	18	Soft, sticky mud		62	58
		d. 1 mile north-northwest from *c*	19	do		62	57
		e. 5 miles a little north of west from Gay Head.	11	do		63	59
86	Sept. 13	West-southwest of Gay Head, 10 to 13 miles:					
		a. 13 miles west-southwest from Gay Head.	25	Gravel, sand, with some mud.			
		b. 10½ miles west-southwest from Gay Head.	25	do		64	

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Temperature.		
					Air.	Surface.	Bottom.
87	1871. Sept. 14	a. 19½ miles west-southwest of Gay Head.	29	Sandy mud	....	......	....
		b. 18½ miles west-southwest of Gay Head.	29	....do	....	62	59

STATIONS FOR 1872, WITH HEADQUARTERS AT EASTPORT, ME.

The dredgings for 1872 were mostly carried on from a large sail-boat; but those in the deeper waters of the Bay of Fundy were made from the United States revenue-cutter Mosswood, Captain Hodgdon. The regions explored were about as follows: Eastport Harbor, South Bay, and Passamaquoddy Bay, all of which are comparatively shallow-water areas; the shallow waters about the island of Grand Menan, especially those among the small islands to the east of Grand Menan; and the deeper waters east of Campobello Island, west of Grand Menan; and toward the center of the Bay of Fundy, between Grand Menan and Nova Scotia.

In connection with the shallow-water dredgings no complete record of observations was kept, but the collections made were appropriately labeled with the precise locality, depth of water, nature of bottom, &c. The more important hauls in deep water, mostly accompanied by temperature observations, are as follows, the letters used to designate them being the same as were employed in the original records:

Serial letter.	Date.	Locality.	Depth in fathoms.	Temperatures.		
				Air.	Surface.	Bottom.
	1872.			°	°	°
+t.	Aug. 24	Bay of Fundy, off Grand Menan, beginning at a point 8 miles SE. by E. of north end of White Head Island, and running NE. for a distance of nearly 3 miles. (Temperatures taken at the beginning and close, and the same at both.)	106-90	......	48	38
+t′.	...do ...	Bay of Fundy, off Grand Menan, north of last; beginning 8⅓ miles E. of White Head Island, and extending about 2 miles SW.	96-100	......	......	37¾
+u.	Aug. 23	Bay of Fundy, E. of Grand Menan, about 2½ miles E. of north end of White Head Island.	28-52	......	53	39¼
u′.	...do ...	Bay of Fundy, E. of Grand Menan, 1⅝ miles E. by S. ¾ S. of north end of White Head Island.	29	......	......	44
+v.	Aug. 28	Grand Menan channel, west of Grand Menan Island; 2⅔ miles N. by W. ½ W. of Southern Head, G. M.	40	......	48	45½
+v′.	...do ...	Grand Menan channel, west of Grand Menan Island; 4¼ miles NNW. ½ W. of Southern Head, G. M.	54	......	47	40
+v″.	...do ...	Grand Menan channel, west of Grand Menan Island; 6 miles N. ½ W. of Southern Head, G. M.	55	......	......	40
+w.	Aug. 16	Bay of Fundy, about 3½ miles east of Herring Cove Head, Campobello Island. (Soft muddy bottom.)	60	......	......	43
+w′.	...do ...	Bay of Fundy, just off Herring Cove, Campobello Island..	27	......	......	46
+x.	Aug. 2	Bay of Fundy, 2½ miles, about SE. of Head Harbor Light, Campobello Island.	90	......	48½	39¾
+x′.	...do ...	About 2¼ miles ENE. of Head Harbor Light, Campobello Island.	77	......	......	42
+x″.	...do ...	About 1⅔ miles NE. of Head Harbor Light	30	......	......	46
+x‴.	...do ...	Midway between Head Harbor Light and Spruce Island..	73	......	48	45
+y.	Aug. 5	Passamaquoddy Bay, off North Harbor, Deer Island	25	......	57½	47
+z.	...do ...	Passamaquoddy Bay, 1¼ miles north of last	32	......	58	46

STATIONS FOR 1873, WITH HEADQUARTERS AT PEAK'S ISLAND, CASCO BAY, MAINE; AND ALSO STATIONS OF THE UNITED STATES COAST SURVEY STEAMER BACHE FOR 1872, 1873, AND 1874, IN THE GULF OF MAINE, &c.

In this list the dredgings indicated by the above heading have been grouped together, as they appear on the chart prepared for publication. Numbers ranging from 1 B. to 78 B. were originally assigned to the Bache dredgings for 1873 and 1874, in papers published by Professor Verrill in the American Journal of Science for April, 1874, and June, 1875, and elsewhere. To these the dredging stations of the Bache for 1872, 18 in number, have been added, thus increasing the list to 97 B. As to the regular series of dredgings made by the Bluelight, under command of Lieut. Commander L. A. Beardslee, in and off Casco Bay, no serial numbers were given to the hauls until the commencement of the temperature observations, July 21. To the numbers (1 to 66), given to such of the subsequent hauls as were accompanied by temperature observations, 100 has been added (101 Bl. to 166 Bl.), and numbers from 167 Bl. to 190 Bl. have been given to the hauls from July 12 to July 21, and from 191 Bl. to 212 Bl. to those taken after July 20, but not included in the temperature series. The descriptions of localities from 101 Bl. to 166 Bl. are taken from the record books for temperatures, with some additions, and from 167 Bl. to 212 Bl. from the eight books of dredging lists, which were kept. Additions to 101 Bl. to 166 Bl., taken from the dredging books, are marked D. L.

The dredging stations of the Bache for 1872 were on and about Saint George's Bank and La Have Bank, and extended as far as Halifax, N. S.; in 1873 they were mostly in the Gulf of Maine, especially in the region of Jeffrey's and Cashe's Ledges, a few being made in Massachusetts Bay; those for 1874 were entirely in the Gulf of Maine.

DREDGINGS BY THE BACHE, 1873.

Serial number.	Date.	Latitude.	Longitude.	Locality.	Depth in fathoms.	Nature of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Apparatus used.
		° ′	° ′				°	°	°	
1 B	Sept. 3	......	......	Off Monhegan Island	52	Soft gray mud	58	55	{ 42 / 44	
2 B	...do	43 39	69 22	7 miles SW. from Monhegan Island	......	Soft mud	58	55	42½	
3 B	...do	43 38	69 17	8 miles S. from Monhegan Island	61	Mud and sand	56	54	{ 43 / 44	
4 B	...do	43 37	69 05	13 miles SE. by S. from Monhegan Island	60	Brown mud, sand	60	55	{ 43½ / 45½	
5 B	...do	43 37	68 59	17 miles SE. from Monhegan Island	72	Brown mud	60	54	{ 43 / 44	
6 B	...do	43 38	69 01	15 miles SE. from Monhegan Island	82	......do	......	......	......	
7 B	...do	43 38	69 01	......do	82	......do	......	......	......	
8 B	...do	43 36	68 32	18 miles SE. by S. from Matinicus Rock	94	Mud and gravel	56	55	......	
9 B	...do	43 36	68 24	23 miles SE. from Matinicus Rock	107	Sticky brown mud	56	57	39½	
10 B	Sept. 4	43 34	68 27	22 miles SE. by S. from Matinicus Rock	104	Soft brown mud	56	57	{ 40 / 41	
12 B	Sept. 13	43 20	68 33	Jeffrey's Bank	60	Brown mud	56	54	42	
13 B	...do	43 23	68 30	......do	105½	......do	58	54	40	
14 B	...do	43 25½	68 40	......do	80	......do	62	60	43	
15 B	...do	43 23	68 44	......do	72½	......do	60	58	{ 42½ / 47	
16 B	...do	43 19	68 49	......do	79	......do	62	58	40½	
17 B	...do	43 15½	68 54	SW. from Jeffrey's Bank	100	Brown mud, gravel	59	57	52	
18 B	...do	43 15½	69 06	......do	106	Brown mud	58	56	40	
20 B	Sept. 16	43 01	70 10	15 miles SE. from Boon Island Light	95	Mud	58	58	{ 37½ / 40½	
21 B	......	42 49	68 50	Cashe's Ledge	52–90	Rocky	52	57	43	
22 B	......	42 52	69 23	56 miles E. of Cape Ann	90	Blue mud	52	56	{ 40 / 43	
23 B	......	42 52	69 35	47 miles E. of Cape Ann	118	Mud	54	57	39	
24 B	......	42 56	70 09	E. of Jeffrey's Ledge	114	Soft mud	59	57	39	
24ªB	......	42 56	70 17½	6 miles farther W	114	......	58	58	{ 36½ / 40	
25 B	......	42 28	70 44	3½ miles SE. from Halfway Rock	29	......	......	54	43½	
26 B	......	42 32½	70 50	Salem Harbor	6	......	......	......	......	
27 B	......	42 40	70 27½	Jeffrey's Ledge, 6 miles E. of Thatcher's Island Lights	24	Gravel and stones	57	58	46	
28 B	......	42 41½	70 24½	8 miles E. by N. of Thatcher's Island Lights	26	......do	57	58	48	
29 B	......	42 47½	70 20½	14 miles NE. by E. ¼ E. from Thatcher's Island Lights	33	......do	70	54	{ 46 / 49	
30 B	......	42 26	70 35	Massachusetts Bay	50	Soft mud	60	58	{ 42 / 45	

DREDGINGS BY THE BACHE, 1873—Continued.

Serial number.	Date.	Latitude.	Longitude.	Locality.	Depth in fathoms.	Nature of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Apparatus used.
		° ′	° ′				°	°	°	
31 B		42 19	70 29	Massachusetts Bay	56	Mud	62	60	41½, 44	
32 B		42 19	70 23	West of Stellwagen's Bank	29	Hard, rocky	64	58	48½, 50½	
33 B		42 20	70 18	On Stellwagen's Bank	22	......do	64	....	48½, 50½	
34 B		42 22	70 11	East of Stellwagen's Bank	44½	Sand	61	....	41½, 44	
35 B		42 08	70 15	Between Stellwagen's Bank and Race Point	34	......do	59	57	48, 50	
36 B		42 18	69 49	23½ miles ENE. ¼ N. from Race Point	142	Soft blue mud	60	58	39, 42	
37 B		42 20	70 00	19¾ miles NE. from Race Point	117	......do	....	....	....	

No record exists of any hauls corresponding to Nos. 11 B. and 19 B.

DREDGINGS BY THE BACHE, 1874.*

Serial number.	Date.	Latitude.	Longitude.	Locality.	Depth in fathoms.	Nature of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Apparatus used.
		° ′	° ′							
38 B	Sept. 2	42 48½	70 37	Thatcher's Island Light, about 10 miles south	41	Soft blue mud	70	66	45	
39 B	...do	42 51½	70 36½	Thatcher's Island Light, about 13 miles south	48	Mud	70	69	45½	
40 B	...do	42 54½	70 35½	Thatcher's Island Light, about 16 miles south	43	Blue mud	70	69	47	
41 B	...do	42 57½	70 35	Thatcher's Island Light, about 18¾ miles south	36–27	Mud and rocks	70½	69	47½	
42 B	Sept. 3	43 05½	70 20	Boon Island Light, NW. by W. ½ W. 6 miles	68	Brown mud	69½	67	52½	
43 B	..do	43 04½	70 28	Boon Island Light, N. by E.; hotel on Isles of Shoals, SW. by W. ½ W.	43	......do	75	65	47	
44 B	...do	43 00½	70 35	Star Island, SW.; Duck Island, W	25	Rocky	75	67½	51	
45 B	Sept. 4	43 05	70 11½	Boon Island Light, WNW. 12½ miles	88	Soft mud	65	67	40	
46 B	...do	43 03	70 04	Agamenticus Mountain, NW. by W. ¼ W	51	Hard sandy mud	65	69½	42	
47 B	...do	43 02¾	70 03	Jeffrey's Ledge, near No. 46 B	25	Sand and gravel	64	58½	45½	
48 B	...do	43 01½	70 03½	Jeffrey's Ledge, near No. 47 B.; Agamenticus Mountain, NW. ½ W.	36	Gravel	64	56½	47½	
49 B	...do	43 02¾	69 52	Boon Island Light, WNW. 27 miles	113		64	65	40	
50 B	...do	43 01⅓	69 45		100		60	56	40	
51 B	Sept. 5	42 56	69 08	W. of Cashe's Ledge	105	Mud and gravel	60	55	41	
52 B	...do	42 51	68 52½	Cashe's Ledge	27	Rock and gravel	60	55	42	
53 B	...do	42 51	68 50	......do	73	Soft mud	63	55	42	
54 B	...do	42 49	68 48⅛	Off SE. edge of Cashe's Ledge	110	Mud	61	61	42	
55 B	...do	42 53½	68 53½	Cashe's Ledge	40	Gravel	60½	65	43	

56 B	do	42	52½	68	54	do	30	do	62	59	40
57 B	do	42	51½	68	52½	do	37	Rocky	....	....	....
57ᵃB	do	42	51¼	68	52¾	do	39	do	....	....	....
58 B	do	43	04	69	05	NW. of Cashe's Ledge	65	Mud and gravel	60½	57	40
59 B	do	43	22	69	17		92	Mud	61	55	41
60 B	Sept. 6	43	17	69	24		65	Mud and sand	61	57	41
61 B	do	43	51	69	38	Booth Bay Harbor, Maine	5	Mud	64	58	51
62 B	Sept. 7	43	40½	69	27	Pemaquid Point, N. 10 miles	48	do	62	62½	47
63 B	do	43	43½	69	30	Pumkin Island, NW. 4 miles	42	Brown mud	68	65	48
64 B	do	43	38½	69	26½	Pemaquid Point, N. 12 miles	58	Mud	61½	57	42½
65 B	do	43	44½	69	22	Monhegan Island, E. by N. 2 miles	47	Soft mud	64½	59	44
66 B	Sept. 8	43	34½	69	31⅓	Monhegan Island, NE. ¾ E. 14 miles	65	Brown mud and gravel	66	64	40
67 B	do	43	25	69	34⅓	Seguin Island Light, N. 8° W. 19 miles	86	Brown mud	68	64	40
68 B	do	43	31	69	31½	Seguin Island Light, NW., near No. 67 B	91	Mud	64½	59	40
69 B	do	43	11	69	35	On Platt's Bank	32	Sand	64	60	46
70 B	do	43	03	69	36		91	Mud	61½	58	40
71 B	Sept. 9	42	55	69	36		96	Brown mud	61	58	40
72 B	do	42	57	69	50		125	do	61	57	39½
73 B	do	42	58⅓	70		E. of Jeffrey's Ledge	102	do	62	59	40
74 B	do	43	01	70	09	W. of Jeffrey's Ledge	88	do	62	60	39
75 B	do	43	02	70	15	do	92	do	64	64	40
76 B	do	43	03	70	25	SW. of Boon Island	51	Mud and gravel	64	63	42
77 B	do	42	58¼	70	33	White Island Light, E. ¾ S. 3½ miles	33	Rocky	69	65	44
78 B	Sept. 12	43	04	70	30	Agamenticus Mountain, NW. by N. ½ N., near Jeffrey's Ledge.	35	Blue clay, mud, sand	61½	60	43

* The surface temperatures taken this year were quite unreliable, in consequence of an erroneous method of observation.

DREDGINGS BY THE BACHE, 1872.

[The letters preceding the serial numbers are the same used to distinguish the hauls in Smith and Harger's Report on the Saint George's Bank Dredgings (Trans. Conn. Acad., vol. iii), and in Professor Verrill's papers in American Journal of Science. The bottom temperatures this year are quite unreliable, manifestly too high in general.]

			°	′	°	′				°	°	°
+ a	79 B	Aug. 29	41	40	68	10	On northwest part of Saint George's Bank	25	Soft sand	....	....	....
+ b	80 B	do	41	40	68	10	do	30	do	....	....	....
+ c	81 B	Sept. 16	41	25	66	45	East of Saint George's Bank	28	Coarse sand	....	....	....
+ d	82 B	Aug. 31	41	25	66	24⅘	do	50	Sand and shells	66	62	45
+ e	83 B	Sept. 16	41	25	65	58.3	do	60	do	61	58	58
+ f	84 B	Sept. 15	41	25	65	50.3	do	65	Dead shells	64	60	55
+ g	85 B	do	41	25	65	42.3	do	430	Sand, gravel, stones	66	65	51
+ h	86 B	Sept. 12	42	56½	64	51.3	On La Have Bank	45	Gravel and stones	64	61	36
+ i	87 B	do	42	44	64	36	South of La Have Bank	60	Gravel, stones, sponges	62	62	....
+ j	88 B	Sept. 11	44	30	63	30	Off Chebucto Head, Nova Scotia, entrance Halifax Harbor	20	Mud and fine sand	....	....	....
+ o	89 B–91 B		42	05	67	49	Off northwest border of Saint George's Bank	110	Soft mud and sand	....	56	49
+ p	92 B		42	03	67	49	do	85	do	....	56	49
+ q	93 B, 94 B		42	00	67	42	Off north border of Saint George's Bank	45	Coarse sand	....	....	....
+ r	95 B		42	03	67	31	do	40	do	....	....	....
+ s	96 B, 97 B		42	11	67	17	Off northeast border of Saint George's Bank	150	Soft sandy mud	....	52	52
	98 B–100 B						(There are no hauls corresponding to these numbers)			....	....	....

DREDGINGS BY THE BLUELIGHT, 1873.

	Serial number.	Date.	Latitude.		Longitude.		Locality.	Depth in fathoms.	Nature of bottom.	Temperature.			Apparatus used.
										Air.	Surface.	Bottom.	
			°	′	°	′				°	°	°	
	101 Bl	July 21	43	32	70	05½	Cape Elizabeth Light, NW. ½ W.; Portland Head Light, N. by W.	24	Gravelly	....	51	44¾	
	102 Bl	July 22	43	44	70	03½	Casco Bay, Stockman's Island, W.; Upper Flag Island, E. by S.	16–22½	Sandy	....	57	50	
	103 Bl	...do	43	42	70	03¼	Casco Bay, Broad Sound, Bates Island, W.; Eagle Island, E.	22–34	Gravel, br. shells	....	52	48	
	104 Bl	July 24	43	41¼	70	08	Casco Bay, Luckses' Sound	12½	Muddy	80	56½	46½	T.
+	105 Bl	...do					Casco Bay, Broad Sound, between Stockman's and Little Birch Islands.	16½	Fine sand	84	62	49¼	
+	106 Bl	...do					Casco Bay, Broad Sound, between Eagle and Bates Islands.	31	Gravel	80	65	45½	
+	107 Bl	July 26					Casco Bay, Broad Sound, between Stockman's and Upper Flag Islands.	16½	Sand	68	56½	47½	
+	108 Bl	...do					......do			....	57⅓	....	
+	109 Bl., 110 Bl	July 27					Casco Bay, Bluelight Cove (channel between Peak's, Great and Little Hog Islands).	3	Muddy	60 / 61	59	56	
	111 Bl	July 28	43	40	70	12	Casco Bay, Bluelight Cove, off Evergreen Landing	3	......do	65	60	56	
	112 Bl	...do	43	39¼	70	13½	Portland Harbor, between Fort Gorges and Fort Preble	11½	Hard	65	59	52	
+	113 Bl	...do					Bluelight Cove	3	Muddy	65	60	56	
+	114 Bl	...do					......do	3	......do	66	62	58	
+	115 Bl	July 29					......do	1¾	......do	60	58	56	
+	116 Bl	...do					......do	2	......do	66	60	57	
+	117 Bl	July 30					Casco Bay, Broad Sound, between Bates and Eagle Islands.	16–22	Gravel and sand	67	60	49½	
	118 Bl	...do	43	43	70	05½	Casco Bay, Broad Sound, between Little Bangs and Stave Islands.	9½–12	Soft gravel, br. shells	66	60	53	
+	119 Bl	...do					Casco Bay, Broad Sound, between Stockman's and Little Birch Islands.	17 (14?)	Sand, gravel, shells	66	60	53	
+	120 Bl	...do					Bluelight Cove	1⅔	Muddy	68	64	60	
+	121 Bl	...do					......do	2	......do	70	66	61	
	122 Bl	July 31	43	38	70	12½	Portland Light, SSW. ⅔ of a mile	13½	Sandy	69	59½	49½	
+	123 Bl	...do					Bluelight Cove	2	Muddy	71	62	58	
+	124 Bl	...do					......do	2	......do	66	62	59	
+	125 Bl	Aug. 1					......do	2	......do	62	60	56	
	126 Bl	Aug. 2	43	42	70	07	Casco Bay, Luckses' Sound, between Hope and Crotch Islands.	11	......do	71	61	47	
	127 Bl	...do	43	44	70	01	Casco Bay, Harpswell Sound, SW. end of Bailey's Island, S. by E.; Ram Island, N. by W.	12½	......do	69	63½	45	
	128 Bl	...do	43	42	70	11	Casco Bay, between Cow Island and Cow Island Ledge	9	Sandy mud, gravel, shells	67	62	54½	
+	129 Bl	...do					Bluelight Cove	2	Muddy	68	63	57	
+	130 Bl	Aug. 3					......do	2	......do	66	61	57	
	131 Bl	Aug. 4	43	41½	70	10½	Casco Bay, Cow Island, W. ½ mile	12	Gravelly	70	65	51	

	132 Bl	...do	43	40	70	05	Casco Bay, between Halfway Rock and Inner Green Island	12½	Gravel and shells	73	63	48½	
	133 Bl	...do	43	38¼	70	04¾	Mouth Casco Bay, Halfway Rock, E. by N. about 3 miles	19	Sandy and rocky	75	62	46½	
	134 Bl	...do	43	40½	70	03½	Mouth Casco Bay, Halfway Rock, SSE.; Eagle Island, NE. ½ N.	18½	Coarse sand, gravel	74	60	43½	
+	135 Bl	...do					Bluelight Cove	3¼	Muddy	71	68	56	
+	136 Bl	...do					......do	3	......do	70	62	58	
	137 Bl	Aug. 5	43	35½	70	04½	West Cod Ledge, off Portland, Cape Elizabeth, W. ½ S.; Halfway Rock Light, NE. ½ N.	13	Sandy and rocky	72	64	46	
	138 Bl	...do	43	32	69	58	Portland Head Light, NW. ½ W. 15 miles; Seguin Island, NE. by E. 15 miles ("18 miles off Cape Elizabeth" D. L.)	48–54	Muddy	65	64	39½	D. and T.
+	139 Bl	Aug. 6					Bluelight Cove	3	......do	68	63	57	
+	140 Bl	...do					......do	2¾	......do	68	62	59	
	141 Bl	...do	43	31	69	59½	Cape Elizabeth, NW. by W. about 14 miles; Seguin Island, NE. by E. about 16 miles.	48–54½	......do	69	64	38	D. and T.
	142 Bl	...do	43	28½	69	59	Cape Elizabeth, NW. 15 miles; Seguin Island Light, NE. by E. ½ E. 18 miles.	48	Stones and mud	72	64	37½	T.
	143 Bl	...do	43	27¾	69	57	2 miles SE. of 142 Bl	64	Muddy	68½	65	36	D.
+	144 Bl	...do					Bluelight Cove	2	......do	64	61	57	
+	145 Bl	Aug. 7					......do	2	......do	65	61	58	
	146 Bl	...do	43	43	70	08½	Casco Bay, Chandler's Cove, Great Chebeag Island	7	Mud, dead eel-grass	70	59	54	
+	147 Bl	Aug. 11					Casco Bay, Broad Sound, between Bates Island and Eagle Island.	25	Gravelly	65	57	47½	
+	148 Bl	...do					Casco Bay, Luckses' Sound, between Stepping Stones and Crotch Island.	15	Soft mud	65	55½	45	
	149 Bl	Aug. 12	43	35	70	05	West Cod Ledge, off Portland, Cod Ledge (buoy?) NE. ½ E. 1 mile.	13	Sandy, with shells	63	61	47	
	150 Bl	...do	43	28½	69	52½	Cape Elizabeth, NW. by W. ½ W. about 20 miles; Seguin Island, NE. by N., about 15 miles.	68	Muddy	64	62½	38	T.
	151 Bl	Aug. 13	43	42¼	69	47	Seguin Island, E. by S. 1 mile; Jackknife Ledge buoy, N. by E. ¾ mile.	12	Sandy	64	52	47	T.
	152 Bl	...do	43	42	69	38	Seguin Island, WNW. 5 or 6 miles	33	Sandy and rocky, some mud	64	57	41½	
	152ª Bl	...do					Same locality, Cod Stomach						
+	153 Bl	Aug. 14					Bluelight Cove	3	Mud	60	58	56	
	154 Bl	...do	43	39	70	13	Main channel, Portland Harbor	9	Sand and mud	62	57	55½	
	155 Bl	...do	43	42¾	70	10¾	Casco Bay, between Clapboard and Long Islands	9	Muddy	64	55½	54	T.
+	156 Bl	Aug. 19					Bluelight Cove	2	......do	61	58	57	
	157 Bl	Aug. 20	43	35¼	69	38	Seguin Island, NNW. 9 miles	75	......do	62	59	38	
	158 Bl	...do	43	40	69	39½	Seguin Island, NW. 5 miles (about same as No. 201 Bl)	40	Sand and gravel, rocks	65	58	38½	
+	159 Bl	Aug. 24					Bluelight Cove	2	Muddy	63	61	60	
+	160 Bl	...do					......do	2	......do	62	58	57	
+	161 Bl	Aug. 25					......do	2	......do	61	58	56	
+	162 Bl	Aug. 27					......do	2	......do	60	58	57	
+	163 Bl	Aug. 29					......do	2	......do	66½	61	57	
	164 Bl	{Aug. 30} {Sept. 1}	43	38	70	09	Off Portland, Witch Rock buoy 1 mile west	11–14	Rocky	58	54	50¼	
	165 Bl	Sept. 3	43	47½	69	55	Casco Bay, Quahog Bay, east of south end of Pole Island	5	Muddy	63	59½	53	
	166 Bl	...do	43	47½	69	55	Casco Bay, Quahog Bay, east of north end of Pole Island	6	......do	63	59	54½	
	167 Bl	July 11	43	41	70	11	Casco Bay, off Cow Island	16	Mud				
	168 Bl	...do	43	40½	70	10¾	Casco Bay, middle of Hussey Sound	17	Rocky				
+	169 Bl	...do					Casco Bay, off Cow Island	(?)	Sand and rocks				
+	170 Bl	...do					......do	(?)	(?)				Tan.
+	171 Bl	...do					Casco Bay, off Hog Island	20	Sand and stones				

DREDGINGS BY THE BLUELIGHT, 1873—Continued.

	Serial number.	Date.	Latitude.	Longitude.	Locality.	Depth in fathoms.	Nature of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Apparatus used.
			° ′	° ′				°	°	°	
+	172 Bl	July 11			Casco Bay, off Crotch Island	(?)	(?)				
+	173 Bl	July 14			Casco Bay, off Overset Island	16	Clean gravel				T.
+	174 Bl	...do			Casco Bay, off mouth of Bluelight Cove, drifting north	15–19	Sand and sponge				
+	175 Bl	...do			Casco Bay, off north end of Hog Island	15	Sand				
	176 Bl	...do	43 44	70 09½	Casco Bay, between Great Chebeag and Basket Islands	7–8	Mud				
	176ª Bl	...do			......do (?)	(?)	(?)				
+	177 Bl	...do			Casco Bay, off North end of Long Island	(?)	Mud				Tan.
+	178 Bl	July 15			Mouth Casco Bay, off Inner Green Island	22	Rocky				
+	179 Bl	...do			......do	17	Sandy				
	180 Bl	...do	43 40½	70 04	Casco Bay, off Jewell's Island	(?)	(?)				
+	181 Bl	July 16			(?)	(?)	Muddy				T.
+	182 Bl	...do			(?)	15–23	Shelly and Spongy				
+	183 Bl	...do			(?)	(?)	......do				
	184 Bl	July 17	43 36¼	70 02	Off Portland, ENE. of West Cod Ledge	14–20	Hard and rocky				
+	185 Bl	...do			Off Portland, WSW. of West Cod Ledge 1½ miles	10–15	......do				
+	186 Bl	...do			Off Portland, near 185 Bl	10	......do				
	187 Bl	...do	43 34¼	70 08	Off Portland, SSW. of West Cod Ledge 3 miles	20–22	......do				
+	188 Bl	July 18			Casco Bay, off Cow Island	17	Sandy				T.
+	189 Bl	...do			......do	13½	Sand and stones				
+	190 Bl	...do			Casco Bay, between Cow Island and Crow Island	14	......do				
	191 Bl	July 21	43 36½	70 04½	Off Portland, near West Cod Ledge	28	Mud and stones				
+	192 Bl	...do			Entrance to Portland Harbor, little west of 122 Bl	10	Rocky and shelly				
+	193 Bl	July 22			Casco Bay, off Whaleboat Island	(?)	(?)				
+	194 Bl	July 24			Casco Bay, off Bateman's (Bates?) Island	13½	Gravel and br. shell				T.
+	195 Bl	...do			Casco Bay, between Ministerial and Eagle Islands, the monument on Mark Island showing over north end of Eagle Island.	32	Gravel and stones				
	196 Bl	July 31	43 35½	70 01	Off Portland, 1 mile east of East Cod Ledge	(?)	(?)				
+	197 Bl	...do			Entrance to Portland Harbor, near 192 Bl	11	Hard				
+	198 Bl	Aug. 4			Casco Bay, Haddock Grounds, Broad Sound	12–18	Gravel and shells				
	199 Bl	...do	43 46	70 05	Casco Bay, off Chebeag Point	11½	Mud				
	199ª Bl	...do	43 43½	70 10	Casco Bay, between Basket and Little Chebeag Islands	(?)	(?)				
	200 Bl	Aug. 13	43 39½	69 38	Seguin Island, NW. 6 miles (see 152 Bl)	35	Muddy				
	201 Bl	Aug. 20	43 37¼	69 51	Seguin Island, NW. 5 miles	45	Rocky and sandy				
+	202 Bl	Aug. 25			Off Portland, East Cod Ledge	(?)	(?)				
+	203 Bl	Aug. 27			Casco Bay, between Peak's Island and Overset Island	18	Rock and sponges				
	204 Bl	...do	43 37	70 01¼	Off mouth Casco Bay, 2 miles off Halfway Rock; the locality mentioned on page 357 of Professor Verrill's Explorations of Casco Bay, Proc. Am. Ass. Adv. Sci., 1873.	27½	Sand, gravel, shells, mud				

+	205 Bl	Aug. 28					Casco Bay, off Whaleboat Island	18	Gravel and shells				
+	206 Bl	Aug. 29					Off mouth of Casco Bay, west of Halfway Rock	(?)	Muddy, &c				
+	207 Bl	do					Casco Bay, Broad Sound	(?)	Muddy and hard, mixed				
+	208 Bl	Aug. 30					Mouth Casco Bay, off Ram Island	18	Sandy, muddy, &c				
	209 Bl	do	43	39	70	08	Mouth Casco Bay, SW. of Outer Green Island to Long Island.	15	Rocky				
+	210 Bl	do					Casco Bay, off Stepping Stones	12	Muddy ?				T.
	211 Bl	do	43	34½	70	07½	Off Portland, Cod Ledge Rock	12½	(?)				
	212 Bl	(?)	43	29½	69	30	Cape Elizabeth, WNW. 30 miles	95	Muddy				

STATIONS FOR 1874 AND 1875, WITH HEADQUARTERS AT NOANK, CONN., AND WOOD'S HOLL, MASS.

In 1874, the headquarters of the United States Fish Commission were established at Noank, Conn., and the area covered by its dredgings included Fisher's Island Sound; the eastern part of Long Island Sound; Block Island Sound; and Gardiner's and Peconic Bays; and also extended some distance to the east, south, and southwest of Block Island. In 1875, with headquarters at Wood's Holl, Mass., dredgings were carried on in Vineyard and Nantucket Sounds; Buzzard's Bay; over a portion of Nantucket Shoals; to the southward of Nantucket Island and Martha's Vineyard; and also on and about Southwest Shoal. The dredgings were all made by the United States steamer Bluelight, Commander L. A. Beardslee, and a separate series of numbers, to designate the stations, was employed for each year. To facilitate the recording of all the dredging stations of the United States Fish Commission on charts, and to bring the southern ones into uniformity with those made to the north of Cape Cod in more recent years, and already recorded both on charts and in reports prepared for publication in a single series of numbers ranging from 1 to 378, 400 has been added to the 1874 dredgings and 600 to those of 1875. In this way all the dredging stations from 1874 to 1879, inclusive, are included in a single series.

The temperature observations recorded in the two following tables were mostly taken with much care. Former experiences had proved that the Miller-Casella thermometers were slow in acting, requiring from three to ten minutes (according to the depth of water) to obtain a correct reading, and they were, therefore, always left down a suitable length of time. The bottom and surface temperatures, in nearly all cases, were taken with Miller-Casella self-registering thermometers; occasionally a United States naval thermometer was employed for surface temperatures, and the same instrument was generally employed for the air.

STATIONS FOR 1874.

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Temperatures. Air.	Surface.	Bottom.	Apparatus.
	1874.				°	°	°	
401	July 13	Fisher's Island Sound, West Clump, bearing S.	7½	Mud	......	......	......	D.
402	13	Fisher's Island Sound	9½	Sand	......	......	......	D.
403	13	......do	11½	......do	......	......	......	D.
404	13	Fisher's Island Sound, off Latimer's Reef.	3½	Rocky	......	......	......	D.
405	....	(No record.)						
406	July 14	Fisher's Island Sound, N. of Young's Rock.	11	Rocky	......	......	......	D.
407	14	Fisher's Island Sound, NW. of Seal Rocks.	9	Sand, stones	......	......	......	D.
408	14	Fisher's Island Sound, N. by E. of Wicopessit.	11½	Clay	......	......	......	D.
409	14	Fisher's Island Sound, Lord's Channel.	11½	Rocky	......	......	......	Tan.
410	14	Fisher's Island Sound, off Napatree Point.	2½	Sand	......	......	......	T.
411	16	Watch Hill Light-House, R. I., NNW., distant about ⅝ mile.	11	......do	......	......	......	D.

STATIONS FOR 1874—Continued.

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Temperatures. Air.	Surface.	Bottom.	Apparatus.
	1874.				°	°	°	
412	July 16	Watch Hill Light NNE., distant nearly ½ mile.	5	Rocky				Tan.
413	16	......do	5	....do				Tan.
414	16	Fisher's Island Sound, off Groton Long Point.	7	Gravel				D.
415	16	Fisher's Island Sound, Groton Long Point NW. by N. ½ mile.	7	....do				D.
416	17	Fisher's Island Sound, ¾ mile W. by N. of N. Hammock Light-House.	6	Sand, mud				D.
417	17	Long Island Sound, New London Light N. by W., distant about 2¼ miles.	8	Sand				D.
418	17	Long Island Sound, New London Light N., distant 1⅞ miles.	9	Sand, mud				T.
419	17	Long Island Sound, Little Gull Island Light bearing S. by E. 2 miles.	40	Gravel				D.
420	20	Fisher's Island Sound, ¼ mile N. of West Clump.	11½	...do				D.
421	20	Fisher's Island Sound, N. Hammock Light W. by S. ⅓ mile.	12½	Sand, gravel				D.
422	20	Fisher's Island Sound, N. Hammock Light S. by W. ½ W. ¼ mile.	13	....do				D.
423	20	Fisher's Island Sound, N. Hammock Light E. ⅓ mile.	17	Gravel				D.
424	20	Fisher's Island Sound, N. Hammock Light E. by N. 1 mile.	7½	Sand, mud				D.
425	20	Fisher's Island Sound, N. Hammock Light NE. by E. ½ E. 1¼ miles.	10¾	Mud				D.
426	20	Fisher's Island Sound, near Middle Clump.	8	Sand				T.
427	22	Fisher's Island Sound, ¼ mile NW. of Middle Clump.	11½–9½	Sand, shells	65	64	62. 5	D.
428	22	Fisher's Island Sound, ¼ mile NNW. of Middle Clump.	11	....do	65	64	62. 5	D.
429	22	Fisher's Island Sound, ⅛ mile NNE. of W. Clump.	8	....do	65	64	63	D.
430	23	Fisher's Island Sound, Eelgrass Light-Ship E. by W., distant ½ mile.	7	Sand, gravel	66	64	62. 5	D.
431	23	Fisher's Island Sound, between Latimer's Reef and Young's Rock.	10½	Sand, gravel, shells.	65. 5	62. 5	61. 5	D.
432	23	Fisher's Island Sound, eastward of Latimer's Reef.	11	Coarse sand, shells, rocks.	65	62. 5	61	D.
433	24	Fisher's Island Sound, Groton Long Point NE. by N., distant ⅓ mile.	8	Sand, shells	72	66	63	D.
434	24	Fisher's Island Sound, between Sea-Flower Reef and Groton Long Point.	7	....do	71	65. 5	62. 5	D.
435	24	Long Island Sound, Race Point bearing E., distant 2⅓ miles.	50	Rocky, with mussels.	72	68	59	D.
436	24	Long Island Sound, about ¼ mile SW. of 435.	50	Rocks, gravel	69	68	58	D.
437	24	Block Island Sound, off Culloden Point, Long Island.	12½	Sand, mud	74	66	61	T.
438	24	Block Island Sound, NW. of Culloden Point, Long Island.	12	Sand				D.
439	27	Fisher's Island Sound, eastern part of Sweeper Sound.	4	Sand, shells	70. 5	66. 5	65	D.
440	27	Fisher's Island Sound, house on Ram Island bearing NE. ½ E.	4	Sand	68. 5	66. 5	65. 5	D.
441	27	Fisher's Island Sound, SW. of Ram Island ¼ mile.	3½	....do	68. 5	66. 5	65	D.
442	27	Fisher's Island Sound, off Middle Clump.	14	Stones, gravel	68. 5	66. 5	64	D.
443	27	......do	10½	....do	67	66	64. 5	D.
444	29	Fisher's Island Sound, NW. of Eel grass Light-Ship, distant about ⅜ mile	7	Sand, gravel, shells				D.

STATIONS FOR 1874—Continued.

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Temperatures. Air.	Temperatures. Surface.	Temperatures. Bottom.	Apparatus.
	1874.				°	°	°	
445	July 30	Block Island Sound, SE. ½ E. of Race Rock nearly 3 miles; E. of Little Gull Island Light-House 5⅜ miles.	45	Sand	76	62.5	57	D.
446	30	Block Island Sound, ⅞ mile about W. by S. of 445.	40	....do	......	......	......	D.
447	30	Block Island Sound, 1⅝ miles about W. by S. of 445.	24	....do	......	......	......	D.
448	30	Mouth of Gardiner's Bay, Long Island, Gardiner's Point Light-House S. about ¾ mile.	14½	Gravel	71	66	63.5	D.
449	30	Gardiner's Bay, Long Island	6½	Mud	71.5	67.5	64.5	D.
450	30	......do	4½	Sand	72	66.5	65	D.
451	30	......do	3	Gravel	72	66.5	65	T.
452	30	......do	6½	Mud	69.5	68.5	65	D.
453	31	Block Island Sound, Watch Hill Light N. by W. 3 miles.	18	Sand	68	66	56	D.
454	31	Block Island Sound, Watch Hill Light N. by E. 3 miles.	18½	Mud, shells	......	......	......	T.
455	Aug. 3	Long Island Sound, Bartlett's Reef Light-Ship E. about 1½ miles.	22	Sand, mud	60.5	64.5	63.5	D.
456	3	Long Island Sound, Bartlett's Reef Light-Ship E. about 2½ miles.	14	Gravel, sand	59	64	63	D.
457	3	Long Island Sound, Bartlett's Reef Light-Ship E. ½ N. about 3 miles.	15½	Sand, gravel, shells	67	64.5	63.5	D.
458	3	Long Island Sound, Hatchett's Point NW. about 2 miles.	19	Gravel, shells	61.5	64	63	D.
459	3	Long Island Sound, off Saybrook, Conn.	4	Sand	67	64.5	63.5	T.
460	3	Long Island Sound, between Cornfield Point and Long Sand Shoal.	9	....	......	......	......	T.
461	4	Little Peconic Bay, Long Island.	7½	Gravel, shells	66.5	74	71.5	D.
462	4	......do	7	Sand, shells	......	......	......	D.
463	4	......do	7	Gravel	......	......	72	T.
464	4	......do	13½–10	Sand, gravel	67	72	71.5	D.
465	4	......do	14	Sand, shells	......	......	......	D.
466	4	Great Peconic Bay, Long Island.	5½	Mud, sand, gravel	67.5	74	72	D.
467	4	......do	5½	Sand	68	73	72.5	D.
468	4	......do	4½	Gravel	66.5	73	72.5	D.
469	4	Little Peconic Bay, Long Island.	9½	Sand, shells	66	72.5	71	D.
470	4	......do	4	Sand	......	......	......	T.
471	5	Gardiner's Bay, Long Island	3½	....do	......	70.5	68	D.
472	5	......do	4	Sand, shells	......	......	......	T.
473	6	Block Island Sound, Watch Hill Light N. ½ W., distant 3 miles.	18–23	Sand	63	63	59 / 60	T.
474	6	Block Island Sound, Montauk Point SW. ½ S. 6 miles.	17	....do	......	63.25	60	D.
475	6	Block Island Sound, Block Island Light ENE., distant about 3 miles.	19½	Mud	......	63.5	60	D.
476	6	Block Island Sound, Block Island Light SE. by E. ½ E. about 4 miles.	18½	Sand, mud	......	64	60	D.
477	6	Block Island Sound, Block Island Light ESE., about 7 miles.	19	Mud	......	64	59	D.
478	6	Block Island Sound, Watch Hill Light NW. ½ W. about 4 miles.	24	Sand	70	64	58.5	D.
479	6	Block Island Sound, Watch Hill Light NW. ½ N. about 3 miles.	22	Sand, shells	......	......	......	T.
480	10	In West Harbor of Fisher's Island.	4	Sand	74	66.5	65.25	D.
481	10	......do	3½	....do	74	66.5	65.25	D.
482	10	In West Harbor of Fisher's Island, off Clay Point.	5½	Sand, mud	74	66.5	......	T.
483	10	Off Hawk's Nest Point, inner side of Fisher's Island.	5½–2½	Sand, gravel, to mud and weeds.	74	......	......	T.
484	10	Fisher's Island Sound, between Middle Clump and Ram Island Reef.	12½	Mud, shells	73.5	69	64.75	D.
485	11	Block Island Sound, about 1 mile S. of E. end of Fisher's Island.	15	Sand	75	66	61	D.

STATIONS FOR 1874—Continued.

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Temperatures. Air.	Temperatures. Surface.	Temperatures. Bottom.	Apparatus.
	1874.				°	°	°	
486	Aug. 11	Block Island Sound, about ⅜ mile S. of E. end of Fisher's Island.	8½	Sand	75	65.5	62.5	D.
487	11	Block Island Sound, about ½ mile off centre of Fisher's Island.	8	Stones	72	65.5	63	D.
488	11	Block Island Sound, off Mount Prospect, Fisher's Island, about ¼ mile from land.	7½	....do	76	66.5	63	D.
489	11	Block Island Sound, about ½ mile westward of 488.	6	Stones, gravel	78	66.5	63.25	D.
490	11	Block Island Sound, about ⅜ mile SE. of Race Point.	5½	....do	76.5	66.5	63.25	D.
491	11	Block Island Sound, about 1¼ miles S. of Mount Prospect.	32½	Sand, shells	75	66.5	58.5	T.
492	12	Noank Harbor	2	Mud	......	......	......	D.
493	12	Fisher's Island Sound, between Sea-Flower and Horse-Shoe Reefs.	4¾	Sand	76	67.5	62.5	D.
494	12	...do	4½	Sand, gravel	75	67	64.5	D.
495	12	Fisher's Island Sound, W. of Sea-Flower Reef Beacon.	6	Fine sand and mud.	......	67	64.5	T.
496	12	Fisher's Island Sound, W. of Sea-Flower Reef Beacon about 1 mile.	6	Sand, mud	72	67	64.5	T.
497	13	Block Island Sound, Montauk Point Light SSE. about 6 miles.	15½	Sand	74	65	64	D.
498	13	Block Island Sound, Montauk Point Light SSE. about 6½ miles.	9	Fine sand and gravel.	71	65	64	D.
499	13	Block Island Sound, Montauk Point Light SSE. about 7¼ miles.	5½	Coarse sand and rocky.	72	65	64	D.
500	13	Block Island Sound, Montauk Point Light S. by E. 4½ miles.	19	Fine sand	72	65	63.5	D.
501	13	Block Island Sound, Montauk Point Light S. by W. about 3 miles.	20–8	Sand, shells	72	66	63.5	D.
502	13	Block Island Sound, Montauk Point Light SSW. about 2½ miles.	8	Stony	72.5	65	65	D.
503	13	Off Montauk Point, Light-House WSW. about 2 miles.	7½	Rocky	72	65	64.5	D.
504	13	Off Montauk Point, Light-House W. about 2 miles.	7½	....do	72	65	64.5	D.
505	14	Fisher's Island Sound, between Eelgrass Light-Ship and White Rock.	5¼	Sand, gravel	67	66	64.5	D.
506	14	Fisher's Island Sound, about 1 mile E. by N. from Eelgrass Light-Ship.	6	....do	67	......	......	D.
507	14	Fisher's Island Sound, Stonington Light NE. ½ E. about 1 mile.	5	Sand	67	......	......	T.
508	14	Fisher's Island Sound, Eelgrass Light-Ship WNW. ¾ mile.	5½	Rocky	67	......	......	D.
509	17	Fisher's Island Sound, Eelgrass Light-Ship NW. by W. about ¾ mile.	7	Stones	69.5	67	63	D.
510	17	Fisher's Island Sound, Eelgrass Light-Ship WNW. 1 mile.	6½–3½	Sand, rocky	69.5	67	63	D.
511	17	Fisher's Island Sound, Eelgrass Light-Ship W. by N. about 1¼ miles.	5½	Hard, rocky	69	......	......	Tan.
512	17	Fisher's Island Sound, Stonington Light ENE. about 1½ miles.	4	Sand	69	66.5	60.5	D.
513	17	Fisher's Island Sound, Eelgrass Light-Ship W. ½ N. about 1 mile.	7	Hard, stones	70	67	63	D.
514	17	Fisher's Island Sound, Eelgrass Light-Ship E. about 1 mile.	7½	Sand	70	66.5	63	D.
515	18	Off Block Island, Montauk Point W. about 9 miles.	20	....do	71	66	47.5	D.
516	18	Off Block Island, Montauk Point NW. by W. ½ W. about 11 miles.	25	Sand, shells	70	67.5	45.5	D.
517	18	......do	23½	....do	70	......	......	D.
518	18	......do	23½	....do	70	......	......	D.
519	18	Off Block Island, Old Harbor Point, Block Island N. 5 miles.	11	Sand, stones	......	67	55	D.

STATIONS FOR 1874—Continued.

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Temperatures. Air.	Temperatures. Surface.	Temperatures. Bottom.	Apparatus.
	1874.				°	°	°	
520	Aug. 18	Off Block Island; Old Harbor Point, Block Island, N. 5 miles.	11	Sand, stones	70	......	......	D.
521	18	Off New Shoreham, Block Island	14	Gravel, stones	70	66	57.5	D.
522	18	......do	18	Sand, gravel	70	66.5	52.5	D.
523	19	Off Block Island, New Shoreham NW. by N. about 6 miles.	14	....do	73	66.5	54	D.
524	19	Off Block Island, New Shoreham NNW.	14½	Coarse sand	73	66	50.5	D.
525	19	Off Block Island, SE. side	14½	Gravel	69.5	66.5	53	D.
526	19	SE. from Point Judith, Rhode Island, about 4 miles.	13½	Sand, gravel	75	67.5	54.5	D.
527	19	S. from Point Judith, Rhode Island, about 2½ miles.	9	Stones	......	69.5	61	D.
528	19	W. from Point Judith, Rhode Island, about 3 miles.	4	Rocks, sand	76	67.5	63	D.
529	19	Off Narragansett Beach, Rhode Island.	8½	Sand, gravel	......	......	......	T.
530	19	......do	10½	Stones, gravel	......	......	......	T.
531	21	Block Island Sound, Watch Hill Light N. ½ E., distant 3 miles.	21	Sand	80	67.25	56.5	D.
532	21	Block Island Sound, SW. ¾ S. of No. 531, distant ½ mile.	20	....do	80	67.25	......	T.
533	21	Block Island Sound, WSW. of No. 531, distant ⅝ mile.	17½	....do	79.5	67.25	......	T.
534	21	Block Island Sound, about S. ¾ E. of east point of Fisher's Island ⅞ mile.	9	Gravel	78	66.5	63.5	D.
535	21	Block Island Sound, east end of Fisher's Island N. by E. about 2 miles.	19½	Sand	78	67	57.5	D.
536	24	Fort Pond Bay, east end of Long Island.	7½	Mud	76	73.5	65.5	D.
537	24	Off Fort Pond Bay, east end of Long Island.	6½	Sand, gravel	......	......	......	T.
538	24	Napeague Bay, off Culloden Point, Long Island.	8½	Sand	......	67.5	65.5	D.
539	24	Napeague Bay, east end of Long Island.	5–8	....do	......	......	......	T.
540	24	......do	6–7	....do	......	......	......	D.
541	24	Block Island Sound, Race Point N. about 1⅓ mile.	42	Stony	70.5	66	......	D.
542	25	Off Hay Harbor, west end of Fisher's Island.	4½	Sand	70	65.5	64.5	D.
543	25	Off west end of Fisher's Island, Race Point about S., distant ½ mile.	7½	Mud, sand	70	65.5	64.5	D.
544	25	Off west end of Fisher's Island, Race Point SSE. 1 mile.	8½	Fine sand	......	......	......	T.
545	25	Off west end of Fisher's Island, Race Point about S. ¼ mile.	5½	Rocks	......	......	......	D.
546	25	Fisher's Island Sound, between East Clump and Ram Island buoy.	7½	Hard	74.5	65.5	65	D.
547	25	......do	14	....do	......	......	......	D.
548	25	Fisher's Island Sound, ESE. from house on Ram Island.	7½	....do	......	......	......	D.
549	27	Off Niantic Bay, Connecticut, W. of Two-Tree Island.	5	Sand	70.5	65	64	D.
550	27	Off Niantic Bay, Connecticut, between Black Point and Two-Tree Island.	5½	....do	......	......	......	T.
551	27	......do	5½	....do	......	......	......	D.
552	27	Long Island Sound, off Saybrook	6	....do	......	......	......	D.
553	27	Long Island Sound, Saybrook Light NE. 2 miles.	7½	....do	......	......	......	T.
554	27	Long Island Sound, Plum Island Light SE. by E. 3 miles.	22	Gravel	73.5	66	65	D.
555	27	......do	26	....do	73.5	66	65	D.
556	30	Off Cox Ledge, ESE. from Block Island about 20 miles. (The shallowest part of Cox Ledge lies in about 41° 11½′ N. Lat. and 71° 02′ W. Long.)	20	Rocky	......	......	......	D.
557	30	Off Cox Ledge	21	Sand, rocks	67	62	51.5	D.
558	30	......do	21	....do	......	......	......	Tan.
559	30	......do	21	....do	......	......	......	D.

STATIONS FOR 1874—Concluded.

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Temperatures.			Apparatus.
					Air.	Surface.	Bottom.	
	1874.				°	°	°	
560	Aug. 30	About 11 miles SE. by E. from Old Harbor Point, Block Island.	21	Rocky				Tan.
561	30	About 10 miles SE. by E. from Old Harbor Point, Block Island.	34	Mud	70	64	52	D.
562	30	do	34	do	70	64	52	D.
563	31	Block Island Sound, Watch Hill Light N. by W. about 3⅓ miles.	19	Sand				T.
564	31	Block Island Sound, Watch Hill Light N. by W. ½ W. about 3¼ miles.	18	Sand				O. T.
565	31	Block Island Sound, Watch Hill Light NNW. about 3⅜ miles.	17	do				O. T.
566	31	Block Island Sound, Watch Hill Light NNW. about 3⅛ miles.	18	do				D.
567	31	do	18	do				D.
568	Sept. 2	On Cox Ledge	19½	Rocky				D.
569	2	do	20	Sand				D.
570	2	do	18½	Rocky				D.
571	2	do	21	do				D.
572	2	do	21	do	72.5	62.5	50	D.
573	2	do	18½	do				D.
574	2	do	19	do				D.
575	2	do	18	do				D.
576	2	do	17	do				D.
577	3	About 8 miles SSE. from Block Island.	19	do				D.
578	3	Crab Ledge, about 7 miles SE. of Block Island.	10½	do				D.
579	3	Crab Ledge, about 8 miles SE. of Block Island.	10¼	do				D.
580	3	About 7 miles off New Shoreham, Block Island.	8–10	do				D.

(There are no numbers 581–600.)

STATIONS FOR 1875.

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Air.	Surface.	Bottom.	Apparatus.
	1875.							
601	July 12	Vineyard Sound, Tarpaulin Cove Light W. by S., Job's Neck NE. by E. ½ E.	11½	Sand, gravel	70			D.
602	12	Vineyard Sound, Tarpaulin Cove Light WSW. 1 mile.	11		70			D.
603	12	Vineyard Sound, Tarpaulin Cove Light NW. by W. ¾ mile.	17		70			D.
604	12	Vineyard Sound, Menemsha Bight.	8		70			D.
605	12	do	5–7					D.
606	12	do	5–7					D.
607	14	Vineyard Sound, Lackey's Bay	6½	Gravel				D.
608	14	Between Martha's Vineyard and No Man's Land, Gay Head Light N. ½ E. 2½ miles.	10	Sand, shells				D.
609	14	North of No Man's Land, Lone Rock S. ⅛ mile.	6	Rocky				D.
610	14	North of No Man's Land	4	Sand				T.
611	14	do	5	do				D.
612	14	Vineyard Sound, Menemsha Bight.	8	do				T.
613	14	Vineyard Sound, Tarpaulin Cove.	14½	Gravel				D.
614	15	Vineyard Sound, S. and E. of Davis Neck Shoal.	5⅓	Sand				D.
615	15	Vineyard Sound, S. of Monant Point.	15	Sand, gravel				D.
616	15	Vineyard Sound, off Davis Neck Shoal.	13	Sand				T.
617	15	Vineyard Sound, off East Chop of Holmes' Hole.	13½	Hard				D.
618	15	Vineyard Sound, off Falmouth	4½	Sand				T.
619	15	do	5	do				T.
620	20	Vineyard Sound, Cuttyhunk Light NW. by N. 2½ miles, Sow and Pigs Light-Ship W. by N.	14	Hard				D.

STATIONS FOR 1875—Continued.

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Temperatures.			Apparatus.
					Air.	Surface.	Bottom.	
	1875.				°	°	°	
621	July 20	Vineyard Sound, Cuttyhunk Light NW. by N. 3⅝ miles, Sow and Pigs Light-Ship WNW.	19	Hard				D.
622	20	Vineyard Sound, Cuttyhunk Light N. 1¾ miles, Sow and Pigs Light-Ship W. by N.	10					D.
623	20	do						D.
624	20	Vineyard Sound, Menemsha Bight.						T.
625	21	Nantucket Sound; Oak Bluffs Hotel W. by S., W. end of Squash Meadow E. by N.	5	Sand				D.
626	21	Nantucket Sound, between Oak Bluffs and Squash Meadow.	6	do				D.
627	21	do	6	do				T.
628	21	Nantucket Sound, Oak Bluffs NW., Cape Poge SE. by E.	5½	do				T.
629	21	Nantucket Sound, about same as 628.	5½	do				T.
630	21	do	5	do				D.
631	26	Nantucket Sound, Cross-Rip Light-Ship E. by S. ½ mile.	10½	Sand	76	69	68.5	D.
632	26	Nantucket Sound, close to Cross-Rip Light-Ship.	11½	Sand, gravel, shells.	76	69	69	D.
633	26	Nantucket Sound, Cross-Rip Light-Ship W. by S. ¾ mile.	12	Sand, gravel	76	69	69	D.
634	26	Nantucket Sound, Cross-Rip Light-Ship WNW. about 1 mile.	10	do	76	69	69	D.
635	26	Nantucket Sound, Brant Point Light, Nantucket, S. by E. 4 miles.	7½	Muddy sand	76	71	69.5	D.
636	26	Nantucket Sound, Brant Point Light SSE. 2½ miles.	8	Mud	76			D.
637	28	Nantucket Shoals, Sankoty Head Light west, distant 10 miles.	16	Sand, shells		59	58	D.
638	28	Nantucket Shoals, about same as 637.	15½	do		59	58	T.
639	28	Nantucket Shoals, Sankoty Head Light west about 9 miles.	14	Sand		60	59	D.
640	28	Nantucket Shoals (a little S. of 639?).	11	Sand, shells		60	59	D.
641	Aug. 4	Buzzard's Bay, Woepecket buoy W. by S. ¾ mile.	7	do	75			D.
642	4	Buzzard's Bay	8	Hard		68	67	D.
643	4	do	5	Sand		69	69	D.
644	4	do	5	do	75	69	69	D.
645	4	Buzzard's Bay, buoy No. 8 off Scraggy Neck NE. ½ mile.	6	Sand, shells				D.
646	4	Buzzard's Bay, off Cataumet Harbor.	6	Sand	75			T.
647	4	do	6	do	75			T.
648	4	Buzzard's Bay	6	do	75			D.
649	5	Vineyard Sound, Tarpaulin Cove Light N. 1 mile.	16	Hard	71			D.
650	5	do	18	do	71	68	67	D.
651	5	Buzzard's Bay, ¾ mile N. of Penikese.	16	Sand		65	64	D.
652	5	do	16	do				D.
653	5	Buzzard's Bay	8½	Mud	71	68	66	D.
654	5	do	9½	Soft mud	71			D.
655	5	do	10	Sand, mud				T.
656	5	do	8	Mud	71	68.5	66	D.
657	5	do		do	71			D.
658	10	About ¾ mile off Gay Head	9	Gravel		66	64	D.
659	10	do	9	Hard	73	66	64	D.
660	10	do	9	do	73	66	64	D.
661	10	About 1⅝ miles off Gay Head	13	Shells		67	65	D.
662	10	Vineyard Sound	10	Sand				T.
663	10	Vineyard Sound, off Tarpaulin Cove.	14½	Hard		68	66	D.
664	10	do	16			67.5	66.5	D.
665	10	do	13½	Hard		67.5		D.

STATIONS FOR 1875—Continued.

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Temperatures.			Apparatus.
					Air.	Surface.	Bottom.	
	1875.				°	°	°	
666	Aug. 11	Off Chappaquiddick, SE. part of Martha's Vineyard.	3	Sand	......	......	......	T.
667	11	......do	5	Sand, stones	72	71.5	71	D.
668	11	......do	6	Sand, gravel	72	......	......	D.
669	11	Off Skiff Island, at SE. corner of Martha's Vineyard.	7	Mud, shells	72	......	......	D.
670	11	......do	29	Sand	74	68	66	D.
671	12	Great Point, Nantucket Island W. 5 miles.	7½	....do	72	56	56	D.
672	12	......do	8	....do	72	56	56	D.
673	12	......do	9	....do	72	......	......	T.
674	12	Sankoty Head, Nantucket Island, W. 1 mile.	6½	Sand, gravel	72	67	66	D.
675	12	Sankoty Head, Nantucket Island, WNW. 2 miles.	16	Hard	72	66	65	D.
676	12	A little west of 675	9	....do	76	......	......	D.
677	12	Sankoty Head, Nantucket, NW. 1 mile.	7½	....do	77	......	......	T.
678	12	Sankoty Head, Nantucket, W. ¼ mile.	4½	Sand, shells	78	......	......	T.
679	13	Nantucket Sound, off west side Nantucket Island.	5½	....do	80	76	70	D.
680	13	......do	7	Mud	80	......	70.5	D.
681	13	......do	5	Sand	80	71.5	71	D.
682	13	Nantucket Sound, Cross-Rip Light-Ship NW. 2⅔ miles.	10	Shells, sand	79	......	......	D.
683	13	Nantucket Sound, Cross-Rip Light-Ship E. about 3 miles.	10½	Sand	79	71	70.5	D.
684	13	Nantucket Sound, Cross-Rip Light-Ship E., Cape Poge Light SSW. 2⅓ miles.	10½	....do	......	71	71	D.
685	13	Vineyard Sound, off Falmouth	5	....do	78	......	......	T.
686	17	Buzzard's Bay, off Nye's Neck	7½	Mud, hard	......	76	......	T.
687	17	......do	6	Sandy mud	......	......	......	T.
688	17	......do	5	....do	......	......	......	D.
689	17	......do	7	Sand	......	......	......	D.
690	17	......do	8	Sand, mud	......	......	......	D.
691	17	Buzzard's Bay, off Wild Harbor, near N. Falmouth.	8	Sand, gravel	75	......	......	D.
692	17	Buzzard's Bay, off West Falmouth ¾ mile.	7½	Shells, gravel	75	......	72	D.
693	17	Buzzard's Bay, SW. of No. 692 about ½ mile.	7	Mud	75	76	73	D.
694	17	Buzzard's Bay, off Hamlin Point	3½	Hard	75	......	......	D.
695	17	......do	5	....do	75	75.5	70.5	D.
696	17	Buzzard's Bay, off Quamquissett Harbor.	7	Sand, mud	75	78.5	70.5	D.
697	23	Vineyard Sound, S. entrance to Quick's Hole.	7½	Stony, mussels	......	67	67	D.
698	23	......do	6	Sand, rocks	64	68.5	68.5	D.
699	23	Vineyard Sound, off Quick's Hole	7½	....do	64	......	......	D.
700	23	Vineyard Sound, south of Cuttyhunk Light 1 mile.	9½	Sand	......	66	65.5	D.
701	23	Vineyard Sound, off Cuttyhunk Light 1 mile.	9	Rocky	64	......	......	D.
702	23	Near mouth of Buzzard's Bay, Cuttyhunk Light ESE. 1 mile.	8½	Gravel	......	66	65	D.
703	23	Vineyard Sound, off south side of Cuttyhunk Island.	9	......	......	......	......	T.
704	23	......do	9	......	......	......	......	T.
705	23	Vineyard Sound, off Robinson's Hole.	15	Sand, gravel	66	68.5	66	D.
706	25	Vineyard Sound, off Falmouth	4	......	69	......	......	T.
707	25	......do	4	......	......	......	......	T.
708	25	......do	6	Sand	68.5	73	72	D.
709	25	......do	5	......	......	......	......	D.
710	31	Vineyard Sound	9	Hard	76	69	69	D.
711	31	......do	10	....do	76	68.5	69	D.
712	31	......do	13	....do	76	69	69	D.
713	31	......do	8	Shells, gravel	76	70	69.5	D.
714	31	......do	6	......	76	70	69.5	D.
715	31	......do	13	Hard, gravel	75	70	70	D.
716	Sept. 1	Off Gay Head, 3 miles SW. buoy No. 25.	17	Mud	......	66	61.5	D.
717	1	Southwest of Gay Head, distant 4 miles.	19	....do	......	66	60	D.

STATIONS FOR 1875—Continued.

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Temperatures. Air.	Surface.	Bottom.	Apparatus.
	1875.				°	°	°	
718	Sept. 1	Southwest of Gay Head, distant 6½ miles.	19	Mud, sand	......	65.5	60	D.
719	1	Southwest of Gay Head, distant 8 miles.	19	Hard, sand	......	60	58.5	D.
720	1	Southwest of Gay Head, distant 8½ miles.	19	Sand	......	......	......	T.
721	1	Southwest of Gay Head, distant 10 miles.	12	Hard	......	......	......	D.
722	1	Southwest of Gay Head, distant 11 miles.	14	....do	......	......	......	D.
723	1	Off NW. end of Devil's Bridge Reef, Gay Head.	9	Rocky	......	......	......	D.
724	1	......do	9	....do	......	......	......	D.
725	3	South of Cape Poge, Martha's Vineyard, in north part of Muskeget Channel.	4–1⅔	Sand	......	......	......	T.
726	3	About the same as 725	5	Sand, eelgrass	......	......	......	D.
727	3	......do	4	....do	......	......	......	D.
728	3	......do	1–4	....do	......	......	......	D.
729	3	About 3½ miles SE. of Cape Poge.	7½	Hard	......	......	......	T.
730	3	About 4 miles SSE. of Cape Poge.	9	Sand, gravel	......	......	......	D.
731	3	About ¾ mile S. of No. 730	9	....do	......	......	......	D.
732	....	(No record.)						
733	6	Off Martha's Vineyard	6	Hard	......	......	62	D.
734	....	(No record.)						
735	6	Off Martha's Vineyard, 1½ miles SE. of Squipnocket Point.	11	Sand	......	......	60	D.
736	....	(No record.)						
737	....	......do.						
738	7	Off Nantucket, ½ mile S. of Tuckernuck Island.	3½	Sand	......	......	65	D.
739	7	Off Nantucket, off S. side of Tuckernuck Island.	8	Coarse sand	......	......	65	D.
740	7	......do	8½	Sand	......	......	......	T.
741	7	......do	11	....do	......	......	......	D.
742	....	(No record.)						
743	8	2 miles S. of Great Round Shoal buoy, 6½ miles a little NE. of Great Point, Nantucket.	15½	Fine sand	65	60	58.5	D.
744	8	3 miles SE. of Great Round Shoal buoy, 9 miles from Great Point.	18	Sand, shells	65	......	58.5	D.
745	8	4 miles SSE. of Great Round Shoal buoy, 9 miles from Great Point.	15½	Sand	......	......	59	D.
746	8	Off Nantucket, N. of McBlair's Shoal.	13	....	......	......	......	T.
747	8	......do	13½	....	......	......	......	T.
748	8	......do	13½	....	......	......	......	T.
749	8	......do	13½	....	......	......	......	D.
750	15	8 miles east of Great Point, Nantucket.	15	Sand	......	......	......	D.
751	15	9 miles east of Great Point, Nantucket.	13	....do	......	......	......	
752	15	8 miles east of Great Point, Nantucket.	20	....do	......	......	......	
753	15	9 miles east of Great Point, Nantucket.	10	....do	......	......	......	
754	15	11 miles east of Great Point, Nantucket.	10	....do	......	......	......	
755	15	12 miles east of Great Point, Nantucket.	10	....do	......	......	......	
756	15	15 miles east of Great Point, Nantucket.	9	....do	......	......	......	
757	15	15 miles east of Great Point, Nantucket.	9	....do	......	......	......	
758	15	16½ miles east of Great Point, Nantucket.	6	....do	......	......	......	
759	15	7½ miles east of Great Point, Nantucket.	9	....do	......	......	......	
760	15	7 miles east of Great Point, Nantucket.	15	....do	......	......	......	
761	15	7½ miles east of Great Point, Nantucket.	10	....do	......	......	......	
762	20	Off Southwest Ledge, Gay Head NE. 11½ miles.	16½	Gravel	64	......	60	D.

STATIONS FOR 1875—Concluded.

Serial number.	Date.	Locality.	Depth in fathoms.	Nature of bottom.	Temperatures. Air.	Surface.	Bottom.	Apparatus.
	1875.				°	°	°	
763	Sept. 20	Off Southwest Ledge, ½ mile W. of 762.	17	Gravel, sand	64		60	D.
764	20	Off Southwest Ledge, ⅓ mile S. of 762.						
765	20	Off Southwest Ledge, ¾ mile W. of 763.	17	Sand, gravel			60	D.
766	20	On Southwest Ledge, ½ mile NW. of 765.	17	....do			60	D.
767	20	Off Southwest Ledge, 1½ miles W. of No. 762.	18	Sand	64		61	D.
768	20	9 miles SW. of Gay Head	20	....do	64		61	D.
769	20	6 miles SW. ¾ W. of Gay Head	20	....do				D.

STATIONS FOR 1877, 1878, AND 1879, WITH HEADQUARTERS AT SALEM, MASS., HALIFAX, N. S., GLOUCESTER AND PROVINCETOWN, MASS.

During these three years the dredgings were carried on from the U. S. Str. Speedwell, commanded in 1877 by Lieut. Commander A. G. Kellogg, in 1878 by Lieut. Commander L. A. Beardslee, and in 1879 by Lieut. Z. L. Tanner. In 1877, headquarters were first established at Salem, and the stations made from there covered the northern part of Massachusetts Bay, and portions of the Gulf of Maine, off Cape Ann. During the session of the commission of arbitration on the fishery claims, however, the headquarters were removed to Halifax, N. S., and dredgings were made in the waters off that coast, from the last of August to the first of October. The Speedwell also made a line of stations on her trip across the Gulf of Maine, from Cape Ann to Cape Sable, N. S. In 1878, with headquarters at Gloucester, Mass., the area dredged over included the northern and central parts of Massachusetts Bay, and the Gulf of Maine, off Cape Ann. In 1879, the dredging grounds were the southern part of Massachusetts Bay, and the Gulf of Maine, off Cape Cod. The bottom temperatures in 1877 were mostly taken with Miller-Casella self-registering, deep-sea thermometers, but in 1878 and 1879 Negretti-Zambra thermometers were used for that purpose. All the temperatures for 1879 were taken with more than usual care, the thermometers employed being frequently compared with a reliable standard.

DREDGINGS BY SPEEDWELL, 1877.

Serial number.	Date.	Latitude.	Longitude.	Locality.	Depth in fathoms.	Nature of bottom.	Temperatures.			Apparatus used.
							Air.	Surface.	Bottom.	
	1877.	° ′	° ′				°	°	°	
1	Aug. 4	42 30	70 45	A little S. of E. from Salem, 4 miles SSE. of Baker's Island	22	Gravelly	71	63 65	46	D.
2	...do			Same as No. 1	22	...do				T.
3, 4	...do			NW. of No. 1	22	...do	72?	60 62?	45?	D.
5	...do	42 28	70 42	Baker's Island NW. by N. 5½ miles, Eastern Point (south of Gloucester) NNE. 6¾ miles.	33	Sand and mud	72		45?	D.
6	...do			SW. of No. 5		...do				T.
7	...do			...do		...do				T.
8	Aug. 6			Halfway Rock NW. by W., Baker's Island NW. by N. ½ N. (true), close to No. 1.	20	Rocky	70	65½	55	D.
9	...do			S. of No. 8	25	Gravelly	69	63½	52½	Tan.
10	...do			Same as No. 8	20½	...do	69½	64½	50½	D. and Tan.
11	...do	42 26	70 37	Thatcher's Island Lights NE. by E. ½ E. 12¼ miles, Baker's Island Light NW. ½ N. 10 miles.	45	Mud	70	64½	48½	D.
12	...do			Same as No. 11						D.
13	...do			1 mile E. of No. 12	50					T.
14	...do			...do						T.
15	Aug. 7			Baker's Island NNW. ¼ W. 3 miles, Halfway Rock NW. by W. 1½ miles, near Nos. 1 to 4, and 8 to 10.	19½	Gravelly	69	66	54½	D.
16	...do			Same as No. 15						Tan.
17	Aug. 8			Halfway Rock NW. by W. 3 miles, Baker's Island Light, NW. by N. 4½ miles; between No. 5 and No. 1.	32					T.
18	...do	42 29	70 38	Halfway Rock W. by N. ½ N. 6½ miles, Eastern Point Light N. ¾ W. 5½ miles.	45	Mud				T.
19	...do			About same place	45	...do				T.
20	...do			...do	45	...do				T.
21, 22	Aug. 10			Halfway Rock W. by N. ½ N. 1½ miles, Baker's Island NW. ¾ N. 3 miles, near No. 1.	26	Hard gravel and stones				D.
23	...do			Halfway Rock W. by N. ½ N. 6 miles, Eastern Point Light N. ¼ E. 5½ miles, near Nos. 18 to 20.	35	Mud and clay nodules				T.
24	Aug. 13	42 30	70 41	Halfway Rock W. by N. ½ N. 4½ miles, Eastern Point Light N. by E. ½ E. 7 miles.	33	Soft mud	70	67½	49½	D.
25	...do	42 27½	70 36	Halfway Rock NW. by W. ½ W. 8½ miles, Eastern Point N. by W. ½ W. 8 miles.	48	...do	69	67½	49½	D.
26–30	...do			Same as No. 25	48	...do				T.
31	...do			...do	48–50	Mud				D.
32	Aug. 14	42 30	70 20	Thatcher's Island Light NW. ¼ N. 13½ miles, Halfway Rock W. by N. 20 miles.	90	...do	78	68	38½ 39	T.

	33	...do					Same as No. 32						T.
	34	Aug. 19	42	37	69	39	Gulf of Maine, Cape Ann W. by N. 42 miles	160	Soft mud	72	70	{ 37½ { 38	} Tan.
	35, 36	.. do					Nearly the same as No. 34						T.
+	37	Aug. 20	42	39	66	58	Gulf of Maine, 155 miles E. of Cape Ann	115	Gravelly	68½	59	{ 38 { 39	} D.
+	38	...do ...	42	42	66	58	Gulf of Maine	112	......do				T.
+	39	...do ...	42	44	66	27	......do	75	Sand and mud	66	55	{ 38¾ { 39½	} D.
+	40	...do	42	46	66	27	About 2 miles N. of No. 39	75	Fine sandy mud				T.
+	41		42	49	66	19	W. of Brown's Bank	82	Rocks and barnacles		54½		D.
+	42	Aug. 21	43	04½	65	01½	SE. ½ S. from Cape Sable about 32 miles	88	Very fine sand	68	62½	{ 33½ { 41	} D.
+	43	...do	43	05½	65	02	SE. ½ S. from Cape Sable about 31 miles	*90					T.
+	44	...do	43	06	65	04½	SE. ½ S. from Cape Sable about 30 miles	*90	Fine sandy mud	66½	62¾		T.
+	45	...do	43	06	65	07	SE. ½ S. from Cape Sable about 28 miles	91	......do			{ 33½ { 39	} T.
+	46	...do	43	05½	65	09	SE. by S. from Cape Sable about 27 miles	*90	......do				T.
+	47	...do	43	10	65	12½	SE. ½ S. from Cape Sable about 22 miles	59	Pebbles and sand				D.
+	48	...do	43	11	65	14½	SE. ½ S. from Cape Sable about 20 miles	59	Rocky				T.
+	49	...do	43	13	65	17	SE. ½ S. from Cape Sable about 18 miles	56	Hard	68	64½	{ 31½ { 40	} Tan.
+	50, 51	.. do	43	14	65	17½	Off Cape Negro, Nova Scotia, SE. ½ S. from Cape Sable 17 miles.	45–50	Large stones				D.
+	52	...do	43	26½	65	14	Off Shelburne, Nova Scotia, 19 miles south	47	Stony	68	64½	{ 36 { 37	}
+	53	Aug. 25					In Bedford Basin, north of Halifax	35	Mud	72	68½	34	
+	54	...do					......do	35	......do				T
+	55	...do					Mouth of Bedford Basin	33	......do				
+	56–58	...do					{ Halifax Harbor, off Herring Cove, between Mars Rock and Neverfail Shoal. }	16	Sand	72	66½	{ 46 { 46½	} D. and T.
+	59	Aug. 28					Halifax Outer Harbor, ¼ mile SSW. Rock Head buoy	25	Gravel	68½	65¾	43½	D.
+	60	...do					Halifax Outer Harbor, ¼ mile N. Rock Head buoy						D.
+	61, 62	...do					{ Halifax Harbor, between Mars Rock and York Redoubt buoy, ½ mile distant. }	20	Shingly			{ 47 { 48½	} D. and T.
+	63	Aug. 29					Bedford Basin, ¼ across harbor from Navy Island	26		{ 67½ { 67¾	66¾ 67	34½ 35	} D.
+	64	...do					......do	40	Mud				T.
+	65	...do					......do	40					T.
+	66	...do					......do	41		68½	68	{ 33 { 34	} R. D.
+	67	...do					......do						T.
+	68	...do					Narrows at mouth of Bedford Basin, drifting in	16		69	68	{ 44¾ { 45	} D.
+	69	Sept. 1	42	44	62	43	About 120 miles S. of Halifax	620	Without bottom		65½	{ 36 { 38	}
+	70	...do	42	45½	62	43	......do	190	Gravel and pebbles	72	66½	{ 38½ { 39	} D.
+	71	...do	42	46	62	44	About 118 miles S. of Halifax	95	......do				D.
+	72	Sept. 4					Sandwich Point (Halifax Harbor) W. ½ N. ⅓ miles	18	Fine sand	†66		{ 39½ { 41½	} D.

* Estimated.

† Inside pilot-house.

DREDGINGS BY SPEEDWELL, 1877—Continued.

	Serial number.	Date.	Latitude.	Longitude.	Locality.	Depth, in fathoms.	Nature of bottom.	Temperatures. Air.	Temperatures. Surface.	Temperatures. Bottom.	Apparatus used.
		1877.	° ′	° ′				°	°	°	
+	73, 74	Sept. 4			Sandwich Point (Halifax Harbor) W. ½ N. ⅓ mile						T.
+	75	do			do		Fine sand and rocks				D.
+	76	do			Halifax Harbor, half way between Litchfield and Mars Rocks.	18	Fine sand				D.
+	77	do			½ mile to the eastward of No. 76	16	Rocky				D.
+	78	Sept. 5			Chebucto Head (entrance of Halifax Harbor) SW. by S. ¾ S. (SW. ¾ S?), ¾–1½ miles.	25	Rocks and nullipore	67	55½	33; 37½	D.
+	79	do			Farther S. and E. than No. 78		Fine sand				D.
+	80	do	44 22	63 28	Chebucto Light N. ½ E. 9 miles	57	Muddy and pebbles	69	56½	32¾; 35¾	D.
+	81	do			do	57	Stony, with sponges and red algæ.				T.
+	82	do			do	57	Mud and sand				Tan.
+	83	do			do	57	Coarse gravel and stones, bryozoa.				D.
+	84	Sept. 6	44 04	63 27	Chebucto Head N. by E. ¼ E. 26 miles	101	Fine sand	65	63	30; 38½	D.
+	85	do			do						T.
+	86	do			do						T.
+	87	Sept. 11			Mouth Halifax Harbor, Litchfield Rock NE. by E. ½ E. 1⅓ miles, Automatic Buoy SE. ¾ S. 2¼ miles, dragging E. to 7 or 8 fathoms on Neverfail Shoal.	21	Very fine sand, stones, and algæ.	72	61½	48⅓; 49	D.
+	88	do			Sandwich Point S. ½ mile, drifting S. with tide parallel to shore until Sandwich Point was W. by N.	17	Kelp, red algæ, and fine sand.	74	62		T.
+	89	do			Same as last	21					
+	90	do			Head of Northwest Arm, Halifax Harbor	6½	Mud and eelgrass	74	62	49	D.
+	91	do			Same as last						
+	92	do			Halifax Harbor, Mouth of Northwest Arm, battery NE. by E. ½ E., quarry opposite.	7		70	62	58	D.
+	93	Sept. 13			Halifax Harbor, ¼ mile from shore off York Redoubt and Sandwich Point.	16	Sand and red algæ				T.
+	94	do			Little farther E. and S. than last						T.
+	95	do			Same as last		Very fine sand, ooze and red algæ.				D.
+	96	do			do						T.
+	97	do			Midway between York Redoubt and McNab's Island Light, Halifax Harbor.						D.

+	98	Sept. 15					Midway between Sandwich Point and McNab's Island Light, Halifax Harbor.	18	Mud and fine sand	61	61	46 / 46½	T.
+	99	...do					......do						
+	100	...do	44	28	63	18	Off Halifax, Devil's Island Light N. by W. ¾ W. 9½ miles, Sambro Light W. by N. ¼ N. 10¼ miles.	42	Shingle	65	61½	34 / 34½	D.
+	101	...do					Off Halifax, Sambro Light W. by N. ¼ N. 9 miles	42	Fine sand with Ophioglypha.				
+	102	...do					......do	42	Rocks and sand				T.
+	103	Sept. 20	44	02	63	20	Sambro Light N. ¾ W. 26 miles, Egg Island NE. 41 miles, 29 miles S. of Chebucto Head.	92	Gravelly and rocky	64	63	35½ / 36½	D.
+	104	...do	44	01	63	20	29¾ miles S. from Chebucto Head	110	Fine sand and mud			35¾ / 36	D.
+	105	...do					Near last		.....do				T.
+	106–108	...do					Same as last						D. and T.
+	109	Sept. 21					Bedford Basin	37		57	57½	34	D.
+	110, 111	...do					......do						T.
+	112	Sept. 24					Chebucto Head Light NW. by W. about 8½ miles	52	Fine sand and mud	64	60	35	D.
+	113	...do					......do	52	......do			35	T.
+	114–117	...do					......do	52	......do				T.
+	118	...do					Chebucto Head Light NW. by W. about 9 miles	53	Sand, mud, to rocks				T.
+	119	Sept. 27					Halifax Harbor, off York Redoubt						
+	120	...do					Halifax Outer Harbor	16					T.
+	121	...do						43					
+	122	...do						60		72	58	36	
+	123	...do					Off Sandwich Point, Halifax Harbor						T.
	124	Oct. 17	42	32	70	22½	Thatcher's Island Light NW. ½ N. 11¾ miles, Halfway Rock W. ¾ N. 19¼ miles.	51	Mud, gravel, and rocks	50	52	45	D.
	125	...do					Cape Ann NW. ½ N. 12 to 14 miles	75		52			D.
	126	...do					......do	75	Mud				D.
	127	...do					......do						T.
	128	...do	42	31½	70	37	Halfway Rock W. by S. 6¾ miles, Eastern Point N. by W. ½ W. 3¾ miles.	36	Mud and fine sand		55	43½	D.

DREDGINGS BY SPEEDWELL, 1878.

129	1878. July 23	42	24	70	33½	Thatcher's Island Light N. ⅝ E. 13½ miles, Eastern Point N. by W. ¼ W. 11⅜ miles.	49		65	60½	38	T.
130	...do					About ⅜ mile NW. ¼ W. of No. 129	49	Mud	68	63		T.
131	...do					Thatcher's Island Light N. by E. ¾ E. 15 miles, 1 mile W. of No. 129.	45		68	62	38	T.
132	...do					Thatcher's Island Light N. ¾ E. 11½ miles, Eastern Point N. by W. ¼ W. 10 miles, 3 miles NW. of No. 129.	45	Mud	70	63	38	T.
132a	...do	42	28½	70	36	Thatcher's Island N. ¾ E. 10 miles, Eastern Point N. by W. ¼ W. 6 miles, Baker's Island W. ½ S. 9 miles.	40	......do				
133	...do	42	32	70	38½	Thatcher's Island NE. ¾ N. 7⅛ miles, Eastern Point N. ¼ W. 3⅜ miles, Baker's Island W. by N. ⅜ N. 6⅛ miles.	33	Rocky	67	61		D.

DREDGINGS BY SPEEDWELL, 1878—Continued

	Serial number.	Date.	Latitude.	Longitude.	Locality.	Depth in fathoms.	Nature of bottom.	Temperatures. Air.	Surface.	Bottom.	Apparatus used.
		1878.	° ′	° ′				°	°	°	
	134	July 23	....	....	Thatcher's Island NE. ⅛ N. 6¾ miles, Eastern Point N. ⅝ E. 2¼ miles, Baker's Island W. ¾ N. 5⅓ miles, 1 mile NW. of No. 133	26	Pebbles and coarse sand ..	68	61	......	D.
	135	July 26	42 33½	70 38½	Eastern Point N. by W. ⅞ W. 2 miles, West Light Thatcher's Island NE. ¼ N. 5¾ miles, 2 miles N. of No. 133.	25	Stony and gravelly	70	58½	40⅓	
	135[a]	...do ...	....	....	About same as No. 135	*25	....	72	......	40	D.
	136	...do ...	....	....	Short distance E. of No. 135 (southwesterly on original chart)	*26	Sand and stones	......	......	......	D. and T.
	137	July 29	42 32½	70 23½	Eastern Point WNW. ¼ W. 16¼ miles, Thatcher's Island NW. ¾ W. 13½ miles.	53	Rocks, drifting into soft mud.	70	65	38½	D.
	138	...do ...	42 33	70 26	Thatcher's Island NW. ¾ N. 9 miles, Baker's Island W. by N. 16⅓ miles.	59	Muddy	......	......	......	T.
	139	...do ...	....	....	Drifting SW. from No. 138	59	......do	......	......	......	T.
	140	...do ...	42 34	70 32	Eastern Point W. by N. ¼ N. 6 miles, Thatcher's Island N. by W. ¼ W. 4½ miles.	38	......do	67	59½	40	D.
+	141	Aug. 1	....	....	Gloucester Harbor, Eastern Point Light ESE., Norman's Woe Rock SW. by S., Fresh Water Cove NW. by W. ½ W.	8½	Sandy	63	57½	44½	D.
+	142	...do ...	....	....	About as last	......	....	......	......	......	T.
+	143	...do ...	....	....	......do	9	....	......	......	50	T.
+	144	...do ...	....	....	......do	......	....	......	......	......	T.
+	145	...do ...	....	....	Gloucester Harbor, between Round Rock and Ten Pound Island Ledge.	8	Sandy	63½	56½	51	D.
+	146	Aug. 1	....	....	About same as No. 145	......	....	......	......	......	T.
	147	Aug. 3	42 33	70 41½	Eastern Point Light NE. by E. ⅞ N. 2¼ miles, Baker's Island W. 4⅛ miles.	16	Gravel, stones, broken shells.	67½	56½	42¼	D.
	148	...do ...	....	....	⅜ mile S. by W. from No. 147	*16	Stony	66	......	......	D.
	149	...do ...	....	....	About 2 miles SSW. of No. 148, Eastern Point NW. ⅞ N. 4⅓ miles, Baker's Island WNW. ½ N. 3⅞ miles.	19½	Sand and gravel	66	61¼	42	D.
+	150	...do ...	....	....	Gloucester Harbor, half a mile S. of Fresh Water Cove, between it and Eastern Point Light.	7½	Sand and mud	70	61	51⅓	T.
+	151	...do ...	....	....	About the same ground	7–10	......do	......	......	......	T.
+	152	...do ...	....	....	About the same ground, just off Fresh Water Cove	......	....	......	......	......	D.
+	153	...do ...	....	....	......do	......	....	......	......	......	T.
	153[a]	Aug. 8	....	....	Eastern Point Light, SW. 2 miles, (on schr. Hattie)	17	....	......	62	44½	
	154	Aug. 15	42 35	70 31	Thatcher's Island NW. ¾ N. 4½ miles, Eastern Point W. ¾ N. 7 miles.	38	Pebbles, coarse sand	69¼	64½	41½	D.
	155	...do ...	42 35	70 30	¾ mile ESE. of No. 154, Thatcher's Island NW. ½ W. 5 miles, Eastern Point W. ¾ N. 8 miles.	45	Muddy	......	......	......	D.
	156	...do ...	....	....	A little E. of No. 155	42	Sand and mud	70½	68¼	41⅓	T.
	157	...do ...	....	....	¾ mile W. of last place	40	Sand and rocks	73	......	42⅓	D.
	158	...do ...	....	....	⅛ mile W. of last place	38	Mud and then rocks	......	......	......	D.

159	...do			Gloucester Harbor, just off Fresh Water Cove	8	Sand	66½		44½	T.
160	Aug. 16	42 36	70 27	Eastern Point Light W. ⅜ N. 9 miles, Thatcher's Island Light, NW. ¾ W. 5¼ miles.	54	......do	71½		39½	D.
161	...do			A little S. by W. of No. 160	*54		64			T.
162	...do			About a mile S. of No. 160	*60	Mud	71¼		39½	T.
163	...do			West Light on Thatcher's Island NW. ¾ W. 6⅓ miles, Eastern Point Light W. ¾ N. 10 miles, a mile SE. ¾ E. from No. 160.	73	Fine sand	70½	65½		T.
164	...do			West Light Thatcher's Island WNW. ⅞ N. 7⅛ miles, Eastern Point Light W. ⅝ N. 10¾ miles, nearly 2 miles E. of No. 160.	75	......do			40	T.
165	Aug. 19	42 44½	70 38	Ipswich Bay, Straitsmouth Light, S. by E. 5 miles, Annisquam Light SW. ¾ W. 5¼ miles.	35	......do	71	64¾	41½	D.
166	...do			About same as last						T.
167	...do			About same as last, ½ mile N			71⅓			T.
168	...do			Straitsmouth Light SE. by S. 4¾ miles, Annisquam Light SSW. ⅜ W. 3¾ miles, 2 miles WSW. of No. 165.	21	Sand	71			T.
169	...do			About ½ mile W. of No. 168	19	......do			40½	T.
170	Aug. 24	42 33	69 59	Eastern Point Light W. by N. ¼ N. 30⅜ miles, Boone Island Light N. by W. ¼ W. 41¼ miles.	90	Fine sandy mud with some gravel.			40	D.
171	...do			A little S. of last	*90	Similar, but more stony	67		39	T.
172	...do	42 33	69 57	Eastern Point Light W. by N. ¼ N. 32¼ miles, Boone Island Light NNW. ⅜ N. 42½ miles.	115	Sandy mud and fine gravel		65½		T.
173	...do			"Drifting towards the N"		......do	68½	65½	39½	D.
174	Aug. 27	42 37	69 40½	Thatcher's Island Light (Western) W. ¼ N. 38 miles, Eastern Point Light W. ¾ N. 42 miles.	140	Muddy	65½		39	T.
175	...do			About as last	*140	......do		66		T.
176	...do	42 38½	69 41½	2 miles N. of last place	175	Mud			38½	T.
177	...do			About as last						T.
178	...do			......do			68		38½	T.
179	Aug. 29			Gloucester Harbor, just off Fresh Water Cove	7	Fine sand	67	59	47	T.
180	...do			About same as last	10	......do				T.
181	...do	42 24	70 36	Eastern Point Light N. ½ W. 7 (11?) miles, Thatcher's Island Light N. by E. ½ E. 14½ miles.	45	Mud	73½	64¼	41½	D.
182	...do			About a mile E. of No. 181						T.
183	...do	42 30¼	70 38	Eastern Point Light N. ¾ W. 4¾ miles, Baker's Island Light SW. by S. ½ S. 7 miles.	45	Mud, gravel, and pebbles				D.
184	...do			A little to NE. of No. 183	45	Mud	75	65½	42¼	T.
185	Aug. 31	42 33	69 55	Eastern Point Light W. by N. 33 miles, Boone Island Light NNW. 42½ miles, White Island Light NW. ½ N. 42 miles.	110	Muddy	68½	64¼	39	D.
186	...do			About same as No. 185	*110	......do	73½			D.
187	...do			About same as last	110	Soft brown mud				T.
188	...do	42 33½	69 58½	About 2 miles W. of No. 187	85	Sandy mud and gravel	68½		40	Tan.
189	...do			About same as No. 188	85	Gravel and pebbles		65½	40	Ag. D.
190	...do			About same as last, drifting towards SE	*100	Muddy				T.
191	...do			About same as last, drifting towards E	*100	Soft brown mud				T.
192	...do			Somewhat E. of last	100–110	......do				T.
193	...do			Somewhat SSW. of last	*100–110	Mud, harder at end				T.
194	...do			Somewhat E. of last	*110	Muddy, harder than last				T.

* Estimated.

DREDGINGS BY SPEEDWELL, 1878—Continued.

Serial number.	Date.	Latitude.	Longitude.	Locality.	Depth in fathoms.	Nature of bottom.	Temperatures. Air.	Temperatures. Surface.	Temperatures. Bottom.	Apparatus used.
	1878.	° ′	° ′				°	°	°	
195	Sept. 2	42 27	70 19	Eastern Point Light NW. ½ W. 16¾ miles, Eastern Light Thatcher's Island NW. by N. 15½ miles.	33–29	Coarse sand	72½	63¾	45½ 48¼	D.
196	...do			½ mile SSW. from No. 195	29	Stony, sponges and gravel.			47½	T.
197	...do	42 25½	70 23	Eastern Point Light NW. ½ N. 15 miles, Eastern Light Thatcher's Island NNW. 14¾ miles, 3½ miles W. from No. 195.	23	Stony and spongy			54½	T.
198	...do	42 31	70 20	Eastern Light Thatcher's Island NW. ⅛ N. 12¾ miles	50	Coarse sand and mud	72½			T.
199	...do			¾ mile S. No. 198, Eastern Light Thatcher's Island NW. ⅛ N. 13½ miles.	98	Muddy	71½	64¾	39¼	T.
200	Sept. 9			Gloucester Harbor, off Norman's Woe	10	Sandy and rocky	64½	60	56½	T.
201	...do			Gloucester Harbor, off Mussel Cove	8½	Sandy mud	63½	61	54	
202	...do			Gloucester Harbor, off Norman's Woe	8–10	Abundant red algæ				
203	Sept. 16	42 31	70 37	Off Gloucester, Eastern Point Light N. by W. ¾ W. 4¾ miles, Baker's Island Light WNW. 8 miles, drifting to SW.	42	Muddy with large stones	62½	60½	47⅘	D.
204	...do			¾ mile SW. by W. from No. 203	40	Soft brown mud	63	60½	48½	D.
205	...do			⅜ mile SW. by W. from No. 203	42	...do				T.
206	...do			⅜ mile NE. by E. from No. 203	42	Muddy				T.
207	...do			Same as No. 203	42	Soft brown mud	65			T.
208	...do	42 33	70 43	Off Gloucester, Baker's Island Light W. ½ S. 3¼ miles, Eastern Point Light ENE. ¼ N. 2¾ miles, Kettle Island N. by W. ⅞ miles.	19–23	Rocky	63½	60		D.
209	...do			⅝ mile N. by W. ¼ W. from No. 208, ⅓ mile from Kettle Island.	17	Rock, gravel, and mud	64	60¾	48½	D.
210	Sept. 17	42 38	70 28½	Off Cape Ann, Salvages NW. 5 miles, Eastern Point W. ¾ S. 9 miles.	60	Soft dark-brown mud	66	60	43	D.
211	...do			About a mile E. of No. 210	60	...do				
212	...do			About ¼ mile S. by E. ½ E. of No. 210	68	...do	65½	60¾	42⅗	D.
213	...do			About ⅓ mile E. by S. ½ S. of No. 212	68	Soft dark-brown mud and hard concretions.				T.
214	...do			A little SW. of No. 213	57	Fine mud and sand				T.
215	Sept. 18	42 31	70 32	Eastern Point Light NW. ¼ N. 7¼ miles, Thatcher's Island Light N. ¼ W. 7¾ miles.	35	Fine sand and few small pebbles.	65½	62	50½	D.
216	...do			½ mile NNE. ½ E. from No. 215	35	Sandy				T.
217	...do	42 30	70 35	Eastern Point Light NNW. ½ W. 5¾ miles, Thatcher's Island Light N. by E. ⅛ E. 7⅞ miles, 2½ miles westerly from No. 215.	45	Soft dark-brown mud				T.
218	...do			Same as No. 217	45	...do				T.

219	...do	42	30	70	33	Eastern Point Light NW. ⅝ N. 7¼ miles, Thatcher's Island Light, N. 8⅜ miles; a mile SW. from No. 215.	32	Rocky, stones of all sizes..	70½	63	55¼	D.
220	...do	42	32	70	35	Eastern Point Light NW. ¾ N. 4¾ miles, Thatcher's Island Light N. by E. ¼ E. 6⅝ miles.	42	Soft brown mud	......	......	......	T.
221	Sept. 21	42	33	70	31	Eastern Point Light WNW. ¼ N. 6⅜ miles, Thatcher's Island Light N. by W. ¼ W. 5⅝ miles.	37–38	Fine sandy mud	67½	62	49⅞	D.
222	...do	....		....		⅜ mile SE. by E. ¼ S. from No. 221	40	......do	......	......	......	T.
223	...do	....		....		About 1⅜ miles E. ½ S. from No. 221	47	Soft brown mud	......	......	......	T.
224	...do	....		....		¼ mile E. by S. from No. 223	47	..... do	......	......	......	T.
225	...do	42	33½	70	35½	Eastern Point Light NW. ¾ W. 3⅝ miles, Thatcher's Island Light N. by E. ¾ E. 5 miles.	26	Rocky	71½	62⅓	53	Tan.
226	Sept. 23	42	36	70	36	Off Cape Ann, Eastern Point Light W. by S. ½ S. 3 miles, Thatcher's Island Light NE. 2⅜ miles.	18	Irregular, rocky	......	......	......	D. and Tan.
227	...do	42	33½	70	40	Off Gloucester, Eastern Point Light NNE. 1¼ miles, S. end Kettle Island E. by S. ⅞ S. 2¼ miles.	23	Rock, sand, and gravel	64½	60½	58	D. and Tan.
228	...do	....		....		Eastern Point Light NE. 2¼ miles, 1½ miles SW. from No. 227.	19	Rock and sand..............	......	......	......	D. and Tan.
229	...do	....		....		Eastern Point Light NE. by N. ¼ N. ⅞ mile, ½ mile N. of No. 227.	19	Rocky and coarse sand....	......	......	......	D.
230	...do	....		....		S. end Kettle Island N. ½ W. ¾ mile, between Nos. 208 and 209	21	Rock, fine mud, and sand .	59½	60½	57¾	D.
231	...do	....		....		Gloucester Harbor, just outside Fresh Water Cove, Eastern Point Light SE.	7	Fine white sand and red algæ.	......	......	......	T.
232	Sept. 24	42	30½	70	38	Eastern Point Light N. ¾ W. 4⅝ miles, Thatcher's Island Light NNE. ½ E. 8⅓ miles.	45	Soft brown mud	62½	61⅜	42	D.
233	...do	....		....		¼ mile S. by W. ¼ W. from No. 232	45	......do	......	......	......	T.
234	...do	....		....		⅞ mile NE. by E. from No. 232; on chart NW. from No. 232, which is probably correct.	43	......do	......	......	......	T.
235	...do	42	33½	70	39	Eastern Point Light N. by W. ½ W. 1⅞ miles, Thatcher's Island Lights NE. ⅛ N. 5⅞ miles, close to No. 135.	22	Rocky	......	......	......	Tan.
236	Sept. 26	42	28	70	31	Eastern Point Light NW. by N. 9⅝ miles, Thatcher's Island Lights N. ¼ W. 10⅜ miles.	28	Rocky, coarse sand, and pebbles.	68¾	61	48½	D.
237	...do	42	31	70	29	Eastern Point Light NW. ⅝ W. 9 miles, Thatcher's Island Lights N. by W. ½ W. 8⅓ miles.	38	Coarse sand and gravel ...	66	61¾	49¾	D.
238	...do	42	30½	70	38	Eastern Point Light N. by W. 4½ miles, Thatcher's Island Lights NNE. ¾ E. 7⅝ miles, close to No. 232.	43	Soft brown mud	69	61⅔	......	T.

DREDGINGS BY SPEEDWELL, 1879.

	1879.	°	′	°	′				°	°	°	
239	July 21	41	51	70	14	Cape Cod Bay, Wood End Light N. 15° E., Indian Hill N. 79° W.	13	Blue mud and fine sand...	70¼	67	65½	D.
240	...do	41	52½	70	15	Wood End Light N. 19° E., Rocky Point N. 74° W	18	....	69½	67	64½	T.
241	.. do	41	57	70	12	Wood End Light N. 16° E., Billingsgate Light S. 55° E......	19	Blue mud and fine sand...	......	......	......	D.
242	...do	41	59	70	13	Race Point Light N. 9° W., Cape Cod Light N. 66° E	21	Blue mud	72	67	62½	T.
243	...do	42	01	70	12	Race Point Light N. 25° W., Wood End Light N. 58° E	20	....	69	66½	60½	T.
244	July 22	42	04½	70	15½	Race Point Light S. 50° E. (dredge) 1 mile, (trawl) 1⅜ miles..	25–30	Fine gray sand..............	70	58	{ 40 } { 45 }	D. and T.
245	...do .. {	42 / 42	08 / 07½	70 / 70	17 / 13½	} Race Point Light S. 27° E. (dredge) 5¼ miles, S. 7 W. (trawl) 4 miles.	28	......do	......	......	......	D. and T.

DREDGINGS BY SPEEDWELL, 1879—Continued.

Serial number.	Date.	Latitude.	Longitude.	Locality.	Depth in fathoms.	Nature of bottom.	Temperatures. Air.	Temperatures. Surface.	Temperatures. Bottom.	Apparatus used.
	1879.	° ′	° ′				°	°	°	
246	July 25	42 06	70 14½	Race Point Light S. 11° E. 2¼ miles, "Spider Ground"	28	Fine gray sand	66	63	......	D.
247	...do	42 07	70 15½	Race Point Light S. 20° E. 3¼ miles	34	do	66	63	......	D.
248	...do	42 07	70 14	Race Point Light S. 1° W. 3¼ miles	32	do	66½	63¼	......	D.
249	...do	42 08½	70 13	Race Point Light S. 13° W. 4⅓ miles	30	Coarse sand	65	62¼	......	T.
250	...do	42 09	70 13	Race Point Light S. 9° W. 5¼ miles	30	do	66½	62¼	......	T.
251	...do	42 10	70 10½	Race Point Light S. 23° W. 6¾ miles	24½	Coarse sand and gravel	65½	60¼	......	D.
252	...do	42 09	70 09½	Race Point Light S. 34° W. 6¼ miles	27	Fine gray sand and gravel	66¼	62¼	......	T.
253	July 28	41 57	70 17½	Cape Cod Bay, "Fishing Ledge," Wood End Light N. 50° E. 7 miles.	17	Rocky	72	65	......	D.
254	...do	....	....	do	21	Sandy	75	65	......	D.
255	...do	....	....	do	18	Rocky	76	66	......	D.
256, 257	...do	....	....	do	16	do	78	68	......	D.
258	...do	41 55	70 20	Cape Cod Bay, Wood End Light NE. ½ E. 9½ miles	20	Soft mud	72	64	......	T.
259	...do	41 57½	70 23½	Cape Cod Bay, Wood End Light ENE. 10¾ miles	24	Blue mud	71	64	......	T.
260	...do	41 58½	70 19	Cape Cod Bay, Wood End Light ENE. 7½ miles	25	Green mud	74	65	......	T.
261	...do	42 00	70 15	Cape Cod Bay, Wood End Light ENE. 3½ miles	26	Mud	74	......	......	T.
262	July 29	42 11	69 57	Off Cape Cod, Race Point Light S. 65° W. 14 miles	80	Blue mud	71	65½	......	D.
263	...do	....	....	do	83	do	71	65¼	......	D.
264	...do	42 10	69 56½	Off Cape Cod, Race Point Light S. 65° W. 15 miles	80	do	71	65¼	......	T.
265	...do	42 09½	69 57	Off Cape Cod, Cape Cod Light S. 30° W. 8 miles	73	Gravel	71	65¼	......	T.
266	...do	42 12½	69 50	Off Cape Cod, Cape Cod Light S. 42° W. 13 miles	120	Blue mud	71½	66½	......	T.
267	July 31	42 13	69 40	Off Cape Cod, Race Point Light S. 81¾° W. 26 miles	135	do	70¼	68½	41	D.
268	...do	42 12	69 40	Off Cape Cod, Race Point Light S. 84½° W. 26 miles	129	do	71	67½	42	T.
269	...do	42 08	69 53	Off Cape Cod, Cape Cod Light S. 67½° W. 9 miles	53	Gravel	70¼	64¼	39½	T.
270	...do	42 06	69 55½	Off Cape Cod, Cape Cod Light S. 66¼° W. 7 miles	42	Blue sand and gravel	71	64½	39	T.
271	Aug. 1	42 06½	70 18	Off Cape Cod, Race Point Light S. 12° W. 2¾ miles	34	Fine yellow sand	70¼	66¼	38¾	D.
272	...do	42 07	70 19	Off Cape Cod, Race Point Light S. 2° W. 3 miles	34	Yellow sand	70	66¾	38	T.
273	...do	42 07½	70 09½	Off Cape Cod, Race Point Light S. 40° W. 5¼ miles	25	Coarse yellow sand and gravel.	69	67	38½	D.
274	...do	42 09½	70 05	Off Cape Cod, Cape Cod Light S. 11° E. 7 miles	30	Coarse yellow sand and broken shells.	73½	68½	30	D.
275	...do	....	....	do	29½	Green mud	72	66½	39½	T.
276	...do	42 08½	70 00	Off Cape Cod, Cape Cod Light S. 20° W. 6½ miles	47	Blue mud	71	66	37½	T.
277	...do	42 02	70 15	Cape Cod Bay, Wood End Light S. 76° E. 3 miles	28	Sand and shells	74	74½	42	T.
278	Aug. 4	....	....	Provincetown Harbor, Long Point Light N. 75° E. ¼ miles	9	Sandy	70	69½	58	D.
279	...do	42 09½	70 15	On Stellwagen's Bank, Race Point Light S. 6¼ miles	13–13½	Sand	74	63	44½	D.
280	...do	42 09½	70 16½	On Stellwagen's Bank, Race Point Light S. 17° E. 6½ miles	12½–13½	Yellow sand and gravel	76	......	44	T.
281	...do	42 12	70 16½	On Stellwagen's Bank, Race Point Light S. 12° E. 8½ miles	14	Fine yellow sand and broken shells.	76	62.3	44	D.

282	...do	42	13	70	13½	On Stellwagen's Bank, Race Point Light S. 3° W. 9½ miles ..	13½	Sand and gravel	72⅕	61⅕	43	D.
283	...do	42	09½	70	22	Southwest of Stellwagen's Bank, Race Point Light S. 44° E. 8¼ miles.	31	Sand and green mud	70.7	65	38½	D.
284	...do ...	42	10	70	22	......do	31	....	70.7	65½	39	T.
285	Aug. 6	42	12	70	25	Southwest of Stellwagen's Bank, Race Point Light S. 44° E. 11 miles.	35½	Green mud	69	68	39	D.
286	...do	42	16½	70	23	West of Stellwagen's Bank, Race Point Light S. 14° E. 14 miles.	37	......do	71	67	39⅕	D.
287	...do	42	17½	70	25½	West of Stellwagen's Bank, Race Point Light S. 20° E. 16 miles.	47¼	......do	68	67⅕	38⅘	T.
288	...do	42	20	70	27	West of Stellwagen's Bank, Race Point Light S. 20° E. 19 miles.	33	Fine blue sand and shells.	72	67.3	38⅘	T.
289	...do	42	19	70	25	Same as last in Record Book; nearly 2 miles SE. on chart ..	45	Fine gray sand	69⅘	68½	38	T.
290	Aug. 11	42	04¾	70	16	Mouth Cape Cod Bay, Race Point Light S. 86° E. 1¼ miles...	31	......do	72	63½	38	D.
291	...do	42	04½	70	16¼	Mouth Cape Cod Bay, Race Point Light S. 55° E. 1¾ miles...	30	......do	......	64	40	T.
292	...do	42	03½	70	18½	Mouth Cape Cod Bay, Race Point Light N. 85° E. 2¾ miles..	29	Blue mud, fine sand.......	69	65	41	D.
293	...do	42	03½	70	19½	Mouth Cape Cod Bay, Race Point Light N. 84° E. 3¾ miles..	27	Green mud	66	65½	39½	D.
294	...do	42	03½	70	23	Mouth Cape Cod Bay, Race Point Light N. 86° E. 6¾ miles..	26	..... do	66½	66	39	T.
295	...do	42	03	70	24½	Mouth Cape Cod Bay, Race Point Light N. 82° E. 7¾ miles..	26	......do	67	65½	39½	R. D.
296	...do	42	02¾	70	26	Mouth Cape Cod Bay, Race Point Light N. 82° E. 9 miles...	26	......do	68½	65	39	D.
297	...do	42	02¼	70	29	Mouth Cape Cod Bay, Race Point Light N. 80° E. 11 miles..	22	Fine sand..................	69	65	39½	T.
298	Aug. 20	42	01	70	32	Mouth Cape Cod Bay, Gurnet Point Light S. 79° W. 3¼ miles.	16	Fine brown sand...........	64	61½	55½(?)	D.
298a	...do	42	00½	70	30	Mouth Cape Cod Bay, Gurnet Point Light S. 88° W. 4¼ miles.	20	Brown sand and pebbles ..	68	59	44	D.
299	...do	42	01½	70	30	Mouth Cape Cod Bay, Gurnet Point Light S. 74° W. 4½ miles	21	Fine brown sand...........	66	61½	45	T.
300	...do	42	01½	70	29	Mouth Cape Cod Bay, Gurnet Point Light S. 75° W. 5 miles, ½ mile S. of No. 297.	20	Brown sand and pebbles ..	68	61½	45	T.
301, 301a	...do	42	01½	70	20	Mouth Cape Cod Bay, Race Point Light N. 65° E. 5 miles ...	27	Soft brown mud	66	60	42½	D. and R. D.
302	Aug. 21	42	12¾	69	46	Off Cape Cod, Cape Cod Light S. 51° W. 16½ miles..........	124	Fine brown mud...........	68	60	41	D.
303	...do	42	11¾	69	47	Off Cape Cod, Cape Cod Light S. 51° W. 15 miles...........	122	Soft brown mud	71	61½	41	T.
304	...do	42	10	69	45	Off Cape Cod, Cape Cod Light S. 61° W. 15 miles...........	122	......do	75½	61½	41	T.
305	...do	42	09½	69	41	Off Cape Cod, Cape Cod Light S. 68° W. 18 miles...........	118	......do	69	61	41	T.
306	Aug. 25	42	06½	70	20	Race Point Light S. 56° E. 5 miles..........................	30	Blue mud	63	61	41	T.
307	...do	42	06½	70	18	Race Point Light S. 46° E. 4¼ miles.........................	31	Blue mud and fine sand ...	65	61¼	43½	T.
308	...do	42	08½	70	18	Race Point Light S. 28° E. 5½ miles, S. edge Stellwagen's Bank.	26	Fine sand and broken shells.	64	61⅕	41	D.
309	...do ...	42	08½	70	17	Race Point Light S. 23° E. 5½ miles, E. of No. 308...........	27	Fine yellow sand..........	66	60⅘	40⅘	T.
310	Aug. 29	42	01	70	11	Cape Cod Bay, Wood End Light N. 33° W. ¼ mile............	21	Blue mud, fine sand.......	63	60½	47⅘	D.
311	...do ...	42	00	70	10	Cape Cod Bay, Wood End Light N. 36° W. 1¼ miles.........	16	......do	67½	61½	49	R. D.
312	...do	41	59½	70	09	Cape Cod Bay, Wood End Light N. 41° W. 2½ miles.........	15	Mud and sand	65	62	50	R. D.
313	...do	41	58	70	09	Cape Cod Bay, Wood End Light N. 26° W. 3½ miles.........	15	Blue mud..................	64	61	50½	R. D.
314	.. do	41	56	70	07	Cape Cod Bay, Wood End Light N. 31° W. 6 miles...........	10	Coarse sand...............	67	61½	61	R. D.
315	...do ...	41	55	70	07	Cape Cod Bay, Wood End Light N. 25° W. 7 miles...........	6	Coarse sand and gravel ...	66	63½	56	T.
316	.. do	41	56½	70	06½	Cape Cod Bay, Wood End Light N. 36° W. 5¾ miles.........	8	......do	69	62	63	D.
317	Aug. 30	42	02	70	14	Cape Cod Bay, Race Point Light N. 3° W. 1¾ miles	25	Blue mud..................	59	60	44⅘	D.
318	...do	42	01½	70	15	Cape Cod Bay, Race Point Light N. 14° E. 2½ miles	28	......do	61	61⅕	44⅕	T.
319	...do	42	02¼	70	15	Cape Cod Bay, Race Point Light N. 10° E. 1¾ miles	26½	..... do	60	60½	44⅘	T.
320	...do	42	02½	70	15	Cape Cod Bay, Race Point Light N. 38° E. 1¼ miles	29	Fine gray sand	63½	61	44½	R. D.
321	...do	42	03	70	15	Cape Cod Bay, Race Point Light N. 62° E. 1 mile	29½	..... do	65	61	44½	T.
322	Sept. 1	42	12½	70	01	Off Cape Cod, Cape Cod Light S. 9° W. 10 miles............	67	Speckled sand, broken shells.	66	60	40½	D.
323	...do	42	13¼	70	01½	Off Cape Cod, Cape Cod Light S. 6° W. 11 miles............	60	Speckled sand	67½	58	40½	T.

DREDGINGS BY SPEEDWELL, 1879—Continued.

Serial number.	Date.	Latitude.		Longitude.		Locality.	Depth in fathoms.	Nature of bottom.	Temperatures.			Apparatus used.
									Air.	Surface.	Bottom.	
	1879.	°	′	°	′				°	°	°	
324	Sept. 1	42	12¾	70	03	Off Cape Cod, Cape Cod Light S. 2° W. 11 miles	45	Coarse sand, black specks, broken shells.	67	61	40⅘	T.
325	...do	42	14½	70	00½	Off Cape Cod, Cape Cod Light S. 8° W. 13 miles	83	Green mud	67	61	40⅘	T.
326	...do	42	14½	70	02	Off Cape Cod, Cape Cod Light S. 4° W. 12½ miles	75	...do	70	59⅘	40½	Ag. T.
327	Sept. 6	42	11	70	12½	S. end Stellwagen's Bank, Race Point Light S. 11° W. 7¾ miles.	17	Coarse sand, black specks.	61½	60	44½	D.
328	...do	42	10	70	13	Off S. end Stellwagen's Bank, Race Point Light S. 11° W. 6¼ miles.	23	...do	72	60½	42	O. T.
329	...do	42	09	70	12	Off S. end Stellwagen's Bank, Race Point Light S. 17° W. 5½ miles.	26	Fine brown sand, pebbles.	67½	60	42	R. D.
330	...do	42	09½	70	13	Off S. end Stellwagen's Bank, Race Point Light S. 8° W. 6 miles.	26	...do	68	60	42	T.
331	...do	42	09¼	70	14	Off S. end Stellwagen's Bank, Race Point Light S. 2° W. 5½ miles.	28	Fine brown sand, black specks.	67	60½	41⅘	T.
332	...do	42	09	70	15	Off S. end Stellwagen's Bank, Race Point Light S. 6° E. 5½ miles.	28	Fine brown sand, shells	70	61	42	T.
333	...do	42	08½	70	16¼	Off S. end Stellwagen's Bank, Race Point Light S. 18° E. 5¼ miles.	27	...do	71	61	42⅘	R. D.
334	...do	42	08¼	70	18	Off S. end Stellwagen's Bank, Race Point Light S. 28° E. 5½ miles.	27	Fine yellow sand	74	61⅕	42	Ag. T.
335	Sept. 9	41	58¾	70	34½	Off Plymouth, Gurnet Point Light N. 30° W. 1¾ miles	7	Green mud, sand, with dead eel-grass.	62	61⅕	55	D.
336	...do	41	58	70	33½	Off Plymouth, Gurnet Point Light N. 40° W. 2¾ miles	11½	Brown sand, specks, eel-grass.	69	61⅕	50	T.
337	...do	41	57¾	70	30½	Off Plymouth, Gurnet Point Light N. 58° W. 4½ miles	16	Green mud and sand	70	62	47⅕	D.
338	...do	41	57½	70	28	Off Plymouth, Gurnet Point Light N. 66° W. 6½ miles	18	Sand, blue mud	71	62½	49⅖	T.
339	...do	41	54	70	28	Cape Cod Bay, Manomet Point N. 67° W. 3½ miles, 3½ miles S. of No. 338.	15½	Mud and sand	75	63	47½	T.
340	...do	41	51	70	27½	Cape Cod Bay, Manomet Point N. 38° W. 6 miles	14	Brown sand and mud	66½	63	49⅕	D.
341	...do	41	51½	70	21½	Cape Cod Bay, Manomet Point N. 68° W. 9 miles	15½	Green mud, sand	65½	63 1/10	48	T.
342	Sept. 10	42	16	69	56	Off Cape Cod, Cape Cod Light S. 22° W. 14 miles	94	Brown mud	63½	58½	41½	T.
343	...do	42	17	69	51	Off Cape Cod, Cape Cod Light S. 33° W. 17½ miles	116	...do	63	57	41½	T.
344	...do	42	19	69	47½	Off Cape Cod, Cape Cod Light S. 35° W. 15 miles (20 miles on original chart).	130	...do	64	57½	41⅘	T.
345	Sept. 13	42	19½	70	45	Off Boston Harbor, Minot's Ledge Light S. 3¼ miles	16	Speckled sand and shells	60	61 9/10	46 9/10	D.
346	...do	42	16	70	38	Massachusetts Bay, Minot's Ledge Light W. 5½ miles	22	Pebbles and broken shells.	66⅕	61 9/10	44⅘	T.
347	...do	42	12½	70	33½	Massachusetts Bay, Minot's Ledge Light N. 66° W. 9 miles.	20	Speckled sand	65	61⅕	46⅕	T.
348	...do	42	09½	70	32½	Massachusetts Bay, Standish Monument (near Duxbury) N. 35° W. 10 miles.	16½	Gravel and sand	66	62½	46⅕	D.

349	...do	42	10½	70	29	Standish Monument S. 36° W. 13 miles	26	Sand and mud	65	61 3/10	43⅘	O. T.
350	...do	42	08½	70	25	Standish Monument S. 56° W. 13½ miles	31	Blue mud	72½	61⅕	43 1/10	D.
351	...do	42	05½	70	22	Race Point Light S. 74° E. 6 miles	30	......do	67	62½	42⅘	Ag. T.
352	Sept. 15	41	54¾	70	07½	Cape Cod Bay, Billingsgate Light S. 53° E. 4 miles	10½	Sand and gravel	61½	64	62⅗	D.
353	.. do	41	53	70	10	Cape Cod Bay, Billingsgate Light S. 78° E. 5 miles	14	Green mud	61	63 3/10	49½	T.
354	...do	41	50½	70	11½	Cape Cod Bay, Billingsgate Light N. 74° E. 6 miles	7	Coarse yellow sand	76½	65½	62	D.
355, 356	...do	41	48½	70	12	Cape Cod Bay, Billingsgate Light N. 56° E. 7¾ miles	7	Fine sand, pebbles	66	64	61⅕	D.
357	...do	41	49	70	09	Cape Cod Bay, Billingsgate Light N. 48° E. 5½ miles	7½	Fine brown sand	65	65 3/10	64	T.
358	...do	41	55	70	10	Cape Cod Bay, Billingsgate Light S. 63° E. 5¾ miles	15	Blue mud	65	64⅕	48⅕	T.
359	Sept. 18	42	04	69	22	Off Cape Cod, Cape Cod Light S. 86° W. 30 miles	105	Green mud	67	58⅗	......	D.
360	...do	42	03	69	22	Off Cape Cod, Cape Cod Light S. 88° W. 30 miles	106	Gray mud	65	58½	......	T.
361	.. do	42	02	69	28	Off Cape Cod, Cape Cod Light N. 89° W. 26 miles	102	......do	62	58½	......	T.
362	...do	42	01	69	34½	Off Cape Cod, Cape Cod Light N. 86° W. 21 miles	106	......do	62⅘	59½	......	T.
363	...do	42	00	69	36	Off Cape Cod, Cape Cod Light N. 84° W. 20 miles	108	Mud, fine gravel	66	59⅗	......	D.
364	...do	41	58½	69	44	Off Cape Cod, Cape Cod Light N. 75° W. 15 miles	70	Hard sand, broken shells	65	60	......	T.
365	Sept. 19	41	38	69	53	Off Chatham, Chatham Light N. 45° W. 2¾ miles	7½	Coarse sand	63	61⅗	......	T.
366	...do	41	37½	69	51	Off Chatham, Chatham Light N. 55° W. 4¼ miles	11	Fine sand	63	61	......	T.
367	...do	41	38	69	49	Off Chatham, Chatham Light N. 67° W. 5½ miles	12	......do	63½	61½	......	D.
368	...do	41	39	69	48	Off Chatham, Chatham Light N. 84° W. 6 miles	15	Coarse sand, gravel	63	61 1/10	......	D.
369	...do	41	41	69	47¼	Off Chatham, Chatham Light S. 78° W. 6¼ miles	18	......do	64	61 1/10	......	T.
370	...do	41	35½	69	42	Off Chatham, Chatham Light N. 75° W. 12 miles	18	Speckled sand	61	57½	......	T.
371	...do	41	35½	69	35	Off Chatham, Chatham Light N. 72° W. 16 miles	34½	Coarse speckled sand	66	61½	......	T.
372	...do	41	40	69	28½	Off Chatham, Chatham Light W. 21 miles	70	Sand and pebbles	61½	59	......	T.
373	Sept. 26	42	07	69	59	Off Cape Cod, Cape Cod Light S. 32° W. 5 miles	42	Fine gray sand, black specks.	58	54	44	T.
374	...do	42	04	69	54	Off Cape Cod, Cape Cod Light S. 75° W. 6½ miles	46	Fine sand, broken shells	64	54½	43	T.
375	...do	42	04½	69	53¾	Off Cape Cod, Cape Cod Light S. 72° W. 7 miles	46	Coarse sand	59	54	45½	T.
376	...do	42	04¼	69	54	......do	46	......do	59	54	45½	D.
377	...do	42	04	69	44½	Off Cape Cod, Cape Cod Light S. 85° W. 13 miles	94	Brown mud	58	57	41½	D.
378	...do	42	04¼	69	39	Off Cape Cod, Cape Cod Light S. 85° W. 17½ miles	96	......do	......	......	......	D.

A series of temperature observations was made by the Speedwell on September 25 and 29, 1879. These had separate numbers from No. 1 to No. 25, and as no dredgings or natural-history observations were made, they have been placed after the tables of dredging localities. Their localities, &c., will be found on the following page (38), and the serial temperatures taken on those days are placed on page 43, at the end of the tables of serial temperatures taken in the course of dredging expeditions.

* TEMPERATURE OBSERVATIONS BY THE SPEEDWELL, SEPTEMBER 25 AND 29, 1879.

Serial number.	Date.	Locality.	Depth in fathoms.	Temperatures.		
				Air.	Surface.	Bottom.
	1879.			°	°	°
1	Sept. 25	Long Point WNW. ¾ mile	17	......	55½	47⅘
2	25	Wood End Light NW. ¼ mile	21	......	55	47
3	29	Wood End Light NE. ¼ mile	22	......	59	45
4	29	Wood End Light N. 80° E. 2 miles	24½	......	57½	44⅕
5	29	Wood End Light N. 55° E. 3¼ miles	21	......	57⅕	45
6	29	Wood End Light N. 48° E. 5¼ miles	21	......	57½	45⅕
7	29	Wood End Light N. 45° E. 7¼ miles	19½	......	58½	46⅒
8	29	Wood End Light N. 50° E. 7¾ miles	19½	......	58½	46
9	29	Wood End Light N. 66° E. 6¾ miles	24	......	59⅕	44⅘
10	29	Wood End Light N. 85° E. 6 miles	26	69½	58	44
11	29	Wood End Light S. 75° E. 5¾ miles	30	69½	58½	44
12	29	Race Point Light S. 71° E. 3¼ miles	33	66		44
13	29	Race Point Light S. 45° E. 4½ miles	34	66	57⅕	44⅕
14	29	Race Point Light S. 32° E. 6 miles	11	67	58	51½
15	29	Race Point Light S. 13° E. 5¼ miles	23	63½	57⅕	52½
16	29	Race Point Light S. 10° W. 6 miles	19	62½	58	49
17	29	Race Point Light S. 30° W. 6½ miles	26	63	57½	46½
18	29	Race Point Light S. 51° W. 8¼ miles	28	62½	57	45
19	29	Race Point Light S. 58° W. 9¾ miles	49	62⅘	57⅘	43⅕
20	29	Race Point Light S. 70° W. 9½ miles	32	62½	57	44
21	29	Race Point Light S. 66° W. 5½ miles	21	64	57	45
22	29	Race Point Light S. 42° W. 5½ miles	28	62⅕	56⅘	46
23	29	Race Point Light S. 18° W. 2½ miles	33	......	57½	44
24	29	Race Point Light S. 83° E. 2 miles	30	61	58	44
25	29	Race Point Light N. 16° E. 2¼ miles	27	61	58	44$\frac{9}{10}$

* See pages 37 and 43.

SERIES OF TEMPERATURES TAKEN BY THE SPEEDWELL IN 1877, 1878, AND 1879.

[A + above the temperature indicates that it is that of the bottom, when that precise depth is not in the table; a Δ before the temperature indicates that the precise depth at which it was taken will be found in column A.]

Date.	Serial number.	Latitude.	Longitude.	Depth in fathoms.	Temperatures.																				A.
					Air.	Surface.	5 fathoms.	10 fathoms.	15 fathoms.	20 fathoms.	25 fathoms.	30 fathoms.	35 fathoms.	40 fathoms.	45 fathoms.	50 fathoms.	55 fathoms.	60 fathoms.	70 fathoms.	80 fathoms.	90 fathoms.	100 fathoms.	110 fathoms.	120 fathoms.		
1877.		° ′	° ′		°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	
Aug. 6	9			25	69	63.5			57¾	55¾	52.5															
6	10			20.5	69.5	64.5	60¾	59⅓	54	+50.5																
6	11	42 26	70 37	45	70	64.5					55.5				48.5											
28	59			25	68.5	65¾				Δ47	43.5															21
29	63			26	67⅝	66⅞	67				+34¾															
29	64			40				60¾																		
29	66			41	68.5	68				36.5				+33.5												
Sept. 1	69	42 46	62 43	620		65⅓				52															+37	
1878. July 23	130			49	68	63		47								(?)										
23	131			45	68	62	60.5	46.5	43	41					38											
23	132			45	70	63	Δ47.5	45¾	43	41					38											7½
26	135	42 33½	70 38½	25	70	58.5	49.5		44.5	Δ41.5	40.5															19
26	135 *a*			25*	72				42.5	41	40															
29	137	42 33½	70 23½	53	70	65	57.5	51¼	51¼	45	46	42.5	40	40	38¾		+38.5									
Aug. 1	141			8½	63	57.5	53.5	+44.5																		
1	145			8	63.5	56.5	Δ54	+51																		4
3	147	42 33	70 41½	16	67.5	56.5		45.5	+42¾																	
3	149			19½	66	61¼			43	+42																
3	150			7½	70	61	Δ56.5	+51.5																		4
8	153 *a*			17		62	52	48		+44.5																
15	154	42 35	70 31	38	69¼	64.5	57¼		42¾	Δ45	44¼	42¼		+41.5												19.5

* Estimated.

SERIES OF TEMPERATURES TAKEN BY THE SPEEDWELL IN 1877, 1878, AND 1879—Continued.

Date.	Serial number.	Latitude.	Longitude.	Depth in fathoms.	Temperatures. Air.	Surface.	5 fathoms.	10 fathoms.	15 fathoms.	20 fathoms.	25 fathoms.	30 fathoms.	35 fathoms.	40 fathoms.	45 fathoms.	50 fathoms.	55 fathoms.	60 fathoms.	70 fathoms.	80 fathoms.	90 fathoms.	100 fathoms.	110 fathoms.	120 fathoms.		A.
		° ′	° ′		°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	
1878. Aug. 15	157			40	73							35.5	41¾	42.5												
16	160	42 36	70 27	54	71.5								41¼		40		+39.5 (?)									
16	161			54*		64		50	47¼	44.5	44.5	44														
16	163			73	70.5	65.5		58	56.5																	
19	165	42 44½	70 38	35	71	64¾						45.5	41.5													
24	170	42 33	69 59	90																Δ39.5	40					75
24	173			115*	68.5	65.5	60¼		55¾		50¾		46½			41¼				Δ39.5				+39.5		75
27	174	42 37	69 40½	140	65.5																			40¾	+39	
27	176 & 177	42 38½	69 41½	175																		40¾			+38.5	
29	179			7	67	59	Δ54½	+47																		3
29	181	42 24	70 36	45	73.5	64¼	60	57	52.5	53¾	50.5	45	44	42.5	41.5											
29	184			45	75	65.5				53.5				42¾	42¼											
31	185	42 33	69 55	110	68.5	64¼																40.5	39			
31	186			110*	73.5			61¼		59		50¾	46¼	44.5		41¼		40¼	39¾	39¾	39¾					
31	189			85		65.5									43.5					Δ39.5	+40					75
Sept. 2	195	42 27	70 19	29 to 33	72.5	63¾	62		55		51.5	+45.5														
9	200			10	64.5	60	58	56.5																		
9	201			8.5	63.5	61	58.5	+54																		
1879. Aug. 4	279	42 09½	70 15	13 to 13.5	74	63		Δ44	Δ44.2																	6.5 & 12
4	280	42 09½	70 16½	12.5 to 13.5	71			Δ52	+44																	6.5
4	281	42 12	70 16½	14		62.3		Δ57.5	+44																	7
4	282	42 13	70 13½	13.5	72.2	61.2		Δ45.5	43																	7
4	283	42 09½	70.22	31	70.7	65			41			+38.5														

6	285	42 12	70 25	35.5	69	68				Δ40			+39													18
6	286	42 16½	70 23	37	71	67				Δ39.9				+39.2												19
6	287	42 17½	70 25½	47¼	68	67.2					38.7					+38.8										
6	288	42 20	70 27	33	72	67.3				Δ43.8			+38.8													16
6	289	42 19	70 25	45	69.8	68.5						Δ39			38											27
25	307	42 06½	70 18	31	65	61¼			43.5			+43.5														
25	308	42 08½	70 18	26	64	61.2			Δ47.2		+41															13
25	309	42 08½	70 17	27	66	60.8*			Δ54.5		+40.8															14
29	312	41 59½	70 09	15	65	62		Δ60	50																	8
29	313	41 58	70 09	15	64	61		Δ60	50.5																	8
30	317	42 02	70 14	25	59	60			Δ59.1		44.8															13
30	318	42 01½	70 15	28	61	61.2			Δ52.5			+44.2														14
30	319	42 02¼	70 15	26.5	60	60.5			Δ52.5		44.8															13
30	320	42 02½	70 15	29	63.5	61			Δ53.1			+44.5														14.5
30	321	42 03	70 15	29.5	65	61			51			+44.5														
Sept. 1	322	42 12½	70 01	67	66	60			Δ44			Δ41				41			+40.5							{12 & 34
1	323	42 13¼	70 01½	60	67.5	58			50			42			41.5			40.5								
1	324	42 12¾	70 03	45	67	61				Δ42					40.8											22
1	325	42 14½	70 00½	83	67	60								Δ41						+40.6						42
1	326	42 14½	70 02	75	70	59.8				51									+40.5							
6	330	42 09½	70 13	26	68	60			Δ51		+42															13
6	331	42 09¼	70 14	28	67	60.5			Δ54			+41.8														14
6	332	42 09	70 15	28	70	61			Δ51			+42														14
6	333	42 08½	70 16¼	27	71	61			Δ53			+42.8														14
6	334	42 08¼	70 18	27	74	61.2			Δ53			+42														14
9	335	41 58¾	70 34½	7	62	61.2	60.2	+55																		
9	336	41 58	70 33½	11½	69	61.2	59	+50																		
9	337	41 57¾	70 30½	16	70	62		52.8	+47.2																	

* Estimated.

SERIES OF TEMPERATURES TAKEN BY THE SPEEDWELL IN 1877, 1878, AND 1879—Concluded.

Date.	Serial number.	Latitude.	Longitude.	Depth in fathoms.	Temperatures.																				A.
					Air.	Surface.	5 fathoms.	10 fathoms.	15 fathoms.	20 fathoms.	25 fathoms.	30 fathoms.	35 fathoms.	40 fathoms.	45 fathoms.	50 fathoms.	55 fathoms.	60 fathoms.	70 fathoms.	80 fathoms.	90 fathoms.	100 fathoms.	110 fathoms.	120 fathoms.	
		° ′	° ′		°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1879. Sept. 9	338	41 57½	70 28	18	71	62.5	62.5	54.8		+49.4															
9	339	41 54	70 28	15.5	75	63	63.5	55	+47.5																
9	340	41 51	70 27½	14	66.5	63	63.8		+49.2																
9	341	41 51½	70 21½	15.5	65.5	63.1	63	60.5	+48																
10	342	42 16	69 56	94	63.5	58.5										43.8					+40.5				
10	343	42 17	69 51	116	63	57					46					45									
10	344	42 19	69 47½	130	64	57.5					45.4					43.2								+41.8	
13	346	42 16	70 38	22	66.2	61.9		57			+44.8														
13	347	42 12½	70 33½	20	65	61.2	61.5	52		46.2															
13	348	42 09½	70 32½	16½	66	62.5	61.3		+46.2																
13	349	42 10½	70 29	26	65	61.3		59	53.9		+43.8														
13	350	42 08¾	70 25	31	72.5	61.2		52.2		46.8		+43.1													
13	351	42 05½	70 22	30	67	62.5		53.8		48		42.8													
15	352	41 54¾	70 07½	10½	61.5	64	63.8	+62.6																	
15	353	41 53	70 10	14	61	63.3		51.5	+49.5																
26	373	42 07	69 59	42	58	54				53				+44											
26	374	42 04	69 54	46	64	54.5			48.5						+43										
26	375	42 04½	69 53¾	46	59	54		51							+45.5										
26	376	42 04½	69 54	46	59	54		51							+45.5										
26	377	42 04	69 44½	94	58	57										42.8					+41.5				

*SERIES OF TEMPERATURES TAKEN BY THE SPEEDWELL SEPTEMBER 25 AND 29, 1879.

Sept. 25	1	......	......	17	......	55.5	......	50.75	......	+47.8	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
25	2	......	......	21	......	55	......	......	......	+47	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	3	......	......	22	......	59	......	56.5	......	+45	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
20	4	......	......	24½	......	57.5	......	......	46.5	......	+44.2	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	5	......	......	21	......	57.2	56.5	46.5	......	+45	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	6	......	......	21	......	57.5	56.2	51	......	+45.2	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	7	......	......	19½	......	58.5	57.5	53.1	......	+46.1	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	8	......	......	19½	......	58.5	57.5	56	......	+4 6	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	9	......	......	24	......	59.2	57	54.1	......	......	+44.8	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	10	......	......	26	69.5	58	57	55.1	......	......	+44	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	11	......	......	30	69.5	58.5	57	55.8	......	46	......	44	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	12	......	......	33	66	67.8	56.2	55.8	......	48			+44	......	......	......	......	......	......	......	......	......	......	......	......	......
29	13	......	......	34	66	59.2	56	54.5	......	51.1	......	......	+44.2	......	......	......	......	......	......	......	......	......	......	......	......	......
29	14	......	......	11	67	58	57	+51.5	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	15	......	......	23	63.5	57.2	56	54.5	......	......	+52.5	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	16	......	......	19	62.5	58	56	54	......	+49	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	17	......	......	26	63	57	56.2	54.5	......	......	+46.5	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	18	......	......	28	62.5	57	56.5	55	......			+45	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	19	......	......	49	62.8	57.8	57.2	54.5	......	48	......	44	......	......	......	+43.2	......	......	......	......	......	......	......	......	......	......
29	20	......	......	32	62.5	57	55.2	51.5	......	47	......	+44	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	21	......	......	21	64	57	55.2	51	......	+45	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	22	......	......	28	62.8	56.5	56.2	46.1	......			+46	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	23	......	......	33	......	57.5	57	56	......	45	......	......	+44	......	......	......	......	......	......	......	......	......	......	......	......	......
29	24	......	......	30	61	58	58	57	......	45	......	44	......	......	......	......	......	......	......	......	......	......	......	......	......	......
29	25	......	......	27	61	58	59	56.8	......	......	......	+44.9	......	......	......	......	......	......	......	......	......	......	......	......	......	......

* See pages 37 and 38.

XII.—REPORT OF OPERATIONS OF THE UNITED STATES STEAMER SPEEDWELL IN 1879, WHILE IN THE SERVICE OF THE UNITED STATES FISH COMMISSION.

By Lieut. Z. L. Tanner, U. S. N., *Commanding.*

All bearings true. Distances in geographical miles.

Prof. S. F. Baird,

United States Commissioner of Fish and Fisheries, Washington, D. C.:

Sir: I have the honor to submit the following report of the operations of the Speedwell during the season of 1879:

The vessel was put in commission at the navy-yard, Washington, D. C., at meridian July 1, and sailed for Provincetown, Mass., on the 9th; passed the capes of the Chesapeake on the morning of the 10th, New York at meridian of the 11th, arriving in Provincetown at 6.30 p. m. of the 12th, three days nine hours from Washington.

July 16, at 9.45, left Provincetown for Gloucester to get the dredging apparatus which was in store at that place. Having taken the necessary articles on board we left for Provincetown at 6.30 p. m., arriving at 12.30 a. m. the 17th. Experienced a violent gale and heavy swell while crossing the bay. The apparatus was landed at the wharf during the day, and at 5.40 on the 18th we left for Boston to procure coal. Arrived at the navy-yard at 11.45 a. m. the same day. Took on board 73 tons of coal on the 19th, and left at 9 a. m. on the 20th for Provincetown, arriving at 2.50 p. m.

Preparations for the work of dredging having been completed, we left the wharf at 9.30 a. m. on the 21st and lowered the dredge at 11.30 a. m. in 13 fathoms, Wood End light-house bearing N. 15° E. 10½′, the current number of the haul being 239. Five hauls were made during the day with satisfactory results, except the temperature observations, which were incomplete, owing to our deep-sea thermometers (Casella Miller's) being out of order.

I shall not attempt to mention the various specimens taken, as I have not sufficient data at hand, and, in fact, their description falls legitimately to the scientific corps who had charge of the dredging operations.

We left the wharf at 10.30 a. m. July 22 and lowered the dredge at 11 a. m. in 25 fathoms, Race Point bearing S. 50° E. 1′. Four hauls were taken with dredge and trawl during the day in from 25 to 30 fathoms. The work was somewhat retarded by a heavy swell from the gale of last night, giving the vessel an uncomfortable motion and making it a matter of some difficulty to keep movable articles in place. Returned to the wharf at 6.30 p. m.

We were detained in port by a southerly gale during the 23d. At 1.30 p. m. on the 24th we got under way and attempted to use the dredge in Cape Cod Bay, but finding the wind and sea too heavy returned to the wharf at 4.30 p. m.

At 9.15 a. m. on the 25th, the weather being favorable, we went out into the channel between Stellwagen Bank and Race Point, where we found the swell quite heavy, giving the vessel an uncomfortable motion.

The dredge was lowered at 10.40 a. m. in 28 fathoms, 2¼′ N. 11° W. of Race Point. Four hauls of the dredge and three of the trawl were taken during the day, returning to the wharf at 7.45 p. m. A thick fog kept us at the wharf during the 26th. The 27th (Sunday) was squally and rainy.

At 8.15 a. m. on the 28th we steamed out to the Fishing Ledge, a rocky patch in Cape Cod Bay, S. 50° W. 7′ from Wood End; the dredge was lowered at 10.15 a. m. in 17 fathoms. Nine hauls were made during the day, five with the dredge and four with the trawl. Returned to port at 6.50 p. m.

At 8 a. m., 29th, left the wharf and steamed outside of Race Point, lowering the dredge at 10.45 a. m. in 88 fathoms. Race Point bearings S. 65° W. 14′. Five hauls were made during the day in from 73 to 120 fathoms of water, two with the dredge and three with the trawl.

We were kept in port during the 30th by a thick fog. The weather cleared during the night, and, at 8 a. m. 31st, we got under way and steamed out to sea, lowering the dredge at meridian in 135 fathoms, Race Point bearing S. 82° W. 26′. Four hauls were made, three with the trawl and one with the dredge, in from 135 to 42 fathoms. The soundings in Nos. 267 and 268 do not agree with the chart, and it is possible Race Point was mistaken for Cape Cod, when the bearings were taken. Returned to Provincetown at 7 p. m.

At 8 a. m., August 1, we stood out to sea, lowering the dredge at 9.30 a. m. in 34 fathoms. Race Point bearing S. 12° W. 2¾′. Seven hauls were taken during the day in from 34 to 42 fathoms, three with the dredge and four with the trawl, returning at 6 p. m. Fires were hauled, as the naturalists required the following day (Saturday) to arrange and preserve the large number of specimens on hand.

At 8 a. m., August 4, we left the wharf and lowered the dredge in 9 fathoms off Long Point, then steamed to the south end of Stellwagen Bank and took four hauls of the dredge and one with the trawl in from 12 to 31 fathoms, returning to port at 6 p. m.

There have been but few bottom and intermediate temperatures taken thus far, and those we have taken are not reliable, owing to the bad condition of the deep-sea thermometers. We received some new Negretti Zambra thermometers to-day, which seem to perform their work perfectly, so that our observations will, doubtless, be more satisfactory in the future.

The 5th was spent by the naturalists in preserving the specimens procured yesterday. We steamed out of the harbor at 8 a. m. of the 6th, and lowered the dredge at 10 a. m. in 35 fathoms, Race Point bearing S. 44° E. 11′. Five hauls were made in from 35 to 45 fathoms, three with the dredge and two with the trawl, returning at 6.20 p. m.

The naturalists were employed during the 7th in preserving specimens. A gale blowing on the 8th and a thick fog on the 9th prevented our leaving the harbor.

At 9 a. m. on the 11th we steamed out of the harbor and lowered the dredge in 31 fathoms, Race Point bearing S. 86° E. 1¼′. Eight hauls were taken during the day in from 26 to 31 fathoms, five with the dredge and three with the trawl, returning at 6 p. m.

The 12th was spent in making some necessary repairs about the engine, and at 4 a. m. 13th we left for Boston to procure coal; arrived at 10.15 a. m. and made the necessary preparations for coaling. Mechanics were sent on board from the navy-yard to make some repairs in the engineer's department. The crew were occupied on the 14th coaling ship, having taken on board 73 tons. Repairs on the machinery were completed at 2 p. m. on the 15th, and at 2.25 we left the yard, arriving at Provincetown at 8.45 p. m.

The weather was unsettled during the 16th, 17th, and 18th, with foggy, rainy weather. During the evening of the 18th the wind increased to a gale from S.E. causing a heavy swell in the harbor. Several vessels drifted on shore and considerable damage was done in the bay. The sea was breaking over the wharf and vessel at midnight, and, fearing the former might not be strong enough to stand the force of the sea and the extra strain imposed upon it by the vessel, which was lying uncomfortably, surging heavily on her fasts, I ordered steam, and at 12.45 a. m. swung the vessel at the wharf, steamed out into the bay and anchored. The weather was very thick, the atmosphere being filled with mist and spray. At about 2.30 a. m. 19th the wind subsided after a furious squall, and at 3 a. m. came out from N.W. in a heavy squall, then settled to a moderate gale with clear, cold weather. The harbor being sheltered, with the wind from this direction, we returned to the wharf at 9 a. m.

The weather was clear and pleasant on the 20th with light variable winds. Although quite smooth in the bay, there was a heavy swell outside, from the gale of yesterday. We left the wharf at 9 a. m. and steamed across the bay, where we found the sea sufficiently smooth for our purposes, and at 11.20 a. m. lowered the dredge in 16 fathoms, the Gurnet lights bearing S. 79° W. 3¼′. Six hauls were made, two with the trawl and four with the dredge, in from 16 to 27 fathoms, generally muddy bottom. At 6 p. m. we returned to our wharf.

The sea was quite smooth on the morning of the 21st, and it was decided to resume work outside of the cape. With this object in view we left the wharf at 7.45 a. m. and stood out to sea, lowering the dredge at 11.30 a. m. in 124 fathoms, Cape Cod light-house bearing S. 51° W. 16½′. Four hauls were made, three with the trawl and one with the dredge, in from 118 to 124 fathoms. Returned to the wharf at 8.25 p. m.

The weather was unsettled and threatening during the 22d, with a fresh gale from S.W. on the 23d, detaining us in port. The 24th (Sunday) was cloudy with frequent squalls and passing fog-banks. Monday 25th, the weather was somewhat better. We left our wharf at 8.45 a. m. and stood out to sea, lowering the trawl at 10.10 a. m. in 30 fathoms, Race Point bearing S. 56° E. 5′. Four hauls were made, one with the dredge and three with the trawl, in from 27 to 31 fathoms. The weather looking threatening we returned at 3.45 p. m.

We were detained in port during the 26th, 27th, and 28th by stormy weather. At 9.10 a. m., 29th, we steamed out into the bay and lowered the dredge at 9.30 a. m. in 21 fathoms, Wood End bearing N. 33° W. ¼′. Seven hauls were made in from 6 to 21 fathoms, one with the trawl and six with the dredge, returning to the wharf at 4 p. m. At 9 a. m., 30th, we left the harbor and lowered the dredge at 10 a. m. in 25 fathoms, Race Point bearing N. 3° W. 1¾′. Five hauls were made, three with the trawl and two with the dredge, in from 25 to 30 fathoms. Returned to the wharf at 3 p. m.

Monday, September 1, at 8 a. m., left the wharf and stood out to sea, lowering the dredge at 11.30 a. m. in 67 fathoms, Cape Cod light-house bearing S. 9° W. 10′. Five hauls were made in from 45 to 83 fathoms, one with the dredge and four with the trawl, returning at 7.45 p. m.

We were detained in port during the 2d, 3d, 4th, and 5th by unfavorable weather, and were obliged to leave the wharf and anchor in the bay on the 4th during a S.E. gale. At 8 a. m., on the 6th, we steamed to the vicinity of Stellwagen Bank, and at 10.25 a. m. lowered the dredge in 17 fathoms, Race Point bearing S. 11° W. 7¾′. Eight hauls were made in from 17 to 28 fathoms, three with the dredge and five with the trawl, returning to the wharf at 6.10 p. m.

We were detained in port repairing trawls, &c., on the 7th, and by stormy weather on the 8th. At 7.15 a. m. on the 9th we left the wharf and steamed across the bay, lowering the dredge in 7 fathoms at 10 a. m., the Gurnet lights bearing N. 30° W. 1¾′. Seven hauls were made in from 7 to 18 fathoms, three with the dredge and four with the trawl. Returned to the wharf at 7.05 p. m.

We left the harbor at 8.15 a. m. on the 10th, and lowered the trawl at meridian in 94 fathoms, Cape Cod light-house bearing S. 22° W. 14′. Three hauls were taken in from 94 to 130 fathoms. Returned at 9.45 p. m.

At 5.55 a. m., on the 11th, started for Boston for coal, arriving at 10.40 a. m. Commenced coaling about 1 p. m., finishing at 2 p. m., on the 12th, having received 86 tons. Mechanics from the navy-yard were employed repairing machinery. At 6 a. m., 13th, left the navy-yard, and at

8 a. m. lowered the dredge in 16 fathoms, Minot's Ledge light-house bearing south $3\frac{1}{4}'$. Seven hauls were made in from 16 to 30 fathoms, four with the trawl and three with the dredge, arriving in Provincetown at 6.25 p. m. The work was seriously interrupted during the latter part of the day by heavy winds and sea.

Monday, September 15, we left the wharf at 9.20 a. m., and lowered the dredge at 10.30 a. m. in $10\frac{1}{2}$ fathoms, Billingsgate Island light-house bearing S. 53° E. 4′. Seven hauls were made in from 7 to 15 fathoms, four with the dredge and three with the trawl, returning at 6.10 p. m. It rained heavily during the 16th, with a fresh breeze from S.W., detaining us in port. The 17th commenced with overcast weather and moderate breeze from N.E., clearing up during the day. At midnight we left the wharf and stood out to sea, lowering the dredge at 6 a. m., on the 18th, in 105 fathoms, Cape Cod light-house bearing S. 86° W. 30′. Six hauls were made during the day in from 70 to 108 fathoms, four with the trawl and two with the dredge. At 8.40 p. m. anchored off Chatham Light in 7 fathoms. Got under way at 5 a. m., on the 19th, and lowered the trawl at 6 a. m. in $7\frac{1}{2}$ fathoms, Chatham light-house bearing N. 45° W. $2\frac{3}{4}'$. Eight hauls were made in from $7\frac{1}{2}$ to 70 fathoms, six with the trawl and two with the dredge. Returned to Provincetown at 9.15 p. m.

The 20th we remained in port drying and repairing dredging apparatus, and were detained by unfavorable weather until 7 a. m., on the 26th, when we stood out to sea and lowered the trawl at 8.30 a. m., in 46 fathoms, Cape Cod light-house bearing S. 32° W. 5′. In heaving in, the rope parted just as the trawl reached the surface; the trawl was lost. We bent another one and lowered it at 10 a. m. in 46 fathoms, Cape Cod light-house bearing S. 75° W. $6\frac{1}{2}'$. The rope parted again while heaving in. The spot was buoyed with the intention of grappling for the trawl.

The breaking of the rope was a surprise, as it was a new $3\frac{1}{4}$-inch Italian hemp rope (at least we bought it for such), and should have borne a working strain of ten thousand pounds, whereas our hoisting-engine would not lift a third of that weight. The work was continued with the dredge during the day, making four hauls in from 46 to 96 fathoms, returning to Provincetown at 6.30 p. m.

We left the wharf at 7 a. m., 27th, with grapnels, &c., prepared to drag for the trawl. When we arrived near the spot we discovered our buoy and line on the deck of a schooner—they had picked it up during the morning. The exact location of the trawl was now unknown, but we dragged for several hours as near the spot as we could get by bearings, &c., without success, returning to Provincetown at 3 p. m.

Upon examination the rope was found to be very inferior in quality, and, a test being applied, it broke twice with a strain of less than two tons—probably not more than one.

The loss of our trawls brought the season's operations to a summary close, leaving a very interesting portion of the coast unexplored.

It will be seen by reference to the accompanying chart that the coast between Chatham and the Cape has not been examined. It was our intention to have done so, and, had it not been for the loss of apparatus so late in the season, it would have been accomplished. It was with much regret that we left this portion of the work incomplete, not only that it is prolific in marine life, but the steep slope of the projecting coast has caught the germs of various species of more northern fauna borne down by the Polar current which impinges upon this portion of our coast, and the low temperature of the water has completed their development.

Monday, September 29, we left the wharf at 7 a. m. and spent the day in taking serial temperatures, running a line across the bay to the vicinity of Plymouth, thence to the southern end of Stellwagen Bank, and to the eastward to 50 fathoms of water, then through the channel between Race Point and the bank, returning to port at 7.10 p. m.

It would be desirable, and it was our intention, to extend this series of observations considerably, but we were delayed much during the month by unfavorable weather, and the time had now arrived when the season's work must end.

We took on board the apparatus belonging to the United States Fish Commission on the 30th, and returned it to Gloucester October 1; leaving the latter place at 9.30 a. m. on the 2d, we arrived at the navy-yard, Boston, at 12.30 p. m. Commenced coaling at 1 p. m.; mechanics from the yard repairing machinery. Finished coaling at 3.30 p. m., 3d. Mechanics completed repairs at 3 p. m. 4th. Left the yard at 4.20 and arrived at Provincetown at 10.20 p. m.

Monday, October 6, we took on board a large number of marine specimens in tanks, the results of the season's work, a portion of them to be delivered to the Peabody Museum at New Haven, the remainder to the Smithsonian Institution, Washington, D. C. Everything was on board and properly secured at 8 p. m., and, at 5.40 a. m., 4th, we left Provincetown and proceeded to sea. Passed over Nantucket Shoals at meridian; passed Point Judith at 11 p. m., arriving at New Haven at 9.45 a. m. on the 8th. The articles consigned to the Peabody Museum were landed during the day, and, at 5.45 a. m., 9th, we left New Haven, passed Hell Gate at 1.30 p. m., arriving at the navy-yard, New York, at 2.30 p. m., where we stopped to fill our tanks with fresh water.

We left the navy-yard at 5.30 a. m., 10th, passed Barnegat at 1.05 p. m., Absecom at 4.30 p. m., Cape Charles at meridian, 11th, and anchored for the night in Cornhill harbor at 10.20 p. m. Got under way at 4.45 a. m., 12th, and arrived at the navy-yard, Washington, at 4.30 p. m. The articles consigned to the Smithsonian Institution were landed during the 13th, which completed the duties of the "Speedwell" under the United States Fish Commission for the season of 1879.

The vessel was subsequently ordered to accompany the United States steamer Nipsic to Norfolk, Va., and left the navy-yard in company with that ship at 7.45 a. m. on the 16th, returning on the 19th, and was put out of commission at meridian, October 24, by order of the honorable Secretary of the Navy.

RECAPITULATION.

Number of days in commission	116
Number of days at the Washington Navy-Yard preparing for sea and going out of commission	16
Number of days making the trip from Washington to Provincetown and return	8
Number of days making trips between Provincetown and Gloucester	2
Number of days making trips between Provincetown and Boston, including time occupied coaling	8
Number of days employed in other than commission work	11
Number of days detained in port on account of weather	28
Number of days detained in port by naturalists preserving specimens	3
Number of days detained in port repairing machinery, dredging apparatus, &c.	4
Number of days employed dredging and trawling	24
Number of days employed taking serial temperatures	1
Number of hauls with the trawl	76
Number of hauls with the otter trawl	2
Number of hauls with the Agassiz trawl	3
Number of hauls with the dredge	58
Number of hauls with the rake-dredge	9
Total number of hauls with trawls and dredges	148
Average number of hauls per day	6
Average depth of water ... fathoms	36.6
Number of surface temperatures taken	169
Number of intermediate temperatures taken	130
Number of bottom temperatures taken	139
Total number of water temperatures taken	438
Number of air temperatures taken	160
Number of soundings taken	180
Distance run while trawling and dredging ... miles	1,081
Distance run making passages ... miles	2,041
Total distance run ... miles	3,122
Average daily distance run while dredging and trawling ... miles	45

Record of dredging of United

NOTE.—Thermometers used are practically correct, error being less

Date.	Thermometer used.	Number of observation.	Locality.			Time.	Tide.
				°	′		
July 21	Green, 2903	239	Wood End Light	N. 15 E.,	10½	11.30 a. m	Flood
21	do	240	do	N. 20 E.,	9½	12.30 p. m	do
21	do	241	do	N. 16 E.,	4½	2.00 p. m	do
21	do	242	do	N. 36 E.,	2¾	3.15 p. m	do
21	do	243	do	N. 55 E.,	1½	4.15 p. m	do
22	do	244	Race Point Light	S. 50 E.,	1	11.00 a. m	do
22	do	244[1]	do	S. 27 E.,	5¼	11.30 a. m	do
22	do	245	do	S. 7 W.,	4	2.25 p. m	do
25	do	246	do	S. 11 E.,	2¼	10.55 a. m	do
25	do	247	do	S. 20 E.,	3¼	11.30 a. m	do
25	do	248	do	S. 1 W.,	3¼	12.25 p. m	do
25	do	249	do	S. 13 W.,	4½	1.05 p. m	do
25	do	250	do	S. 9 W.,	5¼	1.50 p. m	do
25	do	251	do	S. 23 W.,	6¾	2.50 p. m	H. W
25	do	252	do	S. 34 W.,	6¼	3.55 p. m	Ebb
28	do	253	Wood End Light	N. 50 E.,	7	10.15 a. m	do
28	do	254	do	N. 50 E.,	7	10.45 a. m	do
28	do	255	do	N. 50 E.,	7	11.30 a. m	do
28	do	256	do	N. 50 E.,	7	12.15 p. m	do
28	do	257	do	N. 50 E.,	7	12.45 p. m	do
28	do	258	do	N. 50 E.,	9½	1.15 p. m	do
28	do	259	do	N. 67 E.,	10¾	2.20 p. m	Flood
28	do	260	do	N. 67 E.,	7½	3.30 p. m	do
28	do	261	do	N. 67 E.,	3½	4.15 p. m	do
29	do	262	Race Point Light	S. 65 W.,	14	10.45 a. m	Ebb
29	do	263	do	S. 65 W.,	14	11.25 a. m	do
29	do	264	do	S. 65 W.,	15	12.15 p. m	do
29	do	265	Cape Cod Light	S. 30 W.,	8	1.25 p. m	do
29	do	266	do	S. 42 W.,	13	3.15 p. m	L. W
31	Air, Green, 2903	267	Race Point Light	S. 82 W.,	26	Meridian	Ebb
31	Water, Miller	268	do	S. 84 W.,	26	1.00 p. m	do
31	Cassella, 31486	269	Cape Cod Light	S. 67 W.,	9	3.30 p. m	Flood
31	do	270	do	S. 66 W.,	7	4.20 p. m	do
Aug. 1	do	271	Race Point	S. 12 W.,	2¾	9.30 a. m	do
1	do	272	do	S. 2 W.,	3	10.00 a. m	do
1	do	273	do	S. 40 W.,	5¼	11.30 a. m	H. W
1	do	274	Cape Cod Light	S. 11 E.,	7	12.15 p. m	Ebb
1	do	275	do	S. 11 E.,	7	1.25 p. m	do
1	do	276	do	S. 20 W.,	6½	2.15 p. m	do
1	do	*277	Wood End	S. 76 E.,	3	5.00 p. m	L. W
4	Air, Green, 2903	278	Long Point	N. 75 E.,	¼	8.20 a. m	Flood
4	Water, Negretti	279	Race Point	South	6¼	10.45 a. m	do
4	Zambra, 43227	280	do	S. 71 E.,	6½	11.30 a. m	do
4	do	281	do	S. 12 E.,	8½	12.10 a. m	do
4	do	282	do	S. 3 W.,	5½	1.30 p. m	Ebb
4	do	283	do	S. 44 E.,	8¼	2.15 p. m	do
4		†284					
6	do	285	Race Point	S. 44 E.,	11	10.00 a. m	Flood
6	do	286	do	S. 14 E.,	14	12.07 p. m	do
6	do	287	do	S. 20 E.,	16	12.45 p. m	do
6	do	288	do	S. 20 E.,	19	2.07 p. m	H. W
6	do	289	do	S. 20 E.,	19	2.55 p. m	Ebb
11	do	290	do	S. 86 E.,	1¼	10.00 a. m	do
11	do	291	do	S. 55 E.,	1¾	10.30 a. m	do
11	do	292	do	N. 85 E.,	2¾	11.20 a. m	L. W
11	do	293	do	N. 84 E.,	3¾	12.18 p. m	Flood
11	do	294	do	N. 86 E.,	6¾	1.05 p. m	do
11	do	295	do	N. 82 E.,	7¾	2.00 p. m	do
11	do	296	do	N. 82 E.,	9	3.00 p. m	do
11	do	297	do	N. 80 E.,	11	3.45 p. m	do
20	do	298	Gurnet Light	S. 79 W.,	3¼	11.00 a. m	Ebb
20	do	298[1]	do	S. 88 W.,	4¼	1.00 p. m	do
20	do	299	do	S. 74 W.,	4½	1.30 p. m	do
20	do	300	do	S. 75 W.,	5	2.15 p. m	do
20	do	301	Race Point	N. 65 E.,	5	4.00 p. m	do
20	do	301[1]	do	N. 65 E.,	5	4.30 p. m	do
21	do	302	Cape Cod Light	S. 51 W.,	16.5	11.30 a. m	Flood
21	do	303	do	S. 51 W.,	15	1.00 p. m	do
21	do	304	do	S. 61 W.,	15	2.30 p. m	Ebb
21	do	305	do	S. 68 W.,	18	2.55 p. m	do
25	do	306	Race Point	S. 56 E.,	5	10.10 a. m	do
25	do	307	do	S. 56 E.,	4¼	11.04 a. m	do

* Surface temperature, No. 277, doubtful. † No results from No. 284, and no record kept.

States steamer Speedwell, 1879.

than 0°.5. Instruments read to nearest 0°.5. *All bearings true.*

Temperature.				Depth.	Character of bottom.	Wind.	Drift.	Implement used.
Air.	Surface.	Intermediate.	Bottom.					
°	°	*Faths.*	°	*Faths.*				
70	67			13	b. m. f. s.			Dredge.
69.5	67			18	...do			Trawl.
				19	...do			Dredge.
72	67			21	b. m			Trawl.
69	65.5			20	...do			Do.
70	58			25	f. g. s.			Dredge and trawl.
				30	...do			Do.
				28	...do			Do.
66	63			28	...do			Do.
66	63			34	...do			Do.
66.5	63			32	crs. s.			Do.
65	62			30	... do			Trawl.
66.5	62			30	crs. s. G			Do.
66.5	60			24.5	...do			Dredge.
66	62			27	f. g. s. G			Trawl.
72	65			17	R		NW.	Dredge.
75	65			21	S		NW.	Do.
76	66			18	R		NW.	Do.
78	68			16	...do		NW.	Do.
78	68			16	...do		NW.	Do.
72	64			20	m			Trawl.
71	64			24	b. m			Do.
74	65			25	...do			Do.
74	66			26	...do			Do.
71	65.5			88	...do		NE.	Dredge.
71	65.5			88	...do		NE.	Do.
71	65			80	...do		SW.	Trawl.
71	65			73	G		SW.	Do.
71.5	66.5			120	b. m		SW.	
70	68.5		41	135	...do		SE.	Dredge.
71	67.5		42	129	...do		SE.	Trawl.
70	64		39.5	53.5	G		NW.	Do.
71	64.5		39	42	b. s. and G		NW.	Do.
70	60		39	34	f. y. s.		WNW.	Dredge.
70	67		38	34	y. s		WNW.	Trawl.
69	67		38.5	25	crs. y. s. and G.		WNW.	Dredge.
73.5	68.5		39	30	crs. y. s. bk. sh.		SE.	Do.
72	66.5		39.5	29.5	y. s. and G		SE.	Trawl.
71	66		37.5	47	f. y. s. bk. sh.		SE.	Do.
74	74.5		42	28	g. m		SE.	Do.
70	69.5		58	9	b. m		SE.	Dredge.
74	63	6.5 f–44°	44	13.5	S. sh		W.	Do.
71	63	6 f–52°	44	12	S		W.	Trawl.
76	62.5	7 f–57°.5	44	14	...do		W.	Dredge.
72	61	7 f–45°.5	43	15	S. G.		W.	Do.
71	65	15 f–41°	38.5	31	s. gm		W.	Do.
69	68	18 f–40°	39	35.5	g. m		NW.	Dredge.
71	67	19 f–40°	39	37	...do		NW.	Do.
68	67	28 f–39°	39	47.5	... do		NW.	Trawl.
72	67.5	16 f–44°	39	33	f. b. s. sh		NW.	Do.
70	68.5	27 f–39°	38	45	f. g. s.		SE.	Do.
72	63.5		38	31	...do	NW. 1.	N.	Dredge.
70	64		40	30	...do	NW. 1.	SSW.	Trawl.
69	65		41	29	b. m. f. s	NW. 1.	N.	Dredge.
66	69.5		39.5	27	g. m	NNW. 2.	N.	Do.
66.5	66		39	26	...do	NNW. 1.	N.	Trawl.
67	65.5		39.5	26	...do	NNW. 1.	N.	Rake dredge.
68.5	65		39	26	...do	NNW. 1.	N.	Dredge.
69	65		39.5	22	f. s	NNW. 1.	N.	Trawl.
64	61.5		55.5	16	f. bn. s	NNW. 1.	S.	Dredge.
68	59.5		44	20	bn. s. P	NW. 1.	S.	Do.
66	61.5		45	21	f. bn. s	NW. 1.	S.	Trawl.
68	61.5		45	20	f. bn. s. P	W. 1.	E.	Do.
66	60		42.5	27	bn. m	SSE. 1.	Nd.	Dredge.
66	60		42.5	27	...do	SSE. 1.	Nd.	Rake dredge.
68	60		41	124	f. bn. m	Calm.	W.	Dredge.
71	61.5		41	122	...do	Calm.	W.	Trawl.
75.5	61.5		41	122	bn. m	SSE.	W.	Do.
69	61		41	118	...do	SSE.	SE.	Do.
63	61		41	30	...do	N.	SE.	Do.
65	61	15 f–48°.5	43.5	31	bn. m. f. s	N.	SE.	Do.

Record of dredging of United States

Date.		Thermometer used.	Number of observation.	Locality.	Time.	Tide.
				° ′		
Aug.	25	Water, N. Z., 43227	308	Race Point .... S. 28 E., 5½	12.55 p. m	Flood
	25	....do	309	......do .... S. 23 E., 5½	1.30 p. m	...do
	29	....do	310	Wood End .... N. 33 W., ¼	9.30 a. m	...do
	29	....do	311	......do .... N. 36 W., 1¼	10.00 a. m	...do
	29	....do	312	......do .... N. 41 W., 2½	11.00 a. m	...do
	29	....do	313	......do .... N. 26 W., 3½	11.30 a. m	H. W
	29	....do	314	......do .... N. 31 W., 6	12.15 p. m	Ebb
	29	....do	315	......do .... N. 25 W., 7	12.55 p. m	...do
	29	....do	316	......do .... N. 36 W., 5¾	2.15 p. m	...do
	30	....do	317	Race Point .... N. 3 W., 1¾	10.00 a. m	Flood
	30	Water, N. Z., 43230	318	......do .... N. 14 E., 2½	10.30 a. m	...do
	30	....do	319	......do .... N. 10 E., 1¾	11.25 a. m	...do
	30	....do	320	......do .... N. 38 E., 1¼	12.30 p. m	H. W
	30	....do	321	......do .... N. 62 E., 1	1.15 p. m	Ebb
Sept.	1	....do	322	Cape Cod Light .... S. 9 W., 10	11.30 a. m	Flood
	1	....do	323	......do .... S. 6 W., 11	12.30 p. m	H. W
	1	....do	324	......do .... S. 2 W., 11	1.30 p. m	Ebb
	1	....do	325	......do .... S. 8 W., 13	2.50 p. m	...do
	1	....do	326	......do .... S. 4 W., 12.5	4.15 p. m	...do
	6	....do	327	Race Point .... S. 11 W., 7¾	10.25 a. m	Flood
	6	....do	328	......do .... S. 11 W., 6¼	11.10 a. m	...do
	6	....do	329	......do .... S. 17 W., 5½	12.15 p. m	...do
	6	....do	330	......do .... S. 8 W., 6	12.45 p. m	...do
	6	....do	331	......do .... S. 2 W., 5½	1.45 p. m	...do
	6	....do	332	......do .... S. 6 E., 5½	2.40 p. m	...do
	6	....do	333	......do .... S. 18 E., 5½	3.30 p. m	...do
	6	....do	334	......do .... S. 28 E., 5½	4.15 p. m	H. W
	9	....do	335	Gurnet Light .... N. 30 W., 1¾	10.00 a. m	Ebb
	9	....do	336	......do .... N. 40 W., 2¾	10.45 a. m	...do
	9	....do	337	......do .... N. 58 W., 4½	11.45 a. m	...do
	9	....do	338	......do .... N. 66 W., 6½	12.30 p. m	Flood
	9	....do	339	Manomet Point .... N. 67 W., 3½	1.45 p. m	...do
	9	....do	340	......do .... N. 38 W., 6	3.00 p. m	...do
	9	....do	341	......do .... N. 68 W., 9	4.00 p. m	...do
	10	....do	342	Cape Cod Light .... S. 22 W., 14	Meridian	...do
	10	....do	343	......do .... S. 33 W., 17.5	1.45 p. m	...do
	10	....do	344	......do .... S. 35 W., 15	3.45 p. m	...do
	13	....do	345	Minot's Ledge Light ...... South ... 3¼	8.00 a. m	...do
	13	....do	346	......do .... West ... 5½	9.30 a. m	Ebb
	13	....do	347	......do .... N. 66 W., 9	10.40 a. m	...do
	13	....do	348	Standish Monument ...... S. 35 W., 10	11.50 a. m	...do
	13	....do	349	......do .... S. 36 W., 13	12.55 p. m	...do
	13	....do	350	......do .... S. 56 W., 13½	3.15 p. m	Flood
	13	....do	351	Race Point Light .... S. 74 E., 6	4.40 p. m	...do
	15	....do	352	Billingsgate Island Light S. 53 E., 4	10.20 a. m	H. W
	15	....do	353	......do .... S. 78 E., 5	11.20 a. m	Ebb
	15	....do	354	......do .... N. 74 E., 6	12.30 a. m	...do
	15	....do	355	......do .... N. 56 E., 7¾	1.40 p. m	...do
	15	....do	356	......do .... N. 56 E., 7¾	2.15 p. m	...do
	15	....do	357	......do .... N. 48 E., 5½	2.40 p. m	...do
	15	....do	358	......do .... S. 63 E., 5¾	4.20 p. m	...do
	18	....do	359	Cape Cod Light .... S. 86 W., 30	6.05 a. m	L. W
	18	....do	360	......do .... S. 88 W., 30	7.15 a. m	Flood
	18	....do	361	......do .... N. 89 W., 36	9.15 a. m	...do
	18	....do	362	......do .... N. 86 W., 21	11.40 a. m	...do
	18	....do	363	......do .... N. 84 W., 20	1.30 p. m	H. W
	18	....do	364	......do .... N. 75 W., 15	4.00 p. m	Ebb
	19	....do	365	Chatham Light .... N. 45 W., 2¾	6.00 a. m	...do
	19	....do	366	......do .... N. 55 W., 4½	6.30 a. m	...do
	19	....do	367	......do .... N. 67 W., 5½	7.30 a. m	...do
	19	....do	368	......do .... N. 84 W., 6	8.00 a. m	...do
	19	....do	369	......do .... S. 78 W., 6¼	8.30 a. m	...do
	19	....do	370	......do .... N. 75 W., 12	10.00 a. m	Flood
	19	....do	371	......do .... N. 72 W., 16	11.45 a. m	...do
	19	....do	372	......do .... West ... 21	1.30 p. m	...do
	26	Water, N. Z., 43227	373	Cape Cod Light .... S. 32 W., 5	8.30 a. m	Ebb
	26	....do	374	......do .... S. 75 W., 6½	10.00 a. m	...do
	26	....do	375	......do .... S. 72 W., 7	11.00 a. m	...do
	26	....do	376	......do .... S. 72 W., 7	11.50 a. m	...do
	26	....do	377	......do .... S. 85 W., 13	1.15 p. m	...do
	26	....do	378	......do .... S. 85 W., 7½	....	....

steamer Speedwell, 1879—Continued.

Temperature. Air.	Surface.	Intermediate.	Bottom.	Depth.	Character of bottom.	Wind.	Drift.	Implement used.
°	°	*Faths.*	°	*Faths.*				
64	61	13 f–47°	41	26	fs. bk. sh	E.	W.	Dredge.
66	61	14 f–54°	41	27	f. y. s	SE.	W.	Trawl.
63	60. 5		48	21	b. m. f. s	W.	E.	Dredge.
67. 5	61. 5		49	16	....do	W.	E.	Rake dredge.
65	62	8 f–60°	50	15	m. s	SW.	E.	Do.
64	61	8 f–60°	55	15	b. m	SW.	E.	Do.
67	61. 5		61	10	crs. s	SW.	E.	Do.
66	63. 5		56	6	crs. s. G	SSW.	E.	Trawl.
69	62		63	8	....do	SSW.	E.	Dredge.
59	60	13 f–59°	45	25	b. m	NE.	WSW.	Do.
61	61	14 f–53°	44	28	....do	NE.	WSW.	Trawl.
60	60. 5	13 f–52°.5	45	26. 5	....do	NE.	WSW.	Do.
63. 5	61	14 f–53°	44. 5	29	f. g. s	North'ly.	South'ly.	Rake dredge.
65	61	15 f–51°	44. 5	29. 5	....do	North'ly.	E.	Trawl.
66	60	17 f–44°–34 f–41°–50 f–41°	40. 5	67	S. bk. sh	SW.	NE.	Dredge.
67. 5	58	15 f–50°–30 f–42°–45 f 41°.5.	40. 5	60	....do	SW.	NE.	Trawl.
67	61	22 f–42°	41	45	crs. s. sh	SW.	NE.	Do.
67	60	42 f–41°	40. 5	80	g. m	S. by E.	North'ly.	Do.
70	59	20 f–51°	40. 5	75	....do	SW.	SE.	Agassiz trawl.
66. 5	60		44. 5	17	crs. s. bk. sh	NW.	NW.	Dredge.
72	60. 5		42	23	f. s. bk. sh	NW.	NW.	Otter trawl.
67. 5	60		42	26	f. bn. s. P	NW.	NW.	Rake dredge.
68	60	13 f–51°	42	26	....do	NW.	NW.	Trawl.
67	60. 5	14 f–54°	42	28	fne. br. S. bk. sp.	NW.	NW.	Do.
70	61	14 f–51°	42	28	fne. br. S. sh	NW.	NW.	Do.
71	61	14 f–53°	43	27	....do	NW.	NW.	Rake dredge.
74	61	14 f–53°	42	27	fne. S. sp	NW.	NW.	Agassiz trawl.
62	61	5 f–60°	55	7	S. gn. M	SSW.	SE.	Dredge.
69	61	5 f–59°	50	11. 5	br. S. sp	SSW.	SE.	Trawl.
70	62	10 f–53°	47	16	gn. m. s	SSW.	SE.	Dredge.
71	62. 5	5 f–62°.5–10 f–55°	49. 5	18	S. bu. M	NW.	SW.	Trawl.
75	63	5 f–63°.5–10 f–55°	47. 5	15. 5	....do	NW.	SE.	Do.
66. 5	63	5 f–64°	49	14	....do	NW.	SE.	Dredge.
66. 5	63	5 f–63°–10 f–40°.5	41	15. 5	gn. M. S	NW.	SE.	Trawl.
63. 5	58. 5	50 f–44°	41. 5	94	bu. M	NNE.	NNE.	Do.
63	57	25 f–46°–50 f–45°	41. 5	116	....do	NNE.	NNE.	Do.
64	57. 5	25 f–45°–50 f–43°	42	130	....do	NNE.	NW.	Do.
60	62	10 f–57°	47	16	S. bk. spk. sh	SSW.	SE.	Dredge.
66	62	5 f–61°.5–10 f–52°	45	22	R. P. sh	SSW.	SE.	Trawl.
65	61	5 f–61°.5	46	20	S. bk. spk	SSW.	SE.	Do.
66	62. 5	10 f–59°–15 f–51°	46	16. 5	S. G	SE.	SE.	Dredge.
68	61. 5	10 f–52°–20 f–47°	44	26	S. M	SE.	SE.	Otter trawl.
72. 5	61	10 f–59°–20 f–48°	43	31	br. M	SE.	SE.	Dredge.
67	62. 5	5 f–64°	43	30	....do	SE.	SE.	Agassiz trawl.
61. 5	64	10 f–51°.5	62. 5	10. 5	S. G	S.	SE.	Dredge.
61	63. 5		49. 5	14	gn. M	NW.	SE.	Trawl.
76. 5	65. 5		62	7	crs. yl. S	NW.	SE.	Dredge.
66	64		61	7	fne. S. P	NW.	SE.	Do.
66	64		61	7	....do	NW.	SE.	Do.
65	65. 5		64	7. 5	fne. br. S	NW.	SE.	Trawl.
65	64		48	15	bu. M	NW.	SE.	Do.
67	58. 5	50 f–42°	42	105	....do	NW.	NE.	Dredge.
65	58. 5	50 f–44°	42	106	....do	NW.	SE.	Trawl.
62	58. 5	50 f–46°	44. 5	102	....do	SSW.	NE.	Do.
63	59. 5	50 f–46°.5	44	106	....do	SSW.	NE.	Do.
66	60	50 f–46°	44	108	M. fne. G	SSW.	NE.	Dredge.
65	60	30 f–50°	46	70	S. brk. sh	SW.	NE.	Trawl.
63	61. 5		58	7½	crs. S	SSW.	N.	Do.
63	61		52	11	fne. S	SSW.	N.	Do.
63. 5	61. 5		51	12	....do	SSW.	N.	Dredge.
63	61		57	15	crs. S	SSW.	N.	Do.
64	61		54	18	....do	SSW.	N.	Trawl.
61	57. 5		50	18	S. spk	SSW.	N.	Do.
66	61. 5	20 f–47°	......	34	....do	SW.	NE.	Do.
61. 5	59		......	70	S. P	NE.	NE.	Do.
58	54	20 f–49°	46	46	fne. gy. s. bk. sp.	E.	W.	Do.
64	55	15 f–54°	46	46	....do	E.	NW.	Do.
59	54	10 f–51°	43. 5	46	crs. S	E.	NW.	Do.
59	54	10 f–51°	43. 5	46	....do	E.	NW.	Dredge.
58	57	50 f–45°	44	94	bu. M	......	NW.	Do.
......	......	......	......	96	....do	......	......	Do.

Table of serial temperatures.

Date.	Thermometer used.	Number of observations.	Locality.	Time.	Tide.	Temperatures—air and water.							Depth.
						Air.	Surface.	Fathoms.	Temperature.	Fathoms.	Temperature.	Bottom.	
			° ′			°	°		°		°	°	*Faths.*
Sept. 25	Air, Green, 2903	1	Long Pt. N. 67 W., ¾	9.45 a. m	Ebb	......	56	10	51	......	......	48	17
25	Water, N. Z., 42663	2	Wood End Lt N. 45 W., ¼	10.00 a. m	do	......	55	10	52	......	......	47	21
29	do	3	do N. 45 E., ¼	8.15 a. m	Flood	......	59	10	56	......	......	45	22
29	do	4	do N. 80 E., 2	8.30 a. m	do	......	57	15	46	......	......	44	24⅓
29	do	5	do N. 55 E., 3½	9.00 a. m	do	......	57	5	56	10	46	45	21
29	do	6	do N. 48 E., 5¼	9.25 a. m	do	......	58	5	57.5	10	53	46	21
29	do	7	do N. 45 E., 7¼	10.10 a. m	do	......	58	5	56.5	10	51	45	19½
29	do	8	do N. 58 E., 7¾	10.30 a. m	do	......	58.5	5	57	10	56	46	19½
29	do	9	do N. 66 E., 6¾	11.00 a. m	do	......	59	5	57	10	54	45	24
29	do	10	do N. 88 E., 6	11.20 a. m	do	69.5	58	5	57	10	55	44	26
29	do	11	do S. 75 E., 5¾	11.50 a. m	H. W	69.5	58.5	5	57	20	46	44	30
29	do	12	Race Pt S. 71 E., 3¼	12.12 p. m	Ebb	66	58	5	56	20	48	44	33
29	do	13	do S. 45 E., 4½	12.40 p. m	do	66	57	5	56	20	51	44	34
29	do	14	do S. 32 E., 6	1.00 p. m	do	67	58	5	57	......	......	51	11
29	do	15	do S. 13 E., 5¼	1.25 p. m	do	63.5	57	5	56	......	......	52.5	23
29	do	16	do S. 10 W., 6	1.45 p. m	do	62.5	58	5	56	......	......	49	19
29	do	17	do S. 30 W., 6½	2.10 p. m	do	63	57.5	5	56	......	......	46	26
29	do	18	do S. 51 W., 8¼	2.35 p. m	do	62.5	57	5	56	......	......	45	28
29	do	19	do S. 58 W., 9¾	3.00 p. m	do	63	58	5	57	30	44	43	49
29	do	20	do S. 70 W., 9½	3.30 p. m	do	62.5	57	5	55	20	47	44	32
29	do	21	do S. 56 W., 5½	4.00 p. m	do	64.5	57	5	55	10	51	45	21
29	do	22	do S. 42 W., 5½	4.30 p. m	do	63	56	5	56	10	46	46	28
29	do	23	do S. 18 W., 2½	5.10 p. m	Flood	57.5	56	5	57	20	45	44	33
29	do	24	do S. 8 E., 2	5.45 p. m	do	61	58	5	57	20	45	44	30
29	do	25	do N. 16 E., 2¼	6.15 p. m	do	61	58	5	59	......	......	44	27

The following abbreviations are used in the foregoing report and tables:

+. Dredge. Used on the chart.

⊙ Trawl. Used on the chart.

Lt. Light, or light-house.

Pt. Point.

H. W. High water.

L. W. Low water.

°. Over figures—degrees.

′. Over figures—geographical, or sea miles.

Abbreviations of bottoms.

M., or m., for mud.
S., for sand.
G., for gravel.
Sh., for shells.
P., for pebbles.
Sp., for specks.
St., for stones.
R., for rock.
O., for ooze.

bk., for black.
wh., for white.
yl., or y., for yellow.
gy., or g., for gray.
bu., or b., for blue.
gn., for green.
br., for brown.
fne., or f., for fine.
crs., for coarse.
brk., for broken.

The following examples will illustrate the use of the abbreviations of bottoms: crs. yl. s. bk. sp. brk. sh.—coarse yellow sand, with black specks and broken shells. Bu. m., or b. m., blue mud.

Very respectfully, your obedient servant,

Z. L. TANNER,
Lieutenant, Commanding.

APPENDIX D.

PROPAGATION OF FOOD-FISHES.

GENERAL CONSIDERATIONS.

XIII.—THE POLLUTION OF PUBLIC WATERS BY REFUSE FROM FACTORIES.

By C. Tölke.*

[From Circular No. 6, 1879, of the *Deutsche Fischerei-Verein*, Berlin, December 31, 1879.]

Our modern industry, which is steadily progressing from year to year, needs, above everything else, water, and its use is keeping step with the growth of industry. Rivers and brooks are the principal sources of supply, and they again receive the water, after it has been used, in an impure condition, either direct or indirect.

Water which has been used by factories is generally warm and contains numerous particles of refuse, *e. g.*, coloring matter, lime, alkaline salts in various combinations, remnants of plants, slime, &c. It will be evident that large quantities of such refuse will pollute rivers and brooks to such a degree as to render pisciculture impossible and to make the water unfit to be used for drinking by either man or beast.

Phenomena of this kind have been observed in all industrial districts; brooks and rivers have lost the fish which formerly were numerous, the water has become turbid, and during the warm season the air is filled with miasmatic effluvia which are both disagreeable and unhealthy.

An investigation of our smaller rivers and brooks would furnish incontrovertible proof of the growth and magnitude of the evil, and show the necessity of immediate relief.

The complaints concerning the refuse water from factories are growing louder and more numerous from year to year and cause many lawsuits.

In fighting this pollution of our waters the authorities have nothing to back them but the law regarding private waters of February 28, 1843, where it says: "The water used in dyeing, tanning, fulling, and similar establishments shall not be let into a river, if thereby the amount of pure water is diminished or the public is seriously inconvenienced."

Although this paragraph can be construed in various ways, it cannot, even if it is strictly carried out, remove the evil, for it is exceedingly difficult to furnish the necessary evidence, as is proved by the many wearisome and disagreeable lawsuits which have been engaged in on account of this very paragraph. Even if the lawsuit is decided in

* *Ueber Verunreinigung der öffentlichen Gewässer durch Fabrikabgänge.*—[Translated by Herman Jacobson.]

favor of the plaintiff, the only result is that a fine is imposed, the cause of the trouble remaining just the same as before. This law is frequently used for no other purpose but to extort money from the manufacturers, and I know several cases from the province of Saxony where millers and others entitled to the use of water-power have appealed to this law simply for the purpose of obtaining some money. It is self-evident that such a law is of no benefit to the general public, and that it cannot prevent the pollution of public and private waters.

My object in this article is to show that many industries may, without any detriment to themselves, diminish their consumption of water very considerably, and that it will even be to their *own advantage* to entirely avoid the pollution of public and private waters. Among these industries I include sugar refineries, starch factories, distilleries, breweries and malt-houses whose refuse-water is strongly impregnated with organic matter and causes most of the complaints.

The manufacture of beet-sugar, with which I have been familiar for many years, shall form the subject of a special investigation. This important industry, probably the most important of our agricultural industries, has, thanks to a sensible protective tariff and a rational system of taxation, developed from very small beginnings to its present vast extent.

This important industry certainly deserves to be protected in the interest of the national finances and agriculture; but it cannot be denied that this growing industry is the very one which contributes the largest share to the pollution of our brooks and rivers, particularly as it consumes an enormous amount of water.

It will be easily understood, therefore, why the complaints from the beet-sugar manufacturing districts are so numerous and well founded, and every impartial witness will have to concede that the brooks and rivers of those districts produce a very disagreeable impression not only on the eyes, but also on the olfactory organs. Such polluted brooks and rivers are, of course, entirely unfit for fish; but, what is worse, their water cannot be used for drinking and for agricultural purposes.

I will only mention the Bode, Selke, Haltemme, Aller, &c., and the brooks flowing into these rivers, as well as the Bruchgraben, near Oschersleben.

The consumption of water by a beet-sugar factory worked on the principle of diffusion shows the following per centage on the weight of the beets:

	Per cent.
Washing the beets	50
Production of juice	222
Condensation	1,02
Generating steam	150
Purifying through carbonized bones	50
Refining	25
	1,519

A sugar factory using every day 400,000 pounds of beets and working for 20 hours will, therefore, consume the following quantity of water per minute:

	Liters.		Cubic feet.
Washing the beets	83.33	=	2.7
Production of juice	370.00	=	12.0
Condensation	1,703.33	=	55.0
Generating steam	250.00	=	8.1
Purifying through carbonized bones	83.33	=	2.7
Refining	41.66	=	1.35
Total per minute	2,531.00	=	81.85

A factory using anually 7,000,000,000 pounds of beets will therefore consume the enormous quantity of 1,435,000 cubic feet of water. This mass of water is taken either directly or indirectly from public brooks and rivers, and after having been used is returned to them in slightly diminished quantity, but having a temperature of some 40° Réaumur, and containing organic matter and alkalies of every kind.

The high temperature favors the disintegration of organic matter, produces fermentation, causes the formation of algæ and fungi, becomes fatal to animal life, and fills the air with miasmatic effluvia.

It is possible, however, without any detriment to the beet-sugar industry, to diminish the consumption of water by one-half, as has been tried very successfully in factories where water was scarce.

This saving of water is accomplished by—

1. Working the diffusing apparatus by compressed air instead of water. By this means (always supposing a daily consumption of 400,000 pounds of beets) 191 liters, or 6.66 cubic feet of water are saved every minute.

2. By using for washing, generating of steam, and refining the condensed water from the two boilers, and thus saving 375 liters = 12.15 cubic feet.

3. By regaining two-thirds of the condensed water from the boilers, and by cooling the water to the temperature of the air by means of a suitable apparatus, 1,135.5 liters, or 36.6 cubic feet of water are saved.

The total saving per minute is, therefore, 1,205 liters; *i. e.*, one-half of the quantity consumed. Practically, the saving may be less, but certainly not less than one-fourth of the quantity consumed, *i. e.*, 600 liters per minute.

It is evident, therefore, that it would be a great gain if all beet-sugar factories could be compelled by law to introduce the saving system. There could certainly be no objection to this, if we consider that many factories have to follow this system, simply because they have not enough water.

"Polluted waters," properly so called, must be carefully separated from the condensed water which is to be used again. These "polluted waters" may be classified as follows:

1. The water used in washing the beets, containing small particles of soil, leaves, and pieces of beet.

2. The water flowing off from the beets after they are cut, containing many slimy particles.

3. The water coming from the purifying process through carbonized bones, containing salts of every imaginable kind, lime containing phosphoric acid, combinations of ammonia, &c.

4. The condensed water from the first boiler, containing a good deal of ammonia. This water may, of course, be used for washing beets, only it must not pass through the purifying apparatus.

5. The so-called "purifying water," which is thoroughly saturated with lime, sugar, dirt, &c.

These polluted waters must be led into large basins, large enough to give the water time to become clear and pass through a process of fermentation, by which the insoluble organic particles sink to the bottom.

If the water-saving system has been introduced, a factory working 400,000 pounds of beets per day needs only six connected basins about 10 meters long, 2 meters broad, and 1½ meters deep. These basins may be simple earth-pits without any plastering.

All sugar factories already possess similar basins, but they are all too small and arranged in an impracticable manner, so as not to allow the water sufficient time for becoming clear and for fermenting. The first expense is considerable, but the interest and amortization is fully covered by the amount of manure thus gained. The water flowing out of these basins is somewhat turbid, and must not be allowed to enter the brooks and rivers, as is mostly done now, but should be led over fields and meadows, and, after having thus been filtered, flow into the public waters.

The sugar manufacturers fear that similar legal restrictions will prove detrimental to their industry, and that the burdens which they would have to bear in the interest of the general public would prove too heavy. But this idea is erroneous, for the irrigation with refuse water would prove a great advantage to the factories.

A factory using 400,000 pounds of beets per day has enough refuse water to irrigate an area of 20 hectares. Such an area would produce 20,000 to 30,000 pounds of the best hay, and would therefore represent a value of 750 mark=$178.50. The irrigation is by no means confined to the immediate neighborhood of the factory, for by means of a steam-pump and pipes the refuse water can easily be led to the most suitable place. Such an apparatus would not be as expensive as might appear at first sight, as the necessary steam-power would already be found in the factory itself. The cost of an irrigated area at a distance of 2 kilometers from the factory would, according to a very careful estimate, only be about 30,000 mark=$7,140. This sum would be distributed as follows:

For pipes	$4,760 00
For steam-pump	952 00
For draining and grading 20 hectares	1,428 00
	7,140 00

Subtract from this 5 per cent. interest, 2 per cent. amortization = 7 per cent. per annum	$476 00
Rent of 20 hectares, at $42.84 per hectare	856 80
Cutting the grass	285 60
Repairs	285 60
Superintendence	238 00
Total per annum	2,142 00
Value of harvest, at $172.50 per hectare	3,450 00
Net gain	1,308 00

In making this calculation we have not taken into account the great advantage of having a large quantity of good hay, which is much needed in all sugar factories. The manufacturer, who is generally a farmer, can give his cattle larger quantities of better hay than hitherto; the cattle will enjoy better health, and he will have more animal manure, thus saving the expense for artificial fertilizers. Those factories which are worked by a joint-stock company could then give a meadow-area to each one of the stockholders in proportion to the amount of stock held by them.

The well-known civil engineer, A. Elsasser, formerly of Loburg, now of Magdeburg, has most successfully introduced a filtering apparatus for the refuse water in the sugar factory at Roitsch (province of Saxony), and any one interested in this question may there convince himself that the water becomes perfectly clear and odorless. The apparatus at Roitsch, however, is too small, and with the same amount of water twice the area could be irrigated.

Mr. Elsasser wants, for successful irrigation, a very level ground with tolerably loose soil, so the fluid parts of the manure may be evenly distributed. The area which is to be irrigated should be drained at the depth of about one meter; the drain-pipes should lie close together, and be so arranged that the water may flow off easily. The chemical substances contained in the refuse water should penetrate the soil only to a compartively small depth, in order to let the further disintegration take place under the cover of the soil, so that the nutritious matter which has assumed a gaseous form may be assimilated by the soil, and thus find its way into the roots of plants. In this manner the soil is always ready to receive new refuse water. Mr. Elsasser, whilst living at Loburg, has very successfully made 250 hectares of artificial meadows which are irrigated with refuse water from several starch factories. In the potato-starch factories, mostly located on light soil, the advantage of irrigating with potato-refuse water is very evident, for formerly it flowed into brooks and rivers and made the water unfit for fish. Whenever a new starch factory is started intelligent farmers in the first place look to the possibility of irrigating their meadows with the refuse water, and of thus gaining a hitherto unknown wealth of good hay, and the gain from the factory itself only seems a secondary consideration. The best and most surprising specimen of what may be accomplished by constant irrigation with potato-refuse water may be seen at Knoblauchshof, near Loburg, the property of Counsellor Friedrich Knoblauch, of Magdeburg. Here may be seen the largest starch factory in Germany, and by the system of irrigation with potato-refuse water 50 hectares of entirely unproductive land have been transformed into magnificent meadows, yielding 25,000 pounds of the very best hay per hectare. The plans for this establishment have all been made by Mr. Elsasser.

Distilleries, malt-houses, and breweries may of course use their refuse water in the same profitable manner; the area to be irrigated need not be very large, but the expense of making the necessary arrangements will be amply repaid.

After carefully examining this whole question in all its bearings, I have arrived at the conviction that there will be no risk whatever if the government were to prohibit all factories from letting their refuse water flow into public waters in an unfiltered condition. A period of two to three years should be granted for making the necessary changes, and by appointing a commission of competent men the factories should in every possible way be assisted in the work.

Cities and villages should be absolutely prohibited from making rivers and brooks the receptacles of all the filth from their sewers. All exertions to revive our fisheries will be in vain if we cannot give the fish what they need above everything else, viz, pure, wholesome water. It must also be taken into consideration that as matters stand at present an enormous amount of valuable manure is absolutely lost in the refuse water from our factories. If the system of irrigation by refuse water from the factories and the sewers of cities could be generally introduced, our farmers would not only save a good deal of money which is now spent in buying artificial fertilizers, but they would also (more than by protective tariffs) be enabled to successfully compete with the agricultural products of foreign countries.

It is to be hoped that when our legislators—as will be the case at no distant date—take up the important subject of the pollution of public waters by refuse water, they will properly consider all the above-mentioned points.

XIV.—IS SAWDUST INJURIOUS TO THE FISHERIES?

[From report of Mr. A. Landmark, inspector of fisheries, on the condition of the Norwegian fresh-water fisheries during the years 1876–1879.]*

Before giving an account of the Norwegian river fisheries during the years 1876–1879 and reporting the result of the salmon fisheries during the same period, I must briefly dwell on some injurious influences to which our salmon and sea-trout fisheries are exposed, and which hitherto have either not at all or but insufficiently been reached by legislation.

Among these injurious influences I must first of all mention the very general custom of throwing sawdust and other refuse from the saw-mills into the river. It is well known that at present our fishery laws contain no provision prohibiting this practice. Those prohibitory regulations which have been made in the interest of navigation (laws of August 12, 1848, August 26, 1854, and March 24, 1860) are of no practical benefit to the fisheries, because they exempt the owners of saw-mills from the duty incumbent upon all other manufacturers of gathering their refuse, and merely compel them to contribute something towards the expenses of dredging the rivers, which benefits navigation only. This arrangement is very unsatisfactory as far as the fisheries are concerned, for the refuse from saw-mills, and more especially the sawdust proper, is, in various ways, injurious to the fisheries. Sawdust gradually sinks to the bottom, and thus fills the very place where the fish eggs are to develop with impure and injurious matter. Salmon eggs, to which we here have special reference, require for their development a clean bottom, covered with small stones, pebbles, or sand. When brought into contact with sawdust or any other rotting wooden matter for any length of time, the eggs are overgrown by a species of fungus, which invariably kills the germ contained in the egg, and is all the more injurious because it spreads very rapidly from one egg to the other. It is true that it is scarcely probable that very large masses of sawdust will gather in those parts of the rivers where the salmon spawn, because in these places the current is generally very rapid; but still a considerable

* "Om Sagflisens Skadelighed for Fiskerierne." From "Indberetning fra Fiskeri-Inspectören angaaende hvad der til Ferskvandsfiskeriernes Fremme er udfört og om disses Tilstand i Aarene 1876–1879." Christiania, 1881.—Translated by Herman Jacobson.

quantity of it will gather between the small stones on the bottom, and will thus expose to the danger of destruction those eggs which have remained in the spawning places. Unfortunately, however, large masses of eggs, probably by far the larger portion, do not remain in the spawning places, but are carried away by the current and only find a resting place farther down the river, where the current is not so strong and where there are frequently such large piles of sawdust that the eggs are completely buried in them and are of course destroyed. This is all the more injurious to the eggs, as, owing to climatic reasons, the increase of the salmon is principally dependent on those eggs which are carried away from the spawning places and which settle down in the calm and deep portions of the river. The eggs which remain in the spawning places are, in our climate, frequently entirely destroyed by influences which are beyond human control.

It is well known that the quantity of water in our rivers is greatly diminished during winter, so that all the water contained in the river finds sufficient room in a narrow channel, whilst the greater portion of the river bed lies dry. As the salmon spawn in shallow waters, the greater portion of those eggs which are not carried away by the current into deep water will remain on the dry land for a longer or shorter period, exposed to the destructive influence of frost and ice, and will thus inevitably be destroyed. Those eggs which have escaped this danger are threatened by another and not less serious one, namely, the floating ice, which often scrapes the bottom, especially in shallow places, so violently as to change the bed of the river and carry away immense pieces of rock. It may well be imagined what destruction is thereby caused to the eggs lying in such places, and also to the newly-hatched fish.

In comparison with the impurities brought to the river-bottoms by the sawdust, and the consequent destruction of the fish eggs, its other injurious influences on the fisheries are hardly to be taken into account, although in themselves they are by no means inconsiderable. Thus there can be hardly a doubt, that when the water rises and causes the masses of sawdust which have gathered in the river to move, a large number of young fish are carried away with it and are gradually buried in the newly-formed piles of sawdust. This is particularly the case during spring, when the young fish are as yet very weak and cannot swim far. It is also highly probable that the sawdust floating about in the water kills a large number of young fish in the act of breathing, because they can hardly avoid swallowing particles of it which stick fast in the gills and thus eventually cause their death.* I must finally also men-

*It is a very general opinion that this also applies to the grown salmon, as in those rivers which are full of sawdust dead salmon have often been found whose mouths and gills were completely filled with sawdust. I am not prepared to say whether this opinion is correct. Such cases as the one just mentioned are at any rate not so common as to deserve special attention. It has also been said that sawdust will drive the salmon entirely away from a river, but I think that this is very improbable, and could only be possible in cases where a river has been completely filled with it.

tion the circumstance, that the refuse from the saw-mills in many places interferes with the fisheries. We have instances (of which I shall have occasion to speak further on) of fishing-places being so completely filled with heaps of sawdust as to make the hauling in of the nets very difficult and even impossible. The larger pieces of wood which are frequently found among the refuse from saw-mills often interfere very seriously with the fisheries by tearing the nets.

Although the quantity of sawdust in some of our larger rivers has of late years been somewhat diminished by the establishment of steam saw-mills, which use most of their refuse as fuel, the evil is on the increase in many other places, to such a degree in fact as to endanger the very future of the salmon fisheries. The danger is greatest in the salmon rivers in the districts of List and Mandal, the districts where our most productive salmon fisheries are carried on. Many fishery-owners in these districts think the evil has assumed such dimensions that, as long as nothing is done to keep the sawdust out of the rivers, they consider it useless to take any steps for improving the salmon fisheries. At the many meetings for promoting the fishing interests which I have attended in these districts such discouraging opinions have again and again been advanced with more or less earnestness. Although I believe that the fears entertained by many persons in the above-mentioned districts are somewhat exaggerated, I cannot conceal from myself the fact that the evil is a very serious one, and that every year which passes without any preventive measures being taken increases the danger to the salmon fisheries of these districts to such a degree that it may take them a very long time to recover.

With a view of showing the actual state of affairs in this regard in the districts of List and Mandal, and the light in which it is viewed by people in these districts, I shall give some extracts from recent reports.

Mr. Baade, assistant superintendent of fisheries, whom I had commissioned during the summer of 1877 to visit the districts of List and Mandal and examine the condition of the salmon fisheries, says, among other things, in his report, under date of October 20:

"The authorities of these districts have given some attention to the question of the injurious influence of sawdust on the salmon. It seems strange that any doubt should ever have been entertained as to its injurious influence; and all doubts as to this question should have vanished, since most of the saw-mills have introduced circular saws, whose number is constantly increasing. This kind of saw makes the dust much finer, and it becomes all the more injurious to the fish, when—as is frequently the case now—the mills are employed in cutting staves, for which birch and coarser wood generally is used than for boards and planks; the sawdust which is thereby produced is more apt to sink to the bottom instead of being carried away by the current. The injurious influences of this change have become very strikingly apparent in these districts, for in all the salmon streams in this part of the country large masses of sawdust have been noticed on the bottom; this applies to all the streams of these districts, but especially to those which do not have a swift current.

"As an illustration of the deplorable condition to which salmon streams can be reduced by an accumulation of sawdust, we may mention the Undal River, which in a few years will probably not have a single salmon. Its bed along its entire course is covered with sawdust to such a degree as to render many of the fishing stations entirely unprofitable, as the nets cannot be hauled ashore; and in those fishing stations which are still used, such large masses are hauled ashore with the nets that, after the nets have been landed with much difficulty, it becomes hard to determine whether there are fish in them or not, so that the net has first to be trodden on in order to ascertain the fact (!). All the people living along the banks of this stream have been obliged to dig wells, which was frequently a very difficult undertaking, because the water of the stream has become unfit for drinking purposes.* When later in summer all this mass of sawdust commences to decay, there is no doubt that its effluvia will be injurious to public health.

"Under these circumstances it will not be surprising that there have recently been found in several streams dead salmon whose bodies were filled with sawdust, and that fresh spawn and young fish are exposed to special danger from this cause. This is probably also the reason why young salmon are no longer seen below the Melhus stream, which flows into Undal River about one (Norwegian) mile above its mouth. Even small flounders, which are among our hardiest fish and which formerly were abundant in the above-mentioned part of the river, have entirely disappeared, which seems to be sufficient proof of the fact that sawdust is injurious to the salmon, which of all fish can least stand impure water.

"In the other rivers of the district matters are not quite so bad as in Undal River, but still the condition of affairs is by no means satisfactory. Under these circumstances it would not seem advisable to establish hatching apparatus, for profitable as such apparatus might otherwise be, it is to be feared that here it would not answer its purpose, as a disproportionately large quantity of the newly-hatched fish would doubtless soon die in the poisoned water.

"From other places in this district complaints were received that the sawdust made the beds of rivers shallow to an inconvenient degree, and that during freshets the meadows and fields bordering on the rivers were injured by the deposits of sawdust.

"In view of the dangerous dimensions which the above-described evil has assumed in this district, and in consideration of the fact that circu-

*It seems that this observation is, in part at least, based on a misunderstanding. According to a written report by the largest landed proprietor in Northern Undal, the water of the river is at times not fit to drink on account of the sawdust. But the wells in this district were, as far as he knew, dug before sawdust got into the river in any considerable quantity. In Southern Undal the condition of the river was, according to oral reports from the same man, very much the same.

lar saws are constantly coming into more general use, I consider it absolutely necessary to compel the owners of saw-mills by law, no matter whether they use circular or other saws, to collect their sawdust, instead of throwing it into the river. Such a prohibitory law should apply not only to the main stream, but to all its tributaries, and in fact to all the saw-mills in the district, as there is no doubt that the development of all the fresh-water fisheries is greatly retarded and injured thereby."

Under date of September 30, 1879, the governor of the districts of Mandal and List has transmitted to me a number of reports on the sawdust question made to him by the authorities of the various townships, from which I shall give a few extracts:

The authorities of Tveit declare that sawdust has for a long time been considered injurious to the growth and development of the salmon.

The authorities of Oddernos strongly indorse a report from 26 fishery-owners, in which sawdust and other refuse from the many saw-mills on Torrisdal River is declared to be the principal impediment in the way of the increase of the salmon, as both the young and the farther advanced fish are destroyed by it.

The authorities of Vennesland declare that all the owners of salmon fisheries are fully convinced that the throwing of sawdust into rivers is highly injurious to the salmon fisheries.

The authorities of Sogne declare that, although there are few if any salmon fisheries in their district, it is desirable to keep the sawdust out of the salmon rivers as much as possible.

The authorities of Holme are unanimous in their opinion that sawdust injures the fisheries in Mandal River.

The authorities of Southern Undal declare that sawdust in the rivers is the principal cause of the decline of the fisheries, and that as long as no steps are taken to remedy the abuse of throwing it into the rivers, all protective measures will prove unavailing.

All the above-mentioned authorities have moreover strongly insisted on the desirability of some law prohibiting the throwing of sawdust into rivers. Similar declarations have been made by the authorities of Northern Undal, Lyngdal, Vanse, Herads, Krinesdal, Næs and Hitterö.

The district authorities to whom these reports were made have, under date of June 27, 1879, declared unanimously that "they consider it absolutely necessary to pass a law, as soon as possible, prohibiting the throwing of sawdust and other injurious matter into salmon rivers and their tributaries".

The governor also considers it highly desirable to limit, or better still, to prevent entirely, the pollution of the rivers by sawdust or any other impure matter.

To these declarations I shall add an extract from notes taken by me during a visit made in the summer of 1878 to the salmon streams of the List and Mandal districts:

"The fishery-owners on the Torrisdal River, with whom I discussed this question, were all agreed that the increasing quantity of sawdust is one of the principal causes of the decrease of the salmon. The number of common saws has not been much changed during the last ten or twelve years, nor has the annual quantity of wood cut by them been very much increased; but the number of circular saws, of which about ten years ago there were hardly any, has been increased very considerably. In Vennesland, where ten years ago there were only two circular saws there are now twelve to fourteen. The saw-mills with circular saws make both boards and planks and staves, probably as many of the former as of the latter. Probably one-half of the wood used for staves (which were not made at all before the introduction of circular saws) is foliaceous wood, and the rest is principally pine. None of the circular saws collect the sawdust, and its quantity in the rivers is therefore considerably increased. In some still places it is piled up to the depth of several yards, and this is often the case just below the spawning places, while these places are, on account of the greater swiftness of the current, hardly ever covered with sawdust. Decayed fish eggs and dead young fish are also often found in the piles of sawdust."

With regard to the condition of the Undal River, I have made the following observation:

"The principal complaint of all the fishery-owners along this river is the constantly increasing quantity of sawdust. This is particularly noticeable below the Melhus Falls, close above which there are three large saw-mills, all of which empty their sawdust into the river. An old fishing place above the falls is completely filled with sawdust, so that now the water is shallow where formerly it was several fathoms deep. The fishing places below the falls are also suffering from large quantities of sawdust, which fills the stationary nets to such a degree that they have to be kept at some distance from the bottom, so that many fish pass below them. During my visit the sawdust did not give so much trouble as usual, as the water had for some time been exceptionally high, and the current had in consequence carried most of it farther down the river. In quiet nooks and on the banks, however, piles of it could be seen. One of the large landed proprietors in Northern Undal informed me that in the portion of the river nearest to him (and therefore far above the Melhus Falls) the quantity of sawdust was so considerable that after a freshet it would cover the banks to the depth of several inches, and in some places even to the depth of one foot (!). On his own property (Spillinggard) several acres of land are covered in this way. Among the localities which had suffered in this manner he mentioned Einersmoen, Löland, and Vigmostad. After every freshet the sawdust had to be removed in order that the grass might not suffer."

Outside of the districts of List and Mandal the complaints regarding the injuries done by sawdust are not so loud and frequent, and it is probable that in no other part of Norway are the injuries as serious as in the above-mentioned districts. But there is hardly any timbered region where the refuse from the saw-mills is entirely without injurious influence on the salmon and trout fisheries, and in many places these injuries are very considerable. Aside from the Tistedal River, which has almost entirely been depleted of its formerly numerous salmon, we must mention, among the rivers suffering from the same evil, the Glommen, the Sandvik, the Lier, and the Stenkjær.

The above-mentioned facts are, in my opinion, urgent reasons why the owners of salmon fisheries should endeavor to have this important matter regulated by law in the near future. Such legislation should aim at putting a stop to the habit which now prevails to an alarming degree of throwing sawdust or other refuse from the saw-mills into the river. It was therefore a great satisfaction to learn that the commission for examining the condition of our rivers, appointed by royal order of January 22, 1876, has, in its preliminary draft of a law, from other reasons than regard for the fisheries, arrived at the belief that legislation in this matter is urgently demanded (see articles 21 to 25 of draft). With regard to the minority report of the committee, which expresses the opinion that any law compelling the mills to collect their sawdust should (when applied to saw-mills which are not already compelled to do so by the law of August 12, 1848) become applicable only when a new saw-mill is put up, or any of those at present in operation undergo a change, I must express a difference of opinion. I think that such a law by no means meets the wants of the salmon fisheries, as in some places the evil has assumed such dimensions that a law which merely prevents its spreading any more will, in those districts which suffer most, be of little or no use. What the salmon fisheries need are regulations which can be immediately applied to the existing saw-mills, therefore regulations like those proposed by the majority of the commission. The difficulties and expenses connected with the proposed collecting of the sawdust are very small, as will appear from a circumstance reported to me during the summer of 1879 by a very reliable man, namely, that one of the owners in part of a large saw-mill on the Undal River has made an offer to the other owners to gather and carry away, at his own expense, all the sawdust from this mill, on condition that he may consider the sawdust as his undisputed property, and this man, as I was told, has no other use for sawdust than that to which it is put by every farmer.

It is to be feared, however, that the draft of a law prepared by the above-mentioned commission, which, so far, is only preliminary, will not become a fixed law and be enforced for a long time to come on account of the many and great difficulties in the way of its execution. But on account of the threatening dimensions which the pollution of the rivers by sawdust has assumed, especially in our most important salmon districts, it will be dangerous to let more time than is absolutely necessary go by before attempts are made to regulate this matter by legislation.

There is all the less reason to wait for the final report of the commission, since any law prepared by them is sure to be unsatisfactory and not calculated to reach the true interests of the fisheries, as during the parliamentary discussions regarding the appointment of such a commission it was strongly insisted upon that the fisheries be kept out of the range of the commission's work. It therefore seems to me to be very desirable to insert, as soon as possible, in the law on the salmon fisheries a provision prohibiting the pollution of the salmon rivers by sawdust.

By a resolution of the Norwegian Parliament, passed in 1878, I have been commissioned to prepare the draft of a law regulating the salmon and sea trout fisheries, and it is my intention to insert a clause with regard to the injurious influences of sawdust. This whole question is also of considerable importance with regard to the trout and other fresh-water fisheries, and it may therefore be desirable to extend any future legislation on this question to all the rivers, as was proposed by the commission. This whole "sawdust question," although of great importance to the fresh-water fisheries, is, at present at least, of much greater importance to the salmon and sea-trout fisheries, but a provision relating to all the rivers of Norway, and not merely to the salmon and sea-trout rivers, does not seem to be in its proper place in a law regulating the salmon and sea-trout fisheries. It is understood, however, that any law prohibiting the throwing of sawdust into the rivers, if it is not to miss its aim entirely, must be worded in such a way as to include within certain districts the tributaries of the salmon rivers, even if they do not contain any salmon. It is not necessary, however, in this place, to enter into details regarding the provisions of such a law.

XV.—THE THICK OR THIN FERTILIZATION OF EGGS.

By G. F. Reisenbichler.*

[From No. 20 of the "*Oesterreichisch-ungarische Fischerei-Zeitung*," Vienna, May 23, 1880.]

It is well known that to this day practical pisciculturists are doubtful whether the roe squeezed out of the female fish is to be put in a little water, or whether it should be allowed to mix with the milt, and water only be added after this process is finished. There are various reasons, *pro* and *con*, interesting and important enough to form the subject of a short article.

The outer skin of the fish-egg is porous; it consequently absorbs the water from every direction and swells considerably. This process of absorption, however, is finished in a very short time, and then the egg, in a *physical* sense, is dead to its surroundings; it exercises no power of attraction on the water or on the sperm floating in it, and the latter has therefore no occasion to approach the eggs from all sides and endeavor to effect an entrance. On the other hand, it has been shown that the spermatozoa when mingling with the water dies very soon, while it will keep alive much longer when contained in the natural undiluted moisture of the fish. These facts speak strongly in favor of mixing roe and milt without previous addition of *water*, as thereby the roe would waste its power of absorption on the water and the sperm be made to die gradually. The only objection which can be raised is that such a procedure is not in accordance with the dictates of nature, which in such imitations should be followed as closely as possible. This latter reason, however, is only *seemingly* correct and tenable, and at any rate is not applicable to all cases.

It is an open question whether the natural process is not an impregnation of the egg if not entirely outside the water, at any rate with but a slight coating of the eggs with water, in which case the milt would come in contact with the roe as if diluted, and the absorption of water would only take place gradually. Some species of fish, moreover, have some sort of copulation, approaching each other until their lower sides almost touch, bringing roe and milt in such close contact with each other that at least during the first moments a dilution by water can scarcely be thought of.

* *Dick oder dünn Befruchten der Eier, von G. F. Reisenbichler.*—[Translated by Herman Jacobson.]

From the above it will be seen that the mingling of roe and milt *without water* is not entirely without its prototype in nature, as it might appear to a superficial observer, and that this reason, therefore, is without force. There is in reality no advantage, except for a more *general fertilization* of the roe, in gathering it in an empty vessel, sprinkling the milt over it, mixing the two well, and then after a few minutes adding a small quantity of water. In this manner far more eggs are impregnated than when they are placed directly in the water, and thus *physically* killed before the milt can make its influence felt. This procedure, as we have shown above, is *by no means without its parallel in nature*, and cannot be termed unnatural, although in nature it is carried out in a somewhat different manner. Care should be taken, however, in squeezing the roe into an *empty* vessel to *diminish the violence of its fall as much as possible*, because the eggs may be injured in striking the bottom of the vessel, which danger is of course averted if they fall into the water.

The fish from which roe or milt is to be extracted should be brought as close *as possible* to the bottom of the vessel, which has previously been *moistened* with a *clean wet cloth*, so that the distance which the roe and milt have to fall may be diminished as much as possible. For this reason flat vessels with a low edge are the most suitable, because in such the fish can be brought close to the bottom, which is quite smooth, and which has *previously been moistened a little.* At present round vessels are generally used, but *long, oval* vessels, corresponding somewhat to the shape of the fish, would be better, as then the fish might be held over them in its full length. The vessel would, therefore, best have the following shape: it should be long, oval, and flat, and have at the end two raised places in the edge, between which the tail of the fish could be placed, so as to prevent its frequently very violent movements, which hinder the extraction of the roe and milt, while the long shape of the vessel, corresponding to the length of the fish, makes it easier to hold it. The fish may be placed almost entirely in the vessel and made almost to touch the bottom without having either its head or tail resting on the edge of the vessel, or letting only its tail rest in an indentation of the edge. Pisciculturists should never be without such vessels, which make the process of impregnation much easier and pleasanter. It is best if two persons are employed in this process, one holding the spawner and the other the milter, bringing their lower sides close together in a slightly oblique direction over the vessel, and extracting milt and roe simultaneously, so that they may mingle as much as possible immediately on leaving the fish. As one milter is sufficient to impregnate the roe of 3 to 5 spawners, the milter should in this *simultaneous* impregnation either be only partially emptied, and should therefore be used for 3 to 4 spawners, or 2 to 3 of the latter should first be emptied, and while extracting the roe from the last (the fourth) spawner the milter should be emptied completely, thus making only the last extraction a mingling process. This method, which at first seems a little more difficult, is certainly the best for obtaining as complete an impregnation of the eggs as possible. Two persons, however, should always be employed, and the above-mentioned vessel should be used. The partial emptying of the milter is always difficult and often a doubtful experiment. It will, therefore, be best first to extract the roe from three spawners and empty the last spawner at the same time as the milter in the manner above mentioned.

Roe and milt are usually mixed with the hand, which, however, should not be done, as the warmth of the hand may easily injure the milt, and as the mingling process will not be very thorough. If roe and milt are not emptied into water the mingling process may be considerably facilitated by spreading the roe in broad layers and squeezing the milt evenly over it. But for making the mingling thorough a sort of *comb* with *blunt, rounded-off* teeth should be employed, and the teeth should be far enough apart to let the eggs pass through easily. Such combs are, properly speaking, *indispensable*, if the impregnation is to be perfect. The comb is several times drawn up and down through the roe and milt *as soon as* they have been extracted and before they have been watered; the necessary quantity is then immediately added, best by letting it flow evenly and rapidly from a watering-can with narrow apertures. The roe and milt are then again mixed several times by means of the comb, which will make the process of impregnation as complete as it is possible to make it.

All the above-mentioned operations must of course succeed each other *very rapidly*. Special attention should be paid to the temperature; the vessel destined to receive the roe and the milt, the comb and the water, should all have the temperature of the fish, or rather of the roe and the milt, and the use of the hands should therefore be avoided as much as possible. The water should always be taken from that in which the fish have previously lived. The weight of the water to be added should be fully one-half that of the roe and milt. After having been mixed with the comb the watery mixture should be left alone for about an hour in a cool place, so *the eggs may not get warm*, and the impregnated eggs should then be placed in the breeding-troughs with running water, which cleans them of the milt which has now become useless.*

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* We have given the above article in its unaltered form, although we cannot entirely agree with some of the opinions advanced by the author, while we must condemn some of them. We therefore reserve our criticism for a future occasion.—EDITOR OF FISCHEREI-ZEITUNG.

XVI.—REPORT ON OVERLAND TRIP TO CALIFORNIA WITH LIVING FISHES, 1879.

BY LIVINGSTON STONE.

HON. SPENCER F. BAIRD,
United States Commissioner of Fish and Fisheries:

SIR: I have the honor to report as follows:

In compliance with the request of the California fish commissioners to bring lobsters, striped bass, eels, and black bass to California, I began preparations on the 27th of March, 1879, for an overland trip with the above-mentioned varieties of fish.

It will be observed that two of these fishes are salt-water species. Now, a double difficulty attends the transportation of fishes inhabiting salt water. In the first place, ocean water becomes foul when confined in tanks, and in the second place it is incapable of being kept cold *en route* by the introduction of ice, which, of course, would freshen the water to a fatal degree. I will take up by itself the first difficulty, viz, that of the ocean water becoming foul *en route.*

It is well known that ocean water contains an infinite number of microscopic insects commonly called by the general term animalculæ. It is equally true, though not so well known, that these animalculæ are the cause of the fouling of ocean water when confined in tanks.

I have found but two ways of getting rid of this insect life in the water without spoiling the water. One way is to boil the water. This effectually destroys the animal life in it, but it also initiates a series of chemical changes, the result of which is that it precipitates a reddish-brown substance and daily loses more and more of its natural saltness, either of which circumstances would unfit it for sustaining the life of salt-water fishes. This puts boiled ocean water out of the question altogether.

The other way to get rid of the animalculæ in the water is to let it stand two or three weeks, covered and perfectly still. At the end of that time the microscopic creatures will be found at the bottom of the tanks in the form of a deposit of slime. The water above will be perfectly sweet and clear, and will remain so indefinitely.

After trying both ways of clarifying the ocean water I adopted the latter method of letting it stand, and put nearly a thousand gallons in process of preparation. Much of this was spoiled from having been put in casks not absolutely clean, and from other causes, but there was enough left of good water when the expedition started to furnish an abundant supply for the journey.

The necessary supply of ocean water having been arranged for, I next proceeded to secure the striped bass, and with this end in view I wrote to Mr. Eugene Blackford on the subject, and was met by him with a spirit of cordial co-operation. At his suggestion I engaged Mr. Fred. Mather to take charge of getting the bass. I went to New York and saw Mr. Mather, and was informed by him that six-inch bass could be obtained, but none smaller. I told Mr. Mather to go on and get a supply of that size to take to California, and he made arrangements for doing so; but about a week after I received a letter from Mr. Throckmorton containing explicit directions to take only very small bass, and to go in search of them myself. I immediately went to New York a second time, and from there to the Neversink River, New Jersey, and found the place where the young bass could be procured. After making such preliminary arrangements as could be made at that time, I returned to Boston to give my attention to procuring the lobsters and eels. For the remainder of the work of getting the striped bass I refer you to the very excellent report, herewith appended, of Mr. H. W. Mason, who afterwards procured the bass from the Neversink River and accompanied the expedition to California.

I must add here that it being the close season for striped bass in New Jersey, I applied to the fish commission of that State for permission to catch bass in the Neversink, and immediately received the following permit, accompanied by a very cordial personal letter from Mr. Anderson, expressing great interest in the expedition and conveying his best wishes for its success.

[Commissioners: Benj. P. Howell, Woodbury; E. J. Anderson, Trenton; Theo. Morford, Newton.]

STATE OF NEW JERSEY COMMISSIONERS OF FISHERIES,
Trenton, May 21, 1879.

Mr. Livingston Stone, United States deputy fish commissioner, is hereby granted permission to take striped bass from the Neversink River for the purpose of transferring them to the Pacific coast. This authority extends to any of the accredited agents of Mr. Stone, and includes fishing in any manner that he or they may see fit, notwithstanding anything to the contrary in the laws of this State regulating the times and modes of taking fish.

E. J. ANDERSON,
Commissioner of Fisheries of New Jersey.

On arriving at Boston, I at once applied to Mr. S. M. Johnson and Mr. J. R. Johnson of the firm of Johnson & Young, lobster dealers, Warren Bridge, Boston, whose co-operation I had found on several similar occasions of the greatest value, and I take this opportunity to say that from first to last these gentlemen were untiring in their efforts to assist in making this enterprise a success, and they are entitled to a large share of whatever credit there may be in introducing lobsters for the first time into the Pacific Ocean.

The first difficulty to be encountered, viz, the tendency of the ocean water to become foul in the tanks *en route*, was overcome, as above mentioned, by letting the water stand long enough to clear itself of animal life.

The second difficulty of keeping the water cold in the tanks without introducing ice into it, I resolved to meet by using a variety of coolers formed by the mixture of melting ice and salt. I tried three methods of using the freezing mixtures: (1.) Putting the ice and salt in large stone jugs and hanging the jugs in the tanks; (2.) The regular ice-cream-freezer plan of putting the freezing mixture in a vessel surrounding another vessel containing the water to be cooled; (3.) Filling a large earthen drain-tile with the freezing mixture and keeping it in a reserve tank of water from which the water, when cool enough, could be exchanged with the warmer water in the lobster tanks.

All three varieties worked very well, and were employed for nearly the whole trip, the ice-cream-freezer method, however, being found to work the best in actual practice.

After completing my preparatory arrangements for the care of the lobsters in transit, I procured some lobsters of Messrs. Johnson, and in order to test the efficacy of my plans I subjected the lobsters for a fortnight, as nearly as practicable, to the very conditions which they would encounter on the journey, and for this purpose I kept men watching them and dipping the water in the tanks every fifteen minutes, night and day, for fourteen days. The result was very encouraging, and gave strong hopes that the lobsters would reach the Pacific Ocean alive.

For the eels I am indebted to the courtesy of Mr. Seth Green, who procured 3,000 from the Hudson River and delivered them at the Albany depot, charging for them only the cost of getting them and delivering them. They were brought to the depot by Mr. E. L. Marks, to whom our acknowledgments are due for the valuable assistance rendered by him in loading our freight into the New York Central train on the night of the 12th of June. Besides these eels, we took five or six hundred which Mr. Mason brought with him from New Jersey.

I ought here to mention that Captain Vinal Edwards, of Wood's Holl, Mass., very kindly consented at my request to furnish eels for the expedition or to assist in any way he could, but owing to the eels being otherwise provided for, Captain Edwards was not called upon to supply them.

The black bass were furnished by Messrs. Stone & Hooper, of the Cold Spring trout-ponds, Charlestown, N. H.

It was intended to also take scallops and carp, but scallops were out of season and could not be found, and Professor Baird, who was to furnish the carp, concluded to send them at a more convenient time of the year.

All the preparations having been completed, the railroad companies *en route* having been informed of the expedition, and all the parties in charge of fish having been notified by telegraph when to rendezvous at Albany, the expedition started on the 12th of June.

Mr. Mason left Red Bank, N. J., with the striped bass and eels at noon. Mr. Finnigan left Charlestown, N. H., with the black bass at 2 p. m. The writer left Boston, Mass., with lobsters, at 6 p. m., and Mr. Marks left Troy, N. Y., with the eels in season to meet the others at midnight at Albany. After leaving Albany the expedition consisted of Mr. H. W. Mason, of Newton, Mass., Mr. James Finnigan, of Charlestown, N. H., and myself.

On the way from Boston to Springfield with the lobsters I was very materially assisted by Mr. Marshall L. Perrin, of Cambridge, Mass., who voluntarily accompanied me as far as Springfield, and worked with great diligence over the lobsters, which required special attention owing to the fact that 40,000 young lobsters had hatched out in one of the tanks on the way to the Boston and Albany depot in Boston.

The start from Albany was very favorable. The tanks, though very heavy, were loaded on the train all right, the fish were in excellent order, the railroad men were courteous and everything was propitious.

I had, however, no hope of getting all four varieties of fish to California alive. It is obvious to any one that it must be almost impossible to keep fish alive for seven days and nights crowded together in small tanks. Even with the best of care and luck the task is made doubly hazardous on account of the thousand chances of accidental injury which may befall them during a week's journey in the cars. The difficulty becomes more apparent when it is remembered that the aeration of the water must be incessant from the time the fish leave one ocean till they reach the other. If the aeration is forgotten or neglected, though only for a moment or two beyond the limit of safety, the fish are certain to die. With all these contingencies in my mind, I think no one will be surprised that I did not expect to get all the kinds of fish through alive. I thought there was a fair chance of getting two varieties, a very small chance of accomplishing the journey with three varieties, and not one chance in a hundred of getting all four kinds safely over.

The start from Albany was nevertheless propitious and encouraging. We had with us three tanks of lobsters, three tanks of striped bass, two tanks of black bass, and two tanks of eels. The lobster tanks contained 22 female lobsters with over a million eggs nearly ready to hatch out. The striped-bass tanks contained 132 small bass, 3 or 4 inches long, and 30 larger bass, about 6 or 8 inches long. The eel tanks had between 3,000 and 4,000 eels in them. The black bass tanks contained 22 large bass. The tanks were heavy and difficult to lift, weighing about 300 pounds apiece.

Besides the tanks containing fish, there were two large freezing tanks, in which were kept the reserve of ocean water and a constantly renewed freezing mixture to maintain the reserve at as low a temperature as possible. These weighed nearly 300 pounds apiece when full. We also had two five-gallon stone jugs, containing the freezing mixture, and a large supply of ice and salt, an assortment of dippers, hatchets, thermometers, and other small articles indispensable to a journey of this kind.

The main points about the care of the fish were: (1) to keep the temperature of the tanks just right all the time; (2) to keep the water constantly aerated; (3) at every change of cars to make the transfer from one train to another without injury to the fish and in season to take the connecting train.

We left Albany about midnight. The tanks having been put in place for the run to Buffalo, the freezing mixture having been renewed, and the temperature of each tank regulated, Mr. Mason and the writer, about 3 a. m., found a chance for some rest, while Mr. Finnigan took care of the fish till morning. From that time till the end of the journey we arranged the different watches as well as we could to have the burden of the work fall as evenly on all as possible.

The next day we were all very diligently employed in taking care of the fish. Indeed the work of an expedition of this sort is unremitting. It took the whole waking time of all of us to keep the water aerated, the freezing mixture renewed, and the temperature of the various tanks at the proper point. When night came we were all in arrears in the matter of sleep, and I accordingly hired a passenger for $10 to help us through the night, one of our party remaining with him while the other two took some sleep.

I aimed to keep the lobsters at a temperature of between 46° and 55°, the striped bass between 55° and 65°, the eels between 55° and 62°, and the black bass between 40° and 50°. (See table of actual temperatures at close of report.)

It was easy enough to manage the temperatures of all the tanks except those containing the lobsters; but these gave us a good deal of trouble, because they could only be cooled by exchanging the water on the lobsters with the water in the coolers, and by using the stone jugs containing the freezing mixture. On very warm days it was extremely difficult to reduce the temperature in the lobster tanks as fast as the heat of the day raised it. With great pains, however, we succeeded in preventing it from rising high enough to do any mischief.

To keep the temperature of the black bass right it was only necessary to introduce ice as fast as the water became too warm. The temperature of the eel tanks required somewhat more attention, because they both became too warm in warm days and too cold on cold nights. To keep them right we had sometimes to introduce ice and sometimes warm water, which we heated with alcohol lamps, or, when there was one on the car, on the stove. The striped bass tanks were more like the eels in regard to regulating the temperature, it being necessary at times to warm the water and at others to cool it.

I would here call attention to the fact mentioned in Mr. Mason's appended report that the striped bass seemed to do as well in artificial salt water made from sea salt and fresh water as in the salt or brackish water of their natural habitat. This fact very much simplified the carrying of the striped bass, as no reserve of natural salt water was needed for them, and in cooling the water in the freezers when the water in their tanks became too warm, it became only necessary in that emergency to introduce a sufficient quantity of ice water mixed with the proper proportion of sea salt.

On Saturday morning at eight o'clock we reached Chicago. Here we transferred to the Chicago, Burlington and Quincy Road, making the change of cars without accident and leaving Chicago at 10.15 a. m.

On examining the fish after leaving Chicago, we found twenty-five dead striped bass. I find it difficult to account for this disaster, although it was probably the result either of the temperature of their tanks getting too low the preceding night or of insufficient aeration, or both.

We crossed the Missisippi River at seven o'clock Saturday, throwing into the river, as I always have done before, a few fish for luck.

This day's experience was very much like that of the day before, except that the eels from the Hudson showed signs of languishing. Upon noticing the condition of the eels, I resolved to try an experiment with them which has often come to my mind, and which was also suggested by Mr. Marks at Albany.

The experiment consisted in placing a few hundred eels in a bucket containing a piece of grass sod. *It proved to be a perfect success, and undoubtedly solves the problem of carrying eels over long distances.* The eels which were placed in a bucket containing the sod required no attention whatever, and arrived at their destination in perfect order. I venture to say that any number of eels could be safely sent in this manner from Albany to Sacramento by express without a messenger and without any care *en route* except that required to keep them right side up. If my conclusions are correct, the State of California can be abundantly stocked with eels in this way at a very small expense.

We arrived at Omaha on Sunday morning with all the fishes in excellent order. Owing to a telegram going astray, the Union Pacific Railroad authorities were not ready for us on the arrival of the Chicago, Burlington and Quincy train, and in the consequent confusion and difficulty of making the transfer, the black bass tanks must have been overlooked a few minutes too long, for on examining them after leaving Omaha we found seven dead ones. We also found one dead lobster. The lobster proved to be the one that had hatched its brood at Boston, and was undoubtedly not in condition to survive the journey.

We were also obliged to throw away the Hudson River tank of eels to-day, there being no hope of their surviving the journey. Now that the new method of carrying eels has been discovered, I will not attempt to explain why these all died. I will only say that a large number of eels cannot be carried over four days in a tank containing pure, clear water.

No further mishap occurred during the journey. We passed the Laramie plains into the Rocky Mountains in safety, and on the morning of Tuesday, June 17, descended into the valley of Great Salt Lake, at Ogden, with lobsters, striped bass, black bass, and the remaining eels in splendid order.

We made the transfer to the Central Pacific Railroad at Ogden successfully, and renewed our anxious journey with lighter hearts and more hope of favorable results than we had dared to entertain in all the previous part of the journey. Cheered by the hope of getting the fish through alive, we redoubled our exertions and kept at work with the dippers *every minute aerating the water in the tanks night and day* till we reached Sacramento, June 12, at 10.30 a. m. Here we were met by Hon. B. B. Redding, secretary of the California fish commission, and many friends of the enterprise, and it was with great gratification that we showed them the lobsters, striped bass, eels, and black bass in perfect condition. No more trouble was encountered after this, and the fishes reached their various destinations safely. Some of the eels were placed in the Sacramento River and the remainder were left in Alameda Creek. The striped bass were placed in brackish water, in the Sacramento, near Martinez. The black bass were taken to San Mateo by Mr. Mason, and put into the Crystal Spring reservoir, in San Mateo County. The lobsters were carried to Oakland wharf by the writer, where they were met by a steamer chartered for the purpose, which took them to the Bonito light-house, under the shadow of which, in a sheltered bay a few miles outside the Golden Gate, I had the pleasure of placing them with my own hands—the first lobsters ever introduced into the Pacific Ocean. They were all in splendid order except one, and had with them over a million eggs nearly ready to hatch.

Thus terminated one of the most important and difficult expeditions ever attempted with living fishes. The dangers they had to encounter were innumerable. It seemed as if only a miracle could save them, but they escaped all their dangers, and the result was as gratifying as it was unexpected.

Before closing this report I wish to make my grateful acknowledgments to the railroad companies over whose roads we passed, viz, Boston and Albany, New York Central, Lake Shore and Michigan Southern, Chicago, Burlington and Quincy, Union Pacific, and Central Pacific, from all of whom the expedition received the utmost courtesy and the most thorough co-operation. Below will be found a table of the temperatures at which the fish were kept during the journey.

Table of temperatures.

	June 13.	June 14.		June 15.		June 16.		June 17.		June 18.
	12 p. m.	12 m.	12 p. m.	12 m.	12 p. m.	12 m.	12 p. m.	12 m.	12 p. m.	12 m.
	°	°	°	°	°	°	°	°	°	°
Lobsters	54	56	53	57	50	49	47	46	46	45
Striped bass	55	60	66	64	62	62	60	58	57	58
Black bass	44	45	43	50	42	40	42	43	40	43
Eels	56	58	55	59	60	60	58	56	57	57

XVII.—MEMORANDUM ON FISH CULTURE IN JAPAN, WITH A NOTICE OF EXPERIMENTS IN BREEDING THE CALIFORNIA TROUT.

By Sekizawa Akekio.

The Imperial Japanese Government has taken the steps towards carrying on a complete system of fish culture by founding on its property, in different places, hatching establishments, from which many thousand young fish are now annually supplied to some of the rivers which had been exhausted of fish. The first stations established were those at Yuki, Kanagawa Ken, and at Shirako, Saitamo Ken, in 1877. Each of these establishments has a capacity for raising upwards of 30,000 fish.

A great difficulty is met with in this country in getting a good supply of cold water; spring water can rarely be found in abundance, and there is none which can be used; and its temperature varies a good deal with that of the air, and it does not rise to the temperature of 57° F. This is a great drawback.

The hatching establishments have recently been increased to the number of five, which are situated as follows: One in Shiga Ken, another in Shidzuoka Ken, two in Nagano Ken, and the other in Ishikawa Ken. Four temporary camps are also built at convenient places on the rivers for the purpose of supplying fish to those rivers. At these camps salmon eggs are hatched and the young fry kept until they are fit to be turned into the rivers. This work begins towards the end of December, and by the middle of the following April the fry may be set free in the rivers.

The largest establishment in Japan at the present time is that in Shiga Ken. This has an abundant supply of water, with the temperature of 54° F. in summer. It has a sufficient capacity to raise any number of fish. For this establishment lake-trout eggs were brought from Lake Biwa, which is near the hatching station, and the results have been highly satisfactory. There are now at this place 40,000 healthy fish, one year and a half old and in splendid condition; also 250,000 young fry in a thriving condition.

It is worthy of remark that the water from the springs and rivers of Japan is nearly always very soft, containing a very little saline matter, of which a large proportion is silica and very little lime.

FOOD OF THE YOUNG FISH.

Owing to the scarcity of meat in this country, and the expense of getting it to the fishing establishments, I have been unable to feed fish on chopped livers and lungs, &c.; but I have found, after due trial, that a mixture of the chrysalides of silk-worms and wheat flour is a very good substitute, on which the fish do well. The chrysalides are ground up in a coffee-mill, mixed with an equal weight of wheat flour, which mixture is boiled for fifteen minutes and then allowed to cool. After this it is pressed through a wire sieve so as to assume the shape and size of finely-chopped meat, and is then ready for use. I have now used this food for three years and found that the fish thrive upon it; it is much cheaper and far more easily obtained in Japan than meat. Analyses of the chrysalides of two kinds of silk-worm and of the mixture of wheat flour and powdered chrysalis have been made by Professor Edward Kinch, of the Imperial College of Agriculture, Komaba, Tokio, with the following results:

1. Chrysalis of common silk-worm (*Bombyx mori*).
2. Chrysalis of mountain silk-worm (*Bombyx yama-mai*).
3. Mixture of wheat flour and powdered chrysalis.

Percentage composition.

	(1)	(2)	(3)
Water	10.99	9.28	12.23
Ash*	3.24	2.54	3.30
Oil	14.83	23.57	7.16
Albuminoids	47.28	49.75	25.25
Non-nitrogenous substances	23.26	14.86	52.06
	100.00	100.00	100.00

It will be seen that the proximate composition does not differ so greatly from that of meat. It contains a large percentage of nitrogenous matters, and a good deal of fat or oil.

THE FISHERY OF TANEGAWA (SPAWNING RIVER), MIOMOTEGAWA, ECHIGO, JAPAN.

The Miomotegawa (kawa or gawa means river) has its source in Mount Miomote, in the northeastern part of the province Echigo, and thence flowing westward, past Iwafune-gori and Murakami (formerly the castle-town of the Daimio Naito, finally empties into the sea. The length of the river is over 10 ri or 24.4 miles; it is shallow, with a rapid current and clear, and for 10 or 12 miles up from its mouth the bottom is covered with fine gravel. The fish found in this river are *Salmo perryi*,

* Containing—

	(1)	(2)
Silica	2.12	.83
Lime	4.19	1.29
Phosphoric acid	38.50	34.30
Potash	17.87	17.88

Salmo orientalis, &c., the former being so abundant as to afford the chief supply of salt salmon to Echigo and the provinces around, as well as the more northern districts. Formerly this river was the property of the Daimio of Naito, but now the privilege of fishing belongs to a company made up of the Shizoku, his former retainers. The vast profits which they realize may be estimated from the fact that 750 families of Shizoku are living on the net profits, besides paying government taxes and the expenses of repairing the banks of the river, amounting to 5,000 yen annually. In amount of salmon, no other place except Hokkaido can be compared with this, although the river is so small one can easily wade across. There is no doubt that so large a profit arises entirely from the perfection of the methods employed in fishing.

The Tanegawa is a branch of the Miomotegawa running near the town of Murakami, and about 10 cho (1 cho=119.3 yards) from the mouth of the main river. This is selected because of its being a natural spawning bed, providing as it does a clear bottom, level and covered with pebbles for the ripe fish when they come to spawn. Its whole length is about 1,193 yards and its width 50. A fence is made at the upper part across the water so as to prevent the fish from getting higher, while there is another fence at the lower part which has an opening. When the season comes for spawning, a multitude of the ripe fish enter within the fence and swim towards the upper fence. Then the lower fence is shut up, and thus the fish are imprisoned on the spot between the two fences. As a general rule the fish are thus kept inclosed for about one week, until the whole of them have deposited their eggs, after making their nests for themselves. After the spawning is over, the fish are then all caught in nets. After this another lot is allowed to enter, and the process is repeated until the end of November. It is remarkable that when the fish are coming up the schools are so large as almost to fill the river, when many may be caught with the hand; and therefore it is that several watchmen are employed day and night to protect the fish from poachers.

The fish eggs deposited in the bed are well guarded, and after the proper time the eggs are naturally hatched. At the beginning of the following May the young healthy fish go down to the sea, and during this time several watching houses are built along both banks of the river, where men protect the fish and see that they pass in safety. This method of propagating fish has been practiced from the earliest times, it being known that the salmon always return to their native river to spawn; and it having also been found that the result was of the greatest benefit to the country. It is said that this method was invented and first adopted by Mr. Aodo, two hundred years ago, and the Daimio of that time, Naito, adapted this place to that purpose. The regulations for fishing and protecting the fish in this remarkable river are still executed precisely as they always have been in other times.

There are several rivers in the neighborhood of the Miomotegawa, in which salmon are found, more or less, but the fish are decreasing in numbers, owing to the irregularity of the fishing and the neglect of fish propagation.

TOKIO, JAPAN, *April* 12, 1880.

SIR: On the 9th June, 1877, I received, through the kindness of Mr. B. B. Redding, fish commissioner, California, ten thousand trout-eggs of the California trout (*Salmo irideus*) from the McCloud River, California, of which one-half arrived safely and in good condition. As the eggs arrived unexpectedly, I was compelled to use well-water for hatching them, as there was then no establishment for the purpose, and I hoped that, with care, some of the eggs might possibly be thus saved. For this reason I built a temporary hatching-house in my garden, and had the water (57° F.) drawn from the well, pumping it day and night.

All the preparations were completed on the 13th of June, and the apparatus was then fixed, viz: 2 hatching-boxes, 1 foot wide by 6 feet long and 8 inches deep, covered at the bottom with a fine gravel; and a reservoir which contained 400 gallons of water; and the eggs were placed in the box arranged in the usual way. After a week the eggs began to hatch, and from the 7th of July I fed the fish with the yolk of eggs for a month, and afterwards with a mixture of chrysalis and wheat flour. During this period several difficulties had been encountered, and a great many eggs had perished by a disease (showing itself by a white spot on the eggs) and by the neglect of the employés, &c. Finally, it was found that the water was insufficient in quantity to keep the young fry as they grew.

On the 13th of July the establishment at Yuki was completed and the fish were transported there, but on account of hot weather, and the scarcety of ice nearly all the fish died, and those which arrived at their destination alive were only one thousand.

From the year 1877 till the present time the fish have grown satisfactorily, and their average weight is now five pounds, and their greatest length 1 foot and 7 inches.

Among the growing fish I have found a few fully ripe, 3 males and 5 females, and I have already taken 20,000 eggs, and the impregnated eggs are now in the hatching-box (12th April, 1880).

I forward to you herewith a drawing of the mature fish, which is taken of the natural size, and by which you will see how the McCloud trout flourishes in fresh water.

SEKIZAWA AKEKIO,
Bureau of Agriculture, Home Department, Japan.

SPENCER F. BAIRD, Esq.,
Secretary of the Smithsonian Institution.

XVIII.—ON POND-FISHERIES.

By Von dem Borne.

An address delivered October 9, 1878.*

[From Circular No. 6, 1879, of the *Deutsche Fischerei-Verein*, Berlin, December 31, 1879.]

After having given statistics of the pond fisheries in the Prussian provinces of Lorraine, Silesia, Posen, and Schleswig-Holstein, Mr. von dem Borne goes on to say:

"The facts which I have mentioned justifying the conclusion that the pond fisheries deserve the attention of the farmer to the highest degree.

"The net profit is very considerable, and the expense is comparatively small. It is therefore scarcely probable that there will be any loss, as is so frequently the case in other farming operations.

"The ponds *produce* manure, while the fields *consume* it. The water flowing into the ponds forms layers of manure and feeds a number of aquatic plants, which form a highly valuable substitute for straw.

"The shores produce grass, which, however, does not yield any great profit, because it is mostly sour, and, in order not to disturb the carp, has to be cut very carefully.

"The mud which gradually gathers at the bottom of ponds contains much vegetable and animal matter, and, according to its chemical composition, forms a more or less valuable article of manure. Meadows lying lower than ponds may be successfully fertilized by irrigating them by the muddy pond-water. The mud from ponds is also an excellent fertilizer for fields.

"Ponds may also become a source of income to the farmer by being cultivated while lying dry. They furnish a large quantity of manure for the fields. While lying dry ponds are usually planted with grass or oats, but also with potatoes, hemp, summer wheat, and beets. During the first years after having been laid dry the ponds need no manure whatever.

"Like forests, ponds also exercise an influence on the climate, and this influence will be in proportion to their size. The former director of the Principality of Trachenberg (Silesia), Mr. Frieboes, has informed us that fields in the neighborhood of ponds always had more moisture

* *Von dem Borne, "Ueber Teichwirthschaft."*—[Translated by Herman Jacobson.]

even during a dry season, and that vegetation seemed to flourish more. In very damp seasons such fields may even have a hurtful excess of moisture. For a light soil, needing a good deal of moisture, ponds are decidedly beneficial.

"When ponds are laid dry the consequences are similar to those attending the destruction of forests. Fortunately ponds are more easily restored than forests. If it seems profitable to change ponds into fields, the dams should at least be left. In the district of Militsch, *e. g.*, large ponds have been laid dry and changed to fields; on some farm-houses have even been built. A few of these ponds could again be restored to their original condition, but with many of them this was absolutely impossible, although they yielded very little profit as fields, while as ponds they had proved a source of considerable income. Similar experiences have been made in Bohemia, where there is an unusual number of large ponds.

"Whenever ponds are laid dry, the dams should, therefore, be preserved, and no buildings should be erected, and it will be easy to restore them whenever it should be deemed advisable.

"It is profitable to use the ponds from time to time as fields, because it proves favorable to the growth of the fish, and because the grass or grain planted in the ponds needs no manure. When ponds do not receive sufficient food for the fish from rivers or brooks, as is the case with very large ponds, it will be advantageous to introduce a regular system of rotation, and use them, *e. g.*, three years for raising fish, and then three years for raising grain or grass.

"It is of course understood that in constructing ponds it is indispensable to have a sufficient quantity of water. In large ponds this quantity is very considerable, and the entire contents of large rivers are required.

"Thus in Lorraine the Rhine-Marne Canal is used for this purpose, as also the Seille and the Saar; in the district of Militsch, the Bartsch; in the district of Rothenburg, the Neisse, Spree, and the Schöps; and near Peitz, the Spree.

"For small ponds, especially those used for raising carp, it is not advisable to have them fed from rivers, because other fish—particularly pike—get into them and destroy many carp. For hatching-ponds the so-called sky-ponds are the best, *i. e.*, those filled by rain and snow water."

XIX.—THE PISCICULTURAL ESTABLISHMENT OF MR. AUGUST FRUWIRTH IN FREILAND NEAR ST. POLTEN, LOWER AUSTRIA.

By Dr. Emil von Marenzeller.*

[Abhandlungen der k. k. zoölogisch-botanischen Gesellschaft in Wien for 1877.]

An interest has been manifested with us in Austria in transforming waste and unproductive river regions into territories capable of sustaining fish, and the government as well as private individuals have at different periods taken steps towards bringing about this result. But as these efforts were neither systematic nor united, the results were not very striking. It is but a rare case that a private individual owns extensive fishing-waters. Intricate claims to use the water and fish in it—claims made from every side—blunt his energies or frustrate the beneficial measures which he has inaugurated, and even the greatest zeal will grow cold when continually meeting with such hinderances, especially with ignorance and covetousness. Our present system of title-deeds to water property is insufficient, our legislation for protecting the fishing interest is imperfect, and even if there are laws they are not properly carried out. And without such laws properly observed the experience gained nearly a century ago, that the propagation of fish at the right time and right place may be caused artificially, and that with proper measures for protecting the young fish they may be raised without such enormous losses as threaten them in open waters, will be practically useless. While, therefore, private individuals will feel little inclination to place impregnated fish-eggs in waters which they only rent under certain conditions, or whose neighboring waters are owned by persons whose sole aim seems to be the destruction of fish, the impregnation of fish-eggs on a large scale will, at least in our country, be hardly a paying business. Under these circumstances, our object in directing attention to a new piscicultural establishment, well furnished with all modern improvements both foreign and domestic, can only be to awaken sympathy for a most praiseworthy undertaking or to encourage the enterprising manager; but by no means to meet a long-felt general want. But the author is of opinion that the new Austrian fishery laws, which will soon be in force, will form the basis for great improvements in pisciculture,

* *Die Fischzuchtanstalt des Herrn August Fruwirth in Freiland bei St Pölten in Niederösterreich.* Vienna, 1877. Translated by Herman Jacobson.

which will then with us assume its place among the industries of the country, which by right belongs to it, and which in other countries it has occupied for some time. The successful steps taken by Germany in this direction, the activity of the great piscicultural establishment at Hüningen and of other similar establishments, and the noble zeal displayed by the German Fishery Association cannot fail to encourage our pisciculturists in their endeavors. And even if we do not reach very great results in the immediate future, piscicultural establishments, if properly directed, can do much to remedy the lack of fishes in our waters, and become quite profitable to their owners; and this may be done by raising fish for the market. As the grand results of our Bohemian fisheries with regard to the carp and pike are so well known, it is scarcely necessary to say that I am only thinking of the decimated inhabitants of our mountain streams, the trout, &c. Pisciculture so far is, any way, almost confined to the salmonoids. All the piscicultural textbooks show the method to be pursued. In our piscicultural establishments fine specimens of fish raised by them are from time to time exhibited; but all this only conveys the impression as if the possibility of the thing were to be demonstrated, but not that the enterprise in question is and should be independent of various outside influences, and could be successful if certain conditions were properly observed, the efforts and sacrifices to be made as well as the results to be obtained being well understood beforehand. We should be able to determine beforehand the productiveness of a piece of ground about to be transformed into trout-ponds just as much as we are able to do this with regard to carp-ponds, of course taking into account the necessary expenses for feeding or fattening the trout. It should be accurately known under what conditions the greatest possible yield may be secured in the shortest time, and the most favorable conditions for a rapid growth of the young fish should therefore be determined; in short, it should be our aim to gain such general principles and experiences that a person who intends to use his favorable natural surroundings for raising fine food-fish would not be obliged to treat the whole matter in the light of a more or less doubtful experiment, for it *would* remain doubtful, because the causes of success or failure are not fully understood, to do which requires considerable talent of observation, patience, and endurance.

A short time ago I had occasion to visit a new and little known piscicultural establishment, which I resolved to describe more fully in this journal because all its arrangements seemed very fine and perfect and because its proprietor and manager pursues his object with unusual energy. I was convinced that in so doing I would render a service to all persons interested in pisciculture and to this industry itself.

The piscicultural establishment of Mr. August Fruwirth can, by railroad and stage-coach, be reached in five hours from Vienna. It is located in the little village of Freiland, numbering only a few houses, half an hour beyond Lilienfeld, on the banks of the Traisen. It takes two hours and a half, by stage-coach to reach Freiland from the well-known town of St. Pölten; but soon it will be reached in an easier way by the railroad to Schrambach which is shortly to be opened. The piscicultural establishment is located on the right bank of the Traisen at the foot of the Lilienfeld Alps, on a meadow rich in springs, almost at the point of the angle formed by the confluence of the Traisen and the Unrecht-Traisen. Mr. Fruwirth selected this place because it was hoped that after the ponds had been dug there would be a sufficient quantity of water, and because in case of necessity any quantity of water might by a canal be obtained from the Unrecht-Traisen. The establishment, which our diagram shows in its present condition, has not sprung into existence at one time. The proprietor proceeded in a very rational manner by first making an attempt on a small scale, and only extending his operations when he found his expectations realized. In October, 1873, he dug the the pond S_1, because the springs were most numerous in this neighborhood. From this pond the water flowed through four sluices in four canals, which united in the neighborhood of the pond marked *Wa.* In these canals Mr. Fruwirth placed Jacobi's hatching-boxes, without vessels, but simply with a layer of sand for the eggs, near to the sluices, therefore within the limits of somewhat agitated water. The eggs developed in an excellent manner, and it is said that nearly 500 trout trace their origin to this first experiment. As everything succeeded so well, Mr. Fruwirth during the following year built a hatching-house, and by digging a number of new ponds for the young fry he almost brought his establishment to its present condition. After the five ponds for the young fry had been dug, water began to appear in such quantity as to determine Mr. Fruwirth not to get any outside supply for the present. In the beginning the water which flowed off was led direct into the Traisen. This proceeding, however, had some disadvantages which considerably diminished the results of the hatching-period, 1874–'75, and compelled Mr. Fruwirth to adopt energetic measures. As the right bank of the Traisen is very flat, the water which should have flowed off occasionally remained stationary, or the Traisen water entered the establishment and threatened it with destruction. Dams were of not much use under the circumstances. During the winter of 1874, the hatching-house was exposed to very serious dangers. It was impossible to drain the ponds in order to empty them of fish. One or more larger trout remained in the small water-puddles and seriously endangered the life of the small-fry. The only way to obviate the difficulty was to construct a tunnel 108 feet long through the solid rock, through which the water could flow off right by the side of a large weir, thus abolishing all communication with the Traisen. From this tunnel the water flows into the river in the shape of a small water-fall. Much damage was also done by having the sluices closed with a fine wire grating, as the tender young fish were pressed against it by the force of the current and thus perished. Nothing would remedy this evil but an invention which I shall describe further on. During the season 1875–'76 a considerable number of eggs were placed in the hatching-boxes, not only of trout, but also of saibling, and of bastards of trout and saibling, as well as of bastards of trout and salmon, which, through the Salzburg establishment, were ordered from Hüningen. Both in 1875 and 1876 a large number of young fish were placed in the small tributaries of the Traisen. In the autumn of 1876 I saw 1,200 trout, saibling, and bastards of the two, all of them the results of the two above-mentioned hatching-periods. Besides these there were 1,200 large trout in the pond *Wa*, which are used for propagating; but only a portion of these—about 500 from the hatching-period, 1873–'74—are raised in the establishment; the others have been caught and fattened. In the autumn of 1876 the feeding-ponds, 1–16, were constructed, and the system of "chambers" for the young fry was introduced, and some improvements made in the connections between the various ponds and canals.

After this brief historical introduction, I will proceed to describe the present condition of the establishment. The soil which was gained by the digging of the ponds was piled up along the edges, thus forming dikes, on which walks have been constructed between rows of alder and willow trees. There is a fall between all the ponds, so that the surface of the last pond, *Wa*, is about 2 feet lower than that of S_1. It may be stated that on an average there is a fall of about 2 inches to the fathom. The bottom of the ponds is covered by a species of *Chara*, which is growing luxuriantly. At many places of the basins, but especially in the principal pond, S_1, there are numerous springs. With this exception, every pond receives its water from the preceding one. The experience of three years has proved that the fish thrive very much under this arrangement. At the end of the first year the percentage of mortality was 0. From the pond S_1, the water flows through four sluices into the ponds S_2, S_3, S_4, from this one into the pond S_5, and from here through the canal *J K* into the pond *Wa*. The water also flows into the pond *Wa* from the pond S_1 through the canal *S K* and *J K* (to the left), and from the pond *Wa* it flows into the Traisen through the tunnel *A T*. The average depth of the ponds is 2 to 2½ feet. The temperature of the water even in August was 50° to 52° F. near the springs; farther away from these or near the surface, 61° F. In the beginning the sluices were simply protected by a vertical grate; but as the young and tender fish were pushed against it by the violence of the current and were thus frequently injured, Mr. Fruwirth made two new improvements. The one consists of two boards rising above the surface of the water and meeting at an angle. Immediately below the surface square holes are cut in the boards and are covered with a grating; the lower part of the board is hidden by a pile of sand reaching as far as the grating. The other improvement is very similar to this one, only that the place of the boards is taken by a box open on two sides, viz, at the bottom and in the rear; the gratings are in the lower portion of the three sides, quite near the edge. By introducing these improvements Mr. Fruwirth prevents the little fish from coming within the immediate reach of the strong current, and also keeps his gratings free from mud, leaves, &c.

The pretty hatching-house *B* lies about 3 feet deeper than the main pond S_1, and receives its water from this pond through two pipes. The pipe, which is protected by one of the above-described cuniform mud-catchers, begins with a broad portion covered with flannel and perforated like a sieve, leading into a filtering-box 9 feet long and 2 feet broad, filled with alternate layers of sand and charcoal, which are separated from each other by thin perforated boards and pieces of linen. From this filtering-box the pipes branch off to the four Coste hatching apparatus with 25 vessels each, which are inside the house. The number of vessels in the hatching-house is therefore 100. Counting 5,000 eggs for each one, we find that Mr. Fruwirth's hatching-house can accommodate 500,000 eggs. Besides these vessels I saw six Jacobi hatching-boxes with 36 vessels, each capable of holding 2,000 eggs, so that 72,000 more eggs can be accommodated. If all these vessels were filled to their utmost capacity, this establishment could develop more than a million of eggs. After having left the eggs, the young fish go into two wooden boxes placed in the ground on the outside of the hatching-house (on the diagram it would be the south side). From each of these boxes a pipe which can be closed (the two dotted lines) leads into the narrow and shallow ditches marked *j*. These provide for the case that the young fish gathered in the wooden boxes should be too numerous, and that they could not immediately be placed in the "chambers for young fry," which are to be described further on. The thick black line beginning at the letter *Z*, in the pond S_2, is a pipe, by which any amount of water can be introduced if the influx from the hatching-house should not be sufficient. Model order and neatness characterize the interior of the hatching-house. All the necessary apparatus is found here in a suitable selection. I must not forget to mention that there is a reservoir in the floor of the hatching-house, from which water can be obtained by means of a pump. We shall soon see for what purpose this reservoir has been introduced. If we leave this cheerful house by way of its southern front and go to the opposite side, a wooden stair-case invites us to the inspection of a superstructure rising from the middle portion of the hatching-house. Here we find a small but admirably arranged laboratory. On one wall we see several aquaria ranged in stories one above the other. In the lowest and largest one young trout and saibling are sporting.

By means of the above-mentioned pump in the hatching-house, a reservoir placed in the loft above this little room is filled with water, which from here either flows direct into the aquaria or is used in putting in motion some of Spengel's ventilating apparatus. The effect of this very simple and cheap arrangement is excellent. The importance of these large and small aquaria cannot be overrated. In the first place, the little fish can be easily observed, especially as to how they take to the different kinds of food which is offered to them, and, in the second place, the conditions of life of the numerous animalculæ living in the water can be investigated, and such observations will in nearly every case yield some practical result for the pisciculturist. He learns to know a large number of facts which will furnish him the key to many phenomena which are insoluble mysteries to the majority of men. As Mr. Fruwirth also possesses a Zeiss microscope with every contrivance which is required in making microscopic observations, a person may at once go to work. A stove makes it possible to use the laboratory all winter. I must not forget to mention that this room also contains a very complete, well preserved, and tastefully mounted collection of specimens of the trout, the saibling, and bastards, in all the various stages of their development from the egg to the completed second year.

In the pond *Wa* those fish are kept which have reached the age of maturity. During the spawning season they ascend to the hatching-house by way of the channel marked *L;* and as this channel can be closed by a trap-door where it opens into the pond *Wa*, they are easily caught. In extracting the roe Mr. Fruwirth pursues a method different from the one generally adopted. He takes hold of the fish by the head and tail and simply bends it; in doing this only the fully matured eggs come out; there is no danger, like in the so-called "squeezing" process, that many of the immature eggs are also torn loose. The fish which have yielded a portion of their eggs are again placed in their native element separate from the others, and are again taken up after some time. Mr. Fruwirth informed me that as long as he pursued the usual method he often found in the vessels eggs which, although outwardly perfectly healthy, had not begun to develop, whilst at present this is no longer the case. As even when entirely free the trout never discharges all her eggs at one time, this simple and natural procedure adopted by Mr. Fruwirth must be highly recommended.

Before describing some special arrangements, *e. g.*, the feeding-ponds (1 to 16) and the "chambers" for the young fry (*I K*), I will explain the diagram. The gray squares in the ponds S_1 to S_5, and *Wa* are floating boards, which are placed there to give the trout a chance to protect themselves against the rays of the sun or to find a dark place. This object, however, will be better reached in a few years by the growing willow-trees. These boards are weighed down by stones and are therefore a little below the surface. This is very essential, for fish jumping out of the water, as they frequently do, might accidentally alight on these boards and would soon die if the boards were dry and hot. *S K*, the so-called "sorting-chambers," are compartments where during fishing, or whenever it is desirable, the fish may be sorted according to size and species. *W* and *H* mark the dwelling of the keeper and a dog's kennel. *F* is a place for storing salt horseflesh for feeding the growing and matured fish. Nothing but perfectly healthy meat is used. It is cut in strips and pieces with a knife, a sausage-machine having been found impracticable, as it only partly tore the sinews but did not separate them entirely. It frequently happened in consequence that fish were choked by endeavoring to swallow large pieces of meat and sinews sticking together.

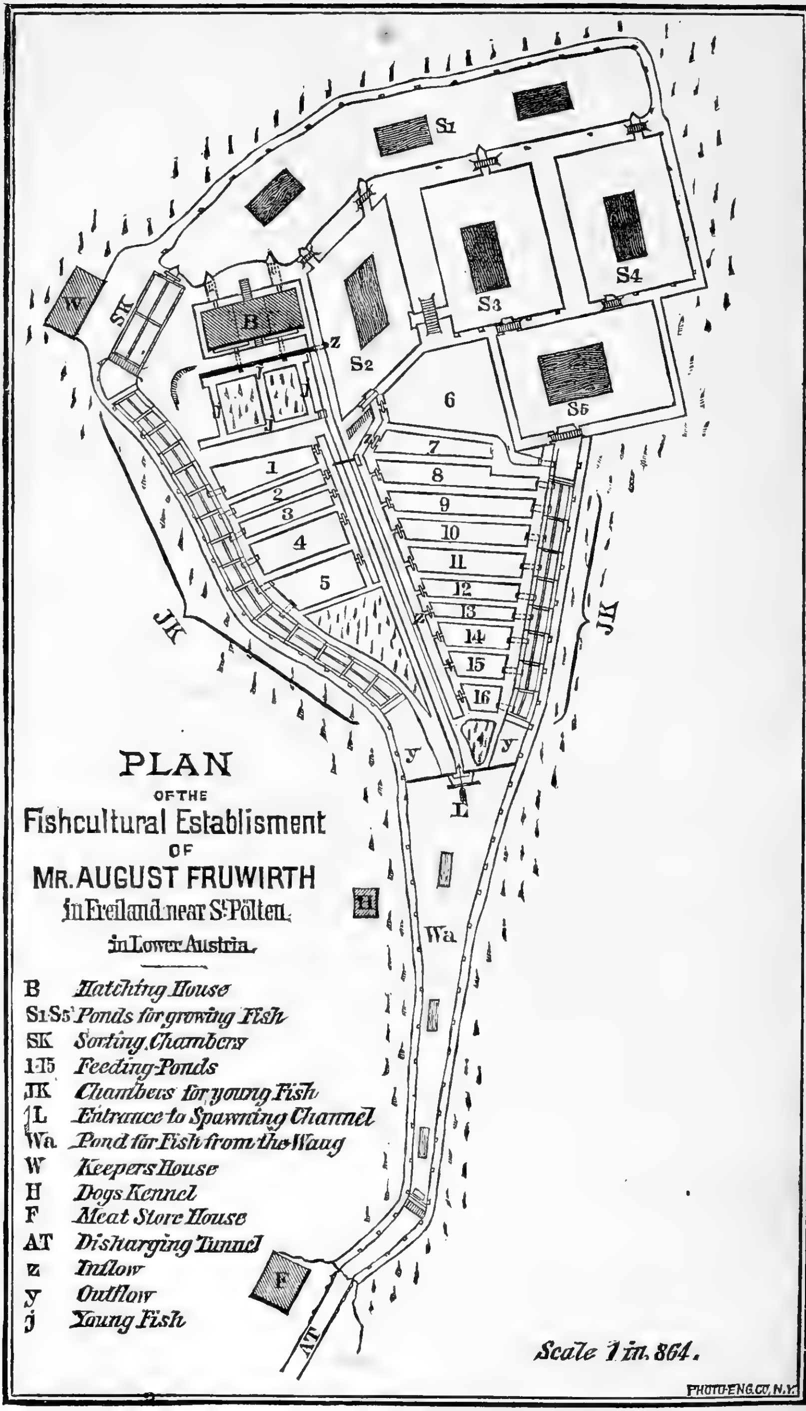
The feeding of the young trout and saibling with good and sufficient food, from the moment they lose the umbilical bag till the time when they can be fed on meat or fish, is really the point on which their rational culture depends. This will influence the percentage of their mortality, and their more or less rapid and successful growth. It is absolutely necessary to give the fish not only good but also sufficient food. Brains, liver, &c., which have been proposed, cannot be called "good" fish food, and the question as to what is understood by "sufficient" can scarcely be answered by those who immediately place their young fry in the ponds, leaving their further fate in the hands of a kind Providence. People who do this will say that the fish when put in ponds are placed in similar surroundings as they would find in open waters, and this is all that is considered necessary for their further development. In reasoning in this manner, however, people entirely forget that it ought to be the object of pisciculture to offer the fish *more* than nature can do—a luxurious but never a starving existence. This does not exclude the possibility that occasionally such experiments are successful, and that the ponds to which the young fish have been assigned contain a superabundance of food; but then it will always be a venture. There should be absolute certainty with regard to the occurrence of food, and wherever the fine net or the microscope only shows few animalcula suitable for fish-food, this want should immediately be supplied. When I visited Mr. Fruwirth's establishment I was surprised at the enormous quantity of insect larvæ and lower crustaceans* living in the dense wilderness of *chara* which covered the bottom of the ponds. One pond, however, which only three weeks ago had been dug up, showed no signs whatever of vegetation. The clear and rapidly-flowing water of the Traisen does not seem to contain any of the above-mentioned animalcula, but when I pulled up some of the thick moss (*Fontinalis antipyretica L.*, *Rhynchostegium rusciforme* Br. et Schimp.) covering the pieces of rock and quickly examined it, I discovered a rich animal life, which had found shelter and food among the moss. Thus the well-known proportional relation between vegetable and animal life also proves to be of great importance to the pisciculturist. It will be his first care to produce a luxuriant vegetation. The natural conditions of Freiland, which must be considered extremely favorable to the development of the

* Prof. Dr. F. Brauer recognized among those gathered during August the larvæ of *Perla-cephalotes P.*, *Nemura* sp., *Chloëcon dipterum L.*, *Hydropsyche* sp., *Rhyacophila* sp., *Stenophylax* sp., *Hydroptila* sp., *Atheryx Ibis*, *Simulia* sp., *Culex sylvatica L.*, *Chironomidens*, *Elmis æneus* Müll., &c. I myself found two species of *Daphnid* (*Alona*, *Simocephalns*), two species of *Cyclops*, and one species of *Cypris*.

lower aquatic fauna, did not satisfy the proprietor. He was anxious to find if it would be possible to increase the fish-food by creating still more favorable natural conditions. He therefore applied to Prof. Dr. Gustav Jäger, in Stuttgart, who several years ago had advocated the construction of "gnat-ponds" as a great aid in raising young trout. After having personally examined the establishment in August, 1876, Dr. Jäger drew up the plan for the feeding-ponds and for the "chambers" for the young fry, as they are represented in our diagram. He thought that it was not good to distribute the young fish immediately over a large pond, as they escape observation; in his opinion it would be far better to place them first in a small pond, and then gradually into larger ones. The fish should be within easy reach, so that their mode of life could be controlled, and the so-called "gluttons," *i.e.*, the stronger ones, which use much of the food destined for the smaller ones, could be removed. But, as in the small space they have less chance to find food, it must be introduced from outside; and to facilitate this process is the object of the feeding-ponds (1–16); they are shallow ponds, with stagnating water, and full of aquatic plants. The feeding-ponds 6–16 receive their water from the canal Z, which is connected with the pond S_2. Sluices regulate the admission of water; subterranean wooden pipes 8‴ square, which can be closed, make the connection with the "chambers" for the young fish. From the canal Z a pipe going over the spawning-canal leads the water into a similar canal running alongside of the feeding-ponds 1–5, which are arranged in the same way as 6–16. The ditches leading to the pond Wa from S_5 and S_1 are used as "chambers" for the young fish. Wooden cross-walls with a wire grating divide these ditches into smaller divisions, which are again subdivided into two parts by a single board running lengthwise. All these separating walls can be removed, and the compartments be made larger. Into these "chambers" for young fish, the contents of the feeding-ponds can be conducted by pipes. These feeding-ponds and "chambers" for the young fish were constructed during my visit, and will already come into use after the hatching-period 1876–1877. The water coming from the feeding-ponds must, of course, not rush into the "chambers" too violently, because this might kill the young fish. As long as ice forms, they cannot be used, on account of their limited depth; but as soon as spring begins, they will, if the vegetation is luxuriant, and if the water is stagnating, and can therefore be easily warmed, become a most successful hatching-place for numberless lower aquatic animals. If even the large ponds, by using a fine net, yielded in a very short time sufficient food for thousands of young trout, it will be all the easier to obtain such food with a fine net from smaller ponds, if the draining of the ponds should not yield the desired result. *The young trout and saibling are therefore raised in the Freiland establishment on exactly the same food as they eat when in open waters; but special arrangements have been made to supply this food in unusually large quantities.*

The period up to which Mr. Fruwirth intends to employ this method of feeding is the end of the first year. During the winter months it is not necessary to add any extra food, as the fish do not require so much food during this season. After the first year the feeding with horse flesh commences.

The piscicultural establishment at Freiland is able not only to supply a very large number of impregnated eggs—this year (1877) it shipped about 40,000 eggs, principally to Germany—but it possesses all the necessary arrangements to raise an indefinite number of fish. In order to ascertain whether it would be possible to transport fish to Vienna, Mr. Fruwirth undertook, in January, 1876, to transport 600 trout (not raised in the establishment), all of them milters, to Vienna. The fish left Freiland at 11.30 p. m., and reached the Vienna fish market the following day at noon in perfectly sound condition. Mr. Fruwirth keeps an exact account of everything which takes place in his establishment, *e. g.*, the number of eggs placed in the vessels, the number of fish hatched, the losses, the number of fish placed in the different ponds, and the expense of feeding the fish and running the establishment. He is always anxious, either by personal observation or by the advice of others, to follow up cause and effect, so that if he continues his work with the same energy with which he has commenced it he will soon be able to supply all the necessary statistics of the hatching and raising of trout and saibling. We have no doubt that he will soon find many imitators who will benefit by his experience, and we see in this prospect the sweetest reward for the many sacrifices which the proprietor of the Freiland establishment has made to the cause of pisciculture.


PLAN
OF THE
Fishcultural Establisment
OF
MR. AUGUST FRUWIRTH
in Freiland near St. Pölten,
in Lower Austria.
B Hatching House
S1-S5 Ponds for growing Fish
SK Sorting Chambers
1-15 Feeding-Ponds
JK Chambers for young Fish
JL Entrance to Spawning Channel
Wa Pond for Fish from the Waag
W Keepers House
H Dogs Kennel
F Meat Store House
AT Disharging Tunnel
z Inflow
y Outflow
j Young Fish
Scale 1 in. 864.
S1
S2
S3
S4
S5
B
W
SK
z
6
1
2
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4
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APPENDIX E.

PROPAGATION OF FOOD-FISHES.

SPECIAL APPLICATIONS.

XX.—REPORT OF OPERATIONS ON THE NAVESINK RIVER, NEW JERSEY, IN 1879, IN COLLECTING LIVING STRIPED BASS FOR TRANSPORTATION TO CALIFORNIA.

By H. W. Mason.

Livingston Stone,
United States Fishery Commissioner:

Sir: In accordance with your instructions, I went to Red Bank, New Jersey, on Wednesday, June 4, to procure striped-bass, fry, scallops, and eels, to experiment upon them to find means of keeping them alive, if possible, and, should the experiments warrant, to transport to Albany, N. Y., one hundred and fifty, more or less, of the striped bass; two hundred eels, and as many scallops as seemed advisable to be transferred to California.

Before starting for Red Bank I received several valuable hints from Mr. Eugene Blackford, of Fulton Market, and though he could not give me much encouragement, he showed much interest in the expedition, and gave me the benefit of valuable experience. He said at once that "bass fry" was wholly distinct from striped bass, and consequently saved me much time in studying the habits of the so-called "fry." In reply to my inquiry as to the practicability of procuring small striped bass, he warned me of the great difficulty of obtaining them, as the striped bass had not at that time appeared in the river. Scallops he rightly pronounced out of season, but kindly offered to try and get me a few to experiment upon.

As to the appearance of striped bass in the rivers in the East, Mr. Blackford is sustained, in spite of the contrary opinion of many fishermen, by the authority of the records kept at Red Bank. This year the first striped bass taken with hook and line at Red Bank was caught on the 9th of June, and this seems to be about the time that the bass usually strike in.

On reaching Red Bank I found that none of the arrangements which you had directed to be made had been attended to; the two men—I cannot say fishermen—employed to catch the bass had but a faint conception of what was wanted, and had provided themselves with an eel-seine wholly insufficient for my use; and even this they dared not haul, although provided with express authority, owing to the State law against seining; the tanks were out of repair, and had been packed away in the freight-house to shrink and fall to pieces. None of the thousand eels which had been promised were ready, but the man offered to *set his pots* at once, pretty small eel-pot, to catch an eel 4 inches long. I immediately discharged the inefficient fishermen, and after considerable difficulty I found a man who had had experience in evading the law, and who had the only real seine in the vicinity. By promise of liberal pay, I secured his valuable services, together with those of his sons, and to them is due the credit of undertaking and carrying through the work that scarcely any one else could or would have brought to a successful issue. While Clayton was preparing his seine and finding men to help him, I instituted inquiries among those who had any reputation as fishermen as to the habits of the bass. Aside from the uniform opinion that bass could not be kept alive overnight, I found no two who agreed as to the primary facts. Only one could be found who had ever found a bass with the spawn in her. He said that he found it in February, but added the incredible story that it weighed thirty pounds. Some thought the bass spawned in the fall; others, in the winter; a few, in the spring, while scarcely any agreed with me that about June 1 was the time. Many said the fish spawned in the ocean; some thought in the brackish water; while others said that the ditches and brooks was the spawning ground. No one had ever as much as seen a bass less than 3 inches in length, and thought it a useless expenditure of time and money to look for them. This is one of the chief places for striped-bass fishing in the country. It is not my place to mention the lack of fish *culture* among the natives.

At high tide, Thursday, June 5, was commenced the series of hauls that lasted without interruption at every high tide for a week. The seine was hauled until midnight Thursday, and twenty fair-sized bass obtained; average length, 8 inches; average weight, $\frac{3}{4}$ pound. The water was salt, as the tide was high. The temperature of the water at six o'clock was 80°; at twelve o'clock, 78°. In the same water, at the same temperature, ten fish lived two hours after being put into the tank. In the same water, at 70°, the rest lived four hours, the water in both cases being constantly aërated. All the fish were dead at 3.30 a. m. Friday.

Friday morning, hauls were made farther up stream in hopes that something that might be denominated "fry" might be obtained. In three hauls no fish were taken; in the fourth, three small striped bass were caught and put in brackish water freshened with ice, temperature 65°. After several barren hauls, nine more were obtained. These were all the fish that could be induced to come ashore on Friday, and all but four lived to be placed in the San Joaquin River two weeks later. Not satisfied with the size of the small bass, I mailed two that died to you to obtain information, and also spent Saturday morning in exploring the mysteries of mud and water in every ditch and brook that empties into or communicates with the Navesink River, above Red Bank, but was unable to find anything that looked like a bass-fry. In a similar expedition Sunday I succeeded in finding two specimens of fry that may have been those of the striped bass; the full bag beneath the throat showed them to be but a few days old. All further attempts to obtain specimens for preservation were fruitless.

Saturday the seine was hauled as far up stream as the boats would float, but no bass less than 3 inches in length were caught, and but six in all. A pair of shad having just spawned were taken in 3 feet of water, over three miles from tide-water. The bass in the tanks did finely with brackish water, 64° to 67°. Aëration was constant. Watched, myself, Friday and Saturday nights, and experimented with ice and salt water until I found what degree of saltness seemed to suit them best. Also tried a few bass in clear spring water, but they did not thrive therein. Put fifty small eels, caught in the mud with a net of mosquito bar, into the tin tank filled with spring water, temperature 55°; found that they needed no care.

The tide was high late Saturday night, and no haul was made until nearly midnight. To avoid handling the fish, the tanks, ice, &c., were taken in the fishing boats. Seven fine medium-sized bass were taken in the course of four hauls, and put into a tank under similar conditions as the small bass.

In spite of continued threats of arrest, the men were almost constantly at work Monday and Tuesday, but very few fish were taken; the air and water were very warm, 90° and 82° respectively, and it was with difficulty that the fish were brought to the wharf alive. An awning was rigged over the tanks and every precaution was used to ward off the sun's rays, which I found almost instant death, especially to the larger fish. At times the fish would come to the top of the water for some hours in spite of every effort to keep them down; again, they would stay perfectly quiet on the bottom for several hours. I was unable for some time to explain their actions, but finally it occurred to me that at low tide the water from the river being fresher than at high tide, when the water in the tanks was renewed at low tide and ice in considerable quantities added, the water became too fresh and the fish suffered. This led to the necessity of adding salt in some form in order to maintain a steady degree of saltness. The sea salt was tried and to my surprise and pleasure worked to a charm. After Wednesday morning fresh spring water with sea salt added was gradually substituted for the turbid water from the river, until, when I left, Thursday noon, at least half the contents of the tanks was made up of artificial brackish water. About a handful of salt to a pail of water seemed about the right proportion.

Tuesday night I put fifteen medium-sized bass in a wooden car and sunk them in the river where the tide ran strongly. In the morning seven only were alive, showing how easily bass will die when put under restraint.

The hauling was continued Wednesday, but as I had sixty small bass, $2\frac{3}{4}$ to $4\frac{1}{2}$ inches long, and thirty medium-sized bass, 6 to 8 inches long, I thought best to be sure of some at least, and so staid myself with the fish on the shore for the first time, the men going out alone with an empty tank, ice, and thermometer. As might have been expected, they made a large haul of 139, mostly small, and lost all but twelve before getting back to the wharf. This rather disheartened them, but after considerable argument they were persuaded to try again Thursday, and very fortunately in the first haul we took seventy-five small bass and six large, and succeeded in bringing every one safe to the tanks. The tanks were thoroughly washed and filled with water, half from the river, high tide, and half from a spring, with sea salt added.

Thursday noon took the train from Red Bank, the tanks being expressed to the Grand Central depot, charge, $15. A large truck, and three men from Adams Express Company, met the train at Jersey City, and at five o'clock the tanks arrived at the Grand Central, and on examination only one dead fish was found.

Finding that a baggage car was run through to Chicago without change I made arrangements to have the tanks taken in that car, discharged the boy I had brought from Red Bank to help, and congratulated myself that I had one hundred and thirty-three small bass, alive and in good condition, thirty-four medium sized bass, and four hundred and fifty, more or less, small eels. The trip to Albany was uneventful, and with the delivery of the fish I gladly relieved myself of the responsibility that had weighed rather too heavily for comfort upon me during the ten days of my service.

As to scallops, Mr. Blackford answering to my telegram that it was "impossible to get scallops," I started Sunday afternoon for Canarsie, Long Island, the center of the scallop fishery. I took with me "Uncle Dan," experienced in scallops and scallop-fishing. We arrived at Canarsie about midnight, being obliged to walk the last five or six miles. In consideration of a heavy fee, a man was found willing to undertake the work of catching the scallop, but, after raking from three until eleven Monday morning, we were obliged to return without as much as seeing a single scallop. I sent a man to the very end of the island to procure the scallop at the Grand Central Depot, Thursday. The trip must have taken at least three days, and as I saw nothing of him there his search must have been unsuccessful. About two weeks earlier the scallop were plenty.

The difficulty of obtaining the bass, requiring the services of from four to eight men day and night for a week. made the expense of my experiments more than it would have been under more favorable circumstances (as a week later in time), but I did not dare to relinquish in the least particular lest I should lose all I had, and leaving the account to speak for its own necessity I respectfully submit this report of my ten days at Red Bank.

HARRY W. MASON.

XXI.—REPORT ON THE TRANSPORTATION OF A COLLECTION OF LIVING CARP FROM GERMANY.

By Dr. O. Finsch.

The fish came from the well-known and reliable fish-cultural establishment of Mr. Rudolph Eckhardt, in Luebbinchen, near Guben, province of Brandenburg, Prussia. There were 100 specimens of the finest kinds of carp, principally mirror-carp (*Cyprinus carpio, rex cyprinorum*), one and a half years old, and measuring from 6 to 8 inches in length.

Lübbinchen is about one and a half hour's ride from the railroad station of Guben, whence the fishes were shipped on the evening of the 21st of April to Hamburg, by an express courier train, which was allowed to carry fish at the same rates paid for passengers' goods.

I did not get a telegram from Mr. Eckhardt until the 22d of April, and, therefore, had only time to receive the fish at the depot. They had been on the way about eleven hours, and were apparently in excellent condition; they were in four coal-oil barrels, each containing 25 fish. Seven fish were found dead in one barrel when they arrived at Hamburg.

Following the instructions of Mr. Eckhardt, I filled up the barrels with fresh water, pumping it in until the water flowed off quite clear, and appeared entirely free from the least mud or slime; then the barrels were replenished three-quarters full.

Owing to the condition of the Elbe, the large transatlantic steamers cannot always reach Hamburg, and are sometimes compelled to anchor near Stade or Glückstadt; this was the case on the day of our departure. We started on the 23d of April, at 10 o'clock a. m., in a small steamer, which conveyed the passengers and their goods to the Lessing, of the Hamburg Mail Packet Steam Navigating Company, and embarked on the Lessing at about 4 o'clock in the afternoon, near Stade. As I had not been advised of the shipment of the fishes from Guben until quite late, I did not have time to purchase a sufficient quantity of ice at Hamburg; however, I could not very well have taken a greater quantity on board the local steamer, whose carrying capacity was somewhat limited, and was crowded with passengers and their goods. There were 560 passengers on board.

I received the following orders from Mr. Eckhardt: "Place the fish, if possible, in the ice-house; if this cannot be done, put the barrels on ice covered with sawdust; put two pounds of ice into each barrel once or twice during the day, and keep the temperature at 4° or 6° Reaum. (about 40° or 45° Fahr.); if the fish cannot be placed in the ice-house or on deck, put them under the deck, but in a room where there is sufficient air; at any rate, the ice should be regarded as the most important thing, as well as necessary for the resorption of air."

As the air in the ice-house, and even in the other rooms below deck (owing to the presence of 5,000 pounds of fresh meat), was not pure, we placed the four barrels—which were very heavy and required four men to handle them—on deck amidships. Captain Voss kindly instructed the steward to give me all the ice I needed; and the first officer, Captain Froboes, was kind enough to take a supply of fresh water from the Elbe in small barrels, which were placed at my disposal in the life-boats, to keep the water cool.

When starting from Hamburg on April 23, the day was quite warm, and having no ice on the small steamer, we pumped in air by means of an air pipe, which refreshed the fish considerably. Temperature of water, 4½° to 5° (40.1° to 41° Fahr.). One fish died.

April 24.—In the North Sea; cool weather; water 5½° (41.9° Fahr.); pumped in air several times.

April 25.—At Havre; very warm day; water 6° (42.8° Fahr.); put in ice twice; aerated the water frequently; six fish dead.

April 26.—In the channel; filled up with fresh water; used ice three times; aerated several times; water 6° (42.8° Fahr.); ten fish have died.

April 27.—In the Atlantic; put in ice twice; aerated; water remained at 5° (41° Fahr.) constantly; thirteen fish dead. All these fish were dying in one barrel, the same in which we found the seven dead fish when they arrived at Hamburg. In order to discover the cause of this mortality, I had all the fish transferred into another barrel, which had been filled with fresh water, and noticed that most of them were relieved in a half hour's time; and those which had been swimming on their sides when in the other barrel became quite brisk again. The barrel from Luebbinchen was cleaned thoroughly, and was found to contain a great quantity of mud; six times the water had acquired a black color, and it was very evident that the barrel had not been cleaned properly (as it should have been), and which unfortunately was the immediate cause of the death of so many fish.

April 28.—Put in ice three times; notwithstanding, the temperature reached 7° (44.6 Fahr.). The balance of the fish which had been taken from the unclean barrel died, making the total loss thirteen, although the barrels had been filled up with fresh water.

April 29.—Put in ice; water 6° (42.8° Fahr.); six fish died.

April 30.—Used ice once; water 5° (41° Fahr.); two fish died.

A dissection of dead fish show that they were all in excellent condition, being fat and well fed. Although we had very fine weather and the ship rolled very little, the sea being nearly smooth, some of the carp had injured their snouts. To prevent any rolling we hove up the barrels (now only two) into the life-boats, where they remained suspended between the davits, and had no greater movement than a lamp in the cabin. These changes for the better were accomplished through the kind and timely assistance of Captain Froboes, the first officer, who took a great interest in the matter.

May 1.—Put ice in; water constantly 5° (41° Fahr.); three fishes died.

May 2.—Put ice in; water constantly 5° (41° Fahr.); one fish died.

May 3.—Put ice in; water constantly 5° (41° Fahr.); five fish died.

(Several times each day air was pumped in.)

May 4.—Put ice in; fresh water; water from 5° (41° Fahr.) to 6° (41.8° Fahr.); three fish died.

May 5.—Put ice in; fresh water; water 5° (41° Fahr.) to 5½° (41.9° Fahr.); five fish died.

May 6.—Put ice in; fresh water; water 5½° (41.9° Fahr.) to 6° (42.8° Fahr.); two fish died.

(Air pump was used every day.)

As we approached the coast the weather became warmer, and I put in more ice than we had been accustomed to use during the past five days; we also replenished the barrels with fresh water.

We arrived about 7 o'clock p. m. at the pier in Hoboken, where Mr. Fred. Mather, who had been commissioned by Prof. Spencer F. Baird, was awaiting me to take charge of the fish on their journey to Washington. Our aggregate loss was 77 dead fish, leaving 23, which comprised our live stock, which may be considered, however, as a satisfactory result. The uncleanliness of the one barrel above mentioned was the cause of the unusual mortality during my trip.

My experience on this trip teaches me that it is easy and practicable, *with the assistance of a keeper*, to bring over living carp from Germany. The transportation, however, should take place during the colder months—from November to March. During these months there is an abundance of room on the steamers, and the fish can be placed in a cool room down in the dark, where the sea air, and particularly the damp air from the banks and during foggy weather, cannot have a disastrous effect upon them. I do not think the sea air good for so purely a fresh-water fish as the carp, as it is too much charged with salt; the salt forms a sort of incrustation, during foggy weather, on the beard and woolen clothing when exposed on deck for any length of time. Fresh water should be used in order to counteract the evil influences of sea air. Fresh water and ice should be at hand in large quantities. If I could have obtained a sufficient quantity of fresh water, which would have enabled me to fill up the barrels daily, I am positive the death rate among the fish under my charge would have been correspondingly light. Ice is also absolutely necessary to keep the temperature below 6 degrees Reaum. (45° Fahr.). Pumping air is also very good, as it carries the air below the surface and produces a circulation at the bottom of the barrels. Whenever the fish (on this trip) were suffering for want of air, and gasping, I immediately employed the air-pump, and the fish would go quietly to the bottom of the barrels, which, in my opinion, is a favorable sign.

While too high an estimate cannot well be placed upon the beneficial results of the air-pump, I cannot close without reiterating my former expressions in favor of the two principal accessories to the successful transportation of carp, namely, *fresh water and ice.*

As it is impossible for one man to fill up and handle the barrels during the voyage, the assistance of the captain and crew is often necessary, and in this connection I cannot speak too highly of Captain Froboes, the first officer of the Lessing, who manifested great interest in the enterprise and rendered invaluable assistance. I have also to thank my zealous assistant, Mr. Ernst Rehre.

Very respectfully,

DR. OTTO FINSCH.

WASHINGTON, D. C., *May* 16, 1879.

XXII.—REPORT ON THE PROPAGATION AND GROWTH OF CARP.

By Mr. Eckardt-Lübbinchen.*

[From Circular No. 1, 1880, of the *Deutsche Fischerei-Verein*, Berlin, February 12, 1880.]

As experiments continued for several years have fully proved that it is possible to ship embryonized carp-eggs and young carp a long distance, I must draw attention to the transportation of carp-eggs and of carp 7 to 14 days old.

There is not another pond-fish which can utilize the food contained in the water to so high a degree as the carp.

Unfortunately, it has hitherto been impossible to raise the carp industry to the place which properly belongs to it in our system of economy, chiefly because it was not possible to obtain the necessary supply of carp-eggs and young carp, which were in great demand, and therefore fetched a high price. This evil may be remedied by the most recent investigations of our pisciculturists, which have fully established the possibility and practicability of successfully shipping carp-eggs and young carp. By their nature the carp-eggs are not at all suited for transportation. Their shell is very tender and easily broken, and, moreover, these eggs are hatched five to ten days after impregnation if the temperature is + 20° to 15° Réaumur, and the sun shines brightly. A special method must therefore be employed. Although this method is undoubtedly open to many improvements, I have felt encouraged to send embryonized carp-eggs to America, and hope that most of them will arrive in a healthy condition.

I am prepared to gather the naturally impregnated carp-eggs clinging to plants or pieces of wood, to estimate their number, and to send them away in specially-prepared boxes.

As the embryo of the carp and the young fish itself develop with remarkable rapidity, it will be necessary, immediately after their arrival at the place of destination, to take out the inner box, and, without opening it, to place it in the water in which the young fish shall be hatched, and then to open the box after it has been in the water for at least an hour. The contents of the box should then be emptied at once into a flat box measuring about 1 to 2 cubic meters, having two openings covered with wire-gauze, and placed in the same pond. Here the eggs should remain until the young fish slip out. The grates should be of iron wire,

* Herr Rittergutsbesitzer Eckardt-Lübbinchen: "*Bericht über Karpfenvermehrung.*"—[Translated by Herman Jacobson.]

six vacant spaces or holes to an inch, so as to prevent injurious aquatic insects from entering. A grate of this kind will allow the young carp to swim through freely; and this is really an essential condition of their well-being, as immediately on being hatched they seek the open water and spread over the whole pond.

After a stay of four weeks, the young carp can be transplanted, but it is not absolutely necessary to do this before autumn or the following spring.

If lakes and rivers are to be directly stocked with young carp, select a quiet shore, with plenty of floating grass and other aquatic plants, if possible on the north side, so it gets the full benefit of the noonday sun. The young fish will then, soon after having been placed in the water, scatter all over the pond, and soon make themselves acquainted with its natural conditions and with the enemies contained in it.

There is no doubt that it will be of great advantage to permanently stock our lakes and rivers with young carp, especially as carp raised in lakes and rivers have a much finer flavor than pond carp, and as this seems to be the only way to raise those large and beautiful carp, weighing 20 to 50 pounds, which are the *beau ideal* of a carp.

Proprietors of lakes, and even those who have rented lakes, should stock their waters with large masses of young carp; and with regard to public waters the same should be done by associations.

Embryonized carp-eggs can be bought here at 2 mark = 57.6 cents per 1,000, and in quantities exceeding 5,000, at 23.8 cents per 1,000.

Young carp (7 to 14 days old) are sold at 10 mark = $2.38 per 1,000, in quantities exceeding 10,000 at $1.19 per 1,000 exclusive of packing and freight to the railroad, which, however, is no very great expense. Boxes, vessels, &c., should be immediately returned at the expense of the sender. Orders are taken till May 1, 1880.

As regards the size which carp should reach in lakes, I take the liberty of giving a correct copy of the following letter received by me some years ago:

SABROD, *September* 6, 1877.

MR. R. ECKARDT-LÜBBINCHEN:

DEAR SIR: In answer to your favor of the 29th August, asking for information concerning large carp, I send you all the information I possess.

My father had, from 1830 to 1840, rented the Swan Lake, and although the rent was not very high, the fisheries in this lake did not pay very well, because its bottom is too uneven, and because it contains some very deep places where fishing apparatus cannot reach. At that time, and perhaps even now, the lake contained magnificent carp, bleie or bream (*Abramis brama*) weighing 16 to 22 pounds, and perch weighing ½ pound. During the common fishing season no carp at all were caught, but only during the spawning period. In warm, sultry weather the carp came up to the surface and could be caught with great caution.

Thus our old fisherman, Lucas, who is still living, in one year only caught two carp, the larger of the two weighing 75 pounds. In the following year I visited the lake, and, as far as I remember, caught about 40 carp, several of which weighed 40 to 50 pounds.

The grandfather of the present Count von der Schulenburg, who was then living at Lieberose, told my father that in a conversation with the Duke of Dessau the duke had praised his large sturgeons and my father his large carp. My father thereupon presented the count with a large carp, which was placed in a lake near Iamlitz, where it remained till autumn. Meanwhile the count had had a little wagon made containing a receptacle suited to the size of the carp, and Mr. Brunsch, locksmith, and Mr. Braun, shoemaker, both citizens of Lieberose, were detailed to transport the carp to Dessau. Both these good people were anxious to earn a little extra money, and during their journey exhibited the carp for money in several towns. This of course caused a delay, and when the carp reached Dessau it was dead, but still fresh enough to be cooked and placed on the ducal table. Its bones were so large that the guests took them home as curiosities.

I do not remember how long the journey lasted, nor in what year it occurred, but it must have been about the middle of the third decade of the present century, for from 1830 to 1833 I attended the college at Güben, was in the same class with your brother Oswald, and afterwards staid with my father till the end of September, 1833. A few years later I visited the Swan Lake and caught the above-mentioned carp. A year previous the extraordinarily large carp had been caught.

I was glad to see that you take an interest in these matters, and have therefore cheerfully furnished the desired information.

I have also a number of years ago read an old chronicle giving a description of the origin of the Schwielsch Lake, and of its former location. Let me know whether this would interest you.

Respectfully, yours,

W. REIGLITZ.

The Swan Lake, located in the county of Lübben, district of Frankfurt-on-the-Oder, measures about 150 hectares. Towards the end of winter it receives a great deal of excellent fish-food in the thaw and rain-water coming from large meadows. The fish found in this lake consequently grow very rapidly, and have a most delicious flavor.

In 1865 I have, during the ice-fisheries in this lake, seen 18 carp weighing from 25 to 40 pounds each, and bleie or bream weighing upwards of 20 pounds. All these large fish had a particularly beautiful shape.

In my own and rented lakes I myself have caught carp weighing from 25 to 27 pounds, which, judging from their scales, must have been about thirty years old.

Carp-culture needs no better recommendation.

XXIII.—RAISING SALMONOIDS IN INCLOSED WATERS.

By Director Haack.*

[From circular No. 1, 1880, of the *Deutsche Fischerei-Verein*, Berlin, February 12, 1880.]

It is a fact often deplored by the friends of fisheries and pisciculture that the finest of our streams, the beautiful mountain brooks, which, clear as crystal, merrily leap from rock, to rock, are, from year to year, less and less suited to fulfill their original purpose, viz, to form the habitation of fish and other aquatic animals.

The water of most of our mountain streams in these days only serves as the motive power of turbines, as the means for washing cotton goods, bleached with chlorine, as the purifier of printed cotton goods after having been treated with phosphoric or hydrochloric acids, as the receptacle for all sorts of chemicals from dye-works and chemical establishments; in fact, it serves for everything imaginable, with the exception of its original purpose, viz, to be the habitation of fish.

Wherever any water-power can be discovered we shall soon find a dam by which the whole brook or river is hemmed and its water led into some channel where it serves some industry. The manufacturer, of course, does not care whether there is enough water left in the river to allow fish to live and flourish. All this is very much to be deplored, but in most cases it can scarcely be changed; for a factory employing hundreds of men and putting millions of money into circulation certainly does more for the general good of mankind than a few trout or salmon.

Even the most enthusiastic friend of fish and the fisheries will have to familiarize himself with the idea that in course of time our small mountain streams will contain but few or no fish, simply because the large factories have driven them away. If, consequently, we do not wish to lose entirely the highly esteemed inhabitants of our mountain streams, the trout and similar fish, ways and means will have to be found to preserve these fish. This may be done by raising salmonoids in inclosed waters.

Besides the brook-trout, the lake-trout and the saibling are particularly suited for raising in inclosed waters; but all these fish are excelled by the bastards of trout and saibling. Such bastards outgrow the fish of a pure breed very considerably even when they are raised under exactly the same conditions. Besides rapid growth, such bastards possess another advantage in their exceedingly delicate flavor, combining the excellence of the saibling with the peculiar flavor of the trout. I must,

* Herr Direktor Haack: "*Einiges über die Zucht der Salmoniden in geschlossenen Räumen.*"—[Translated by Herman Jacobson.]

therefore, consider the bastard of saibling and trout as the most suitable fish for raising in ponds.

Our beautiful aesche or grayling (*Salmo thymallus*) is unfortunately not suited for raising in ponds, principally because it is confined to insect food. This is all the more to be deplored, as this fish is particularly sensitive to the impurities of the water.

The huchen (*Salmo hucho*), on account of its great voracity and because it never eats anything that is dead, is only suited for raising in ponds where there are large numbers of small and otherwise worthless fish.

The experiments in raising the finer species of *Coregonus*, *e. g.*, the *Coregonus marana* and the *Coregonus Wartmanni*, in ponds are of too recent a date to pronounce an opinion upon them. But so far these experiments have been encouraging.

The only salmonoid which has been raised in ponds for any length of time is the trout. Thus the trout-ponds near the Wolfsbrunnen at Heidelberg are widely known, as are also the trout-ponds of several fish dealers, *e. g.*, those of Peter Haenlein, at Mombach, near Mayence, of Mr. Leyfried, and Helmstätter Brothers, near Würzburg.

Trout are not *raised* in any of these ponds, but merely *fattened*. The dealers buy, often at a great distance, young trout measuring 5 to 6 inches in length, which have been caught in brooks, and place them in their ponds. Here they are sorted according to years and fed with the worthless cyprinoids which are caught in large numbers in the Neckar, the Rhine, and the Main. In Heidelberg and Würzburg these food-fish are generally placed in the ponds alive, but in Mayence they are only put in dead. The former method of feeding is more convenient and may especially be recommended in small ponds where the trout have not to hunt far for their food. The method of feeding with dead fish adopted in Mombach, near Mayence, is better calculated to fatten the trout.

The food-fish are kept at Mayence in a live condition, and are every day at a certain time taken to the neighboring village of Mombach, where the trout get them dead but entirely fresh. Great care is taken that the trout leave no remnants, and the excrements and scales of the food-fish are carefully removed every day.

In all the places which have been mentioned the quantity of spring water used for feeding the ponds is comparatively small; nowhere is it more than can be conveyed by a pipe measuring about three and a quarter inches in width. At the Wolfsbrunnen, near Heidelberg, the quantity of water used for feeding the trout-ponds was larger, but since most of the water is used by the city water-works, the ponds have to manage with less water.

In Würzburg and Mayence the trout-ponds are quite small, properly speaking, only large tanks made of wood and cemented, which may be laid dry and cleaned at any time.

The Heidelberg ponds are much larger, and are, as far as I know, only cleaned once a year, late in autumn. Special care is taken to remove the leaves which during summer and autumn are blown into the ponds. These leaves thoroughly soaked with water sink to the bottom of the pond and form the principal breeding place of the hurtful small leeches, which, if once settled in a pond, can scarcely be exterminated.

A fish-dealer in Frankfort-on-the-Main fattens the trout in a still simpler manner. As there is not sufficient spring-water in Frankfort for feeding the trout-ponds, Schauermann Brothers, of that city, have large floating boxes in the Main, which are used as trout-ponds. In autumn, when the water of the Main has sufficiently cooled off, medium sized trout caught in brooks are placed in these boxes and are amply fed with live fish. The trout can, of course, only remain in these boxes till the beginning of summer, but by that time their weight has been doubled or trebled.

The most interesting method of fattening fish is undoubtedly that of Mr. Kuffer, superintendent of the royal fisheries at Munich. It is really a pleasure to see how this Nestor of pisciculturists manages his establishment. Partly in small stone troughs and partly in small ponds trout may be seen by the hundred weight, not only alongside of each other, but in a literal sense above each other. In some of the stone troughs there are certainly more trout than water; but not only trout, but the magnificent saibling of the Schlier Lake, large *Salmo hucho*, enormous numbers of splendid eels from Italy, and, above everything else, hundreds of thousands of the finest crawfish are here gathered within a narrow space and enjoy the most careful treatment.

Mr. Kuffer's establishment is highly favored by its natural location and by the peculiarity of the Munich fish-trade. Powerful springs rise from the two so-called "ports" in the almost perpendicular wall of rocks forming one side of the court-yard. Summer and winter these springs flow from the rock with the same strength, the same temperature, and with ever clear and sparkling water; and thus it becomes possible to keep such large numbers of trout and other fish within such a small space.

In one court water from the river Isar can be brought in for the special benefit of the cyprinoids; and the experience of many years has convinced Mr. Kuffer that this mixed water is absolutely necessary to acclimatize the saibling which have been imported from the Schlier Lake. If these fish were immediately put into pure spring-water they would soon suffer from the byssus and would die.

The peculiarity of the Munich fish-trade greatly favors this method of keeping fish, as nearly every one buys his fish after the scales have been taken off and after they have been cleaned. In this manner Mr. Kuffer obtains a great quantity of entrails, and especially roe, of which all fish are very fond.

The trout and the *Salmo hucho* are not only fed with fish-entrails, &c., but also with live cyprinoids. It is very interesting to observe the great economy with which Mr. Kuffer manages his establishment. Absolutely nothing is lost. Dead fish and remains of fish which are refused by the trout are given to the crawfish, which besides this receive a great deal of vegetable food, especially corn soaked in water.

Mr. Kuffer knows nearly every one of his fish, certainly all the larger ones. Some especially large and beautiful specimens of *Salmo hucho* and of trout have been in Mr. Kuffer's care for a number of years. Particular attention is of course paid to the female trout, the egg-producers, as the sale of eggs in the various stages of development forms no inconsiderable source of income. It is interesting to see how carefully Mr. Kuffer treats his fish. As soon as any one has the least sore place or shows the slightest trace of byssus, as soon as a fish does not swim about with its accustomed liveliness, it is taken out of the larger pond or tank and placed in a special department. Here it is kept until it has entirely recovered, or, as is mostly the case, it is as soon as possible utilized in the most profitable manner. Epidemics which are so frequent in other piscicultural establishments have never occurred in Mr. Kuffer's establishment, probably because they are checked in the bud by immediately removing diseased fish.

The crawfish epidemic, which is constantly advancing further east, has made some ravages in Mr. Kuffer's establishment.

As regards the treatment of fully-matured trout, Mr. Kuffer stands without a rival.

Pisciculture proper, *i. e.*, the raising of food-fish from impregnated eggs, is not carried on to any extent in Mr. Kuffer's establishment. There is too little room and too little time for this.

Regarding those establishments in which food-fish are raised from impregnated eggs, I cannot report as favorably as on those establishments where fish are merely fattened.

The reasons why most of our piscicultural establishments proper do not flourish are manifold. The chief cause, however, has been carelessness in the selection of a location. And where the location and the condition of the water were favorable, it was often impossible to procure suitable food in sufficient quantities, at any rate at a reasonable price.

A beginner in pisciculture is generally mistaken as regards the quantity of food required, thinking that it is sufficient to let a proper quantity of water flow through his ponds, but forgetting that fish live *in* the water but not *by* the water.

Principally owing to this question of feeding the fish, most attempts to raise trout in small ponds have remained experiments.

I also know establishments whose location enables them to procure at all times a sufficient quantity of food, but whose supply of water is not sufficient.

The largest and most successful establishment for raising salmonoids is undoubtedly the one belonging to the Klein Brothers, at Illhäusern, in Alsace. During a period of four years a quantity of trout had been raised in this establishment, valued at 150,000 francs. This flourishing establishment has unfortunately been totally inundated and partly destroyed by the freshets in the Rhine and the Ill during the year 1874. Nearly all the trout were lost, and since that year this establishment has not been in operation.

Besides the natural food which the Ill supplied in considerable quantities, horseflesh was exclusively used for feeding the fish. The horses which were slaughtered were always carefully examined by veterinary surgeons, and the flesh was fed to the fish in accordance with their size; the larger ones got it chopped up in small pieces, and the young fish, ground fine. Two horses were generally used every week. As skin and bones were profitably sold, the horseflesh generally cost the establishment 3 to 4 cents per kilogram, and often much less.

The establishment over which I preside, during the first years was very successful in the raising of trout, and I used horseflesh exclusively for food. It was salted and came packed in barrels from Mülhausen, in Alsace. It was the very best meat, free from sinews and bones, and cost me, including cost of transportation, 4 to 6 cents per kilogram. I kept a very careful account of my expenses for food, and found that it cost me from 50 cents to 73 cents to raise 1 kilogram of trout. Considering that trout sell at $1.25 to $1.50 per kilogram, my profit was considerable. In this calculation, however, I have taken no account of the natural food which the trout find in the larger ponds containing aquatic plants. By this method of feeding, some trout weighed 2½ to 3 pounds when two and a half years old. Unfortunately I had to give up this method, as, doubtless owing to some infected meat, an epidemic broke out among my trout and carried off every one of them.

There can be no doubt that the epidemic was caused by infected meat, since it broke out on the same day in all my ponds, many of which had no connection whatever with each other. Not only the larger fish, but also those which were only a few months old, in fact, all my salmonoids, died in one day.

For several reasons I could not buy the horses alive and have them examined and slaughtered at my establishment, and I was consequently obliged to give up this method of feeding fish. I must say that I have not obtained a similar success with any other food.

I am told that the establishments at Aubach and Baitzenburg are worked on the same principle, though I do not know with what success.

In raising saibling in small ponds, the greatest success in Germany has been obtained by Mr. Wieninger, at Teisendorf, in Upper Bavaria. Here may be seen within a small space many thousands of great and small saibling, all raised from the egg.

It is truly astonishing that so large a number of fine fish can be raised with so little change of water. I must warmly recommend this establishment to all persons interested in pisciculture.

The establishment at Hellbrunn, near Salzburg, is also very successful in raising saibling.

Both these establishments use horseflesh as food, but as nearly the whole population of these poor mountain regions lives on horseflesh, it is more expensive than in most other places, and the profit is consequently not as large.

Although the price of fish is high in those parts, saibling fed in this manner fetch a higher price than those caught in the lakes.

These establishments are, nevertheless, very instructive, for they prove the possibility of raising large quantities of salmonoids within a narrow space, and of raising fish from impregnated eggs till they are fit for the market.

As very little capital is required for starting such establishments, they would certainly be a source of profit if a less expensive article of food could be found, or if they could be started in places where horseflesh is cheaper.

Saibling are also raised in numerous private establishments in Austria and Bavaria, which are all more or less successful.

This fine fish certainly deserves the great care which it enjoys in many places.

In the following I shall give my views regarding the raising of salmonoids in inclosed waters.

Before spending any money in starting a piscicultural establishment, a man ought to inform himself as accurately as possible regarding the water which will be at his command. He must know the average quantity of water, counting in the dry season; he must know the temperature of the water during the greatest heat and the greatest cold, and also the exact nature of its fall on the territory in question.

Every beginner should also not only inform himself theoretically, but practically, and this object will best be attained by visiting some prominent piscicultural establishments. The best season of the year for such visits is in March and April, because in well-regulated establishments everything of importance can then be seen to the greatest advantage. Although such hints seem almost superfluous, they are nevertheless much needed.

Large piscicultural establishments have been started by men who possessed little practical and no theoretical knowledge. People will begin, not with 5,000 to 10,000 trout eggs, but with hundreds of thousands, yea, millions of eggs, in the hope that large profits will quickly be realized. If—as will generally be the case—these profits do not come; if, on the contrary, failure is succeeded by failure, the whole cause is condemned, and we often hear it said: "So-and-so has also commenced to raise trout, but of course nothing came of it! Pisciculture is a delusion!"

It is just as difficult to make millions of money in pisciculture as in anything else. An intelligent, thrifty, and, above everything, persevering and hard-working man, will always realize some profits from this as yet comparatively little known industry, especially as long as there is not much competition. But he who thinks that pisciculture will in a short time make him a rich man had better engage in any other occupation, for there is scarcely any branch of human industry which requires such constant personal attention and work as pisciculture!

But my zeal for a good cause has led me too far from my subject.

If a locality does not offer a sufficiently large quantity of water; if there is little or no fall; if there is no absolute safety from freshets, no extensive establishment should be started, but a more favorable place should be selected, even if the first expense be greater.

By carefully ascertaining the temperature of the water both during winter and summer, the pisciculturist will know what salmonoids he will be able to raise.

Saibling can only be raised in places where the water, even during the hottest season, does not reach a temperature higher than + 14° Réaumur (64° Fahr.). A higher temperature, even if the water is changed frequently (63.50° Fahr.), will kill all the fish.

I am not able at the present time to say exactly what degree of temperature the bastard of trout and saibling can stand, as I have not yet concluded my observations on this subject. But as regards trout—both brook and lake trout—I am prepared to say that they can stand a much higher degree of temperature than is generally supposed. If the change of water does not take place too slowly, trout can live in any river-water. I have already observed that the temperature in ponds has reached 22° to 23° Réaumur (81° to 84° Fahr.) without causing the slightest disadvantage to the trout. During a high temperature the change of water must of course be frequent and rapid. If the temperature is very high the trout is not quite as voracious as otherwise, but does not suffer in any way.

I must in this connection mention the following fact:

During last summer I ascertained, by numerous and accurate observations, that our German trout can stand a much higher degree of temperature than the American *Salmo quinnat*, which had been so highly recommended to us on account of its power of resistance to warmth. In three of my ponds the influx of Rhine-water suddenly ceased during the hottest part of summer, because the Rhine-Rhone canal was laid dry. In consequence, all my California salmon died in a very short time, while nearly all my German brook and lake trout remained alive.

The beginner in pisciculture will see from the above what kinds of salmonoids it will be most profitable to raise.

It is not the object of the present brief treatise to give exact rules for raising the various salmonoids from the earliest stage of their development, as this would require more space than is offered by the circulars. I must, therefore, confine myself to a few general hints, hoping that at some future time I may be allowed to enter more into details.

I, therefore, begin with the treatment of the young fish after they have lost the umbilical bag, *i. e.*, have become able to seek their own food.

As a general rule the work of most pisciculturists is done as soon as their young trout or salmon have lost the umbilical bag, and nothing remains to be done but to place the young fish in suitable locations in brooks and rivers. But the chief work of him who wishes to fatten his fish for the market in inclosed waters only commences at this point.

There will be a difference in the method of raising trout and saibling.

According to my experience the simplest and best method for trout is to place the young fish, as soon as the umbilical bag has disappeared, or, better yet, a few days previous, in a small artificially-meandering brook and leave them there till autumn. This brook must be so arranged that the influx of water can be thoroughly regulated. In the beginning the water must flow in only in small quantities and gradually increase till the middle of summer, when the influx can scarcely be strong enough. This artificial brook should, if possible, be arranged in close proximity to some natural brook, but so that it cannot be injured by high water. The well-closing grates at the entrance and exit should be movable, so that coarser grates can be substituted when the fish grow larger and the influx of water is stronger. The most suitable material for such grates is a piece of perforated tin. It is understood that such an artificial brook must have artificial hiding places made of stones, broken pieces of drain-pipe, boards, and suitable aquatic plants. In this brook the trout are left till October or November. If it is of considerable extent and not overcrowded with fish, artificial food is scarcely needed.

Before new fish are placed in the brook in autumn even the last of the young fish must be removed. In order to do this, it is absolutely necessary to remove even the last drop of water from the brook. It is better that a few of the one-year old trout should perish than that a single one should remain. The danger that a larger trout will devour the majority of the new fish is of course much greater in an inclosed than in an open brook, as in the latter there are so many more natural hiding-places.

In raising saibling and bastards of saibling I consider it necessary to keep them during the first year in small, thoroughly inclosed waters, and to feed them with artificial food. All my attempts to raise saibling in the same manner as trout have only yielded negative results. The young saibling which, in those deep waters where it is accustomed to live, has never met with an enemy, has completely forgotten how to fight for its existence.

It is very interesting to observe how different the mode of life of the trout is from that of the saibling, even from their earliest youth up.

Young saibling are not at all shy, and when the inclosure is opened they will not fly but come quite close, while trout raised in exactly the same manner will nearly always remain shy, and certainly fly rapidly whenever the inclosure is opened. It is no rare occurrence that young trout, whenever their inclosure is opened, shoot off with such rapidity as to become stunned by bumping against the sides, and even to become fatally injured.

Young saibling, as well as young trout, unless placed in large artificial brooks, should at first be fed exclusively on small crustaceans. Although it may in some localities involve trouble and expense to procure such living food, it is everywhere possible to obtain it. As soon as the young fish have grown a little larger the larvæ of various kinds of gnats, which surely can be obtained everywhere, are a most suitable food. Only after the young fish have for several weeks been exclusively fed on live food, artificial food should be given to them. The best food for all young salmonoids will under all circumstances be the brain of cattle, ground fine. With a sharp brush the brain is rubbed two or three times through a close wire-sieve, and this sieve is then washed out in the artificial brook close to the entrance. In the beginning but very little should be given, and all the remains should be carefully removed; gradually, however, the quantity should be increased. As soon as the fish are a few months old the feeding process will gradually become easier, and the brain should then be rubbed through a coarse sieve. But rarely will any particle of the brain fall to the bottom, as the fish will greedily devour it all. At this period it will be well to vary the food a little; and I can conscientiously recommend raw meat of the muscle part, for the smaller fish, of course chopped fine. Wherever there are properly inspected horse slaughter-houses horseflesh may be used, which is of course cheaper; but wherever you are not absolutely certain of obtaining healthy flesh, the more expensive beef should be used. The little trouble and expense should not prevent any one from giving the young fish from time to time worms chopped fine, as well as the larvæ of the phryganids carefully removed from their shell, which are found in great abundance in every water. The small expense incurred by thus varying the food will be amply repaid by the better condition of the fish.

The chief point in feeding fish in inclosed waters will be to observe the greatest cleanliness; and the basins should every day be carefully cleaned of all remnants of food and excrements. It will, therefore, be found advantageous to place the young fish in elevated basins, so that all remains of food &c., can be removed by means of a gutta-percha tube.

As long as the fish are quite small such a tube should be furnished with a fine sieve. If the basins are not elevated the cleaning must be done by means of a pipette.

The most scrupulous care in removing all remnants of food and dirt from inclosed waters is absolutely required for raising salmonoids. In natural brooks, which have an abundance of aquatic plants, the numerous small crustaceans keep the water sufficiently clean, while in artificial brooks man must be the scavenger.

During the first year no food can be too expensive, as the quantity of food required is not very great. I have kept an exact account, and even when using brain, which is the most expensive food, from spring till autumn (the time when fish eat most), it never cost me more than ½ to ¾ cent apiece. When fed in this manner the fish had reached an average length of a finger; the expense had therefore not only been amply repaid, but the gain was infinitely larger than the expense. Such a young saibling or bastard is worth at least 4 to 5 cents and even more, for its period of growth is only just commencing. I say advisedly "period of growth," for during the first year fish grow most rapidly, comparatively speaking. After having lost the umbilical bag a trout weighs about 0.125 grams; and as a trout when one year old will, if well fed, weigh 20 to 25 and even 30 grams, the original weight has increased about 200 fold. Growing at the same rate, a trout when two years old would weigh about 4 or 5 or even 6 kilograms. Well-fed saibling are ready for the market when two years old.

As soon as the fish grow larger the question of feeding them becomes more important; for a larger quantity of food is required. Expenses should now be carefully calculated, for otherwise it may happen that artificially-raised fish are twice and three times as expensive as those caught in open waters.

This question of food is really the main question in raising salmonoids in inclosed waters; and so far this question has not even been answered approximately.

As I have already mentioned, the raising of salmonoids will be profitable in such places where small food-fish, principally of the *Alburnus* and *Leuciscus* kind, which never grow large enough to serve as food for man, can easily be obtained. There are a great many such places, and whenever all the other conditions are favorable salmonoids can be successfully raised.

To feed the young fish exclusively with meat—on account of the cheap price, it will have to be horse-flesh—has many serious disadvantages, and I would not advise any one to introduce this method of feeding in any large piscicultural establishment.

Two years ago I thought I had discovered the right method, and commenced to feed my salmonoids with herrings. The trout and saibling ravenously devoured the herrings, which had been soaked for twelve hours and then chopped fine. But soon I discovered that great caution had to be used in this method of feeding, because even the cheapest herrings are very fat and hard to digest.

As an occasional food I can recommend herrings, because at times they can be bought very cheap, and because salt herrings can be kept for years. You are therefore certain of having food all the year round.

It would be advisable to make experiments with using salt-water fish as food, because they are at certain seasons of the year cheap and to be had in great abundance.

The smelt, *e. g.*, which at times are caught in large numbers, would certainly form an excellent food for salmonoids. There are other fresh-water fish besides the *Alburnus* and *Leuciscus* which might be very ac vantageously used as food for trout; thus, *e. g.*, the crucian carp, which in North Germany is found in enormous numbers in every little pond. Such little ponds are, on account of the great fecundity of the crucian, so densely populated that these fish became absolutely worthless as an article of human food. As the crucian is a very hardy fish, and can easily be transported long distances, there is a possibility of feeding large numbers of trout with live fish.

I was therefore deeply interested in the views expressed some time ago in the Deutsche Fischerei-Zeitung, by Mr. Dallmer, superintendent of fisheries, that certain portions of his district increased their production of trout very considerably by using the crucian as an article of food. This production should be still higher in the neighborhood of large cities, such as Hamburg, Bremen, Hanover, and Berlin, because there salt-water fish can at times be bought very cheap.

As long as trout will bring \$1.20 to \$1.42 per kilogram, there is no fear that a well-arranged piscicultural establishment, well supplied with suitable food, will not pay.

The raising of salmonoids in inclosed waters is an industry which has been by far too little developed, and which most assuredly has a great future.

I shall endeavor as far as possible to give a clear idea of this industry at the coming International Fishery Exposition.

Quite young salmonoids, as well as some one and two years old, will be exhibited in inclosed waters and be fed in a rational manner.

It is my earnest hope that many new followers may be gained for this important branch of industry, to which I have given special attention for quite a number of years.

XXIV.—TREATMENT OF YOUNG SALMONOIDS AND COREGONI FROM THE TIME THEY LEAVE THE EGG TILL THEY ARE FULLY DEVELOPED AND CAN BE PLACED IN OPEN WATERS.

By Director Haack.*

[From Circular No. 1, 1880, of the Deutsche Fischerei-Verein, Berlin, February 12, 1880.]

Young salmonoids and coregoni, after having left the egg, remain in the hatching apparatus until the umbilical bag has been completely consumed, and they have thus been enabled to swim about and seek their food.

Immediately after the hatching process and for some time after it, it will be well to decrease the influx of water a little, because otherwise the weak and helpless little fish are pressed against the grate and are injured. Gradually the influx of water may be increased in the place where the salmonoids are kept, and after a few weeks have elapsed it can scarcely be strong enough, for the fish have then become so strong that they can easily resist the current.

For the tender coregoni, however, the influx of water must never be very strong, if losses are to be avoided. Nor can the exit-grate ever be too fine for these little fish. The exit-grate should be carefully fixed with putty all round the edges (common putty will do), for even the smallest opening may become a door of escape to these diminutive and scarcely visible fish.

Some time after being hatched the young salmonoids lie perfectly helpless at the bottom of the hatching apparatus, only their pectoral fins are in constant motion to admit fresh water to the gills. From time to time such a young salmon or trout rises to the surface and paddles about with considerable difficulty, but only to sink again immediately to the bottom.

The young coregoni, however, immediately after being hatched, swim about quite lively. Scarcely anything is visible of this little fish except the head with the two large eyes; the body, thin as a thread and transparent as water, can only be seen by a very close observer.

During the early stages of their existence young salmonoids generally

* Herr Director Haack: "*Behandlung der ausgeshlüpften jungen Salmoniden und Coregonen bis zu ihrer völligen Entwickeung und das Aussetzen derselben.*" [Translated by Herman Jacobson.]

keep very close together, and sometimes they even gather into such a dense heap that the lower ones are squeezed to death.

In old-fashioned hatching apparatus, therefore, such gatherings of the fish should, as much as possible, be prevented by moving the boards of the lid and by changing the current of water. In the California and Wilmot apparatus there is no danger of fish squeezing each other to death, because the rising current of water makes such a gathering of the fish impossible. For this reason alone apparatus with a rising current is to be decidedly preferred.

During the whole umbilical period the whole work of the pisciculturist consists in constantly renewing the water and in removing any dead or dying fish. In the California apparatus the inside boards can be moved up and down from time to time, and thus any dirt gathered in the grates can be removed.

If the water is pure, and the young fish are strong and healthy, a single man can superintend several millions of young fish during the umbilical period.

The umbilical bag grows smaller every day, and the little being, which at first did not at all resemble a fish, gradually assumes the shape of a fish. The body, in the beginning only a thin thread, grows thicker every day; the fins grow stronger; the color, at first only a monotonous pink, white, or orange, becomes more directly marked; dark cross-streaks and reddish dots begin to appear, and the inner organs gradually develop more and more. Finally the young fish is completely formed; it no longer rests quietly at the bottom, but rises to the surface and meets the current; it begins to snap after little particles floating about in the water by making a pushing motion. The little fish hereby shows its desire for food, and now is the most suitable time to place the fish in open waters, or, at any rate, in larger boxes or tanks. This, in most cases, finishes the work of the pisciculturist.

There has been a good deal of dispute as to where it would be most advantageous to place the fish after they have been hatched, and even at this day opinions differ greatly on this point. As a general rule I consider it best to place the young fish in open waters immediately after the umbilical bag has disappeared, or, better still, shortly before it disappears. My reason for this is simply this, that in a large piscicultural establishment it is utterly impossible to feed and raise the young fish in accordance with the dictates of nature. By giving artificial food, either ground brains, chopped meat, liver, blood, &c., the fish are easily tamed. They forget—or rather they never learn—to seize their food, which naturally consists of living animals. In the narrow tanks the young fish never learn to know their enemies, and consequently are not able to escape the manifold dangers threatening them in open waters.

Other experienced pisciculturists maintain that it is far more advantageous to keep the fish, if possible, for a whole year in inclosed waters, and thus to let them outgrow the majority of their enemies.

The adherents of this method base their views on the experience of many years. They say that when they placed the young fish in open waters immediately after the disappearance of the umbilical bag, their stock of fish was not perceptibly increased, while upon one-year-old fish being placed in open waters the stock increased rapidly.

Many readers will doubtless wonder how, in the face of such observations, I can advise to place the fish in open waters when quite young.

I must reply, in the first place, that I said "I advised it as a general rule," and in spite of the above-mentioned experience, which I by no means doubt, I feel constrained to abide by this view.

"As a general rule," it is certainly best to place the young fish in open waters immediately after the umbilical bag has disappeared.

The increase of our migratory fish, especially of the salmon kind, is justly considered by our most prominent pisciculturists as the main object of rational pisciculture, and for this object governments have granted subsidies.

Where there is a question of repopulating large streams and their tributaries, a few thousand fish are of no avail, but millions must be placed in the rivers. But who could raise artificially even a single million of salmon in narrow inclosed waters?

A well-fed young salmon or trout (the latter grows a little faster) can weigh as much as 30 to 35 grammes in a year's time. A million of such fish therefore represent a weight of 300 to 350 kilograms, valued at $48,000 to $57,600. If a sum like this could be made so easily our country would swarm with piscicultural millionaires.

Even if my calculation only includes really well-fed, one-year-old salmon or trout (and it is based on exact weighings) the management of one million of fish, even if they are not all well-fed, involves such enormous weights and values that any one can see the impossibility of carrying on pisciculture in this manner on any very large scale. And then we do not even take into account epidemics which will always occur among large masses of fish.

We shall most decidedly reach far more satisfactory results if annually at a trifling expense we place several millions of young, strong, and healthy salmonoids (but only such) in open waters immediately after the umbilical bag has disappeared, and there let these little fish fight their own battle for existence. Success will and must crown such efforts.

If most fishermen and many pisciculturists entertain very little hope for the future of fish which have been placed in open waters at so early an age, this must simply be ascribed to the very generally entertained idea that such young fish are simply food for larger fish, an opinion based on the idea that a little fish hatched in a hatching-apparatus is an entirely different being from a fish hatched in the open water.

Unfortunately this idea is not altogether erroneous; for by far too many "artificial" young fish have been placed in the open waters. We have been altogether too "artificial"; our whole system of pisciculture has been too "artificial."

The chief mistake which we have made in all our piscicultural efforts is this: that we have principally used the convenient, pure, and clear spring water in our hatching apparatus.

It is true that a piscicultural establishment using only such clear spring water presents a very pretty appearance. The eggs lie in water transparent as crystal; they can be distinctly seen at all times; the water is never muddy; no sediment ever disfigures the eggs. Altogether such a piscicultural establishment is a thing of beauty.

The pisciculturist can tell you accurately that on the twenty-fourth or twenty-fifth day the eye-dots become visible in the egg; he can calculate almost to the minute when the first young fish will be hatched; he even knows, when he places the impregnated eggs in the water, when the young fish will have lost their umbilical bag and when the apparatus will be ready to receive other eggs. Such a hatching apparatus, furnished with clear spring water, is very convenient indeed, if it has an even temperature of + 7 to 8° Réaumur.

The poor pisciculturist, however, who has to work with brook water, often has to wait one hundred days instead of twenty-three or twenty-four, before he can see the first eye-dots in his eggs; then many, many days have to elapse until the young fish are hatched and have lost their umbilical bag. How often does it happen moreover, that the most carefully arranged filtering apparatus does not make the water quite clear. In the muddy water the eggs and young fish are frequently not to be seen! and then the endless time till the hatching process is finished!

Whilst the whole development of the embryo can be finished in six weeks in the beautiful clear spring water having a temperature of 8° Réaumur, it often takes six months in the cold, muddy, and ugly-looking river water!

Who would not under these circumstances prefer the beautiful spring water?

And still!

The spawning season of the trout and salmon commences about the end of October and lasts till the middle of November. The pisciculturist who works with spring water must therefore place his young fish in the water towards New Year, whilst he who works with river water cannot do this till the end of April or the middle of May.

Which of the two is to be preferred under these circumstances?

The first food of the young salmonoids, and probably of most fish, are small crustaceans (*Cyclops*, *Daphnia*, &c.). Most of these diminutive animals, which fill the water in enormous quantities, had in autumn cared for the propagation of their race by laying winter eggs. They then bid adieu to this hard world and died. They departed this life with the consoling hope that the life-bringing sun of spring would from the eggs laid in the mud, where they would peacefully rest all winter, produce lively little animals like themselves, and that these animals would either produce live offspring or lay summer eggs, and thus soon again fill the water with milliards of young crustaceans.

Young salmon or trout placed in the water at the coldest season of the year—towards Christmas or New Year, or even four to five weeks later—find the water almost empty of animal life. Only a few stragglers of the more hardy *Cyclops* kind are still swimming about. Otherwise, everything is dead. The young salmon or trout therefore seek for food in vain. Days will pass before they can catch a single crustacean; they grow weak and miserable, and become an easy prey to their numerous enemies.

These young salmon and trout, however, which were placed in the water towards the end of April or middle of May, found their table already spread. Numberless swarms of different little aquatic animals filled the water, and often it would require only the opening of the mouth to obtain ample food. It is a pleasure to watch these little fish during April or May. The little stomach is filled almost to bursting, and you can almost see the fish grow. In a very short time such fish have far outstripped their poorly-fed brothers, which were placed in the water a few months sooner. The well-known farmers' rule, that if you wish to raise fine cattle you must give the animals good strong food whilst they are young, applies likewise to fish.

Only he who having eyes to see does not wish to see can, after what has been said, advocate the spring-water theory.

Fish hatched in spring water having a temperature of 7 to 8° Réaumur are in nowise fit to be placed in open water. Such *artificially* hatched fish can only be raised in inclosed waters by *artificial* feeding.

In nature a trout will, as a general rule, never go close up to the spring for the purpose of spawning; and whenever it is done, the quantity of water is so small that its temperature is altogether influenced by the temperature of the air.

In some rivers which are "rivers" almost from their springs, and where consequently the temperature of the water cannot be much influenced by that of the air, the trout will not spawn till March. This is, *e. g.*, the case in the river Blane, near Blaubeuren, in Würtemberg. The salmon almost exclusively spawn in the open river, where for months the temperature of the water is almost zero (Réaumur).

I therefore say, if so-called artificial pisciculture can so far not boast of any great results, the sole cause must be found in the very generally employed method of hatching in spring water.

If pisciculturists, therefore, in spite of having placed young fish in open waters year after year, have not been able to see any increase in their stock of fish, a searching investigation will invariably reveal the fact that "artificial" pisciculture, in the truest sense of the word, has been the cause; in other words, that young fish hatched in warm spring water, effeminate beings, had been placed in the open water.

A fish hatched in cold water in a hatching apparatus differs in nowise from a fish naturally hatched in the open water. Just as little as *all* the naturally hatched fish are destroyed by their enemies, just as little will this be the case with artificially hatched fish.

The artificially-hatched chicken does by no means present a parallel case, for even a fish born in the open water does not enjoy a mother's tender care.

The pisciculturist has done enough by protecting the eggs and those young fish which still have an umbilical bag against their enemies. Fish that are able to swim about must protect themselves and fight their own battle for existence.

I consider it already as an immense gain if of the young fish placed in open waters only 10 per cent. grow up to be fit for human food. In nature scarcely 1 per cent. of the eggs laid develop into mature fish; for even 1 per cent. would in a short time fill our rivers to overflowing.

It would, however, be too rash a conclusion if we were to maintain that the only right way in all cases would be to place the young fish in open waters at a very early age. I therefore repeat what I said before, "I recommend it as a *general* rule."

As far as our European salmonoids and the more common kinds of *Coregonus* are concerned—of whose eggs it is easy to obtain many millions—it is decidedly best to place them in the open water immediately after the umbilical bag has disappeared.

In the case of fish, however, of whose eggs only a few thousand can be obtained, *e. g.*, the American *Salmo fontinalis* and *Coregonus marœna*, it would be decidedly wrong not to let these valuable fish enjoy further care. In this case it becomes a duty to put off the fight for existence as far as possible, and not to place them in open waters until they have outgrown most of their enemies.

But even here it will be preferable to raise the young fish strictly in accordance with the dictates of nature. Fish which are to be placed in open waters should, therefore, not be confined in too narrow receptacles and be fed in too artificial a manner, but in ponds carefully cleared of all enemies and fully secured against intruders by grates. Fish which are to be raised for the open water are not intended to be tamed.

Thus, *e. g.*, the Madui-marœnes flourishes in ponds one to two meters deep, fed with spring water, without introducing any artificial food. The number of fish should, of course, be in due proportion to the size of the pond. In such ponds the marœnes may be kept one or two years and then placed in a lake.

Also, regarding the saibling, I rather incline to the opinion that it is better not to place this fish in open water until it is one to two years old.

The saibling has the peculiarity of living (with the sole exception of the spawning-season) at a very great depth. It has, therefore, never learned to know its enemies, and has never learned to fight for its own existence.

So far, at least, it has been my experience that saibling which were placed in the water at the same time with trout of an equal size were rarely caught again, although these fish, if alone in the same water, continued to flourish.

Wherever, therefore, it is not possible to place in lakes which already contain saibling several hundreds of thousands of these fish, I would advise not to place them in the open water until they have reached the age of one to two years. The same may be done by a pisciculturist who can only operate with 1,000 to 2,000 trout-eggs, provided that he has a chance to raise his trout for one to two years, according to the dictates of nature, in inclosed but tolerably large waters.

It is not advisable to place in open waters trout which one to two years have been fed on brain, meat, &c., in narrow inclosed waters. Such fish must be raised to the age of maturity in inclosed waters.

Where are the young fish to be placed? Young fish which are able to swim had therefore best be placed in locations which naturally-born fish would prefer. For trout and salmon this would be a place in a brook containing a good many stones and aquatic plants. It does not matter if the current is pretty lively if it only does not become a rapid or waterfall.

The young trout and salmon will here soon find suitable hiding-places among the stones and aquatic plants, and it will not be long before they begin to hunt for little aquatic animals. It need scarcely be mentioned that it is best to distribute the fish over as large a space as possible.

It will hardly be possible to select a place for the restless coregoni. Care should only be taken that these tender young fish are not placed in bays of lakes, in ports, &c., because the numerous cyprinids generally gathered in such places might mistake the little coregoni for small worms, and therefore devour them.

It is therefore advisable to place the young coregoni in the middle of the lake and let them select the most suitable dwelling-places.

I would, finally, ask all pisciculturists, beginners as well as those possessing much experience, to examine carefully all I have said. I feel convinced that, after a careful and conscientious examination, every thinking pisciculturist will abandon the injurious spring-water theory and adopt the less convenient but more natural method of hatching the fish in brook-water.

XXV.—REPORT OF OPERATIONS AT THE UNITED STATES SALMON-BREEDING STATION ON THE McCLOUD RIVER, CALIFORNIA, DURING THE SEASON OF 1879.

By Livingston Stone.

Hon. Spencer F. Baird,

Sir: I beg leave to report as follows: The general features of the season's operations in taking salmon eggs were the same as reported in previous years with the one exception, that two racks were placed across the McCloud River this season instead of one, as heretofore. The upper rack is intended to obstruct the course of the salmon up the river, and to detain them at the fishery, where they can be caught for the purpose of securing their eggs. This plan of detaining the spawning fish at a favorable point for capture, by placing an impassable barrier in the river, was first adopted in 1874, and has proved itself a great success. The annual yield of salmon eggs increased the first year it was tried from two million to five million and a half, and was secured with far less labor than ever before. From that time to this, also, it has enabled the United States Fish Commission to obtain all the eggs it required to supply both this country and foreign countries, the quantity culminating last year in a total number of fourteen millions.*

This obstructing the salmon by an impassable rack really amounts to the same as confining them in pens, except that it is on a larger scale. As the rack prevents them from going up the river, and their irrepressible instinct to ascend the river keeps them from going down, they become confined on a large scale under the most favorable conditions possible. Their native river is their prison. All their surroundings are favorable, natural, and healthful. They have the whole volume of the river for their water supply, and in every way it is the most desirable form of confinement possible; nothing better could be wished. The great advantage of this method of confinement showed itself as soon as it was tried in the vastly-improved condition of the salmon. While before hundreds of the spawning salmon died in the artificial

* Note.—The total number reported in 1878 was twelve millions, this being the number, according to measure; but, the eggs that year being smaller than usual, the actual number, according to count, must have exceeded fourteen millions.

ponds and corrals in which they were placed, now none whatever die, or appear even to suffer, from the effects of their confinement.

Some people have ridiculously supposed that placing an obstruction across the river would do mischief, by setting an example to lawless persons, who would be tempted to do the same elsewhere. The utter folly of such a supposition is at once apparent to any one who knows anything about the matter, and I consequently do not need to say anything further on the subject.

Besides this upper rack to detain the salmon, a second rack, reaching nearly but not quite to the bottom, was put across the river just below the fishing-ground. The object of this second rack was to prevent the salmon from falling below the fishing-ground during the fishing season, for, although the instinct of the salmon is so strong to ascend the river, they will, nevertheless, when they find they cannot pass the upper rack and are being constantly harassed by the drawing of the seine, fall back down the river far enough to get out of reach of the net. Here they will remain, unless driven off, and deposit their spawn. From this source of trouble our fishing operations have suffered every year, and this year I thought I would try the experiment of putting the additional rack, just mentioned below the seining-ground, to see if it would not prevent the fish in some degree from dropping down the river out of reach of the net. The rack, not reaching the bed of the stream by eight or ten inches, is no obstruction to the ascending salmon, as they swim very low, but does obstruct the salmon above the dam from going down the river, as they swim higher and do not hunt so diligently for a passage for escape in that direction. The practical workings of this second rack did not, however, meet our expectations, and I would not recommend its use again.

The work of building the first bridge and rack began in May, and on the 10th of July the river was entirely closed to the salmon. The second bridge was then built, but the rack connected with it was not lowered into the river until the 1st of September. The upper rack was no sooner completed than the salmon began to accumulate as usual in great numbers below it. There were large patches where the river was black with them. Thousands could be seen from the high banks on either side of the river. They assaulted the rack by hundreds, and so many could be seen jumping at once that they could not be accurately counted. They seemed to be so innumerable that high hopes were cherished of an unusually successful season, but when we came to make a trial haul of the net we found how illusive the most flattering hopes may prove to be. All this immense accumulation of fish in the river turned out, with very few exceptions, to be young male salmon, or, as they are commonly called, grilse. This discovery occasioned no little dismay and alarm.

Day after day we hauled the net, from the middle of July to the middle of August, but with the same result. There appeared to be nothing but small grilse in the river. We caught them by thousands—young male salmon weighing from two to six pounds—while the female salmon were so scarce that they did not average more than one to every fifty fish caught. We tried to get rid of the grilse. We gave hundreds to the Indians. We let thousands go up the river through the bridge, but still they did not materially diminish, nor did the number of females increase. The river seemed to be full of grilse and nothing else. I think the most plausible explanation of this excessive disproportion of the two sexes in the river is as follows: The canneries on the main Sacramento were running at their fullest capacity all summer, having a vast number of drift-nets in the river nearly all the time. It is quite possible that some of them fished with small-meshed nets. This would account for the fact that no large fish reached the McCloud. The great increase of salmon in the Sacramento, occasioned by artificial hatching, accounts for the other part of the mystery, viz, the immense number of grilse.

The law prohibiting the capture of salmon in nets comes into force on the 1st day of August. Consequently, the course of the salmon up the Sacramento was unobstructed by nets after that day, and about two weeks later large salmon began to appear in the McCloud, and from that time they continued to increase, so that by the 1st of September we occasionally caught as many large salmon as small ones, and of the large ones one-half or more were frequently females.

As the season progressed another peculiarity developed itself. After a few days of taking eggs, the spawning season, contrary to all our previous experience, seemed to remain at a standstill; in other words, the number and proportion of ripe spawners did not increase with the progress of the season as usual. For instance, on the 6th of September, when the McCloud salmon had nearly finished spawning in 1876, the ratio of unripe females to the ripe ones was greater than it was a week before, and, judging from the unadvanced condition of the females on that day, one would have said that the spawning season had just commenced, instead of having been in progress nearly a fortnight. No explanation of this peculiarity has yet presented itself.

By the 20th of August the corrals for holding the spawning salmon were put in the river, the spawning-house was built, all the trays and covers and troughs of both hatching-houses were put in order, and everything placed in readiness for taking eggs.

It had been my expectation to take a very large number of salmon eggs this year. Indeed, I hoped to eclipse all previous years, and was going on with that expectation till I received your telegram stating that not over six million eggs would be required. On receiving this dispatch I reduced my force to the lowest number possible to carry on operations. and with this number I continued work until the eggs were all taken and shipped.

We took the first salmon eggs on the 25th of August, and on the 8th of September the quota for California was filled. I set aside for the State this year 2,300,000 eggs. The State receives this allotment in the form of eggs and hatches the eggs at the State's expense, placing the newly-hatched salmon in the tributaries of the main Sacramento to keep up the stock of that river.

It may not be out of place to add here that since the artificial hatching has been carried on at this place the salmon in the Sacramento have immensely increased; so much so that, although the canneries have increased and the sea-lions and the fishermen also, the salmon have, nevertheless, made a steady gain in numbers; or, to use the words of Hon. B. B. Redding, the secretary of the California fish commission, "the commission has, with the aid of the artificial hatching of salmon, beaten the sea-lions, the canneries, and the fishermen combined."

After all the eggs are taken for the State, the next thing is to take eggs for the ice-car which conveys the eastern consignments from Redding, Cal., to Chicago, Ill. In order to fill this car and not to be obliged to use eggs that are too far advanced nor those which are not sufficiently advanced, it is necessary to take them within a limited number of days, otherwise one of the two evils just mentioned must be encountered, and either one would be fatal to the successful transportation of the eggs across the continent. In order to facilitate this, we rested from taking eggs on the 9th of September, and on the 10th we began taking for the car-load. On the night of the 17th of September we had six million eggs in the large hatching-house. The eggs in the large hatching-house mature in about nineteen days. Besides the main hatching-house there is a smaller one, where the water supply is so much warmer that the eggs mature in eleven days, or a week earlier than in the other house. On the 18th of September, therefore, we stopped taking eggs again, and recommenced taking from the supplementary hatching-house on the 21st and continued till the night of the 24th. These eggs, maturing about the same time as the main lot, furnished sufficient of the right age for shipment in the ice-car, and gave us a total in round numbers of seven million eggs.

MATURING AND PACKING THE EGGS.

Nothing new was introduced this year into the usual method of hatching the eggs, though somewhat more care was exercised in taking the eggs, which resulted in a better impregnation and a consequently smaller loss in bringing the eggs forward for shipment.

The packing of the eggs was also conducted as usual. Last year and the year before some apprehension was felt lest the supply of packing moss, which is only found in one locality, near Mount Shasta, might in time be exhausted. Our apprehensions were entirely put at rest this year by finding that a new growth had come on where we first gathered the moss seven years ago, which shows that it is growing as fast as it is being gathered, and consequently will be inexhaustible if the supply is not drawn on any faster in the future than it has been during the eight seasons that we have used it. The ice-car was employed as usual to convey the eggs from Redding to Chicago. The entire space not taken up by the crates of eggs was filled full of ice and all the eggs, with possibly the exception of one crate, arrived at Chicago in first rate condition. From here the more northern consignments were distributed by the express companies, while the southern eggs were shipped into a regular refrigerator car and forwarded to Washington, whence they were sent by express to their destinations.

YOUNG SALMON FOR THE SACRAMENTO.

Two and one-half millions of eggs for California were left at the fishery, where they were hatched out at the expense of the California Fish Commission and the young fish placed in the tributaries of the Sacramento.

THE INDIANS.

It will be remembered, perhaps, that last year a good deal of uneasiness was caused at the fishery and in the neighboring settlements by the threatened attitude of some of the Indians to the north and east of the McCloud River. Nothing was apprehended from the Indians in the immediate vicinity of the fishery; but there were others at no great distance from us who were inciting their companions to make an outbreak, and we heard of frequent threats of mischief being made by the northern and eastern Indians, and by some restless spirits nearer home; and although the actual danger of an attack might have been very slight, it was perfectly apparent that the hostility to the whites, which then extended from the Sierra Nevada range to the Missouri River, had reached the McCloud, and that many Indians not far from us had caught the infection. All this was entirely changed this year. It could be seen in the faces of the Indians. The universal uprising of all the Indians between the Sierras and the Missouri, which had been so long contemplated, and which was to have culminated in July, 1878, having been checked by the vigilance of the War Department, the project seems to have been given up for the present, and the effect of it was felt even at this distance. The Indians who advocated an uprising last year were silent on the subject this year, and the air of insolence among the more lawless ones last season had entirely disappeared this season. Indeed, the Indians were never better behaved or more manageable than they were this year; and it is only justice to them to say that much of the success of our work here is due to their assistance. A large number (between twenty and thirty) of them are employed at the fishery every year, and they are very efficient and valuable assistants, particularly in handling the fish, drawing the seine, picking over the eggs, and similar work. If we could not have the Indians to help us, it would be very difficult to supply their place.

THE PRESENCE OF SOLDIERS AT THE FISHERY.

We pass naturally from the Indians to the soldiers, although this year the soldiers were not needed to protect us from the Indians. They were, however, needed, and, indeed, a military guard is needed here every year on general principles. It is not so much what the soldiers do when they are here that makes them valuable, as it is their presence on the premises.

Their mere presence is a great help, because it prevents trespasses from being committed, and, on the principle that a remedy that prevents disease is worth more than the remedy which cures the disease, it is an excellent thing to have soldiers on the reservation. For instance, it was habitual with the Indians to kill the spawning salmon before the soldiers arrived, and not only this, but a corner post of the reservation was twice torn up this spring by white men and thrown away. An Indian's horse was shot on the reservation, and one settler drew a shotgun on another in a quarrel, which might have terminated fatally. A settler also attempted to build a fence within the reservation, and the timber on the reservation was cut indiscriminately by outsiders before the soldiers came. Nothing of this sort has occurred since the arrival of the military guard, and would never have happened at all had the guard been here at the time these trespasses were committed.

I take this opportunity to acknowledge the courtesy of General McDowell in sending the guard to the Fishery Reservation immediately upon my application for it.

Allow me to say in this connection that the Fishery Reservation ought to be extended at the earliest possible moment. Settlers are beginning to come to the McCloud River. They take up a claim, burn the Indian rancheries, shoot their horses, plow up their graveyards, and drive the Indians back into the hills, the ultimate result of which must be approximate starvation.

Besides this, miners may at any time roil the river above the fiishery by their mining operations, and thus ruin almost the last and only spawning-ground of the Sacramento salmon. Fishermen may come in with their nets below the fishery, and by capturing the spawning salmon wholly destroy the usefulness of the United States salmon-hatching station at this place.

These considerations make it highly desirable that the reservation be extended at least far enough up the river to include the trout-breeding station, which has just been established four miles above the salmon fishery.

In closing I beg to recommend that scientific investigations be carried on at the McCloud River in connection with the regular fishery work.

Owing to the long-standing hostility of the Indians in this neighborhood, and for various reasons, very little scientific work has ever been done here, and almost every naturalist who visits this region finds something new to science. This circumstance, added to the fact that it is a very interesting region generally, from a scientific point of view, makes it very desirable that in future scientific investigations be connected with the regular work of the United States Fish Commission at this point.

LIVINGSTON STONE.

Table of temperatures taken at the United States salmon-breeding station, McCloud River, California, during the season of 1879.

Date.	Air.				Water.			Wind.	Lowest night temperature.	Weather.
	Shade.			Sun.						
	7 a. m.	3 p. m.	7 p. m.	3 p. m.	7 a. m.	3 p. m.	7 p. m.			
	°	°	°	°	°	°	°		°	
July 4	59	79	66	93	55	59	56	S.	50	Clear.
5	57	86	70	112	54	58	56	W.	56	Do.
6	62	90	68	122	54	58	57	SE.	46	Do.
7	50	86	67	112	54	58	58	SE.	45	Do.
8	58	84	74	112	54	59	57	S.	45	Do.
9	58	87	68	113	54	59	58	E.	46	Do.
10	59	88	82	112	55	59	59	NE.	52	Rain.
11	60	70	65	....	56	58	55	S.	51	Clear.
12	60	83	70	110	55	58	58	SE.	53	Do.
13	64	82	65	110	56	60	58	SW.	58	Do.
14	58	87	70	110	56	60	58	E.	50	Do.
15	57	90	75	120	56	60	60	W.	51	Do.
16	64	96	83	132	56	62	61	E.	50	Do.
17	62	98	80	128	56	60	60	SE.	53	Do.
18	62	96	80	112	56	62	61	W.	54	Do.
19	58	89	79	110	56	60	60	S.	53	Do.
20	57	89	72	116	56	60	60	SE.	52	Do.
21	58	90	58	120	58	60	60	S.	50	Do.
22	60	97	58	126	58	61	60	W.	51	Do.
23	58	98	59	128	58	62	60	S.	59	Do.
24	53	101	61	132	58	62	61	W.	51	Do.
25	54	98	65	130	59	62	60	S.	50	Do.
26	60	106	80	140	58	62	60	SE.	50	Do.
27	60	107	83	140	59	62	61	SW.	50	Do.
28	64	98	80	128	60	62	61	SE.	58	Do.
29	60	100	82	130	58	62	61	SW.	54	Do.
30	62	100	83	130	58	62	61	SE.	55	Do.
31	60	102	82	131	58	62	61	NE.	56	Do.
Aug. 1	72	103	80	134	58	62	60	N.	56	Do.
2	74	103	75	136	56	62	69	N.	52	Do.
3	56	99	77	120	56	62	61	NE.	53	Do.
4	50	97	77	119	56	62	61	SE.	52	Do.
5	48	97	74	128	55	61	61	SE.	53	Do.
6	54	100	74	128	56	60	60	E.	46	Do.
7	58	100	82	130	56	60	61	SE.	51	Do.
8	58	102	86	130	56	60	61	SE.	54	Do.
9	65	103	72	132	56	60	61	S.	55	Do.
10	60	103	74	130	56	60	61	E.	57	Do.
11	57	100	74	128	56	62	61	S.	55	Smoky.
12	56	102	74	128	56	62	61	S.	55	Clear.
13	52	102	73	124	55	60	61	S.	49	Do.
14	52	102	72	124	55	60	61	W.	48	Do.
15	64	103	80	134	56	59	59	NE.	47	Do.
16	62	94	74	120	56	59	59	W.	50	Do.
17	62	97	73	124	56	59	59	W.	59	Do.
18	59	94	74	120	56	59	59	W.	55	Do.
19	58	89	74	118	56	59	58	SW.	55	Do.
20	54	88	73	114	56	59	58	SW.	50	Do.
21	56	62	74	....	56	59	59	S.	50	Rain.

Table of temperatures taken at the United States salmon-breeding station, &c.—Continued.

Date.	Air.				Water.			Wind.	Lowest night temperature.	Weather.
	Shade.			Sun.						
	7 a. m.	3 p. m.	7 p. m.	3 p. m.	7 a. m.	3 p. m.	7 p. m.			
	°	°	°	°	°	°	°		°	
Aug. 22	58	80	67	112	56	59	56	....	56	Clear.
23	58	89	65	112	54	58	57	SE.	50	Do.
24	68	96	70	126	54	58	57	SW.	52	Do.
25	50	94	74	112	54	58	57	S.	47	Do.
26	49	82	76	100	54	58	56	S.	48	Do.
27	60	64	65	....	54	58	56	S.	55	Cloudy and rain.
28	48	76	62	98	54	58	55	N.	44	Clear.
29	50	80	64	98	54	57	55	N.	45	Do.
30	54	96	70	124	54	58	56	N.	50	Do.
31	50	96	68	118	53	58	56	W.	46	Do.
Sept. 1	62	94	62	116	53	58	57	W.	50	Do.
2	60	98	62	110	53	58	57	W.	52	Do.
3	54	103	69	130	53	58	56	W.	48	Do.
4	56	102	66	135	53	57	56	SW.	52	Do.
5	54	96	60	125	53	58	56	S.	54	Do.
6	53	86	64	106	53	58	55	S.	46	Cloudy.
7	52	90	62	102	53	58	55	S.	48	Clear.
8	48	85	66	94	54	58	56	S.	50	Do.
9	50	80	64	94	55	57	55	N.	46	Do.
10	48	84	66	93	54	57	56	N.	44	Do.
11	52	98	68	106	54	57	57	S.	52	Do.
12	56	95	68	104	55	57	56	S.	52	Do.
13	57	97	64	106	54	56	56	W.	53	Do.
14	53	97	68	110	54	57	56	N.	50	Do.
15	50	102	67	122	55	57	56	N.	47	Do.
16	48	102	63	123	55	57	56	E.	46	Do.
17	55	98	66	108	54	56	56	NW.	52	Do.
18	52	100	62	112	55	56	56	W.	48	Do.
19	50	100	60	110	54	57	56	W.	46	Do.
20	53	88	64	98	54	56	55	W.	48	Do.
21	53	90	64	108	54	56	55	S.	48	Do.
22	55	84	62	98	54	56	54	SW.	50	Do.
23	48	85	64	98	53	55	54	S.	43	Do.
24	48	84	66	95	54	55	55	S.	45	Do.
25	48	76	64	88	53	55	53	S.	46	Hazy.
26	57	82	64	92	52	55	54	SE.	48	Clear.
27	48	84	64	93	53	55	53	S.	46	Do.
28	63	76	62	....	52	55	53	S.	46	Cloudy.
29	56	82	56	93	51	54	53	S.	45	Clear.
30	45	63	50	....	51	54	53	S.	44	Rain.

Table of temperatures taken at the United States salmon-breeding station, McCloud River, California, during the season of 1879.

Month.	Air.				Water.			Wind.			Weather.
	Shade.			Sun.							
	7 a. m.	3 p. m.	7 p. m.	3 p. m.	7 a. m.	3 p. m.	7 p. m.	7 a. m.	3 p. m.	7 p. m.	
	°	°	°	°							
October 1	48	88	......	102	51	52	......	......	......	......	Clear.
October 2	44	......	......	......	50	......	......	......	......	......	
October 3	43	......	......	......	49	......	......	......	......	......	
October 4	42	......	......	......	51	......	......	......	......	......	
October 5	......	......	......	......	......	......	......	......	......	......	
October 6	51	......	......	......	49	......	......	......	......	......	Cloudy.
October 7	......	......	......	......	......	......	......	......	......	......	Do.
October 8	38	74	......	82	48	51	......	......	E.	......	Clear.
October 9	42	72	......	80	48	51	......	......	E.	......	Do.
October 10	42	......	......	......	48	......	52	......	E.	......	Do.
October 11	44	48	47	......	49	48	48	......	SW.	......	Cloudy.
October 12	42	52	48	......	47	49	49	......	SW.	......	Rainy and cloudy.
October 13	43	......	46	......	48	......	49	......	SW.	......	Cloudy.

Table of temperatures taken at the United States salmon-breeding station, &c.—Continued.

Month.	Air.				Water.			Wind.			Weather.
	Shade.			Sun.							
	7 a. m.	3 p. m.	7 p. m.	3 p. m.	7 a. m.	3 p. m.	7 p. m.	7 a. m.	3 p. m.	7 p. m.	
	°	°	°	°							
October 14	42	56	53	76	49	52	52	......	E.	......	Clear.
October 15	50	61	52	72	49	52	52	......	S.	......	Cloudy, a. m.; Clear, p. m.
October 16	42	68	53	90	49	51	51	......	E.	......	Clear.
October 17	38	71	......	96	48	52	......	......	......	......	Do.
October 18	40	70	55	88	48	51	51	......	......	......	Do.
October 19	42	70	50	90	48	52	52	......	......	......	Do.
October 20	46	72	56	90	49	51	51	......	SW.	......	Cloudy, a. m.; Clear, p. m.
October 21	46	78	57	100	49	51	51	......	W.	......	Do.
October 22	......	65	52	96	......	51	51	......	W.	......	Do.
October 23	......	......	52	......	......	......	50	......	W.	......	Do.
October 24	......	......	56	......	......	......	......	......	......	......	Do.
October 25	......	......	......	......	......	......	......	......	......	......	Do.
October 26	......	......	......	......	......	......	......	......	W.	......	Do.
October 27	46	80	57	120	48	51	51	......	W.	......	Do.
October 28	48	75	58	95	48	51	51	......	W.	......	Do.
October 29	40	78	54	127	48	50	50	......	W.	......	Do.
October 30	38	77	48	112	47	49	49	......	W.	......	Do.
October 31	38	65	51	95	46	50	50	......	W.	......	Do.
November 1	38	65	65	90	46	50	......	......	W.	......	Clear.
November 2	36	68	52	98	46	49	49	......	W.	......	Do.
November 3	35	61	48	......	46	48	48	......	......	......	Cloudy.
November 4	40	65	54	......	46	48	48	......	SW.	......	Do.
November 5	50	53	51	......	48	......	......	E.	S.	......	Do.
November 6	45	60	......	......	48	49	48	......	S.	......	Clear, a. m.; Cloudy, p. m.
November 7	33	53	45	......	47	48	48	......	S.	......	Cloudy.
November 8	41	46	......	......	46	46	46	......	S.	......	Rain.
November 9	41	46	......	......	46	46	46	......	E.	......	Do.
November 10	34	......	47	......	43	46	46	......	S.	......	Clear.
November 11	46	......	40	......	46	46	46	......	S.	......	Do.
November 12	46	43	42	......	46	46	46	......	S.	......	Rain.
November 13	43	45	46	......	46	46	46	......	S.	......	Do.
November 14	46	53	44	......	46	46	46	......	S.	......	Cloudy.
November 15	42	54	42	62	47	47	47	SE.	NE.	......	Cloudy, a. m.; Clear, p. m.
November 16	33	60	39	78	45	46	46	......	NE.	......	Clear.
November 17	48	72	......	85	43	45	45	......	NE.	......	Do.
November 18	36	72	41	80	43	45	45	NE.	SE.	......	Do.
November 19	30	......	43	......	43	45	45	......	NE.	......	Do.
November 20	30	......	......	......	43	......	......	......	NE.	......	Do.
November 21	28	62	40	87	43	45	45	......	NE.	......	Do.
November 22	30	62	42	105	43	45	45	......	NE.	......	Do.
November 23	28	56	41	80	43	47	47	......	NE.	......	Do.
November 24	30	60	40	92	45	47	47	......	E.	......	Do.
November 25	30	57	42	107	45	45	45	......	NE.	......	Do.
November 26	34	56	41	85	42	45	45	......	NE.	......	Do.
November 27	28	51	42	85	42	43	43	......	SE.	......	Do.
November 28	29	50	43	......	43	43	43	......	NE.	......	Cloudy.
November 29	29	50	40	......	44	44	48	......	NE.	......	Rain.
November 30	40	44	44	......	45	45	45	......	......	......	Do.

Table of distribution of salmon eggs from the United States salmon-breeding station, McCloud River, California, during the season of 1879.

State.	Commissioner.	Number asked.	Number assigned.	Number forwarded.	Destination.
Iowa	B. F. Shaw	50,000	50,000	50,000	B. F. Shaw, Anamosa, Iowa.
Kansas	D. B. Long	100,000	100,000	100,000	D. B. Long, Ellsworth, Kans.
Maryland		500,000	500,000	500,000	T. B. Ferguson, Baltimore, Md.
Minnesota	R. O. Sweeny	400,000	400,000	400,000	R. O. Sweeny, Saint Paul, Minn.
Nebraska	W. L. May	50,000	50,000	50,000	W. L. May, Frémont, Nebr.
Do		50,000	50,000	50,000	H. S. Kaley, Red Cloud, Nebr.
Do		100 000	100,000	100,000	J. G. Romaine, South Bend, Nebr.
New Jersey	E. J. Anderson	500,000	500,000	500,000	Mrs. J. H. Slack, Bloomsbury, N. J.
North Carolina	L. L. Polk	350,000	350,000	350,000	S. G. Worth, Morgantown, N. C.
Ohio	E. D. Potter	200,000	200,000	200,000	E. D. Potter, Toledo, Ohio.
Pennsylvania	James Duffy	200,000	200,000	200,000	James Duffy, Marietta, Pa.
Do	do	100,000	100,000	100,000	Seth Weeks, Corry, Erie County, Pa.
Utah	A. P. Rockwood	100,000	100,000	100,000	A. P. Rockwood, Salt Lake City, Utah.
Virginia	M. McDonald	300,000	300,000	300,000	M. McDonald, Lexington, Va.
Do		200,000	200,000	200,000	W. F. Page, Wytheville, Va.
West Virginia	H. B. Miller	150,000	150,000	150,000	C. S. White, Romney, W. Va.
Wisconsin	N. K. Fairbank	300,000	300,000	300,000	N. K. Fairbanks, Geneva Lake, Wis.
Netherlands		100,000	100,000	100,000	Zoological Society, Amsterdam.
New South Wales		50,000	50,000	50,000	J. Stuart, Merrickville, Sydney, N. S. W.
France		100,000	100,000	100,000	Acclimatation Society, Paris.
Germany		100,000	100,000	100,000	Deutsche Fischerei Verein.
Canada		100,000	100,000	100,000	S. Wilmot, Newcastle, Ontario.
New York	E. G. Blackford	50,000	50,000	50,000	E. G. Blackford, New York, N. Y.

Table of salmon eggs taken at the United States salmon-breeding station, McCloud River, California, during the season of 1879.

Date.	Number of eggs taken.	Total number of eggs taken.	Number of salmon spawned.	Total number of salmon spawned.
Aug. 24	3,850		2	
27	9,900	13,750	3	5
29	61,050	74,800	15	20
30	90,750	165,550	19	39
Sept. 1	155,100	320,650	38	77
2	261,800	582,450	60	137
3	270,600	853,050	61	198
4	367,400	1,220,450	75	273
5	382,800	1,603,250	92	365
6	260,700	1,863,950	60	425
7	318,450	2,182,400	71	496
8	409,200	2,591,600	92	588
10	882,200	3,473,800	223	811
11	239,250	3,713,050	56	867
12	519,750	4,232,800	95	962
13	313,500	4,546,300	87	1,049
14	242,550	4,788,850	56	1,105
15	429,000	5,217,850	75	1,180
16	462,000	5,679,850	115	1,295
17	363,000	6,042,850	100	1,395
21	462,000	6,504,850	115	1,510
22	198,000	6,702,850	57	1,567
23	104,500	6,806,850	27	1,594
24	82,500	6,889,350	26	1,620

Table of weights of female salmon after spawning, McCloud River, California, 1879.

	Total number of fish.	Total weight.	Average weight.
August 30.—Weight (pounds), 14, 13, 14, 12, 15, 10, 10, 10, 15, 9, 9, 13, 10, 12, 8, 15, 9, 8, 7	19	213	11.21
September 1.—Weight (pounds), 13, 16, 8, 15, 17, 9, 9, 9, 6, 8, 8, 12, 10, 10, 11, 16, 8, 12, 8, 16, 10, 11, 14, 8, 8, 16, 12, 7, 10, 13, 10, 10, 8, 10, 9, 8, 10, 10	38	405	10.65
September 2.—Weight (pounds), 12, 11, 9, 11, 9, 9, 8, 12, 12, 7, 8, 11, 11. 11, 11, 8, 13, 14, 9, 6, 8, 15, 14, 9, 8, 14, 7, 9, 14, 10, 8, 9, 12, 11, 13, 11, 9, 14, 10, 14, 15, 8, 12, 17, 12, 11, 5, 12, 13, 10, 10, 11, 15, 12, 15, 13, 12, 8, 16, 7	60	655	10.9
September 3.—Weight (pounds), 13, 7, 15, 10, 13, 10, 12, 12, 11, 11, 10, 15, 11, 10, 8, 12, 13, 15, 16, 16, 12, 15, 8, 17, 10, 14, 9, 10, 14, 17, 14, 17, 6, 16, 9, 13, 14, 8, 10, 17, 11, 13, 8, 13, 11, 11, 7, 12, 10, 16, 14, 10, 16, 14, 8, 9, 8, 10, 8, 15. 14, 11, 10, 9, 16, 15, 18, 14, 13, 10, 12, 8, 13, 10, 7	75	896	11.99
September 4.—Weight (pounds), 15, 7, 14, 10, 11, 11, 12, 12, 11, 7, 12, 11, 8, 11, 13, 14, 13, 15, 10, 8, 7, 6, 15, 9, 8, 16, 6, 8, 12, 14, 12, 17, 8, 14, 12, 12, 15, 14, 13, 9, 12, 10, 12, 13, 16, 14, 13, 14, 10, 16, 8, 14, 8, 11, 8, 8, 8, 7, 8, 8, 8	60	668	10.95
September 5.—Weight (pounds), 16, 9, 16, 12, 16, 16, 16, 16, 12, 13, 7, 10, 12, 6, 8, 7, 15, 11, 15, 12, 9, 12, 11, 10, 7, 21, 10. 14, 15, 9, 14, 12, 13, 10, 17, 8, 8, 9, 12, 11, 14, 9, 11, 6, 11, 11, 12, 8, 12, 13, 10, 11, 6, 9, 7, 13, 9, 9, 9, 7, 7, 7, 9, 8, 14, 8, 15, 10, 8, 8, 8, 13, 10, 13, 10, 8, 8, 11, 12, 8, 7, 8, 7, 8, 17, 11, 13, 9, 15, 12, 11, 8	92	991	10.37
September 6.—Weight (pounds), 9, 10, 13, 9, 16, 14, 6, 12, 12, 5, 12, 18, 12, 14, 7, 11, 14, 9, 10, 8, 14, 12, 8, 11, 11, 13, 9, 13, 12, 12, 13, 15, 15, 12, 8, 12, 11, 15, 8, 12, 10, 11, 8, 9, 11, 14, 8, 7, 13, 9, 9, 9, 9, 9, 9, 10, 9, 12, 8, 8	60	662	11.03
September 7.—Weight (pounds), 12, 17, 13, 11, 10, 14, 7, 11, 15, 8, 15, 7, 8, 12, 12, 16, 8, 12, 14, 11, 10, 14, 13, 14, 11, 14, 10, 8, 10, 10, 13, 10, 16, 14, 18, 10, 11, 13, 9, 12, 10, 11, 8, 6, 12, 9, 15, 9, 12, 10, 10, 9, 12, 7, 11, 8, 9, 9, 8, 8, 8, 9, 14, 9, 17, 10, 12, 11, 8, 12, 12	71	796	11.21
September 8.—Weight (pounds), 12, 9, 10, 13, 10, 8, 15, 10, 12, 9, 8, 16, 10, 16, 9, 14, 14, 10, 12, 11, 11, 17, 10, 6, 8, 7, 10, 13, 8, 10, 17, 15, 14, 14, 9, 8, 8, 8, 5, 14, 8, 14, 10, 12, 13, 16, 12, 15, 13, 11, 12, 8, 16, 14, 13, 8, 10, 13, 10, 11, 11, 14, 14, 10, 8, 8, 10, 11, 16, 15, 11, 12, 15, 7, 7, 7, 8, 6, 9, 14, 8, 9, 16, 10, 8, 8, 12, 8, 14, 9, 14	92	1,020	11.08

Record of seining operations conducted at United States fishery, Baird, Cal., on the McCloud River, from July 22 to September 22, 1879, on account of United States, by Livingston Stone.

Date.	Hour.	Temperature of air.	Condition of—		Fish taken.		Ripe fish, females.
			Sky.	Water.	Males.	Females.	
		°					
July 22	7.30 p. m.	70	Clear.	Clear.	300	2	
24	7.35 p. m.	70	...do	...do	500	8	
26	7.30 p. m.	72	...do	...do	450	25	
30	7.40 p. m.	75	...do	...do	1,000	6	
Aug. 1	7.00 p. m.	80	...do	...do	400	5	
4	7.30 p. m.	75	...do	...do	700	11	
7	7.15 p. m.	82	...do	...do	220	7	
8	7.30 p. m.	74		...do	100	7	
11	7.45 p. m.	70			500	32	
12	1.15 p. m.	100	Clear.	Clear.	200	7	
12	7.45 p. m.	71	...do	...do	1,000	20	
16	7.00 p. m.	74	...do	...do	200	5	
17	7.00 a. m.	62	...do	...do	100		
17	7.30 p. m.	73	...do	...do	250	61	
19	7.00 p. m.	74	...do		300	61	
22	7.00 p. m.	67			250	26	1
24	7.15 p. m.				200	60	4

Record of seining operations conducted at Baird, Cal., on the McCloud River, from August 25 to September 4, 1879, on account of United States, by Livingston Stone et al.

Date.	Hour.	Temperature of air.	Fish taken.		Ripe fish, females.
			Males.	Females.	
		°			
Aug. 25	7.00 p. m.	67	180	65	4
27	7.15 p. m.	65	130	23	7
28	7.00 p. m.	....	150	150	12
29	7.15 a. m.	....	95	100	10
31	7.00 p. m.	68	100	29	7
31	7.10 p. m.	67	200	59	9
31	7.45 p. m.	64	200	44	4
31	7.50 p. m.	64	300	49	9
31	9.30 p. m.	62	200	56	6
31	9.40 p. m.	62	300	55	5
31	12.00 p. m.	57	100	23	3
Sept. 1	7.30 a. m.	60	100	30	6
1	7.45 a. m.	65	30	5	1
1	8.10 a. m.	67	55	25	7
1	7.15 p. m.	62	70	82	2
1	7.30 p. m.	62	40	20	....
1	8.20 p. m.	56	56	15	3
1	9.00 p. m.	56	200	50	6
1	9.45 p. m.	52	50	20	6
1	10.20 p. m.	51	80	15	4
1	10.55 p. m.	50	150	45	9
1	11.50 p. m.	50	145	35	3
2	7.10 a. m.	57	400	175	20
2	7.30 a. m.	69	125	30	6
2	8.40 a. m.	80	100	57	7
2	7.00 p. m.	64	480	150	27
2	7.15 p. m.	64	150	20	2
2	8.45 p. m.	58	100	20	9
2	9.45 p. m.	57	85	15	5
2	10.45 p. m.	56	80	20	4
2	11.30 p. m.	54	90	15	4
3	7.30 p. m.	68	200	40	12
3	7.50 p. m.	66	160	40	6
3	8.10 p. m.	64	130	20	5
3	9.00 p. m.	56	270	20	6
3	9.45 p. m.	55	240	35	14
3	10.40 p. m.	53	170	30	11
3	11.35 p. m.	52	130	28	9
3	12.15 p. m.	52	240	35	9
3	7.10 a. m.	54	400	100	20
3	7.30 a. m.	64	125	75	5
3	9.05 a. m.	80	80	10	....
4	7.10 a. m.	56	100	10	1
4	8.30 a. m.	64	60	40	5
4	9.05 a. m.	75	275	100	6
4	10.40 a. m.	82	225	50	4

Record of seining operations conducted at Baird, Cal., on the McCloud River, from September 4 to September 21, 1879, on account of United States, by Livingston Stone.

Date.	Hour.	Temperature of air.	Fish taken.		Ripe fish, females.
			Males.	Females.	
Sept. 4	7.30 p. m.	66	300	30	12
4	7.45 p. m.	64	100	46	6
4	8.15 p. m.	58	300	103	12
4	9.00 p. m.	56	200	75	6
4	9.30 p. m.	55	100	50	3
4	10.00 p. m.	54	500	150	7
4	11.00 p. m.	54	300	125	5
4	12.00 p. m.	54	300	150	7
5	7.40 a. m.	57	300	90	13
5	7.50 a. m.	60	200	50	4
5	1.40 p. m.	90	175	75	13
5	7.15 p. m.	66	175	30	11
5	7.45 p. m.	62	125	13	....
5	8.30 p. m.	62	125	14	4
5	9.15 p. m.	58	125	14	3
5	10.10 p. m.	58	250	50	5
5	11.00 p. m.	56	200	35	5
5	11.30 p. m.	56	250	30	6
5	12.10 p. m.	56	200	35	5
6	7.30 a. m.	58	200	50	7
6	7.45 a. m.	60	350	100	8
6	8.40 a. m.	68	125	35	4
6	1.35 p. m.	90	150	20	8
6	7.15 p. m.	60	200	50	7
6	7,30 p. m.	58	200	50	10
6	8.30 p. m.	57	300	40	6
6	9.30 p. m.	56	200	50	7
6	9.45 p. m.	56	300	25	6
6	10.30 p. m.	56	200	25	6
6	11.30 p. m.	55	500	80	13
6	12.15 p. m.	55	200	40	5
7	7.10 a. m.	54	150	50	37
7	1.20 p. m.	91	150	50	15
7	1.40 p. m.	91	100	40	4
7	7.15 p. m.	64	400	100	13
7	7.30 p. m.	62	200	25	8
7	8.10 p. m.	60	200	25	4
7	9.00 p. m	60	150	10	2
7	9.30 p. m.	58	250	25	4
7	10.40 p. m.	58	200	20	4
7	11.30 p. m.	56	200	20	8
7	12.10 p. m.	54	150	18	4
8	7.05 a. m.	58	150	50	9
8	7.20 a. m.	62	175	40	7
8	1.40 p. m.	95	200	50	9
8	7.15 p. m.	65	200	23	9
8	8.05 p. m.	64	300	15	8
8	9.00 p. m.	62	200	20	10
8	9.45 p. m.	60	150	25	6
8	10.15 p. m.	59	200	20	6
8	11.10 p. m.	58	150	25	4
8	12.00 p. m.	58	100	15	5
9	7.10 a. m.	54	400	125	21
9	9.30 a. m.	67	300	75	15
9	9.45 a. m.	70	225	50	8
9	2.00 p. m.	89	100	20	4
9	2.15 p. m.	90	300	50	11
9	7.30 p. m.	65	400	50	6
9	8.00 p. m.	65	300	30	7
9	9.00 p. m.	61	125	20	5
9	10.00 p. m.	60	150	20	9
9	10.45 p. m.	60	25	3	2
9	11.50 p. m.	60	75	15	5
10	7.20 a. m.	52	100	40	8
10	9.30 a. m.	70	125	50	10
10	1.35 p. m.	89	200	125	11
10	7.50 p. m.	60	400	50	4
10	8.45 p. m.	60	300	30	4
10	9.10 p. m.	59	125	20	3
10	10.30 p. m.	58	150	20	3
10	11.05 p. m.	58	25	3	4
10	12.00 p. m.	60	75	5	3
11	7.30 a. m.	54	125	20	7
11	7.45 a. m.	58	200	30	7
11	1.40 p. m.	88	150	28	7
11	7.30 p. m.	60	260	60	21

Record of seining operations conducted at Baird, Cal., &c.—Continued.

Date.	Hour.	Temperature of air.	Fish taken.		Ripe fish, females.
			Males.	Females.	
		°			
Sept. 11	9.00 p. m	55	200	50	1
11	10.00 p. m	55	300	20	7
11	10.45 p. m	54	200	10	5
11	11.30 p. m	51	100	5	....
12	7.45 a. m	60	150	25	14
12	9.00 a. m	65	100	15	7
12	2.00 p. m	98	450	50	15
12	7.00 p. m	61	200	14	9
12	8.45 p. m	61	150	10	7
12	9.40 p. m	60	200	7	5
12	10.30 p. m	58	100	12	5
12	11.30 p. m	54	150	6	2
13	7.40 a. m	58	250	20	19
13	8.00 a. m	62	150	30	8
13	6.30 p. m	65	300	20	13
13	7.10 p. m	64	150	10	4
13	8.00 p. m	60	100	25	8
13	8.30 p. m	59	75	5	1
13	10.00 p. m	55	75	4	4
13	11 00 p. m	52	100	10	6
14	8.00 a. m	70	100	15	8
14	9.30 a. m	84	75	10	6
14	9.45 a. m	86	300	30	9
14	6.30 p. m	69	150	15	11
14	7.20 p. m	65	200	10	8
14	8.00 p. m	61	150	10	9
14	9.30 p. m	59	100	5	4
14	10.10 p. m	57	75	6	2
14	11.00 p. m	56	50	5	5
14	11.45 p. m	55	50	8	5
15	8.05 a. m	68	75	14	9
15	8.15 a. m	70	100	23	13
15	10.00 a. m	80	300	25	13
15	2.00 p. m	96	200	40	19
15	7.00 p. m	67	200	15	11
15	7.35 p. m	65	100	6	5
15	8.20 p. m	61	150	14	10
15	9.00 p. m	60	200	23	13
15	9.50 p. m	60	150	7	4
15	10.40 p. m	58	175	12	7
15	11.45 p. m	56	100	8	4
16	7.45 a. m	62	50	15	15
16	9.45 a. m	86	75	20	12
16	10.15 a. m	88	300	60	38
16	7.00 p. m	65	200	17	7
16	7.50 p. m	60	100	4	1
16	8.40 p. m	59	200	10	8
16	9.20 p. m	55	100	10	6
17	3.30 a. m	49	75	15	7
17	4.30 a. m	49	50	15	9
17	5.50 a. m	50	150	25	15
17	8.00 a. m	60	25	6	2
17	8.10 a. m	62	40	8	6
17	9.30 a. m	81	50	9	4
17	10.00 a. m	86	50	10	5
20	2.00 p. m	82	125	5	5
20	2.15 p. m	84	75	4	1
20	2.45 p. m	86	100	10	4
20	3.45 p. m	86	125	10	4
20	4.40 p. m	78	30	8	2
20	6.55 p. m	62	150	20	10
20	7.45 p. m	60	75	7	4
20	8.20 p. m	58	80	9	5
20	9 00 p. m	56	90	9	6
21	8.05 a. m	58	80	11	8
21	8.20 a. m	64	50	7	5
21	10.00 a. m	78	50	6	6
21	10.10 a. m	80	50	2	2
21	11.00 a. m	82	75	6	4
21	1.40 p. m	85	175	30	20
21	2.05 p. m	87	10	7	4

XXVI.—CALIFORNIA SALMON IN THE NETHERLANDS.

By C. J. Bottemanne.*

[From "*Nederlandsche Staats-Courant*" No. 246, October 18, 1880, official journal of the Dutch Government, published at the Hague.]

Mr. C. J. Bottemanne, of Bergen op Zoom, chief superintendent of the fisheries of the Scheldt and other rivers in the south of Holland, who has been commissioned by the government to superintend the experiments in stocking some of the Dutch rivers with California salmon, has made the following report on the results of his experiments during the period 1878–1880:

During the investigations relative to the different kinds of salmon inhabiting our rivers, and the condition of the fisheries, which our government had made during the years 1869 and 1873, my attention was directed to the circumstance that so little is heard nowadays of salmon being caught which had been marked before they were set out, and that it is very difficult to mark any considerable number of young salmon, which, nevertheless, is necessary for furnishing the only possible proof of the beneficial influence of pisciculture upon the fisheries. I consequently arrived at the conviction that other steps must be taken to convince not merely the general public, but especially the fishermen, that pisciculture was no chimera, but a science, and a considerable industry whose benefits *they* were principally destined to reap, and towards the furtherance of which they must extend a helping hand. After mature deliberation I found that the best way to reach this object would be to put salmon of a kind not known in our country in some of our rivers which contain few or no salmon. Such a river was soon found. The Limberg Meuse is well known as containing but few salmon, for although formerly these fish were frequent in that river, hardly any are caught there now. Another great difficulty was the question as to what kind of salmon should be selected. It must be a fish which, when caught, would not leave a doubt in the mind of the fisherman who had caught it that it was a salmon, and still it must differ from the common Rhine salmon. The fisherman, in fact, must be able to see at once that he has caught

* *Californische zalm in Nederland.* Translated by Herman Jacobson.

a strange salmon. In addition to all this the salmon must, of course, be of a good quality.

Various circumstances favored me. During my stay in America, in the autumn of 1874 I saw in Mr. Seth Green's piscicultural establishment, in the State of New York, some young California salmon which had been brought from California when still contained in the egg. Even when quite small they could at once be distinguished from the Rhine salmon, and a drawing of an older salmon of the same kind convinced me that I had found what I was looking for. As it was for the time being impossible to obtain eggs of the California salmon, I made an attempt to take trout-eggs back with me to the Netherlands, and, considering the difficulties attendant upon this attempt, it must be said that it proved reasonably successful.

In 1876 I at last found a live specimen of about the size of a St. Jacob's salmon in the New York aquarium, which, as far as its external appearance was concerned, fulfilled all the conditions required of it.

I had no opportunity to judge of the flavor of fresh salmon, but I tasted some that had been canned, and found it very good. If I therefore succeeded in obtaining eggs of this California salmon (*Salmo quinnat*), in transporting them safely to the Netherlands, and hatching them there, no one who caught such a fish would fail to see its difference from the Rhine salmon (*Salmo salar*), and the fact could not be kept a secret, as, in my opinion, is generally done when a marked Rhine salmon is caught.

When, therefore, late in the autumn of 1876, the minister of finance asked me to take the place of superintendent of the Scheldt fisheries, I immediately accepted the offer, and in February, 1877, talked over the matter with Prof. Spencer F. Baird, the American Commissioner of Fisheries, whom I had learned to know during my visits to the United States. Before I left America, he promised to send me in the autumn a considerable quantity of California salmon. Late in the summer of the same year (1877), Professor Baird sent me 100,000 salmon-eggs, which were accompanied by his assistant, Mr. Fred. Mather, as far as Bremerhaven, where, owing to the impossibility of my receiving them, they were received by the assistant director of the Royal Zoological Society, "Natura Artis Magistra," of Amsterdam, in whose gardens these eggs were to be hatched. Through the kindness of the director, Dr. G. F. Westerman, the society undertook the hatching of these eggs free of expense. To my great sorrow nearly all these eggs perished, owing to their not having been properly packed.

Some fish were successfully hatched; but with the exception of three, they all died very soon. These three, however, developed so well, that I had no doubt that if other eggs were sent and were more carefully packed the attempt would prove successful. As soon as Professor Baird was informed of the failure, he at once offered to send other eggs, which arrived during the year 1878. These eggs, which, at my suggestion, had been packed in a different way, arrived in good condition at

Amsterdam via Bremen. This time the minister, at my suggestion, offered to bear all the expenses, to be paid from the treasury of his department, leaving the whole matter entirely in my hands.

When, on the 26th of October, the eggs were placed in the gardens of the Zoological Society, where they were to be hatched, 82,600 out of the 85,000 which had been received were found to be in good condition. Of these 19,497, or 24 per cent., perished during the incubation. This was probably caused by the high temperature of the water during the hatching process; it is also possible that in unpacking the eggs I did not change the temperature gradually enough. Raising the temperature too quickly and letting it remain high is very apt to prove injurious to the eggs. When hatched, many of the little fish did not seem to possess the necessary strength to get free of the egg-shell when it burst, and in their attempts to do so some of them were choked.

Through the good care which was taken of the young fish in the gardens of the Zoological Society, about 61,000 young salmon were successfully hatched, whose umbilical bag had almost entirely disappeared. Although there was no precedent that salmons younger than one year had been set out in rivers, 50,000 of these fish had, nevertheless, to be set out in the river Meuse, near Venlo, in January, 1879, as the Zoological Society needed all the space at their command for the hatching of Rhine salmon.

In spite of the very unfavorable weather, as there was a hard frost, we succeeded in preventing the freezing of the water in the cans in which the fish were transported, principally through the very valuable aid extended by the superintendents of the railroad stations at Amsterdam, Utrecht, Boxtel, and Vinlo. Although the journey—and, therefore, the stay of fish in the cans—lasted about eight hours, the loss was trifling. With the same success 5,000 young salmon were set out in the Zwaansprong, near Apeldoorn, and about the same number in the small streams which feed the Molecate ponds near Hattem, to which the owner, Baron van Heeckeren van Molecate, kindly gave his consent. The object was to have an opportunity of observing the development of the young fish when in a free condition. In spite of all precautions it seems that the young fish escaped from Molecate; and although every effort was made to track them, they could not be found.

In the Zwaansprong we were more successful. It is true that their number decreased through cannibalism; but this is a common occurrence with fish of prey when—as in this case purposely—they are not fed. A considerable number, however, were lost by the breaking of a dike, the fish escaping through the opening into the Diereusche Canal. As the break in the dike was fortunately soon discovered, about 1,400 of the deserters were caught and placed in one of the ponds of the neighboring establishment of Mr. Nordhoek Hegt. As early as October, 1879, I found young salmon measuring 13½ centimeters. Of those which had been set out in the Meuse many were observed during the first few days after their liberation; but after that nothing more was seen of them till the spring of 1880, when some of them were again seen. Finally Mr. Rijke succeeded in May, 1880, in catching several of these salmon near Fegelen. One of these fish put up in spirits of wine was sent me by Mr. Rijke, and found to measure 14 centimeters.

In 1879 the Dutch Government asked the American Government to make another attempt to send salmon-eggs. The request was granted, and the eggs, which had been carefully looked after during the voyage, arrived at Rotterdam in excellent condition. The vessel which brought them was the steamer "Schiedam," Captain Chevalier, of the Netherland-American Steamship Company. This company brought these eggs to Europe free of expense, as the German Lloyd had done on former occasions. The number of eggs was somewhat less than the year before, viz, about 60,000 (59,300). Of these 10,146 perished during the hatching process—counting in, however, 1,200 which were already spoiled when they arrived; the loss during this attempt was therefore only 15 per cent. During the umbilical period 2,154 more were lost (counting in 345 that were deformed). The total number of fish which were successfully hatched was, therefore, 46,000.

As it seemed too great a risk to set out these young salmon in open rivers, and as I knew of no small stream which fulfilled all the conditions for their successful raising, I proposed to his excellency the minister this time to put all the young fish in the piscicultural establishment of Mr. Nordhock Hegt, on the Zwaansprong, and to keep them there till the spring of 1880. I made this proposition, because up to that time I had not heard anything about any of the young salmon having been caught which the year before had been set out near Blerik. As his excellency granted my request, 45,500 young salmon were successfully transported to the Zwaansprong, where they grew rapidly. According to their size they are distributed through several ponds. The mortality was very small, and it is probable that during the coming spring a large number of young salmon can be set out in the Meuse.

In the basins of the zoological garden at Amsterdam, I retained 500 of these fish. Some of these fish, which from the Zwaansprong were taken to the piscicultural establishment at Velp, I saw last summer and found them in excellent condition. The size of these young fish seems to keep step with their voracity, which is truly astonishing, and which, in spite of the ample and good food thrown to them, proved a considerable source of danger to their weaker brethren.

The young fish from the hatching period, 1878–'79—several hundred in number—which are still in the Zwaansprong, measure at the present time 22–23 centimeters, whilst young fry taken there in March, 1880, measure 6–7 centimeters.

It is a great satisfaction to me that Professor Baird has expressed his willingness this year also to send some salmon-eggs to the Netherlands.

The result of all our experiments so far may be summed up as follows: After counting out those eggs which on their arrival in the Netherlands were found to be in bad condition, the loss—including the deformed fish—during the hatching and umbilical periods was 26 per cent. in 1878, and not quite 21 per cent. in 1879.

If in pisciculture one has 74–79 per cent. sound young fish at the end of the umbilical period, the result must be called very satisfactory. I think that this result is in the highest degree satisfactory if we take into consideration the many stages of the long journey which the eggs had to perform before they reached their final destination. First, they were gathered in the wilderness of California, the gatherers being protected by the bayonets of soldiers; then they had to travel quite a number of miles over a rough road in jolting wagons before they reached the railroad. Thereupon they had to be in the cars for a whole week—often in a tropical heat—traveling from California to New York; in that city there would generally be some delay until they could be placed on board the steamer; this would be followed by a voyage of very nearly two weeks, their whole trip concluding with a railroad journey from Rotterdam to Amsterdam.

If after young salmon have been set out in the Meuse in January, 1879, the percentage of successfully hatched fish is more favorable than I had expected, and if, as now seems likely, more than 80 per cent. of the young fish taken to the Zwaansprong continue to live, salmon of this kind will certainly be caught in our rivers in a few years.

Hardinveld and Gorinchem will probably be the first places where such salmon will be caught, as the young salmon, when going towards the sea (if not all, at any rate by far the greater number), will go by way of the Nieuwe Mervede to the Holland Deep and will return the same way.

If our experiments are again successful this year, a considerable increase of the Meuse salmon fisheries will be noticed in a few years.

C. J. BOTTEMANNE.

XXVII.—REPORT OF OPERATIONS AT THE UNITED STATES TROUT PONDS, McCLOUD RIVER, CALIFORNIA, DURING THE SEASON OF 1879.

By Livingston Stone.

Hon. Spencer F. Baird:

Sir: In pursuance of your instructions to establish a station for taking and distributing the eggs of the California brook trout (*Salmo iridea*), I examined all the streams emptying into the McCloud River for a distance of twelve or fifteen miles above the salmon-breeding station, and, on the 25th of July, selected a location for the purpose mentioned at the mouth of a stream on the east side of the McCloud, four miles above the salmon fishery. The location is eminently favorable for the work, and possesses the two essentials for a trout-breeding station, viz, great abundance of clear, cold water, and excellent facilities for capturing wild trout for breeders. It is also only four miles from the fishery reservation, which will undoubtedly prove to be a great convenience in the carrying on of the two places.

The name of the stream which was selected for the trout-breeding station is the George Crook's Creek, a creek deriving its name from that of a white settler who was murdered there by the McCloud Indians in 1873.

We found everything there, of course, in its primeval condition, and had to do a great deal of hard work to grade the place properly, and to bring a sufficient supply of water to the requisite elevation. This work, and the catching of breeding-trout, occupied most of the time till about the 1st of September, when we began to put up the hatching-house and dwelling-house.

The greatest drawback to the place is that it is approached only by an Indian trail from the fishery reservation, and all supplies of every description have to be packed upon the backs of men or horses. It would not be very difficult, however, to build a wagon-road there, and some day this will, perhaps, be done. When this road is built I think it will be the most favorable location for trout-breeding that can be found in California.

The establishment of a trout-breeding station in an uninhabited region like the cañon of the McCloud furnishes so many peculiar features that you will perhaps excuse considerable detail in describing how it was accomplished.

The first thing was to find a suitable location. With this object in view a party of three, consisting of Mr. Greene, Mr. Redcliff, and myself, started one July morning on horseback for an expedition up the river, bringing a fourth horse along with us to carry our blankets and provisions. Taking the narrow Indian trail on the west side of the river—for there are no roads on either bank—we followed it for eight miles to Mr. Campbell's ranch, where we forded our horses and took the trail on the east bank of the river. There are no white settlers above this point, and our ride from here was through a country wild and picturesque in the extreme. The trail, probably the same that the Indians have traveled for centuries, wound over the cliffs and around the hills of the cañon, among some of the most magnificent landscapes in the world. We were soon inclosed in a circle of almost inaccessible mountains, where high, precipitous cliffs extended down sometimes to the water's edge, and through which the McCloud somehow wound its tortuous way, not so much a river here as a succession of foaming cascades. The Yosemite Valley is sublime and stupendous in its grandeur, but there is a brilliancy and enchantment about the beauty of the Upper McCloud that I have never seen in the Yosemite or anywhere else. Our path, as may be supposed, was far from being smooth or safe. Being very little traveled, as there are but few Indians so far up in the mountains as this, the trail was sometimes so rough and narrow that it seemed as if horses could not possibly keep their footing; and, rough and narrow as it was, the trail sometimes led along the very edge of rocky, precipitous bluffs, where a misstep of two or three inches from the path would throw horse and rider down hundreds of feet into the cañon below. Our horses, however, were sure-footed, and about nightfall we safely reached the mouth of Nosonnie Creek, where I had been informed there was a good site for trout ponds. As we approached the creek, we saw, across an intervening gulch or two, a waving field of wild oats, yellow and bright as gold, where we decided at once to camp for the night, the long, clean oat straw furnishing a luxurious bed for the campers as well as abundant food for the horses. The night, passed under the open California sky on our deep beds of straw, was delightful, and we awoke the next morning rested and refreshed, having been disturbed but once in the night, owing to the approach of a bear or panther which partially stampeded the horses.

The next morning we made a thorough examination of the creek and found it wholly unsuitable for a trout-breeding station. The gulch through which it flows is narrow and almost a solid mass of bowlders. The water was warm, which implies droughts in the summer and floods in the winter, and what was alone sufficient to settle the matter, the approach to the creek was altogether too difficult to make a location there at all desirable unless the place furnished great counterbalancing advantages. This not being the case, and as any more distant point would be out of the question, we took up our line of march down the river again, keeping on the east side trail all the way. We crossed several streams on our way down, but found none that were suitable till we reached the George Crook's Creek, four miles from home. Here, to our great delight, we found almost everything favorable. The stream ran clear and cold, and though not so large as Nosonnie Creek, it was large enough. There was a long reach of comparatively still water in the McCloud at this point, where set-lines for catching parent trout could be advantageously set. There were sugar pines near for cutting out shakes and lumber, and oaks for fire-wood. There was a flat piece of ground just where we wanted it for the buildings and ponds, and although it was evidently going to be no small undertaking to get the water from the brook to the station, it was nothing compared with the immense labor it would have taken at Nosonnie. I was not long deciding to locate here, and on the next Monday morning at sunrise had taken possession of the land and had posted a notice on one of the trees that I had taken up the claim.

We immediately went to work to build a rude brush camp and a temporary house, and to repair the trail from the creek to the salmon fishery, so that I could send up pack-horses with the tools, provisions, cooking utensils, and other things needed at the camp. This preparatory work was a labor of some days, the nights of which we diligently improved by catching parent trout for the ponds, the month of July being the best month of the whole year for catching trout in the McCloud River. As soon as possible I sent up a boat and a stove, six Indians taking them up through the rapids by great exertions in a single day.

As rapidly as we could we got to work on the buildings and ponds, and especially on the ditch which was to take the water supply from the creek. This last was a toilsome work of weeks, as we had to dig through an elevation which, though not large, was almost filled with immense bowlders. Another laborious task was getting the lumber for the buildings to the camp. To carry a single board over these mountain trails in a burning sun is no slight task, and to carry all that were needed for dwelling-house and hatching-house, besides the provisions, tools, and furniture, was a great labor. The work progressed, however, until now we have a thoroughly appointed trout fishery with a commodious and comfortable dwelling-house, and probably the finest collection of trout ever brought together in one place.

I cannot forbear mentioning here one or two little incidents which, though not of much importance in themselves, serve to illustrate some of the peculiar features of working in this uninhabited country.

Six years ago, when we first located the salmon fishery on the river bank, there was but one white settler on the McCloud. His name was George Crooks. In the fall of the same year he was murdered on his own ranch by the McCloud Indians, because they said the land belonged to them. It is at this place that we have established the trout-breeding station, and it must be remembered that the minds of the Indians have not been changed in the least since they killed George Crooks and threw his body into the river.

A few days after we had built our camp and begun work there, last July, it happened one Sunday that one of the men was left alone in charge of the camp. As the day wore on he thought he heard a slight noise near him, and on looking up he saw to his great surprise three Indians standing over him, each with a drawn knife in one hand and a rifle in the other, and here, on the very spot where the last settler was murdered, they told him the same story that they had told the murdered man, viz, that this was their land, that the white men had no business there, and that they did not want white men on the McCloud River at all. The young man had no weapons about him, and was wholly at their mercy. They would undoubtedly have killed him, as they would certainly have been glad to do, if they could have summoned up the courage to face the consequences. But though they staid with him three hours, their valor did not reach this point, and they finally left him as they found him, in possession of the place.

Some time after, in November, the same young man, whose name is Loren Green, in climbing a bluff to recover what he supposed was our stolen dog, found the dog to be a panther, which prepared to attack him so suddenly that he barely escaped with his life, by jumping into his boat and pushing out into the river. I think I may say to my fellow trout-breeders in the settled States of the Atlantic coast, that building trout-ponds here is not like building trout-ponds at home.

At first the men all slept, not only under the open sky, but on the ground. After a while, however, they requested me to get them hammocks, because the scorpions and rattlesnakes, of which they had killed a considerable number, were so thick. Of course, I complied with their request, but it did not prevent one of the men from being struck on the leg by a rattlesnake, his heavy boot saving him from receiving a fatal stroke. Nor did it save Mr. Myron Green from a nearly fatal bite from a tarantula. Mr. Green, on retiring to his hammock for the night, threw his clothes upon a rock near by. During the night a tarantula crawled into his clothes, and on Mr. Green's dressing in the morning, he was terribly stung by the venomous creature. Moistened tobacco was immediately put upon the wound, and a tumberful of alcohol administered inwardly, after being somewhat diluted by water. This checked the progress of the poison, and saved Mr. Green from a very serious if not fatal consequences.

I mention these incidents merely to show that with tarantulas, scorpions, rattlesnakes, Indians, panthers, and threats of murder our course here is not wholly over a path of roses.

As the spawning season of the trout at this point does not come on till the beginning of the next year, I can do nothing more in this report than to give a description of the buildings that have been erected and of the work that has been accomplished preparatory to the taking of the eggs, which I will now endeavor briefly to do, leaving the subject of the natural history of the trout to some future time, after we have had experience in hatching them and extracting their eggs.

A ditch 220 feet long, 5 feet deep, and averaging 3 feet in width, conveys the water from the creek to the trout-ponds. To turn the water of the creek into the ditch, a dam 30 feet long and two feet high, built of solid rock and heavy timbers, has been constructed across the creek for a protection against high water, which, in these mountain torrents, is very formidable. A breakwater of solid rock has been built at the head of the ditch, 55 feet long and 4 feet square. The water for the trout-ponds is taken directly from the creek into the supply ditch by a plank box 12 inches square. The ditch first delivers the water from the creek into a pond 18 feet long, 16 feet wide, and 6 feet deep. From this pond a short ditch takes the water into a second pond 24 feet long, 12 feet wide, and 7 feet deep. Thence the water proceeds partly by a ditch and partly in a natural channel back to a lower point of the creek from which it was taken.

Just below the ponds, and between them and the McCloud River, is the hatching-house, 24 feet long and 18 feet wide, with 8 feet posts. The hatching-house, which is on the same general plan and finished with the same apparatus as the hatching-house at the salmon-breeding station, has a hatching capacity of 6,000,000 trout eggs.

Adjoining the hatching-house on the south is a dwelling-house substantially built, 30 feet long and 18 feet wide, with an addition on the south 18 feet by 12 feet, with a shed roof. There is also a long supplementary ditch, 400 yards in length, carrying 40 inches of water, miner's measure, taken from a point higher up the creek, which, in case of accident to the original supply ditch, would bring water to the ponds till the injuries to the original ditch could be repaired. Another ditch is so constructed that it can irrigate several acres of clear and fertile land, which can then be used for a garden. All these structures are placed above the highest high-water mark of the river, so as to be entirely free from danger when this formidable river is at its highest. This completes the enumeration of the most important structures that have been built at this point; but in neighboring creeks two large fish-traps have been placed to catch the wild trout of the river when they come up to spawn. The traps are 14 feet long, 8 feet wide, and 5 feet deep. They are built of poles, with heavy timbers to hold them in place. A dam and rack are built across the creek, similar to the dam and rack at the salmon station on the McCloud, to force the ascending trout to the trap. The traps are covered at the top, so that when the high water pours entirely over them the trout cannot escape. By the help of these traps a large number of spawning trout are captured, which help very much to increase the yearly harvest of eggs.

In my next report I hope to give a detailed account of the catching of the trout and taking of the eggs, besides some new features in the natural history of the California trout, which have been obtained at this station.

I will merely add now that, at the present writing, December 5, 1879, we hope to secure during this first season of the United States trout-ponds on the McCloud River upwards of 300,000 eggs.

I will close this report by saying that an application to the President has been made for an extension of the present fishery reservation so as to include the trout-ponds. The application was originally made for a larger tract with especial reference to the Indians, but a modification was afterwards made in the application which restricted the extension to a tract of land reaching only from the mouth of the McCloud to a point eight miles above it. It is to be hoped that this extension to a point eight miles up the river will be made, for while this cannot injure the rights of any one, it will place the operations of the trout-pond station on a much securer basis, and will facilitate the work there in a very great degree.

XXVIII.—REPORT ON THE PROPAGATION OF PENOBSCOT SALMON IN 1879-'80.

By Charles G. Atkins.

1.—Change of location.

The original experiments in the propagation of Penobscot salmon were made in 1871, in the towns of Bucksport and Orland, in the State of Maine. The fixtures for the development of the eggs were located in the town of Orland, at Craig's Brook (tributary to Alamoosook Lake and through that to Eastern River and the Penobscot), and the most of the salmon used that year were confined during the summer in an inclosure in the edge of Alamoosook Lake, in close proximity to the hatching-house. With a view to testing the capacity of different waters to sustain the breeding fish in health, a few of them were also confined in Dead Brook, another tributary of Eastern River, and a few more were turned into Spofford's Pond, commonly known as "Great Pond," a small sheet of water near Bucksport village. The fish in these three places did equally well, and came to the spawning season, in the months of October and November, in good health, as was proved by the few that came to hand at that date.

The site selected for a hatching-house was exceptionally good, but the facilities for keeping the breeding fish from June to November in that vicinity were far from satisfactory. The water of the brook, which is exceedingly pure, had been tried and found totally unfit. The temporary inclosure in the edge of the lake was entirely successful, but it was exposed to all the force of storms sweeping across two miles of open water, and would, therefore, never be safe from breach under the force of waves or drifting rubbish. Besides, the shore was straight, and a large inclosure would be costly. At Dead Brook the water was satisfactory, but there was no good site for a hatching-house. At Bucksport were found the best site for an inclosure, a convenient site for a hatching-house, and water, which was not, to be sure, so pure as at either of the other places, but which was believed to be quite good enough.

So, in 1872, the works were established at Bucksport, where operations were pushed as vigorously as the funds warranted, and with a fair degree of success, for four years. During these years it became apparent that the water which supplied the hatching-house was not suitable for the purpose. The pond was shallow, with a bottom of black mud, very soft and very deep. The shores were partly marshy, and the brooks that fed it were devoid of copious springs and much affected by drought. The water was very dark in color, strongly impregnated with earthy and peaty solutions that were always unpleasantly prominent to the taste, especially when low and warm, as after midsummer. Copious rains, which commonly came in September or October, so far improved it that I think it was then equally good with ordinary river water for the development of salmon spawn; but the rains did not always fall in due quantity, and at the right season. That happened in 1874. The brook had ceased to flow from the pond in the summer and was giving but a very small stream, barely enough to supply the hatching-house, when the spawning time came. The salmon were taken with much less trouble than usual, and a large lot of spawn, apparently in the very best condition, was deposited in the troughs. The water was at first warm, and tasted very muddy, and was full of minute vegetation of a low order. I was not free from anxiety as to its effect on the eggs, but nothing could then be done but wait and see. The temperature soon fell, but the water mended but slowly in other respects. However, the eggs did not die. They were faithfully attended. Inspection showed that they were well impregnated. Midwinter came and the embryos were well grown and strong, as far as we could see, and I flattered myself with the hope that this would be the best lot of eggs ever sent out from the establishment. We began to pack them for shipment, and then discovered that the shells lacked strength. On exposure to the air they shrunk and put on the appearance of half-dried currants, and many of them collapsed altogether. But there was no escape from packing them up and sending them off to their destinations. Great loss ensued. It was not so bad with the eggs that were kept here and hatched for the State of Maine, which were nearly, if not quite, as good as ever.

The next year, 1875, the rains came in good season, and the eggs taken and distributed turned out remarkably well. But it was evidently necessary to provide a hatching-house where we could command better water, for use, at least, when that at the old hatching-house should be unsuitable from lack of rains. Just at this point the subscriptions of the United States and Connecticut commissions were withdrawn, the funds formerly appropriated being needed more in another direction. The remaining subscribers, the Maine and Massachusetts commissions, did not feel able to carry on the establishment alone, and it was, therefore, closed in 1876. The next year the lease under which the premises had been occupied expired, and being unable to meet the views of the proprietor as to the terms of a renewal, I was forced to look about for a new site for both the salmon pond and the hatching-house.

It was of course very desirable to have hatching-house and salmon pond close together. But I was limited in my search by the necessity of having the salmon pond easily accessible from tide-water, and at convenient distance from the mouth of the Penobscot, where alone the breeding fish could be had in sufficient quantity for our use. After diligent examination of the whole region, I was forced to fix upon separate locations for the pond and hatching-house.

For a pond we went back to Dead Brook—to the very spot tried in 1871; for a hatching-house to the original site on Craig's Brook.

Dead Brook is tributary to Eastern River, which it joins between Orland village and Orland Falls, in a low and swampy region, partly overflowed by the backwater from the dam at Orland. Its lower portion is from this cause broader and deeper and more sluggish than in its natural condition, as well as more accessible by water. The Orland dam is provided with a lock, and large boats have been accustomed to load with wood in Dead Brook for transportation down the river. Our salmon cars could thus reach the brook from any point in tide-water, and the salmon thus transferred to our inclosure without the overland carriage to which they were subject in Bucksport.

A section of the stream about 80 rods long was selected for our inclosure. The bottom was mostly gravel, partly overlaid by a thin stratum of mud supporting a rank growth of water weeds. The water itself was pure,—rather better than the average of rivers in Maine—the sources of the stream being in two natural ponds in a hilly and wooded district. Wooden racks, which had before done service in the pond at Bucksport village, were made into barriers to form the upper and lower ends of the inclosure. The sides were formed by the banks of the brook, which would be high enough to retain the water and the fish except in extreme freshets, but to guard against escape in any event close fences were built along all the banks liable to submergence.

The hatching-house is located at the mouth of Craig's Brook, on the east side of Alamoosook Lake, across which it is necessary to transport all the eggs as soon as taken, the distance being near two miles, a little more than half of it being by water. Aside from its location at a distance from the spawning place, this site has all the desiderata for a first-class hatching-house. The water is abundant and pure, part from springs and part from Craig's Pond, and the steep inclination of the ground affords complete facilities for managing and aerating the water. An old mill stood ready for our use, and was fitted up with troughs and other appurtenances, patterned after those in use at Grand Lake Stream.

In charge of the operations I placed Mr. H. H. Buck, of Orland, who had already had experience in the work at Bucksport and Grand Lake Stream.

2.—Collecting breeding salmon.

Arrangements for a supply of breeding salmon were made with several fishermen in the southwestern part of Verona—mostly the same men who had furnished salmon to the old establishment. They were provided with dip-nets, cars, and boxes, such as they needed. Mr. Avery H. Whitmore was employed to receive the fish, agree upon their weight, and forward them to Orland. The collection of salmon from the weirs was done mainly in cars (transformed fishermen's dories), partly in boxes carried in the fishermen's boats. They were generally taken from the weirs just before low water and brought at once to Mr. Whitmore, who dispatched them to Orland on the flood of the very next day tide, except when the number was very small. The fleet of cars reached the lock at Orland just before high water, and were then given in charge to Mr. Buck, who dispatched them to the inclosures. The time occupied in transfer was about five hours.

The subscription to the fund warranted the purchase of a smaller stock of breeding fish than usual, and being quite sure of getting all we wanted in a few days, the purchase was delayed until the price had fallen to a low figure, as is always the case in June, when the catch, especially in the New Brunswick rivers, approaches the maximum. This year the time of plenty came earlier than usual, and for our first load of salmon, June 10, we had to pay but 8½ cents per pound. From this time the collecting proceeded without interruption until June 21, when, having impounded 264 salmon, we suspended operations for the season. The following is a daily record of the purchases:

Date.	Number of boat-loads.	Number of salmon.	Total weight.	Average weight.	Price.
1879.			*Pounds.*	*Pounds.*	*Per lb.*
June 10	4	60	730	12.17	$0 08½
June 11	2	35	395	11.28	09
June 12	1	14	169	12.07	09
June 13	2	24	314	13.08	09½
June 14	2	22	276½	12.57	12½
June 16	2	23	301	13.09	13½
June 18	1	17	188	11.06	13½
June 19	2	21	244	11.62	13½
June 21	3	48	630	13.12	
Total	19	264	3,247½	12.30	

The price per pound, it should be explained, is only one item in the cost of the salmon. Each fisherman received, in addition, a bounty of from thirty-five to sixty cents each for capturing, risking, and delivering them alive and in good condition to Mr. Whitmore. Then the transportation to the lock at Orland was another item, and the complete account would also include the wages of the men who took them from Orland to the inclosure in Dead Brook and the cost of the cars and other apparatus. The cost, delivered at Orland lock, exclusive of apparatus, is made up of items easily separated from others, and amounts to $558.92 for 264 salmon, averaging $2.16 for each. This is about as low as can be expected in the future, the price per pound having ruled so much lower than usual as to probably offset any saving we may make in other directions hereafter.

3.—A DISASTROUS SUMMER.

We had for the most part rather favorable weather, and the fish did not suffer much in capturing or transporting. The loss was, however, greater than used to be at Bucksport. Thirty-two salmon were found dead in the inclosure, and it is possible that a very few died and were not found. The most of these dead fish were found between June 30 and July 10—not any of them after the latter date. This goes to show that the fish died, not from anything deleterious in the inclosure, but from injuries received in transitu, although some of them were free from any external injury. There were many injured about the eyes, which may well have occurred in the cars. Mr. Buck's note-book has the following item about these fish:

"Some of these fish seemed to be in perfect condition when found; some had lost only an eye; others were badly chafed and bruised."

After the 10th of July the deaths had apparently ceased, and things went on prosperously in preparation for a yield of a million of eggs. But disappointment awaited us.

On the 17th and 18th of August a very heavy fall of rain occurred, and caused a high freshet in Dead Brook. Such an event was unexpected; yet we supposed we were ready for any such emergency. When the brook began to rise the men in charge watched carefully at the upper barrier, which, being at a narrower and shallower place, bore the brunt of the onset, and intercepted all the stumps, logs, brush, and other floating *debris* which were borne down from above. So long as this barrier was kept free and all the rubbish removed from the stream it was thought that the lower barrier, standing in deeper and wider water and a very gentle current, must surely take care of itself over night. But danger lay in an unsuspected quarter. The quiet water within the inclosure supported a dense growth of water-weeds, and a rise of two or three feet and a considerable increase in the strength of the current tore these from their roots and bore them down against the lower barrier, where they were arrested. In the course of the night so much of this material had accumulated as to close all the interstices as by a thick mat. The water, being thus impeded, rose above the barrier to such a height that the racks could no longer withstand the pressure, and they burst open, letting out all the salmon that chose to go.

It was at first hoped that while the freshet lasted the salmon would all be trying to ascend the stream, and would therefore, for the most part, remain in the inclosure until repairs were effected; but it afterwards became evident that most of them must have gone out of the gap during the few hours that it remained opened. Some of them were even taken in weirs four miles down the river within four days after the disaster. The full extent of the loss was not ascertained until the spawning time arrived, and the fish remaining in the inclosure were seined up for manipulation. It was then found that out of the 232 salmon supposed to have remained on hand after July 10 but 59 remained to us, 40 males and 19 females.

4.—The spawning.

The fish gave evidence of approaching maturity as early as October 20, and on the 24th the first spawn was taken. The following statement exhibits all the spawning operations in detail:

Record of spawning operations at Dead Brook.

Date.	Females.		Eggs from each female.			Corrected No. of eggs.	Notes.
	Length.	Weight.	Weight.		Estimated number.		
1879.	*Inches.*	*Pounds.*	*Lbs.*	*Oz.*			
Oct. 24	29	6	2	6	6,300		
24	35	15¾	1	0	3,100	17,141	Partly ripe.
24	30	7	2	7	6,200		
27	....	....	2	4	6,300		From fish partly ripe on 24th.
27	....	....	0	14	1,800	24,313	Respawning.
27	31	9*	2	8	6,750		
27	31	9*	2	9	6,750		
30	36	15¼	4	10	10,800	12,549	
30	....	....	1	9	3,600		Respawning.
31	29	10½	1	14	5,400	6,938	
Nov. 5	....	....	1	8	3,600		Respawning.
5	38	17½	4	2	10,800		
5	37	17	4	10	10,350	43,601	
5	31	10	1	14	5,400		
5	30	11	2	10	6,750		
8	....	....	3	14	9,000		Respawning.
8	36	14½	4	0	9,200	33,426	
8	32	11½	3	5	8,800		
10	....	....	1	12	4,000		Respawning.
10	36	12¾	4	7		48,611	
10	30	7½	2	9	36,000		
10	38	15¼	5	10			
10	29	8½	1	9			
12	....	....	2	2	3,600	12,107	Respawning.
12	30	7	2	8	6,400		
15	....	....	0	8	1,000	8,276	Respawning.
15	30	8*	2	4	6,400		
Total	....	213	71	5	178,300	211,692	

* These weights are estimated.

From these details we obtain the following generalizations:

	Inches.
Average length of the 19 females	32.5
	Pounds.
Average weight of same, exclusive of spawn	11.2
Average weight of same, inclusive of spawn	14.9
Total weight of spawn taken	71.3
Average weight of spawn from each female	3.7

The number of the eggs was underestimated. When those remaining sound in mid-December were packed for shipment they amounted to 200,500, and 11,192 by count had been picked out; total, thus computed, 211,692.

From this total we deduce the following averages:

Average number of eggs per mother fish 11,141
Average number of eggs per pound weight of mother fish 745
Average number of eggs per pound of spawn 2,981

The weight of males was not recorded. It was intended to weigh them all at last, but as they were chafing badly they were turned down the brook November 13, with a few exceptions, and we saw but few of them afterwards; and the ice having become troublesome, we did not think it worth while to try to catch them. (Mr. Buck's notes.)

Mr. Buck's success in impregnation of the eggs was equal to the best I ever knew. The following estimate comes, I think, pretty near the facts: At the time of packing the eggs there were picked out 3,408 unimpregnated eggs. If we assume that half of all those previously taken out were unimpregnated, we have a total of 7,329 unimpregnated eggs, equal to 3.46 per cent., from which it follows that 96.54 per cent. were impregnated.

5.—TRANSFER AND HATCHING OF THE EGGS.

Of the total number of eggs, 211,692, there were picked out 11,192, and the remainder, 200,500, distributed among the subscribers, as in subjoined Table II. There died in transitu 8,673, of which 8,000 hatched out in the moss, being too near their maturity for transportation. There were further losses of 4,268 before hatching, and 7,011 after hatching, leaving 180,264 healthy fish which were turned free. Thus of the original number 5 per cent. were rejected before shipping; 4 per cent. were lost in transitu; 2 per cent. more died in the troughs before hatching; 3½ per cent. died after hatching, and 85 per cent. reached the feeding age and were liberated.

Appended will be found a series of tables, from I to VI, exhibiting in detail the principal operations of the year, and observations noted.

TABLE I.—*Statement of salmon bought alive at Bucksport in* 1879.

Date.	Whence received.	Number of salmon.	Weight of salmon. Several weights.	Weight of salmon. Aggregate.	Weight of salmon. Average.	Daily summary. No. of salmon.	Daily summary. Weights. Aggregate.	Daily summary. Weights. Average.	Daily summary. Date.
1879.			*Pounds.*	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	1879.
June 10	A. H. W.	9	23, 20, 15, 12, 12, 11, 11, 10, 8	122	13.55				
10	J. W.	10	18, 12, 11½, 11½, 11, 11, 10½, 10½, 10, 10.	116	11.60				
10	H. W.	12	22, 20, 19, 13, 12, 12, 12, 11, 11, 10, 10, 10.	162	13.50				
10	P. A.	19	21, 20, 19, 11, 11, 11, 10, 10, 10, 10, 10, 10, 10, 9, 9, 9, 9, 9, 8.	216	11.37				
10	J. A.	5	12, 11, 11, 10, 10	54	10.80				
10	R. A.	5	20, 11, 10, 10, 9	60	12.00	60	730	12.17	June 10

TABLE I.—*Statement of salmon bought alive at Bucksport in* 1879—Continued.

Date.	Whence received.	Number of salmon.	Weight of salmon. Several weights.	Weight of salmon. Aggregate.	Weight of salmon. Average.	Daily summary. No. of salmon.	Daily summary. Weights. Aggregate.	Daily summary. Weights. Average.	Daily summary. Date.
1879.			*Pounds.*	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	1879.
June 11	A. H. W	10	15, 13, 12, 12, 12, 11, 11, 10, 10, 9.	115	11.50				
11	J. W	5	22, 12, 11, 10, 10	65	13.00				
11	H. W	3	12, 11, 11	34	11.33				
11	P. A	9	12, 12, 11, 11, 10, 10, 10, 10, 9	95	10.55				
11	J. A	6	13, 11, 11, 10, 10, 9	64	10.67				
11	R. A	2	11, 11	22	11.00	35	395	11.28	June 11
12	A. H. W	1	15	15	15.00				
12	J. W	3	12, 11, 10	33	11.00				
12	H. W	1	10	10	10.00				
12	P. A	5	23, 12, 11, 10, 10	66	13.20				
12	J. A	3	12, 11, 10	33	11.00				
12	R. A	1	12	12	12.00	14	169	12.07	June 12
13	A. H. W	5	22, 15, 13, 11, 10	71	14.20				
13	J. W	6	12, 11, 11, 10, 10, 9	63	10.50				
13	H. W	2	22, 10	32	16.00				
13	P. A	8	21, 15, 13, 12, 12, 11, 10, 10	104	13.00				
13	R. A	2	20, 13	33	16.50				
13	J. A	1	11	11	11.00	24	314	13.08	June 13
14	A. H. W	5	22, 12, 12, 11, 10	67	13 40				
14	J. W	2	12, 11	23	11.50				
14	H. W	4	14, 12, 11, 11	48	12.00				
14	P. A	6	15, 12, 11, 11, 11, 10	70	11.67				
14	J. A	1	12	12	12.00				
14	R. A	4	23½, 12, 11, 10	56½	14.12	22	276½	12.57	June 14
16	A. H. W	5	15, 13, 12, 12, 11	63	12.60				
16	J. W	8	22, 21, 12, 11, 11, 10, 10, 9	106	13.25				
16	H. W	6	22, 21, 13, 12, 11, 11	90	15.00				
16	P. A	1	10	10	10.00				
16	J. A	....		....	......				
16	R. A	3	13, 10, 9	32	10.67	23	301	13.09	June 16
18	A. H. W	5	12, 11, 10, 10, 9	52	10.40				
18	J. W	5	12, 12, 10, 10, 8	52	10.40				
18	H. W	7	20, 12, 11, 11, 10, 10, 10	84	12.00	17	188	11.06	June 18
19	A. H. W	7	15, 12, 11, 11, 10, 10, 9	78	11.14				
19	J. W	1	10	10	10.00				
19	H. W	3	17, 12, 10	39	13.00				
19	P. A	5	13, 12, 12, 10, 8	55	11.00				
19	J. A	2	16, 14	30	15.00				
19	R. A	3	13, 10, 9	32	10.67	21	244	11.62	June 19
21	A. H. W	25	22, 20, 20, 20, 19, 18, 18, 15, 13, 12, 12, 12, 12, 12, 11, 11, 11, 11, 11, 11, 11, 10, 10, 10, 10.	342	13.68				
21	J. W	6	22, 13, 13, 12, 12, 10	82	13.67				
21	H. W	10	21, 17, 13, 12, 12, 11, 11, 11, 10, 9.	127	12.70				
21	P. A	7	14, 12, 12, 11, 10, 10, 10	79	11.28	48	630	13.12	June 21
			Total	.....	....	264	3,247½	12.30	

TABLE II.—*Record of shipment of salmon spawn from Bucksport, December*, 1879.

Date.	Consignee.	Address.	On whose account.	For what State.	Number of eggs.			Hours on route.	Distance.	Date of arrival.	Date of unpacking.	Condition.	Died on journey.
					Belonging to State.	Donated by United States.	Total.						
									Miles.				
1879. Dec. 15	A. H. Powers	Plymouth, N. H.	New Hampshire commission.	New Hampshire.	22,500		22,500	24	351	Dec. 16		Poor	*8,000
16	...do	...do	Massachusetts commission.	Massachusetts	22,500		22,500	24	351	Dec. 17		Good.	78
24	...do	...do	New Hampshire commission.	New Hampshire.	8,000		8,000	48	351	Dec. 26		..do	38
17	H. J. Fenton	Windsor, Conn.	Connecticut commission.	Connecticut	60,000		60,000	44	343	10 a. m., Dec. 19	4 p. m., Dec. 19	..do	226
24	Mrs. J. H. Slack	Bloomsbury, N. J	New Jersey commission.	New Jersey		25,000	25,000	45	525	11 a. m., Dec. 26	2 p. m., Dec. 26	..do	80
24	T. B. Ferguson	Druid Hill Park, Baltimore, Md.	United States commission.	Maryland		62,500	62,500	50	661	4 p. m., Dec. 26	9 a. m., Dec. 27	..do	251
					113,000	87,500	200,500						

* These were all hatched on the way.

TABLE III.—*Statement of the hatching of Penobscot salmon eggs*, 1880.

In charge of hatching.	Place of hatching.	Total number of eggs sent to each establishment.	Died on journey.	Died in incubation.	Number hatched.	Died after hatching.	Sent out.	Actually planted.
A. H. Powers	Plymouth, N. H	53,500	*8,116	1,669	43,215	192	43,023	43,023
H. J. Fenton	Poquonock, Conn	60,000	226	880	58,894	610	58,000	58,000
A. A. Anderson	Bloomsbury, N. J	25,000	80	219	24,701	4,189	20,512	20,512
Frank Behler	Baltimore, Md	62,500	251	1,500	60,749	2,020	58,729	58,729
		200,500	8,673	4,268	187,559	7,011	180,264	180,264

*8,000 of these hatched on the journey.

TABLE IV.—*Distribution of Penobscot salmon reared from eggs collected in* 1879.

States.	Where finally hatched.	Waters stocked.	Tributaries in which fish were placed.	Locality.	Date of transfer.	Number of fish.
New Hampshire	Plymouth	Merrimack River	Pemigewasset River	Campton, Grafton County	Apr. 21, 1880	43,023
Connecticut	Poquonock	Farmington River, tributary to Connecticut River.	West Brook	Windsor, Hartford County	Apr. 10, 1880	10,000
		Do	Birch Brook	do	— —, 1880	6,000
		Do	Thrall's South Brook	do	— —, 1880	10,000
		Do	Thrall's North Brook	do	— —, 1880	10,000
		Do	White Brook	do	— —, 1880	10,000
		Do	Trout Brook	do	— —, 1880	12,000
New Jersey	Bloomsbury	Delaware River	Shumaker's Eddy	Warren County	Mar. 24, 1880	20,512
Pennsylvania	Baltimore, Md	Susquehanna River	Trout Run	Williamsport	Mar. 23, 1880	12,000
		Do	Juniata River	Huntington	Mar. 23, 1880	11,000
		Monocacy River	Rock Creek	Gettysburg	Apr. 9, 1880	7,729
		Potomac River	Conococheague Creek	Greencastle	Apr. 9, 1880	5,000
Maryland	Baltimore, Md	Monocacy River	Hunting Creek	Mechanictown	Mar. 24, 1880	3,000
		Monongahela River	Youghiogheny River	Oakland, Md	Apr. 5, 1880	10,000
		Chesapeake Bay	Potomac River	Piedmont	Apr. 6, 1880	10,000

TABLE V.—*Temperature of water in Dead Brook.*

Date.	Hour.	Temperature.	Date.	Hour.	Temperature.
1879.		*Deg. Fahr.*	1879.		*Deg. Fahr.*
June 9	8 a. m	60	July 9	7 a. m	61
11	8 a. m	55	10	7 a. m	62
12	8 a. m	55	11	7 a. m	63
21	8 a. m	62	15	10 a. m	71
25	8 a. m	70	16	10 a. m	71
29	8 a. m	67	17	8 a. m	71
30	8.30 a. m	66	18	9 a. m	66
July 2	7 a. m	64	21	7 a. m	67
3	7 a. m	66	22	8.30 a. m	67
5	7.30 a. m	64	23	9 a. m	64
6	8 a. m	64	27	9 a. m	62
7	8 a. m	62	Aug. 4	9 a. m	70
8	7 a. m	62	5	7.30 a. m	69

Average for 7 observations in June	62.14
Average for 17 observations in July	65.12
Average for 2 observations in August	69.50
Average for 26 observations between June 9 and August 5	64.65

TABLE VI.—*Temperature of water in hatching-house at Craig's Pond Brook.*

Date.	Hour.	Temperature.	Date.	Hour.	Temperature.
1879.		*Deg. Fahr.*	1879.		*Deg. Fahr.*
Oct. 25	3 p. m	51	Nov. 23	10 a. m	49
27	4 p. m	53	24	4 p. m	46
30	12 m	54	26	8 a. m	47
31	3.30 p. m	49	27	8 a. m	46
Nov. 2	11 a. m	50	28	11 a. m	50
3	4 p. m	50	29	12 m	50
5	4 p. m	49	30	9 a. m	44
7	3 p. m	51	Dec. 2	10 a. m	49
9	4 p. m	53	3	1 p. m	46
10	5 p. m	52	4	1 p. m	48
11	2 p. m	52	5	2 p. m	45
12	4 p. m	51	6	1 p. m	45
14	5 p. m	48	8	4 p. m	47
15	4 p. m	52	10	2 p. m	43
16	9 a. m	51	12	4 p. m	44
17	5 p. m	51	15	3 p. m	40
18	5 p. m	48	18	1 p. m	37
19	3 p. m	50	20	3 p. m	36
20	9 a. m	48	24		35

Average for 4 observations in October	51.75
Average for 22 observations in November	49.45
Average for 12 observations in December	42.92
Average for 38 observations between October 25 and December 24	47.63

XXIX.—REPORT ON THE PROPAGATION OF SCHOODIC SALMON IN 1879-'80.

By Charles G. Atkins

1.—Preparations.

The experience of the preceding season had demonstrated the usefulness of a developing-house by the side of the stream, and the experimental structure of that year was this year replaced by a permanent house of small size, measuring on the ground 18 by 22 feet. Were it necessary to use this house for the hatching of fish, it would be too small to be very effective; but as it is only used to bring a portion of the eggs through the earlier stages, the cold water retarding their development till, by shipment of earlier lots, room is made for them in the other house, a comparatively large capacity is secured by making the troughs very deep. The principal ones are 17 inches deep inside, accommodating our deepest frames, with 20 trays of eggs in each, and having a capacity of about 35,000 eggs to each foot in length of trough. There will be room for at least eight troughs, with an aggregate capacity of 2,560,000, and it is practicable to increase this 50 per cent. by making deeper troughs, and to even double it by submitting to considerable inconvenience in the routine work. The supply of water is practically unlimited, and its six-inch conduit now delivers from 60 to 100 gallons per minute, according to the head in the stream, which is affected by the rise and fall of a connecting mill-pond used by the tannery. The head of the conduit is in the stream, two rods from the shore, and, it is supposed, far enough out to secure a supply of water always pure, just as it comes from the lake.

Measures were also taken to increase the volume of water at the old hatching-house by laying a log aqueduct to a springy spot 21 rods distant, and 13 or 14 feet above the floor of the troughs; an opportunity is thus afforded for æration, which goes far to make up for the meager volume secured (only a gallon and a half per minute), and makes this an important addition to our supply.

The experience of the previous season had also suggested a removal of our fixtures for capturing and manipulating the fish to some point above the dam. A very convenient site was found on the west side of the stream opposite the head of the approach to the tannery canal, 230 feet above the dam. Here is near a quarter of an acre of shallow water, where we can locate all the inclosures needed for the management of a far greater supply of salmon than we have ever had. By stopping their descent at this point we shut them out from all spawning ground except a few square rods immediately above the nets. This insures us hereafter (accidents aside) practically the entire stock of breeding salmon belonging to this stream. An unpretentious shed was erected to shelter working parties, and the inclosures arranged about it with reference to convenient access.

2.—Fishing and spawning.

The season was ushered in by a heavy rainfall, August 17 and 18, which raised all the lakes and streams in this region. Grand Lake stood, August 20, at 3 feet 3 inches on our gauge, being 15 or 18 inches above its ordinary level at that season. It was doubtless in consequence of the increased volume of water that the unusual phenomenon of an August run of salmon down the stream occurred, and this run, or the presence of considerable numbers of salmon in the stream, continued until the spawning season. September 14, the last day of the open season, one man, fishing with a single baited hook, took 17 fish, and found them biting as freely as any day in June. The water afterwards fell to 2 feet 3 inches, at which point it held until the close of the spawning season.

Our first nets were put into the water three or four days prior to September 15, putting a stop to the descent of fish either in the canal or main stream. The canal net had to be lowered often for the passage of boats, and on these occasions a few salmon stole into the canal, but with these exceptions no fish are believed to have passed us after September 12. They were often to be seen leaping from the water above the barriers, and it was the opinion of some of the old residents that an unusually large run of fish was impending.

Nothing noteworthy occurred until the last of October, the time being occupied by the force at work in laying the aqueducts and building the new house. October 30 the inclosures at the spawning place were put in order for the capture of fish, which had been purposely avoided up to this date to save the injury from chafing, to which they are always more or less liable when in confinement. But the salmon having commenced the work of nest-digging in some spots on the 27th of October, it was deemed that the time had now come for their capture.

The early runs of fish were very satisfactory, 153 coming in the first night, 164 the second, and 119 the third. There was then a falling off until the night of November 5 and 6, when but 60 fish came in. All this time the males greatly exceeded the females, not only in the totals, but each night by itself. It was not until November 7–8 that the females presented themselves in equal numbers with the males. That night there were 41 of each sex taken, and the total up to that date was 563 males, 322 females. For the rest of the season the catch of females far exceeded that of males. The total for the season hardly bore out the great anticipations which some had formed in September, but was nevertheless quite respectable—938 males, 1,084 females, total 2,022. For the sake of comparison the numbers taken in other years may be given, as follows: 2,628 in 1875, 1,021 in 1876, 4,151 in 1877, 2,908 in 1878.

The most of the fish were measured, and the average length of the females was found to be 17.2 inches, and of the males 18.9 inches. The length of the females was the same as in 1878, but exceeded the average for 1875, 1876, and 1877 by 1, 1.5, 1.3 inches, respectively. The length of the males exceeded the average for 1875, 1876, 1877, and 1878 by about 2.1, 3.2, 2.1, .7 inches, respectively. The longest male was 24 inches, the shortest 15 inches; the longest female 22 inches, the shortest 13 inches.

The taking of spawn, which began November 7, proceeded without noteworthy incident until November 22, when the last fish were manipulated. In all, 978 females were deprived of their spawn, and yielded a total of 1,113,456 eggs, an average of 1,136 eggs each. According to our estimates the average yield for the first week was 1,205 eggs apiece. These are considerably higher averages than any other season. The average for 1877 was 1,066 eggs per female.

The ratio of impregnation, deduced by careful calculation later in the season, from the number of unimpregnated eggs found after the others were well developed, averaged 93.3 per cent. The best result (96.5 per cent.) was obtained November 19, in a lot counting 82,000 eggs; the poorest (75.6 per cent.) November 7, in a lot numbering 8,500. No novelties were introduced in the methods of manipulation; experience had convinced me that the methods generally followed here were the best for this species of fish. Many experiments were tried in 1877 and 1878 with a hope of discovering some mode of avoiding the serious loss by reason of non-impregnation, which has always troubled us at this establishment, but the results had not indicated any change in the essential features of our former practice. The prolongation of contact between the eggs and milt was found to effect no improvement in the desired direction, but to become, when excessive, a source of positive injury. One single experiment tried this year illustrates this fact. November 21 a batch of eggs numbering 27,156 was divided, the greater part being treated in the usual way, and the smaller part, numbering 5,156, were subjected to contact with the milt for 4 hours and 40 minutes. Of the former, 91.9 per cent. were found to be impregnated, and they turned out as good as average; the latter died, to the last egg, before development was completed, being one by one picked out and thrown away. Whether any improvement can be effected on the rate of impregnation attained this year I am in doubt. The prevalence of ovarian disease among the Schoodic salmon is, so far as can be seen, an irremediable difficulty, which will probably always result in quite a percentage of eggs incapable of impregnation and of others which, though they may be impregnated and develop through the earlier stages, are yet destined to perish in the egg or alevin stage.

3.—Development and shipment of the eggs.

The eggs were divided between the old and new houses, 655,000 being placed in the former and 458,000 in the latter. Only the ordinary losses were sustained, and as large a percentage—perhaps a little larger than usual—were brought up to the shipping stage. The unimpregnated eggs were removed from the most forward lots early in January, and from the later lots in March. Without dwelling on the details, the sum of eggs rejected was 74,614 unimpregnated and 46,842 that died from other causes, making a total of 121,456 by actual count, or 11.3 per cent. This loss left 992,000. The 25 per cent. reserve for the lake and stream amounted to 248,000, and the remainder, 744,000, were divided among the subscribers to the fund. The following statement shows the basis of the division, and the numbers of eggs falling to each party:

Party.	Contribution.	Ratio.	Quota of eggs.
United States	$1,400	$\frac{14}{24}$	434,000
Massachusetts	500	$\frac{5}{24}$	155,000
Connecticut	300	$\frac{3}{24}$	93,000
New Hampshire	200	$\frac{2}{24}$	62,000

The first shipments were made January 6, and others followed during the month, to the number of 570,000, which exhausted the supply in the old hatching-house. The remainder, being in the cold water of the new house, did not reach the proper stage for packing until March, and indeed would not have reached it until April had they not been removed to the old house in January, as soon as the early shipments made room for them.

The packing for transportation was performed after our usual manner, the only change made being the abandonment of sawdust as a packing material, and a slight reduction in the size of the outside cases. The employment of dry moss and leaves as an enveloping material enables us without risk to reduce the thickness of the envelope, with a resultant advantage in lessening the weight and cost of carriage. Speaking in the absence of any comparative test, I think that in dry sphagnous moss we have the most effective material that comes within a proper limit as to cost. It is exceedingly light, and an exceedingly poor conductor of heat. We find it on numerous peat bogs in the vicinity. When wet it is very soft, and the best material in which to imbed the eggs. To dry it we pull it in August or September and spread it thinly on some dry open ground, and wind and sun soon take away its moisture. Leaves are gathered in the neighboring forest, and are mostly beech and maple. It is a good deal of trouble to gather them, and should much wet weather prevail after their fall it may easily happen that in the hurry of fish-catching and spawning the few opportunities to gather them dry are neglected, and the first fall of snow lays them so flat to the ground that they never dry after it. So far as protecting the eggs against frost is concerned, I doubt whether dryness adds to the efficiency of either of these materials, but as deducting from their weight it is important.

The route by which the packages were formerly shipped was through Calais, from which point they were expressed by rail through Bangor to their various destinations. This route had the advantage of only twelve miles sledding to Princeton, from which place they went by rail to Calais, but the arrangement of winter trains was such that eggs had to lie over nearly a whole day in Calais as well as a night in Princeton, so that they were fifty-two hours on the route from Grand Lake Stream to Bangor. To save twenty-four hours of this time, I this year sent the cases from Princeton by stage to Forest Station, on the European and North American Railway. This subjected them to a five or six hours' ride in the open air, in the coldest part of the day, but my confidence in our mode of packing was justified by the event, for none were frozen.

The packages all went safely to their destinations, except one to France, which was a total loss. Of the twenty-seven sent to various points in this country, sixteen were reported as arriving in "good" condition; one, "O. K."; two, "excellent"; three, "very good"; one, "first-class"; one, "best ever received." None whatever opened in bad condition. The aggregate deaths of eggs in transit to all points in America were 6,621, being a little less than 1 per cent.

The success of those who managed the hatching was very uneven. In most cases the loss incurred was quite small, but in a few it was very large. As in the preceding season, the losses were generally greatest in those lots that were transported farthest. Those sent to Minnesota, however, sustained but a very small loss. The losses reported both before and after hatching amount to 101,910; the young fish sent out from the hatching-houses to 840,871; and those actually planted to 832,131. According to this statement there was a shrinkage of 159,869 between the shipment of the eggs and the final planting of the fish, and the small allowance to be made for the unreported lots hatched in New York and Wisconsin will not affect the result materially. To go still farther back, we find that of 1,113,456 eggs taken, 93.3 per cent. were impregnated, 89 per cent. brought to the shipping stage, and 75 per cent. brought to the feeding stage and turned free.

Appended will be found, 1st, a diary covering the time of the most important operations of the year; 2d, a record of fishing operations; 3d, a record of spawning operations; 4th, the result of the measurement of the fish; 5th, meteorological observations; 6th, a statement of the results of the development of the eggs at Grand Lake Stream; 7th, a record of the shipment of the spawn; 8th, a statement of the hatching of the eggs; 9th, a statement of the planting of the young fish.

4.—Extracts from Diary at Grand Lake Stream, 1879–'80.

Grand Lake Stream, September 2, 1879.—Munson says that he came up on the 20th of August, and that day noted the water to be 3 feet 3 inches on our mark above the dam, there being at the time a strong north wind. To-day, with a calm, I find it to be 2 feet 8½ inches. (But a small part of this difference is probably owing to the wind.) Mr. Munson had also observed a fall. The rain of August 17 and 18 undoubtedly caused a temporary rise.

Fish are now running on the stream. Haycock and Emerson fishing to-day and yesterday, took 7—all of them on the stream; tried the lake in vain.

Temperature of water in old hatching-house (in the woods near the "Milford Turnpike," an unfinished road) is 48° at 11 a. m; of Low's spring, just afterwards, 49°; but the sun was shining into the latter a little.

Munson has just finished getting in moss. Got 187 bushels dry and 100 bushels wet—all from a bog near the Princeton road, about two miles distant. (The moss was all *Sphagnum*. Drying was effected by spreading it on dry ground, exposed to sun and wind.)

Munson says that the past spring and summer the fishing was not quite so good as usual. The weather was cold, backward, and stormy until the season was well advanced. He thinks a good many have run through into the stream lately.

September 3.—Water at old hatching-house, at 6 a. m., 47½° F. In the stream at cottage, at 7 a. m., 66½°; at 4 p. m. (day sunny and warm), 69½° F.

I have estimated the volume of water at the old hatching-house, thus: 4 faucets, each fill a two-quart dish in 13 seconds; 2 others in 11 seconds each; 7th faucet and waste in about 40 seconds; this gives a total of 16.116 gallons per minute. From Low's spring I find, by same method, a flow of 2½ gallons per minute.

Low's spring by measurement to-day I find to be 20 feet 6 inches above the bank of Grand Lake Stream, 31 feet above the surface of the stream below the dam, and 28 feet 3 inches above the present level of Grand Lake. Its distance from the bank is about 662 feet, and from the water's edge about 686 feet.

Mr. Ferguson to-day caught 8 Schoodic salmon far down the stream. Six of them weigh as follows, respectively, viz: 2 pounds 9 ounces, 2 pounds 9 ounces, 2 pounds 3 ounces, 1 pound 8 ounces, 1 pound 15 ounces, 2 pounds 12 ounces. They thus average 2 pounds 4 ounces. Mr. Munson thinks the general average during the fishing season was fully equal to this. With the salmon Mr. Ferguson took a chub weighing 1 pound 3 ounces.

September 19.—Returned from Bucksport yesterday. Mr. Munson reports that since my last visit (first week in September) the fish (Schoodic salmon) have continued to run into the stream. Both he and

Ripley are of opinion that more fish have run past us than we shall catch this season. I don't think they are right. On the last day of fishing, September 14, Forbes caught 17, and he says they did not bite better at any time in spring or summer.

The nets were put in two or three days before the 15th instant.

Considerable progress has been made in a ditch which is intended to bring more spring water into the old hatching-house from a pool on the upper side of the turnpike, which appears to be filled by neighboring springs.

This afternoon I set my three men at work on the excavation for a hatching-house by the stream, on the site occupied by a temporary structure last year. We throw a dam of logs and stone across the stream and turn the water against the bank.

October 1, 1879.—Arrived again from Bucksport at 11 a. m., via Princeton and Big Lake. Water high for the season in Big Lake, but has lately fallen some. Has fallen slightly in Grand Lake.

I find the excavation for the new hatching-house by the stream completed or nearly so. The ditch for aqueduct to old hatching-house has progressed some and a very hard piece of ground reached where many rocks will require blasting.

October 9, 1879.—Having all the materials collected, we slack a cask of lime and begin digging a trench to receive a concrete foundation for our new hatching-house by the stream. This afternoon I find the ground in our excavation to be about 22 inches below the level of the mill-pond from which we must take our supply of water and eight inches higher than the stream at the point at which the hatching-house must discharge. The stream has perhaps been raised a little at this point by our *debris* being driven into it just below. The ground here is all clay—no bowlders except on the surface.

Munson and Ripley to-day finished blasting in the aqueduct ditch, which is now very nearly complete. The first water was struck 260 feet from the hatching-house, where a small vein oozed out of the east bank; several veins above that before reaching the pool. Total length 330 feet = 20 rods. At a rough estimate there is five feet fall from bottom of upper end of the ditch to the eaves of the hatching-house, at which height I propose to take the water into the building. Surface of pool is three feet higher still. North of this pool, on a hillside, at a distance of 500 feet and an elevation of nearly 25 feet above this pool, is a large spring, whose waters spread over a good deal of ground and then sink out of sight. I shall make my arrangements to lead this, at some future time, into the aqueduct laid this fall. (This was accomplished the next season.) I shall lay an aqueduct of logs, using $2\frac{1}{2}$-inch bore below the road, and $1\frac{3}{4}$ above it. The logs are partly bored already. Mr. William Cavanagh, of Saint Stephen, is doing the work. We use green Norway pine sticks, 7 inches at the top for small bore and 9 inches for large, 14 to 16 feet long.

October 9.—In half an hour in a boat above the dam I see four salmon leaps. Everybody says they are plenty up there. I have not had time to hunt them.

October 15.—The foundation of our new hatching-house by the stream completed to-day. Dimensions, 22 by 18 feet; rather too small an affair, it seems, to write much about, but yet with our deep troughs it has a capacity of 2,560,000.

The foundation is 18 inches thick at the bottom, and narrows up some at top. The ground being already excavated to a level about 6 or 8 inches above the surface of the stream alongside, we excavated a trench for the foundations two feet deep on the northeast and southeast sides, 18 inches deep on the west side. This trench was filled by pouring in a mass of concrete upon the bottom, bedding large stones upon it, and filling in with concrete. The stones were settled into place by heavy wooden mauls, and the same and also smaller ones were used in ramming the concrete into place. After we reached the top of the ground we began carefully placing large stone, and thus built up 15 or 16 inches higher, at which level I propose to lay the sills. The high water of spring will therefore wet our walls some distance above the sills, but we can at any time in the future jack up the building and build the walls higher. The concrete used in this work consisted as follows: 1 part dry London Portland cement; 1 part slacked-lime paste (Rockland lime); 5 parts fine sharp sand; about 7 parts stream gravel of mixed sizes. All were measured in a pail, except the gravel, which was estimated in a heap; water not measured. The mortar for laying the first stone above the ground was 1 part London Portland cement, 1 part lime-paste, 6 parts sand. Thence up we used 3 parts Rosendale cement, including a little lime-paste, 3 parts sand.

October 17, 1879.—Conclude with F. Shaw & Bros. lease of fishery rights, &c., for five years, with privilege of renewing for five more.

Measured volume of water flowing into the old hatching-house, and found 8.24 gallons per minute. Our aqueduct was laid yesterday, but water was shut off to fix the inlet, so that above represents the volume of the original spring. I am sure that not one-twentieth of it comes from the brook.

October 18.—Measured (roughly) the volume of water in the spring north of Forbes's house (this was on the site since selected for a third hatching-house), and found it to be between one and two gallons per minute. Low's spring gives to-day .714 gallon per minute.

October 20.—Left Grand Lake Stream for Bucksport.

October 26.—Back again at Grand Lake Stream. This afternoon, being in boat up the lake as far as the Sister Islands (two miles from the dam), measured temperature of water in several places. On sunny southerly side of Sister Island, out of the wind, I found 51° F. On northerly side I find 50°; on surface of lake, in deep water, below Munson's Island, 49°; in stream at our house, just after our return, I find 47°.

On the shore of Sister Islands, in edge of water, I picked up a stone (granite) twice as big as my hand, which, like all the other stones, is covered with an olive-green slime. I brought it down and on putting it into a dish of water find the slime is a forest of growing plants of several kinds; in this is a multitude of living creatures, mostly entomostraca, a good many slender larvæ of insects, several kinds, and half a dozen amphipod crustacea of the common sort, which I take to be *Gammarus fasciatus* Say, as per S. I. Smith, in the United States Fish Commission 2d Report, p. 653. Altogether, judging roughly, I should say that there are probably more than 500 animals large enough to be seen with the naked eye on this stone, say 10 *Gammarus*, 20 gastropod mollusks, 100 insect larvæ, and 400 entomostraca. The entire bottom at this place, being covered by a similar growth of vegetation, I suppose it is equally well populated with animals. Sandy bottom, or gravel fine enough to be disturbed by waves, is, of course, a less favorable place.

October 27.—At the dam to-day I could see no indications of spawning. A net was put in immediately above the dam on 21st. (The main net, crossing the stream and barring access to it from the lake at the point where our pounds are to be located, was put in place prior to September 15. This one near the dam is to act as a safeguard and assist in the capture of some stray fish between the upper net and the dam.) On the gravels below the dam the fish have begun to dig nests as usual.

October 29.—To-day we begin setting stakes for pounds above the dam, at the same place as last year, and substantially on the same plans. Shall add some large pounds and locate our spawning-shed there.

October 30.—Finished nearly all the upper pounds at the spawning place (same referred to on 29th), and put them in shape for catching fish. One male came in during the day. Changed the net opposite the house (in the stream below the dam), putting it up at the head of the run and gravels; have contrived a trap in connection with it, but this is not quite completed.

At the old-hatching house I found the temperature of the water in the spring to be 47° F. In the feed-trough in the house it is 46½° F.

At 11 a. m. to-day the volume of water inside the old hatching-house was 17.22 gallons per minute, the several faucets yielding from 2.14 to 4.28 gallons per minute. The aqueduct water is not yet admitted, and very little brook water is coming in.

October 31.—Finished pounds, all except that intended for twice-spawned fish. Also got the trap below the dam on the gravels in order for service.

November 1.—This p. m. the aqueduct was delivering 3.75 gallons per minute of muddy water of 40° F. temperature. The supply in old hatching-house from other sources amounts to 17.21 gallons per minute of a temperature of 46°. Low's spring yields 3 gallons per minute, of temperature of 47°.

November 3.—The new hatching-house by the stream is nearly completed. Troughs and conduits still to be arranged. The troughs of the old hatching-house were taken out into a shed in the spring. Of late they have all been cut in two (now 10 and 14 feet long), varnished with two coats of asphaltum, and replaced.

We get no female fish below the dam. Judging from what I can see of the fish in the pool immediately below the dam, I think several hundred are there, but I believe them to be mostly males. One good nest was made on night of 1st just above our net across the west run. Yesterday I looked for other recent works below the dam, but found none. Above the dam no nests started yet. Net still in place about 20 feet above the dam. This afternoon I saw three fish there—one female, two males.

One of our nets, that separating the second and third pound, dips its upper line 2 inches below the surface of the water, but I think no fish have passed over it. This evening, at 9, Munson examined the third pound carefully, and found no fish in it. (I find these fish are much more inclined to force their way under an obstruction than over it. Yet they will sometimes search the nets for holes several inches above the surface of the water, standing bolt upright, with their heads entirely out of water, and working along inch by inch, and occasionally they will leap quite out of the water in attempting to scale the barriers. These phenomena have, however, come under my observation only when large numbers of the fish are crowded together.)

November 4.—This morning I found among the females taken above the dam one that was surely ripe. We have tried none of our captured fish yet.

November 6.—This forenoon early Mr. Munson found a great run of smelts at the spawning shed (above the dam). He said he could have dipped any number if they had not been so shy and quick. As it was he dipped 150 or 200, which I have preserved. They are mature, showing clearly spawn and milt through their transparent bellies. [These smelts are among the most diminutive of their genus, averaging in length but little more than 2 inches. They are found in several if not all of the Schoodic lakes. In one of the tributaries of "Upper Dobsy" Lake (Indian name *Sysladobsis-sis*) they are wont to spawn late in the month of February.]

Meshed in a net we found a Schoodic salmon $9\frac{1}{2}$ inches long, weighing 7 ounces; red spots plainly to be seen, but not very bright; the dark bars on the sides very faint; sex, male, yielding milt.

November 7.—Began taking spawn. There are but few ripe fish. Below the dam fish appear to be numerous, but we have not caught many yet. Our trap does not work first rate. I dipped this evening on a spawning-bed a male Schoodic salmon, $7\frac{3}{4}$ inches long, weighing $3\frac{1}{2}$

ounces, very ripe with milt, with red spots and bars still very distinct. There are a good many of these here. I have never observed many of them before. Indeed, when the men got me two specimens of that size last season I regarded them as the first I had ever seen. It may be (though not probable) that they have always been present but mistaken by me for chubs or young trout. I think I have always been too much on the alert to be so deceived. By lamp-light their distinctive marks are not visible while the fish are swimming in the water, but by daylight, standing on a pier of the dam, I see one of them in the stream unmistakably marked.

November 9.—Fish have been coming in slowly and a good many of them are spawning outside of our nets, though few of those we have taken have appeared ripe. I should say that half a dozen pretty good nests have been made at the head of the "west run" (a narrow channel between the shore and the gravels below the dam) and as many more commenced there. Below the lower nets three or four nests are completed, or nearly so, and others begun. That is all below the dam. Above the dam, near the approach to the sluice-gate, one nest is in process of making, and I see the pair on it to-day. Just above our "damnet" are, say, eight or ten pretty complete nests. Between that and our upper nets there are, say, ten or twelve nests partially made, of which three or four are nearly complete, besides a dozen spots where fish seem to have been working a very little. Above our upper nets I see about 8 nests, but none of them complete. On the gravels above our spawning-shed fish are now spawning, and I propose to have them fenced off to-night. Some of the fish in our main pound are beginning to spawn.

Between our dam-net and upper net (a space measuring about an acre) are a good many fish; I should think 200 or 300. We have tried in vain to drive them up under the lifted nets, and now propose to sweep that pool with a large seine to-morrow. Fish do not run up through the dam from the pool below to any great extent at this time. Since October 21 we have had a net stretched across the stream 20 feet above the dam to intercept them, and in the space left between this net and the dam I have at no time seen more than a dozen fish, and only one nest has been commenced there, though it is an excellent spot for spawning. [In 1878 we used this space as a trap for fish descending, lifting the net by a long line leading ashore, and at set hours during the night letting it suddenly fall and entrapping all the fish that had sought this spawning-bed. We could not then determine whether the fish caught came from above or from below, but our experience this season indicates that they came from above, and that the fish that occupy by day the great pool below the dam seek spawning-beds on the gravels below them, and not above. This is another manifestation of the instinct of the Schoodic salmon to move downward instead of upward to seek spawning-ground.]

Very few fish have got into the canal this season. Less than a dozen have thus far been seen there.

November 10.—We got our seine (264 feet long) into the water at 10½ a. m., and it took till past three to get it hauled in. We took in all 534 fish, 269 males and 265 females. How these fish came there is unknown, but it is possible that the most of them were lying in this pool when the nets were put in place above and below them. This might be made a receptacle for early-caught fish hereafter.

November 12.—To-day we finished the first overhauling of our main pound, containing all the salmon caught prior to November 7. There were found to be 1,298 salmon, of which 639 were males and 659 females, of which latter 231 only were ripe.

We have now had in hand and entered on the record all the fish caught up to this date, and find them to be 807 females and 807 males. Compared with our fishing record this shows a deficit of 262 males and 99 females, and one whose sex was unknown; total, 362. That is to say, our fishing record shows 362 fish taken into our inclosures more than were found therein. Either some have escaped from us, or, as appears more probable, have stolen under the chains that weight down our nets from the main pound to the one from which the fish are dipped, and thus been dipped up and counted a second time. Such deficits occur every year.

The catch in the trap below the dam has come to a close, apparently by the whole of the fish below the dam being caught up. The net above the dam was put in place October 21, since which time no fish have been able to descend the stream past that point. Hence we have the data for a rough estimate of the number of salmon that descended before that time. Of such fish there were captured 287, of which 168 were males and 119 females. These had been congregated in the deep pool below the dam. If we estimate 50 per cent. of this number to have descended the stream still farther, we have a total of 430 salmon that descended into the stream before October 21; allow 100 per cent. and we have a total of 574, which I think is quite up to the possibilities of the case.

November 13.—We have now handled 1,622 salmon, of which 807 were males and 815 were females. Of the females only 282 have been found gravid and ripe, and these have yielded 339,400 eggs, or 1,205 eggs each. This is an uncommonly heavy yield for Schoodic salmon, indicating what our record of measurement shows, that within a few years the fish have increased in size.

November 15.—The fish in our main pound are very restive—that is, a part of them are. A few are evidently spawning. I find ten nests under way in this inclosure, but don't think many eggs have been laid. I therefore decide to begin overhauling the main pound again to-day.

Weather remarkably mild and favorable. Last week the lower lakes were frozen so that the steamer could not come up from Princeton. On the night of the 5th the temperature of the air fell to 10° F., but since the 7th it has stood constantly above the freezing point.

November 16.—Have put into the old hatching-house 655,100 eggs, all I think prudent to trust there this year, and shall fit up the troughs in the new house for the remainder of the crop.

November 17.—Set the reservoir tank, the head trough, and two deep hatching-troughs in the new house, and at once placed eggs therein.

November 19.—Examined lot 1 to-day, and find that the embryonic disk now covers about one-third of the yelk. Out of 100 only 75 appeared to be developing, indicating a loss of 25 per cent. from non-impregnation. [This is afterwards determined to be very nearly correct, but it was an exceptionally poor lot.]

November 21.—The embryonic disk in lot 1 (14 days from impregnation) now covers half of the yelk. In lot 2 (10 days from impregnation) it is just beginning to expand.

November 22.—To-day we admit to the old hatching-house a new supply of water, derived from the brook that flows past, which up to this date has been shut out the present season, pending the preparation of a pool for it to clarify itself in. This new supply increases the volume in the hatching-house from 10¼ gallons to 14¾ gallons per minute and lowers its temperature from 46½° to 45° F. It will thus nearly double the capacity of the house. The water from the new aqueduct is not yet admitted.

Grand Lake was frozen over last night as far up as Cedar Island (¾ mile above the dam), but a scow was to-day forced through the ice.

To-day we finish taking eggs and carry up 800 of our fish and liberate them in the lake from 1 to 2 miles distant.

November 23.—By filling an empty trough and making a careful allowance for leakage, I compute that each of the three troughs in the new hatching-house is to-day using 17.7 gallons of water per minute, and that three times as much is flowing to waste; that gives 53 gallons in the troughs and 53 gallons waste, a total of 106 gallons per minute. The size of the conduit is six inches square; its fall and length not accurately ascertained, but the grade is near 1 in 1,000. This is while the mills are shut down; with the mills running the head and the volume in the hatching-house would be somewhat less. [Afterwards ascertained to be 30 per cent. less.] The dams that control the water at the lower ends of these troughs are leaky, and in case of a stoppage of water would leak dry in a short time, estimated at from 16 to 26 minutes. On inquiring of Mr. Munson, I learn that he purposely left leaks at the bottom of the dams to create a bottom draft, lest there should be too strong a surface current at the expense of the lower trays of eggs. He and Mr. Buck did that last year, having observed that the sediment settled much more on the lower than the upper trays, indicating that the surface current was the stronger. I approve this, and also approve putting in cross-boards just above the dam, both at surface and bottom, to prevent these two currents being too direct, thus robbing the middle trays of proper circulation. The leaking out of the water when the flow ceases is also of advantage, in that it secures the eggs against danger of stagnant water, which is much more to be feared than exposure to air with accompanying danger of freezing in any except the coldest of hatching-houses.

November 25.—About 17 gallons of water per minute flowing in the old hatching-house. We have laid some gravel drains to lead tributary springs into the pool whence starts our aqueduct.

November 26.—The old hatching-house has to-day a supply of about 14.6 gallons of water per minute; temperature in the troughs, 45° F.; the main spring being 46½° F. At the new hatching-house the volume is 12 gallons per minute for each trough, temperature 35° F.

At Low's spring a volume of 2.15 gallons per minute, and at the spring near the cove about 5 gallons per minute.

Aqueduct at the old house discharging about 1½ gallon per minute.

In lot 1 (19 days from impregnation), the yelk is four-fifths covered by the embryonic disk. In lot 2 (15 days from impregnation), the yelk is one-half covered.

Ice has closed the lake as far as Cedar Island since the 23d. We broke through it this forenoon with the expectation of carrying the rest of our fish up the lake, but the wind was boisterous and the cold closed the new channel so fast that we were compelled to delay still further the liberation of the fish. Commenced taking out the nets.

November 30.—Heavy rain yesterday morning and warm weather took off all the snow and a great part of the frost out of the ground, and so weakened the ice in Grand Lake (which had only been frozen as far as Cedar Island) that a crew of tannery men broke a channel through to open water this forenoon. In the afternoon our men carried up four boat-loads of fish and liberated them; we have very few left on hand.

The rain gave us in our aqueduct a great flood of water, which was, however, very muddy, from our newly filled ditches. To-day the flood has somewhat sudsided, about 15 gallons per minute now discharging, and it is much clearer, but not yet clear enough to use in the hatching-house, to which it has not yet been admitted. The brook rose also and was shut out of the house yesterday morning. For the present the old spring (also much swollen but not muddy) gives us an ample supply of water.

At the new hatching-house the water grew very clayey early in the thaw, and continued so all of yesterday, but to-day is nearly as clear as ever. Mr. Munson says not a great deal of sediment on the eggs, and what there is washes off readily, unlike the sediment that came into this house last year from the brook, which seemed to "stick." This clayey water must get into the conduit through cracks at the joints, and when the filling is well settled it will doubtless cease to flow. This conduit is 153 feet long, and has its head in the stream about 2 rods from the bank, where I suppose it will receive pretty pure lake water, the brook water following the shore and running *over* the conduit. This brook is the same that runs by the old hatching-house, whose discharge it receives, but in the half mile between the two houses it runs most of the way through peaty bogs and alder swamps and receives the drainage of several potato fields and stable yards, for which reasons we shut it out from the stream house.

December 1.—On November 27 and 30 and to-day I have examined lots 2, 3, 4, 5, 6, and 7 with especial reference to their impregnation, with following results:

Number of lot.	Date of impregnation.	Date of examination.	Number of eggs examined.	Number found unimpregnated.	Impregnated, rate per cent.
2	Nov. 11	Nov. 27 Nov. 30	6,900	630	90.87
3	Nov. 12	Nov. 30	1,350	153	88.75
4	Nov. 13	Nov. 30	1,800	120	93.33
5	Nov. 15	Dec. 1	1,200	86	92.84
6	Nov. 15	Dec. 1	4,600	256	94.44
7	Nov. 15	Dec. 1	1,600	156	90.25

This is strictly correct as far as it goes, each egg having been closely scrutinized, and in the case of the larger lots, as 2 and 6, samples for examination were taken from 14 to 23 different parts of the lot.

December 3.—At 4.30 a. m. leave Grand Lake Stream for Bucksport. W. H. Munson, as usual, is left in charge of the eggs.

January 3, 1880.—Arrived from Bucksport last night about 12 o'clock. I find to-day that everything is in good order.

The eggs in the old hatching-house all show colored eyes, pretty dark in the earliest ones, very light in the others, being just discernible. I measure the volume of water flowing and find it to be 16.8 gallons. About 1½ gallons of this comes from the new aqueduct, the rest from the brook and spring. Mr. Munson says this is the lowest stage of the water at this house since I left, a month ago. For the most part the faucets have been running very full; it has dropped off only within a few days. At time of the heavy rains the aqueduct water was very muddy and had to be turned off; in fact it was not turned into the hatching-troughs at all until after that. The brook was somewhat muddy (not very), and was turned off for a short time. The spring gave a great abundance of clear water through all the rains.

January 6, 1880.—Made first shipment of spawn to-day. The mode of packing has not been essentially changed since this establishment was first opened. We have, however, discontinued the use of sawdust as a material for outside packing. This year we have a supply of dry moss and dry leaves. The cases always leave the hatching-house about half past two in the afternoon, are taken by Princeton, 12 miles, and there remain over night, under cover, and generally in a warm room. The next morning they are taken by the "stage," a journey of five hours and 28½ miles, to Forest Station, on the European and North American Railway, where they are delivered to the American Express Company about noon. That evening they reach Bangor, and those bound out of the State reach Boston next morning.

January 20.—Transferred to the old hatching-house all the eggs in the new house except about 80,000.

The water running in the old house is now restricted to 3 faucets; has been so for several weeks. The volume to-day is 15.31 gallons per minute. I expect the volume to diminish during the month to come. The aqueduct yields just about 1½ gallon per minute. This is not strictly pure water, but very near it. A pailful has a slightly clayey tinge.

January 22.—We have now sent away 550,000 eggs. This embraces all of the eggs taken up to November 15, inclusive, except 39,000 left in the troughs. These were originally estimated at 605,000. Thus they measure out within 16,000 of original estimate. As many more than that have been picked out, the original estimate must have been too low. (The number given in the tabular statements is a revised estimate based on the measure now made.)

January 26.—Having now sent away all the eggs that are developed enough to go, shipments must be suspended until other lots brought out from the new house can be sufficiently developed. Temperature of the water in the new house is now 34°, and in the old house 40° F.

March 6.—Returned from Bucksport last night. Water has been very abundant. The volume flowing at old hatching-house to-day I estimate at 31.15 gallons per minute, of which 3¾ gallons comes from the aqueduct. The brook water is now shut out. The aqueduct water has been clear except on one occasion in February. All the eggs are now in the old hatching-house. The last were brought out March 2, and are now so well advanced that the eyes show a little color.

The earliest eggs taken, November 7, began to hatch February 17, were half out February 23, and all out March 1. These have been all the time in the old hatching-house in water averaging 46.36° F. in November, 41.30° in December, 40.33° in January, 39.41° in February, a general average of nearly 42°, and an average period of 108 days. Eggs taken November 15 are just beginning to hatch.

5.—Tabular statements.

Table I.—*Record of fishing at Grand Lake Stream, Maine, October and November, 1879.*

Date.	Weather during the night.	Height of Grand Lake, 7 a. m.	Temperature. Air, 7 a. m.	Temperature. Water, 7 a. m.	Schoodic salmon caught. Catch in detail. Hour.	Catch in detail. Males.	Catch in detail. Females.	Catch in detail. Unknown.	Catch in detail. Total.	Daily summary. Males.	Daily summary. Females.	Daily summary. Unknown.	Daily summary. Total.	Notes.
1879.		*Ft. In.*												
Oct. 30, 31	Full moon 29th; flying clouds; strong northwest wind all night.	2 4	36	47	9 p. m.	70	23	....	93					1 togue; 1 whitefish; both in upper pounds.
					7 a. m.	47	12	1	60	117	35	1	153	
Oct. 31, Nov. 1	Mostly clear; strong northwest wind all night.	2 4½	36	44	9 p. m.	69	33	....	102					1 togue; 1 whitefish; both in upper pounds.
					7 a. m.	44	18	....	62	113	51	....	164	
Nov. 1, 2	Clear all night; moon rises 6.8 p. m.; wind fresh northwest most of night, dying away toward morning.	....	20	42	9 p. m.	43	47	....	90					
					7 a. m.	20	9	....	29	63	56	....	119	
Nov. 2, 3	Cloudy	2 3¾	23	42½	9 p. m.	21	11	....	32					
					7 a. m.	12	9	....	21	33	20	....	53	
Nov. 3, 4	Cloudy; snow at 11.40 p. m.; wind in evening gentle northeast, changing in morning to north, strong or very strong; moon rises at 7.52 p. m.	....	25	40½	9 p. m.	50	19	....	69					
					7 a. m.	12	6	....	18	62	25	....	87	
Nov. 4, 5	Evening dark; toward morning clearer; wind ceased at 10 p. m.	....	22	40	9 p. m.	29	16	....	45					1 whitefish.
					7 a. m.	27	21	....	48	56	37	....	93	
Nov. 5, 6	Clear all night; moon rises at 9.56 p. m.; wind in evening light northwest, dying completely away before midnight.	2 3¼	10	38½	9 p. m.	18	13	....	31					1 whitefish; 1 small male Schoodic salmon, 9½ inches long, 7 ounces weight, yielding milt.
					7 a. m.	5	4	....	9	23	17	....	40	
Nov. 6, 7	Clear in evening, cloudy after 8 or 9 p. m.; wind none in evening, very little afterward; light snow occasionally after 10 o'clock.	....	28	40	9 p. m.	38	28	....	66					1 brook trout (*S. fontinalis*) in lower pound.
					7 a. m.	17	12	....	29	55	40	....	95	
Nov. 7, 8	....	2 3	35	40½	9 p. m.	24	25	....	49					
					7 a. m.	17	16	....	33	41	41	....	82	

TABLE I.—*Record of fishing at Grand Lake Stream, Maine, October and November, 1879*—Continued.

Date.	Weather during the night.	Height of Grand Lake, 7 a. m.	Temperature.		Schoodic salmon caught.									Notes
					Catch in detail.					Daily summary.				
			Air, 7 a. m.	Water, 7 a. m.	Hour.	Males.	Females.	Unknown.	Total.	Males.	Females.	Unknown.	Total.	
1879.		*Ft. In.*												
Nov. 8, 9	Mostly cloudy; calm, with a slight squall and hail at 2 a. m.	....	38	41	9 p. m.	13	20	....	33	......	......	....	......	1 whitefish.
					8 a. m.	10	27	....	37					
										23	47	....	70	
Nov. 9, 10	Evening clear, but very dark; moon rises at 1.20 a. m.; slight snow-squall at 11.30 p. m., followed by rain, which was heavy about 1 a. m., and light afterward; total fall, 0.15 inch.	2 8	54	41	9 p. m.	30	68	...	98	......	......	....	......	1 whitefish.
					12 midnight	12	17	....	29					
					7 a. m.	14	14	....	28					
										56	99	....	155	
					3 p. m.	269	265	....	534	269	265	....	534	Seined from space between our upper trap and the dam; probably all new fish, but possibly part of them escaped from our main pound.
Nov. 10, 11	Evening clear, but dark, with fresh northwest wind; wind increased after midnight, with flying clouds.	....	34	41½	7 p. m.	15	13	....	28	......	......	....	......	Several whitefish.
					9 and 11 p. m.	38	91	....	129					
					7 a. m.	67	46	....	113					
										120	150	0	270	
Nov. 11, 12	Evening dark and calm; snow, with light northerly wind, began at midnight and continued light till morning.	....	34	42	7 p. m.	4	4	0	8	......	......	....	......	4 whitefish.
					9 p. m.	3	2	0	4					
					11 p. m.	0	4	0	4					
					12 p. m.	27	6	0	33					
					7 a. m.	5	7	0	12					
										38	23	0	61	
										1,069	906	1	1,976	
										262	99	1	362	Deduct deficiencies found November 12.
										807	807	0	1,614	Remainder.
Nov. 12, 13	Evening clear, with northerly wind, gentle; wind increased to fresh at 10 and so continued all night, with cloudy sky.	....	36	42½	7 p. m.	1	4	0	5					
					9 p. m.	3	9	0	12					
					11 p. m.	0	5	0	5					
					7 a. m.	8	34	0	42					
										12	52	....	64	

Nov. 13, 14	Calm and cloudy		42	43	7 p. m.	20	26	0	46				
					9 p. m.	0	6	0	6				
					11 p. m.	3	12	0	15				
					7 a. m.	11	17	0	28	34	61	0	95
Nov. 14, 15	Dark; light rain all night; wind south, strong in evening; lighter toward morning.	2 2½	53	44	7 p. m.	10	22	0	32				
					9 p. m.	2	7	0	9				
					11 p. m.	5	8	0	13				
					7 a. m.	5	10	0	15	22	47	0	69
Nov. 15, 16	Wind light west, shifting to fresh northwest early in evening.		34	43	7 and 10 p. m.	13	47	0	60				
					7 a. m.	10	20	0	30	23	67	0	90
Nov. 16, 17	Calm; clear at first, clouded toward morning.	2 2¾	34	43	7 p. m.	5	15	0	20				
					9 p. m.	3	8	0	11				
					11 p. m.	1	3	0	4				
					7 a. m.	2	4	0	6	11	30	0	41
Nov. 17, 18	Wind easterly; cloudy		28	41½	10 p. m. and 7 a. m.	6	9	0	15	6	9	0	15
Nov. 18, 19	Wind northeast, changing about midnight to north, light to fresh; snow till 1; after clearing.		24	39	10 p. m. and 7 a. m.	7	5	0	12	7	5	0	12
Nov. 19, 20	Cloudy, with wind very light northeasterly		28	40	7, 9, and 11 p. m.	6	4	0	10	6	4	0	10
Nov. 20, 21	Snow in evening; clear after 11 p. m		15	37						10	2	0	12
	Total									938	1,084	0	2,022

TABLE II.—*Record of spawning operations, Grand Lake Stream, 1879.*

Date.	Remarks.	Fish at first handling.						Females spawned.	Females respawned.	Eggs.			Remarks.
		Total.	Males.	Females.						Number.	Lot.	Impregnation, per cent.	
				Unripe.	Ripe.	Spent.	Total.						
1870. Nov. 7	All taken below dam up to this date	103	71	23	9	0	32	9		8, 500	1	75. 6	
11	Respawning same								9				
11	At upper trap last night at 10 and 11	108	30	64	14	0	78			261, 500	2	91. 0	
11	At upper trap this morning	113	67	26	20	0	46	239					
11	Main pound	1, 136	561	356	205	14	575						
12	do	162	78	54	26	4	84	26		31, 000	3	88. 0	
13	Respawning fish of 11th and 12th							8	265	38, 900	4	92. 8	
	Summary to date	1, 622	807	523	274	18	815	282	274	339, 900			282 females yield 339,900 eggs=1,205 eggs each.
15	Fish of last night	69	22	18	26	3	47	26		33, 700	5	93. 7	
15	Part of main pound							248		249, 000	6	93. 6	
15	Fish of this evening	63	13	5	41	4	50	41		33, 000	7	88. 5	
17	Respawning								315	45, 000	8	81. 7	New hatching-house.
18	From main pound							116					
								122					
18	Fish taken this evening	6	3	0	2	1	3	2		260, 000	9	96. 2	
18	From part of fish taken since Saturday	74	26	4	32	12	48	32					
19	This morning's catch	7	5	2			2	2					
19	Remainder taken since Saturday	8	4		4		4	4		82, 000	10	96. 5	
19	Remainder of main pound							1					
19	Rehandling of fish found unripe on 15th							81					
20	Respawning								299	42, 000	11	95. 7	
21	do								61	22, 000	12	91. 9	Usual way.
21	Fish taken last night and others handled before, mixed.							21		5, 156	13		Kept in milt 4 hours and 40 minutes. Afterward all died.
22	Final spawning								24	1, 700	14	81. 4	
	Total	1, 849	880	552	379	38	969	978	970	1, 113, 456	14	93. 3	978 females yield 1,113,456 eggs=1,136 eggs each.

TABLE III.—*Measurement of Schoodic salmon, Grand Lake Stream, Maine,* 1879.

Date.	Males.				Females.			
	Number measured.	Length.			Number measured.	Length.		
		Average.	Longest.	Shortest.		Average.	Longest.	Shortest.
1879.		*Inches.*	*Inches.*	*Inches.*		*Inches.*	*Inches.*	*Inches.*
Nov. 7	70	18.8	24	16	32	17.2	20	15
Nov. 15	515	19.0	22¼	15	427	16.8	22	14
Nov. 18	245	18.7	23½	15	270	17.6	21½	14½
Nov. 19	37	18.8	22	15	61	17.9	20	13
Sums	866	18.9	24	15	790	17.2	22	13

TABLE IV.—*Observations on temperature and weather at Grand Lake Stream.*

Date.	Temperature.				Height of Grand Lake.	Wind.	Other phenomena.
	Air.	Water.					
		Stream.	Old hatching-house.	New hatching-house.			
	7 a. m.	7 a. m.	a. m.	a. m.			
1879					*Ft. In.*		
Aug. 20					3 3	N., strong	
Sept. 2			48		2 8½	Calm	
3		66½	47½				
19		61½	48½				
20					2 7¼	Calm morning	Mostly cl'dy: li't showers.
21	48	61			2 8	Northerly, gentle to fresh	
Oct. 1			48			Light westerly	Mostly clear.
2	55	62				NW., brisk a. m.; calm p. m	Clear.
3	60	61½	48			S. to NW., variable; light to fresh.	Clear to cloudy; variable.
4	51	61				NW., very strong	Clear.
5	49	59	47½			NE., light	Cloudy.
6	38	58			2 7	NW., gentle	Clear.
7	45	58½				Westerly, gentle	Do.
8	60	59½				NW., gentle	Clear at 2 p. m.; air 84°; water of stream 62½°.
9	65	62			2 6¾	NE. to SE., variable, gentle	Clear.
10	53	62½				NE., gentle	Cloudy and light rain.
11	40	58½				Easterly, light	Cloudy.
12	45	58				Northerly	Do.
13	48	56½				NW., strong	Clear.
14	45	53				do	Do.
15	45	53				do	Cloudy; light rain morning and evening.
16	52	54	48			do	Clear, after rainy morning.
17					2 4¼	SW., light	Clear; warm.
18	51	56				S., light	Cloudy; rain at 10 p. m.
19	56	56				NW., strong	Cloudy, mostly; rain in morning.
20	32	48				do	Clear.
21	33	48				Southerly, light	Do.
22	38	50				S., light	Cloudy.
23	55	52				S	Rain.
24	40	51				NW., strong	Clouds and occasional light snow.
25	26	47				do	Clouds light; a few pellets of snow.
26	24	45			2 3	W., fresh	Clear.
27	24	46			2 2½	S., light	Light clouds.
28	36	46½				SE., light to gentle	Cl'dy; rain p. m. and night.
29	48	48			2 4½	E., changing at noon to N., very strong.	Rain most of day, not heavy.
30	36	46½	46½		2 4	SW., changing about 4 p. m. to NW.	Mostly clear, clouds light.

TABLE IV.—*Observations on temperature and weather at Grand Lake Stream*—Continued.

Date.	Temperature.				Height of Grand Lake.	Wind.	Other phenomena.
	Air.	Water.					
		Stream.	Old hatching-house.	New hatching-house.			
	7 a. m.	7 a. m.	a. m.	a. m.	Ft. In.		
1879.							
Oct. 31	36	47			2 4½	Westerly, very strong	Mostly cloudy.
Nov. 1	26	44	46			NW., strong	Clear.
2	20	42			2 3¾	NW. & W., fresh to gentle.	Clear; cloudy evening.
3	23	42½				E.; NE., p. m	Clear a. m.; cloudy p. m.; snow at 11.40 p. m.
4	25	40½				N. to NW., strong	Snow in morning, slight am't; cl'dy most of day.
5	22	40	48		2 3¼	NW., fresh	Clear most a. m.; cloudy most p. m.
6	10	38½				Variable, very light	Clear.
7	28	40	47		2 3	NE. to SE., very light	Cloudy; trifle of snow last night and to-day.
8	35	40½				Southerly, light	Cloudy.
9	38	41			2 3	do	Clear, mostly.
10	54	42½				NW., strong	Clear.
11	34	41½	48			NW., light, mostly; var	Do.
12	34	42				Easterly, chang'g to northerly; light.	Snow in early morn'g, then very light rain.
13	36	42½				Northerly, fresh, dying to calm at night.	Cloudy; occasional slight snow.
14	42	43			2 2½	Southerly and SW., gentle increasing to fresh.	Cloudy; some sprinkling.
15	53	44				Southerly, light	Cloudy; slight rain.
16	34	43	47½		2 2¾	NW. to N., gentle	Clear.
17	34	43				NW., fresh	Do.
18	28	41½	47			NE., light to gentle	Cloudy; snow commenced at 4 p. m.
19	24	39	46½			Northerly, gentle	Clear, mostly.
20	28	40				NE., gentle to fresh	Began to snow at 9 a. m. ceased at 10 p. m.
21	15	37	46½			NW., strong	Clear; drifting snow.
22	2	34	45			W., fresh to gentle	Clear.
23	31	36				E	Rain and sleet all day.
24	21	36½				NW	Clear
25	5	35				S	Cloudy a.m.; began to snow at 12 m.; turned to rain; cleared at 7 p. m.
26	25	35	45		2 3	NW., strong	Clear.
27	15	34				Variable, light	Cloudy, mostly.
28	39	35				Southerly	Clear, mostly.
29	51	37				S., chang'g to NW. at night	Rained nearly all day; flurry of snow in eve'ng.
30	15	34½	43½			NW., strong	Clear; ice has moved down to near the dam.
Dec. 1	9	34½	43½			NW., light; changing to southerly.	Clear morning; cloudy p. m.
2	31	33½					
3	30	34	42½	34		NE	Cl'dy, with snow and rain.
4	32	34	42	34		SW	Cloudy and raining.
5	19	32½	41	32½		W	Clear at times.
6	20	33	41½	33½		S	Cloudy morn'g; clear p. m.
7	38½	35½	42½	35½	2 7½	SE	Heavy rain; clearing away at noon.
8	30	34	40½	34		S., changing to W	Cloudy morning; clear rest of the day.
9	17	32½	40	32½		NW., light	Clear and very bright.
10	20	33	39½	33		NE	Cloudy day.
11	47½	34½	41	34½		S	Cloudy, with a little rain.
12	32	34½	40½	34½		NE	Cloudy morn'g; at 12 commenced a snow squall.
13	10	32½	40	32½		W., light	Clear.
14	8	32½	40½	32½	2 9½	NE	Cloudy day.
15	23	33	42	33		NE	Snow, 7 inches.
16	20	33	42	33		W	Clear day.
17	14	33	42	33½		NE	Snow, 1½ inch.
18	—7	32	42	33		NW	Clear.

TABLE IV.—*Observations on temperature and weather at Grand Lake Stream*—Continued.

Date.	Temperature. Air. 7 a. m.	Water. Stream. 7 a. m.	Old hatching-house. a. m.	New hatching-house. a. m.	Height of Grand Lake.	Wind.	Other phenomena.
1879.					Ft. In.		
Dec. 19	6	32	42	33	....	N	Clear.
20	2	32	42	33	....	E., changing to W	4 in. snow; clear at 10 a. m.
21	—14	32	41	32½	....	NW	Clear.
22	—19	32	41	32½	....	NE	Cloudy; 3 inches snow.
23	2	32½	41	33	....	SW	Clear.
24	7	33½	41	33½	....	NE	Snow, 4½ inches.
25	22	33½	41½	34	....	N	Cloudy.
26	—16	32½	41	33	....	N	Clear.
27	—24	32	40	32	....	NE	Clear morn'g; cloudy p. m.
28	8	33½	41½	33½	....	NE	1 inch snow in morning; clear p. m.
29	23	34	42	34	....	S	Cloudy; thick fog.
30	30	34	42	34	....	E., changing to W	1½ inches snow in morning; clear p. m.
31	—19	32	40	32½	....	N., changing to E	Clear morn'g; cloudy p. m.
1880.							
Jan. 1	2	32	40	33	....	NW	Clear; 5½ inches snow last night.
2	29	34	41½	34	....	SW	Partly cloudy.
3	9	33½	41	33½	....	N	Clear.
4	12	33½	41	34	....	S	Cloudy; rain and hail; 2 inches snow.
5	27	34	41	34	....	NW	Clear.
6	—10	33	40	33½	....	S	Cloudy morn'g; snow p. m.
7	23	33½	41½	34	....	N	Clear.
8	4	33	41	34	....	NW	Do.
9	12	32	40½	33	....	W	Do.
10	28	34	41½	34½	....	SE	Cloudy.
11	2	33½	40½	34	....	N	Clear.
12	28	34	41	34½	....	SE	Cloudy.
13	18	33½	41	33½	....	NE	Cloudy; 2 inches snow.
14	—6	32	40	32½	....	N	Clear.
15	—7	33	40	33	....	SW	Cloudy.
16	0	33	41	33	....	NE., to S., light	Cloudy all day.
17	22	34	41	34½	....	Southerly, very light	Cloudy and foggy all day.
18	34½	34	41	34½	....	S	Cloudy and rainy.
19	30	34	41	34½	....	N., light	Cloudy nearly all day.
20	14	33½	40½	34	....	W	Clear morn'g; then cloudy; 5 inches snow.
21	10	32	40	32½	....	NE	Cloudy and blustering snow-storm.
22	2	32	40½	32	....	W., light	Clear.
23	16	33½	41	33½	....	E	Cloudy, rainy, and foggy.
24	26	34	39½	34	....	NW	Clear morn'g; cloudy p. m.
25	12	33½	40	34	....	SW	Clear.
26	11	33½	40	34	....	SW	Do.
27	23	34	40½	34	....	S	Clear a. m.; cloudy p. m.
28	34	34	41	34½	....	SW	Cloudy morning; partly clear.
29	12	33	38½	33½	....	N	Cloudy half the day.
30	—7	32	39½	32	....	W	Clear morn'g; cloudy p. m.
31	42	35	40	35	....	SW	Cloudy, foggy, and sunshine.
Feb. 1	28	34	39½	34½	....	SE	Cloudy all day.
2	—15	33½	39	34	....	N	Clear.
3	— 6	32	39½	32	....	NE	Cloudy; 7 inches snow.
4	8	33	39½	33½	....	W., light	Cloudy morning; clear p.m.
5	4	32½	39	33	....	W., very light	Clear.
6	8	33½	39½	33½	....	Southerly, light	Cloudy morn'g, then clear.
7	—10	32	39	32½	....	SW	Clear.
8	2	32½	39	32½	....	W., light	Clear morn'g; then clouds.
9	18	33	40	33½	....	SW	Clear nearly all day.
10	—16	32	39	32	....	W., light	Clear all day.
11	— 6	32½	39½	33	....	Northerly	Clear; 1½ in. snow last night.
12	20	33	40	33½	....	SE	Cloudy; 1 in. snow & rain.
13	31	33½	40	34½	....	S	Cloudy.

TABLE IV.—*Observations on temperature and weather at Grand Lake Stream*—Continued.

Date.	Temperature. Air. 7 a. m.	Water. Stream. 7 a. m.	Water. Old hatching-house. a. m.	Water. New hatching-house. a. m.	Height of Grand Lake.	Wind.	Other phenomena.
1880.					*Ft. In.*		
Feb. 14	25	33½	40	34		E	1½ inches snow.
15	6	32½	40	33		NE	Cloudy.
16	20	33	40	33½		NE	Do.
17	0	32	40	32		W., light	Clear morn'g; then clouds.
18	34	34	40	34½		S	Cloudy morn'g; then clear.
19	30	34	39	34½		W	Clear most of the day.
20	5	32½	38	32½		NW	Clear.
21	6	33	39	33		SE	2 inches of snow after 12 m.
22	18	33½	40	34		SW	Clear.
23	14	33½	39½	34		E	Cloudy morn'g; 7½ in. snow
24	19	33½	40	33½		W	Clear.
25	6	32	39½	32½		W	Do.
26	32	34	40	34½		SE	Showers.
27	31	34	38	34½		W., light	Clear.
28	30	34½	38	34½		NE	Cloudy morn'g; then clear.
29	38	34½	39½	35		S	Rain.
Mar. 1	23	34	39½	34		NE	Cloudy morn'g; then clear.
2	11	33½	39½	34		NW	Clear.
3	15		39			SW	Cloudy nearly all day.
4	33		39½			SW	Cloudy morn'g; then clear.
5	31		39½			NE	Cloudy; 2 inches snow.
6	14		40			N	Clear morn'g; then cloudy.
7	12		40			NW	Do.
8	31		40			SE	2 in. snow; afterwards cl'r.
9	— 9		39½			N., light	Clear.
10	12	34	40	34½		SE	2 in. snow; clear at noon.
11	— 1		40			N	Clear.
12	0		39½			NE	Cloudy nearly all day.
13	—10		39½			W., light	Clear.
14	10		39½			Easterly	1 inch snow.
15	6		39			NE	Clear.
16	18		40			E	Cloudy, and 2 inches snow.
17	21	34	40	34		W	Cloudy nearly all day.
18	20		40			NW	Clear.
19	23		40			SW	Clear most of the day.
20	24		40			W	Clear.
21	28	34½	40	35		Southerly	Cloudy, partly.
22	16		40			W	Clear part of the day.
23	28		40			NW	Cloudy; then clear.
24	27		40			NE	Cloudy morn'g; then snow
25	20		39			NE., strong	Cloudy; 14 inches snow.
26	10		39			W	Clear.
27	2	32½	38½	33		N	Do.
28	22		39½			NE	Clear part of the day.
29	24		40			E	Cloudy nearly all day.
30	21		40			N	Partly cloudy.
31	27	34½	40			NE	Cloudy.
Apr. 1	28		41			N	Cloudy morn'g; then clear.
2	17		40			W	Clear.
3	26		39½			S	Foggy and rainy.
4	44	35½	39			S	Showers.
5	42		38			SW	Cloudy morn'g; clear p. m.
6	34		38½			NW	Clear.
7	28		39			N	Cloudy nearly all day.
8	20		39			N	Clear part of the day.
9	19		39			W	Clear morn'g; then cloudy.
10	32	35	39½			SE	Do.
11	41		39½			S	Cloudy, with a shower.
12	14		40			N	Clear.
13	26		40½			S	Cloudy.
14	30		41			NW	Clear.
15	32		41			NE	Clear, then cloudy.
16	36	36½	41½			NW	Clear.
17	21		41½			E	Snow and rain.
18	28		41			NE	Cloudy morn'g; then clear.
19	28		40½			W	Clear.

TABLE IV.—*Observations on temperature and weather at Grand Lake Stream*—Continued.

Date.	Temperature.				Height of Grand Lake.	Wind.	Other phenomena.
	Air.	Water.					
		Stream.	Old hatching-house.	New hatching-house.			
	7 a. m.	7 a. m.	a. m.	a. m.			
1880.					*Ft. In.*		
Apr. 20	35	38½	40			S	Cloudy, and showers.
21	38		40			NW	Clear.
22	36		40			SW	Do.
23	34		40			N	Do.
24	30	40	39½			N	Do.
25	26		39			N	Do.
26	34		40			E	Cloudy, with a little rain.
27	40	40	41½			SE	Cloudy and foggy.
28	30		40			N	Clear.
29	38		40			N	Clear half of the day.
30	46	39½	41			SE., strong	Rain.
May 1	32		41			NW	Squally nearly all day.
2	38	40	41			NE	Cloudy morn'g; then clear.
3	36		41½			SE	Foggy morn'g; then clear.
4	42		42			NW	Clear.
5	40		42½			W	Do.
6	52		42½			E	Cloudy; showers.
7	37		42½			N	Clear.
8	38		42½			N	Do.
9	52		42½				
10	54		42½				
11	53		42			Southerly	Showery morn'g; then cl'r.
12	52		42			W	Clear.
13	44		42			NE	Showers.
14	39		41½			N	Cloudy.
15			41½			N. by E., strong	Clear.
16	50		42½			N. W., strong	Do.
17	54		42½			Variable	Cloudy.
18	52		42			Calm	Clear.
19	46		42½			Southerly, strong	Cloudy.
20	56		43				
21	56		44			SW	Showery morn'g; then cl'r.
22	53		43½			E	Cloudy.
23			44			S	Showery part of the day.
24	54		44			SE	Foggy morning.
25	57		44½			NW	Clear.
26	55		44			S	Foggy morning.
27	64		45½			SW	Clear.
28	74		45½			NW	Clear morn'g; then clouds.
29	50		44			W	Clear.
30	55		45			NW	Clear morn'g; then cloudy.
31	52		44½			SE	Rainy.
June 1	57		44½				
2	61		45½				
3	59		45				
4	37		44½				Heavy frost.
5	50		44½				
6			45				
7			44				
8	52		44				

TABLE V.—*General summary of observations on temperature at Grand Lake Stream, Maine, from September 2, 1879, to June 8, 1880, inclusive.*

Date.	Air at 7 a. m.						Water in stream at 7 a. m.					
	Number of observations.	Average degrees.	Max.		Min.		Number of observations.	Average degrees.	Max.		Min.	
			Date.	Degrees.	Date.	Degrees.			Date.	Degrees.	Date.	Degrees.
1879.												
September	1	48.00	21	48	21	48	3	63.00	3	66½	21	61
October	29	44.34	9	65	26	24	29	53.93	10	62½	26	45
November	30	28.23	10	54	22	2	30	39.50	1	44	27	34
December	31	12.97	11	47½	27	—24	31	33.13	7	35½	31	32
1880.												
January	31	15.05	31	42	6	—10	31	33.34	31	35	1	32
February	29	13.10	29	38	10	—16	29	33.14	29	34½	3	32
March	31	16.42	4	33	13	—10	7	33.86	31	34½	27	32½
April	30	31.10	30	46	12	14	1	35.50	4	35½	4	35½
May	29	49.55	28	74	1	32	....	....	....	....	....	....
June	6	52.67	2	61	4	37	....	....	....	....	....	....

Date.	Water in old hatching-house, a. m.						Water in new hatching-house, a. m.					
	Number of observations.	Average degrees.	Max.		Min.		Number of observations.	Average degrees.	Max.		Min.	
			Date.	Degrees.	Date.	Degrees.			Date.	Degrees.	Date.	Degrees.
1879.												
September	3	48.00	19	48½	3	47½	....	....	....	....	....	....
October	5	47.60	1	48	30	46½	....	....	....	....	....	....
November	11	46.36	5	48	30	43½	....	....	....	....	....	....
December	30	41.30	1	43½	10	39½	29	33.31	7	35½	27	32
1880.												
January	31	40.53	10	41½	29	38½	31	33.69	31	35	30	32
February	29	39.41	26	40	20	38	29	33.50	29	35	3	32
March	31	39.64	31	40	27	38½	6	34.08	21	35	27	33
April	30	40.00	27	41½	5	38	....	....	....	....	....	....
May	31	42.92	28	45½	1	41	....	....	....	....	....	....
June	8	44.62	2	45½	7	44	....	....	....	....	....	....

TABLE VI.—*Results of development and hatching of eggs at Grand Lake Stream, 1879-'80.*

Lot numbered.	Date.	Development of the general stock.								Hatching of those retained.						General averages before and after division.					
		Original number of eggs.	When divided.	Picked out before division.			Number divided.	Number shipped.	Number retained.	Picked out dead after division.			Number hatched.	Died after hatching.	Net result in fish to be planted.	White eggs picked out.			Impregnation computed.‡		
				Unimpregnated.*	Miscellaneous, unimpregnated and others.†	Total.				Unimpregnated *	Miscellaneous, unimpregnated and others.†	Total.				Known to be unimpregnated.*	Miscellaneous.†	Total.	Unimpregnated.		Impregnated.
	1879.														*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*No.*	*Pr. ct.*	*Pr. ct.*
1	Nov. 7	8, 500	Jan. 18	1, 641	1, 444	3, 085	5, 415	2, 500	2, 915	....	96	96	2, 819	38	2, 781	19. 3	18. 1	37. 4	2, 074	24. 4	75. 6
2	Nov. 11	261, 500	Jan. 12	20, 237	11, 463	31, 700	229, 800	229, 800	....	....	....	....	....	....	....	7. 7	4. 4	12. 1	23, 676	9. 0	91. 0
3	Nov. 12	31, 000	Jan. 13	3, 046	2, 254	5, 300	25, 700	25, 700	....	....	....	....	....	....	....	9. 8	7. 3	17. 1	3, 722	12. 0	88. 0
4	Nov. 13	38, 900	Jan. 13	2, 117	2, 283	4, 400	34, 500	34, 500	....	....	....	....	....	....	....	5. 5	5. 9	11. 4	2, 802	7. 2	92. 8
5	Nov. 15	33, 700	Jan. 14	1, 438	2, 262	3, 700	30, 000	30, 000	....	....	....	....	....	....	....	4. 3	6. 7	11. 0	2, 117	6. 3	93. 7
6	Nov. 15	249, 000	Jan. 18	13, 042	9, 803	22, 845	226, 155	223, 800	2, 355	....	106	106	2, 249	54	2, 195	5. 2	4. 0	9. 2	15, 983	6. 4	93. 6
7	Nov. 15	33, 000	Jan. 18	2, 700	3, 624	6, 324	26, 676	23, 700	2, 976	....	209	209	2, 767	36	2, 731	8. 2	11. 5	19. 7	3, 787	11. 5	88. 5
8	Nov. 17	45, 000	Mar. 2	2, 763	3, 237	6, 000	39, 000	39, 000	....	....	....	....	....	....	....	6. 1	7. 2	13. 3	3, 734	8. 3	91. 7
9	Nov. 18	260, 000	Mar. 16	3, 816	16, 184	20, 000	240, 000	86, 000	154, 000	1, 300	228	1, 528	152, 472	664	151, 808	2. 0	6. 3	8. 3	9, 971	3. 8	96. 7
10	Nov. 19	82, 000	Mar. 16	1, 200	5, 511	6, 711	75, 289	24, 000	51, 289	....	42	42	51, 247	150	51, 097	1. 5	6. 8	8. 3	2, 853	3. 5	94. 5
11	Nov. 20	42, 000	Mar. 16	....	3, 315	3, 315	38, 685	....	38, 685	800	106	906	37, 779	88	37, 691	1. 9	8. 1	10. 0	1, 794	4. 3	95. 7
12	Nov. 21	22, 000	Mar. 16	....	2, 284	2, 284	19, 716	....	19, 716	1, 100	101	1, 201	18, 515	28	18, 487	5. 0	10. 8	15. 8	1, 785	8. 1	91. 9
13	Nov. 21	5, 156	Mar. 19	....	5, 156	5, 156	....	....	....	....	....	....	....	....	....	....	100. 0	100. 0	....	....	....
14	Nov. 22	1, 700	Mar. 16	....	636	636	1, 064	....	1, 064	125	56	181	883	2	881	7. 3	40. 7	48. 0	316	18. 6	81. 4
	Total.	1, 113, 456	....	52, 000	69, 456	121, 456	992, 000	719, 000	273, 000	3, 325	944	4, 269	268, 731	1, 060	267, 671	5. 0	6. 3	11. 3	74, 614	6. 7	93. 3

*The eggs entered in columns thus marked are those that were separated from the others by concussion, to which they were subjected on purpose to kill the unimpregnated.

†These eggs were taken out from day to day through the season, and are supposed to have consisted of about 20 per cent. unimpregnated, 80 per cent. impregnated that died from other causes.

‡Computed by adding 20 per cent. of the "miscellaneous" white eggs to those "known" to have been unimpregnated.

TABLE VII.—*Record of shipment of Schoodic salmon spawn from Grand Lake Stream, Maine, January and March,* 1880.

Date.	Consignee	Address.	Final destination.	For whose use.	Number of eggs. Belonging to State.	Donated by United States.	Total.
1880.							
Jan. 6	H. J. Fenton	Windsor, Conn	Poquonock, Conn	Connecticut Commission	80,000		80,000
7	E. A. Brackett	Winchester, Mass	Winchester, Mass	Massachusetts Commission	60,000		60,000
7	A. H. Powers	Plymouth, N. H	Plymouth, N. H	New Hampshire Commission	50,000		50,000
12	P. H. Christie	Verbank, Dutchess Co., N. Y	Clove, Dutchess Co., N. Y	P. H. Christie		10,000	10,000
12	F. Mather	Newark, N. J	Paris, France	Acclimatization Society		10,000	10,000
12	Mrs. J. H. Slack	Bloomsbury, N. J	Bloomsbury, N. J	New Jersey Commission		20,000	20,000
12	Jas. Duffy	Marietta, Pa	Marietta, Pa	Pennsylvania Commission		12,500	12,500
12	Seth Weeks	Corry, Pa	Corry, Pa	do		12,500	12,000
13	O. A. Dennen	Moosehead Lake, Maine	Moosehead Lake, Maine	Maine Commission		25,000	25,000
13	N. K. Fairbank	Chicago, Ill	Geneva Lake, Wisconsin	N. K. Fairbank		25,000	25,000
13	B. F. Shaw	Anamosa, Iowa	Anamosa, Iowa	Iowa Commission		20,000	20,000
14	R. O. Sweeny	Saint Paul, Minn	Saint Paul, Minn	Minnesota Commission		20,000	20,000
14	D. B. Long	Ellsworth, Kans	Ellsworth, Kans	Kansas Commission		10,000	10,000
14	S. G. Worth	Morganton, N. C	Morganton, N. C	North Carolina and South Carolina Commissions.		40,000	40,000
15	J. G. Portman	Pokagon, Mich	Pokagon, Mich	Michigan Commission		30,000	30,000
15	F. N. Clark	Northville, Mich	Northville, Mich			10,000	10,000
15	H. W. Welsher	Madison, Wis	Madison, Wis	Wisconsin Commission		20,000	20,000
19	T. B. Ferguson	Baltimore, Md	Baltimore, Md	Maryland Commission		25,000	25,000
19	M. McDonald	Lexington, Va	Wytheville, Va	Virginia Commission		20,000	20,000
19	C. S. White	Romney, W. Va., via Green Spring Run.	Romney, W. Va	West Virginia Commission		20,000	20,000
19	E. D. Potter	Toledo, Ohio	Toledo, Ohio	Ohio Commission		30,000	30,000
26	E. A. Brackett	Winchester, Mass	Winchester, Mass	Massachusetts Commission	15,000	5,000	20,000
Mar. 2	do	do	do	do	80,000		80,000
8	E. G. Blackford	Fulton Market, New York City	New York City and Caledonia	New York Commission		10,000	10,000
9	H. J. Fenton	Windsor, Conn	Poquonock, Conn	Connecticut Commission	13,000	5,000	18,000
9	A. H. Powers	Plymouth, N. H	Plymouth, N. H	New Hampshire Commission	12,000	5,000	17,000
15	O. A. Dennen	Moosehead Lake, Maine	Moosehead Lake, Maine	Maine Commission		24,000	24,000
	Total				310,000	409,000	*719,000

* In addition to the 719,000 eggs shipped, as per this schedule, there were kept at Grand Lake Stream 273,000 eggs, of which 248,000 represented the 25 per cent, reserve for the lake and stream, and 25,000 were hatched for parties in Calais, to whom they had been donated. These figures give us a total of 992,000 eggs divided, as the net result in eggs of the season's work.

TABLE VII.—*Record of shipment of Schoodic salmon spawn from Grand Lake Stream, Maine, January and March*, 1880—Continued.

Date.	Consignee.	Number of cases.	How packed.*	Time en route.†	Distance.	Arrived at final destination.	When unpacked.	Condition on unpacking.	Number died in transportation.
1880.				*Hours.*	*Miles.*				
Jan. 6	H. J. Fenton	1	Dry moss outside	68	502	10 a. m., January 9	2 p. m., January 9	Good	690
7	E. A. Brackett	1	Dry leaves outside	72	389	January 10			432
7	A. H. Powers	1	......do	49	515	3 p. m., January 9	3.15 p. m., January 9	Good	582
12	P. H. Christie	1	Dry moss outside	103	687	9 a. m., January 16	10 a. m., January 16	Very good	100
12	F. Mather	1	Dry moss outside; re-packed by Mather in his method.	....	3, 260				10,000
12	Mrs. J. H. Slack	1	Dry moss outside	75	683	5 p. m., January 15	6 p. m., January 15	In very good condition	125
12	Jas. Duffy	1	......do	73	723	3 p. m., January 15	5 p. m., January 15	O. K	41
12	Seth Weeks	1	......do	96	972	2 p. m., January 16	3 p. m., January 16	Good	158
13	O. A. Dennen	1	......do	68	232	11 a. m., January 16	2 p. m., January 16	....do	145
13	N. K. Fairbank	1	......do	150	1, 483	8 p. m., January 19	9 p. m., January 19	....do	184
13	B. F. Shaw	1	......do	141	1, 607	11 a. m., January 19	3 p. m., January 19	....do	188
14	R. O. Sweeny	1	......do	116	1, 789	10 a. m., January 19	10 a. m., January 20	Best ever received	230
14	D. B. Long	1	......do	170	2, 095	4 p. m., January 21	10 a. m., January 22	Good	200
14	S. G. Worth	1	......do	118	1, 515	12 m., January 19	3 p. m., January 19	In excellent condition	350
15	J. G. Portman	1	......do	100	1, 299	6 p. m., January 19	7 p. m., January 19	Good	210
15	F. N. Clark	1	......do	120	1, 158	January 20	January 20	....do	563
15	H. W. Welsher	1	......do	121	1, 536	3 p. m., January 20	4 p. m., January 20	....do	377
19	T. B. Ferguson	1	......do	75	805	4.50 p. m., January 22	10.30 a. m., January 23	....do	169
19	M. McDonald	1	......do	169	1, 363	3 p. m., January 26	3 p. m., January 26	First class	263
19	C. S. White	1	......do	125	1, 005	7 p. m., January 24	10 a. m., January 25	Very good	320
19	E. D. Potter	1	......do	92	1, 158	10 a. m., January 23	12 m., January 23	Excellent	40
26	E. A. Brackett	1		72	389	January 29			132
Mar. 2	......do	2		....	389			Good	564
8	E. G. Blackford	1	Dry moss outside	‡68	‡617	10 a. m., March 11	12 m., March 11	....do	§500
9	H. J. Fenton	1	......do	44	502	......do	2 p. m., March 11	....do	20
9	A. H. Powers	1	......do	48	515	2 p. m., March 11	3 p. m., March 11	....do	14
15	O. A. Dennen	1	......do	99	232	5 p. m., March 19	9 a. m., March 20	....do	24
		28							

* The eggs were in all cases first packed in shallow wooden boxes in layers, alternating with wet moss. The outside packing, 2 or 2½ inches thick, was either dry moss or leaves.

† Time here given is the time between leaving Grand Lake Stream and arrival at final destination. In addition to this the eggs were packed up some hours generally before starting, and some time elapsed after arrival at destination before unpacking.

‡ This is only the transportation to New York.

§ All this loss occurred between New York and Caledonia.

TABLE VIII.—*The hatching of Schoodic salmon, season of* 1879-'80.

Place of hatching.	In charge of hatching.	No. of eggs sent to each.	Died in transit.	Died in incubation.			No. hatched.	No. of fish sent out.	No. actually planted.	Remarks.
				Before hatching	After hatching.	Total.				
Connecticut, Poquonock	H. J. Fenton	98,000	710	4,080	1,400	5,480	93,210	91,000	91,000	
Iowa, Anamosa	G. F. Slocum	20,000	188	...	...	1,000	†18,812	‡19,000	19,000	
Kansas, Ellsworth	D. B. Long	10,000	200	200	200	400	9,600	9,400	9,400	
Maine, Moosehead Lake	David Brown	49,000	169	1,231	2,000	3,231	47,600	‡47,769	47,769	
Maine, Grand Lake Stream	Wm. H. Munson	273,000	(*)	4,269	1,060	5,329	268,731	267,671	267,671	
Maryland, Baltimore	Frank Behler	25,000	169	2,033	6,098	8,131	22,798	16,700	16,700	
Massachusetts, Winchester	E. A. Brackett	160,000	1,128	...	...	†1,270	...	157,600	§157,600	
Michigan, Pokagon	J. G. Portman	30,000	210	807	26,883	27,890	28,983	2,100	2,100	
Michigan, Northville	F. N. Clark	10,000	563	...	...	435	9,002	9,000	9,000	
Minnesota, Saint Paul	S. S. Watkins	20,000	230	277	215	492	19,493	19,278	19,238	
New Hampshire, Plymouth	A. H. Powers	67,000	596	888	463	1,351	65,516	65,000	60,500	
New Jersey, Bloomsbury	A. A. Anderson	20,000	125	...	...	557	...	19,318	19,318	
New York, Caledonia	Martin Fitzgerald	5,000	500	400	600	1,000	4,100	3,500	3,500	
New York, New York and Brooklyn	E. G. Blackford	5,000	...	...	...	100	...	...	...	No further report.
New York, Clove	P. H. Christie	10,000	100	324	326	650	9,576	9,250	9,250	
North Carolina, Morganton	S. G. Worth	40,000	350	6,000	2,500	8,500	33,650	16,825	12,625	
Ohio, Toledo	Flavel Grant	30,000	40	...	...	2,000	...	27,960	27,960	
Pennsylvania, Marietta	J. P. Creveling	12,500	41	267	1,692	1,959	12,192	10,500	10,500	
Pennsylvania, Corry	Seth Weeks	12,500	158	2,126	3,516	5,642	10,216	6,500	6,500	
Virginia, Wytheville	Wm. F. Page	20,000	263	177	1,120	1,297	†19,560	‡23,500	23,500	
West Virginia, Romney	Z. G. Graham	20,000	320	1,000	8,680	9,680	18,680	10,000	10,000	
Wisconsin, Geneva Lake	Frank Welsher	25,000	184	625	15,191	15,816	24,191	9,000	9,000	
Wisconsin, Madison	H. W. Welsher	20,000	377	...	...	...	...	...	...	No record kept.
		982,000	6,621	...	...	101,910	...	840,871	832,131	

*Not transported.

NOTE.—This statement is made up from reports returned by the recipients of the eggs. In nearly all cases all the figures are exactly those returned to us. In some cases, however (marked †), I have inserted figures obtained by computation from the reports received. It will be observed that in three cases (marked ‡) the number of fish reported as planted exceeds those stated to have been hatched. These discrepancies may arise from various causes, the most probable of which is an overestimate of the number of young fish sent out from the hatching-house.

§In the case of Massachusetts the fish were delivered free to applicants, who took them from the hatching-house and made no return as to the occurrence of losses; the number set down as actually planted may therefore be in excess of the true number.

TABLE IX.—*Statement of the planting of young Schoodic salmon in 1880.*

State.	Eggs finally hatched at—	Waters in which the fry were placed.	Tributary to what other water.	Locality of deposit.	Date of transfer.	No. of fish.
Maine	Mount Kineo, Moosehead Lake.	Masterman Brook	Moosehead Lake	Tomhegan Township, Somerset County	June 25, 1880	9,554
		Shaw Brooks	do	Day's Academy, Grant, Piscataquis County	do	9,554
		Hatchery Brook	do	do	do	9,554
		Mansell Brook	do	Somerset County	do	9,554
		West Outlet	Kennebec River	do	do	9,553
	Grand Lake Stream	Grand Lake	Saint Croix River	Hinkley Township, Washington County	do	243,671
New Hampshire	Plymouth	Tolman Pond	Merrimack River	Nelson, Cheshire County	May 4, 1880	3,000
		Adams Pond	do	Sandwich, Carroll County	May 13, 1880	1,500
		Winnisquam Lake	do	Laconia, Belknap County	May 18, 1880	5,000
		North Pond	Connecticut River	Stark, Coos County	May 19, 1880	4,000
		Berry Pond	Merrimack River	Pittsfield, Merrimack County	May 20, 1880	2,500
		Spofford Lake	Connecticut River	Chesterfield, Cheshire County	May 20, 1880	3,000
		Diamond Pond	do	Stewartstown, Coos County	May 25, 1880	2,500
		Cunningham Pond	Merrimack River	Peterborough, Cheshire County	May 26, 1880	2,500
		Emerson Pond	do	Rindge, Cheshire County	May 26, 1880	2,500
		Gilmore Pond	do	Jaffrey, Cheshire County	May 26, 1880	2,500
		Walker's Pond	Saco River	Conway, Carroll County	May 28, 1880	6,000
		Newfound Lake	Merrimack River	Hebron, Grafton County	June 2, 1880	3,000
		Heart Pond	do	Canaan, Grafton County	June 2, 1880	2,500
		Walker's Pond	do	Boscawen, Merrimack County	June 8, 1880	2,000
		Long Pond	Connecticut River	Benton, Grafton County	June 9, 1880	3,000
		Sunapee Lake	do	Newbury, Merrimack County	June 10, 1880	4,000
		Cold Pond	do	Acworth, Sullivan County	June 10, 1880	3,000
		Bean Pond	Merrimack River	Warner, Merrimack County	June 10, 1880	3,000
		Echo Lake	Connecticut River	Franconia, Grafton County	June 14, 1880	3,000
		North Pond	Merrimack River	Sandwich, Carroll County	June 17, 1880	2,000
Massachusetts	Winchester	Mendon Pond		Mendon, Worcester County	May or June, 1880.	1,500
		Onota Lake	Housatonic River	Pittsfield, Berkshire County	do	18,000
				Holliston, Middlesex County	do	5,000
		Naumkeag Lake		Ashburnham, Worcester County	do	10,000
				Sharon, Norfolk County	do	5,000
		Battacook Pond		Groton, Middlesex County	do	4,000
				Brewster, Barnstable County	do	8,000
		Fresh Pond		Falmouth, Barnstable County	do	4,000
		Hardy's Pond	Charles River	Waltham, Middlesex County	do	2,000
				Otis, Berkshire County	do	6,000
		Wenham Pond		Wenham, Essex County	do	8,000
		Dorrity Pond		Millbury, Worcester County	do	4,000
		Little Pond		Braintree, Norfolk County	do	4,000
				Sandwich, Barnstable County	do	2,000
		Long Pond		Rochester, Plymouth County	do	4,000
		Mahkunac and Overic Ponds		Stockbridge, Berkshire County	do	20,000

TABLE IX.—*Statement of the planting of young Schoodic salmon in* 1880—Continued.

State.	Eggs finally hatched at—	Waters in which the fry were placed.	Tributary to what other water.	Locality of deposit.	Date of transfer.	No. of fish.
Massachusetts	Winchester	Buell Pond			May or June, 1880.	20,000
		Eel Pond		Melrose, Middlesex County	do	2,000
				Westfield, Hampden County	do	18,000
		Dennis Pond and Bass River		Yarmouth and Dennis	do	8,000
		Mystic Pond		Winchester and Medford	do	4,100
Connecticut	Poquonock, Hartford County.	Pitsquag Pond	Connecticut River	Durham, Middlesex County	Apr. & May, 1880.	5,000
		Higganum Reservoir	do	Higganum, Middlesex County	do	5,000
		Rogers Lake	Long Island Sound	Lyme, New London County	do	5,000
		Quinnebaug Lake	do	New Haven County	do	5,000
		Halfway River	Housatonic River	Fairfield County	do	5,000
		Canaan Mountain Pond	do	Litchfield County	do	5,000
		Kanosiac Pond	do	Fairfield County	do	5,000
		Still River	do	do	do	5,000
		Quosepaug Lake	Naugatuck River	Litchfield County	do	5,000
		Plainville Reservoir	Farmington River	Hartford County	do	5,000
		Pemparaug River	Naugatuck River	Waterbury, New Haven County	do	5,000
		Parry's Pond	Long Island Sound	Fairfield County	do	5,000
		Mianus River	do	do	do	5,000
		Black Pond	Quinipiac River	Meriden, Hartford County	do	5,000
		Bolton Reservoir	Hockanum River	Bolton, Tolland County	do	5,000
		Scontic River	Connecticut River	Enfield, Hartford County	do	5,000
		Broad Brook	do	Hartford County	do	5,000
		Salmon Brook	Farmington River	do	do	5,000
		Colt's Reservoir		do	do	1,000
New York	Spring Side, Clove, Dutchess County.	Upton Pond	Wappenger's Creek and Hudson River.	Clinton, Dutchess County	Apr. —, 1880	4,000
		Bullis Pond	Fishkill Creek and Hudson River.	Washington, Dutchess County	do	1,650
		Little Whala or Crystal Lake	do	Pawling, Dutchess County	do	2,000
		Furnace Pond	do	Beekman, Dutchess County	do	1,600
	Caledonia	Blue Pond Inlets		Monroe County		3,500
New Jersey	Bloomsbury	Outlet of Stagg Pond	Pequest and Delaware Rivers	Sussex County	Apr. 6, 1880	19,318
Pennsylvania	Marietta	Bear Lake	Susquehanna River	Wilkesbarre, Luzerne County	Apr. 8, 1880	5,000
		Heart Lake	do	Montrose, Susquehanna County	do	4,000
		Tigley Lake	do	Susquehanna County	do	1,000
		Donegal Spring	do	Lancaster County	do	500
	Corry	Sugar Lake	Allegheny River	Venango County	May 10, 1880	3,000
		Lake Pleasant	French Creek	Erie County	Sept. 6, 1880	3,500
Maryland	Baltimore	Pond	Monocacy River	Buckeystown, Frederick County	Mar. 22, 1880	200
		Little York	Ohio River	Oakland	Apr. 5, 1880	3,000
		Pond	Monocacy River	Buckeystown	Apr. 15, 1880	500
		do	Gwynn's Falls	Pikesville	Apr. 18, 1880	500
		do	Lake Roland	Green Spring Valley	Apr. 19, 1880	500

		do	Patapsco Falls	Carrollton	do	500
		do	Patuxent River	Oakland	Apr. 20, 1880	500
		do	do	Baltimore	do	500
		do	Gwynn's Falls	Airey Hill	do	500
		Trout Branch	Patuxent River	Baltimore	do	500
		Pond	Linganore Creek	Unionville	Apr. 21, 1880	500
		Winter's Run	Bush River	Wilna	Apr. 22, 1880	500
		Pond	Gunpowder River	Baltimore	Apr. 24, 1880	500
		do	Gwynn's Falls	Near Catonsville	Apr. 26, 1880	500
		Mill pond	Potomac River	Clear Spring	Apr. 28, 1880	500
		Pond	Bush River	Belair	do	500
		do	Patapsco River	Eden	Apr. 30, 1880	500
		Patuxent River	Chesapeake Bay	Baltimore	May 1, 1880	500
		Dripping Spring	Gunpowder River	do	May 4, 1880	200
		Pond	Big Gunpowder River	Long Green Valley	May 6, 1880	500
		do	Deer Creek	Norrisville	May 8, 1880	500
		do	Potomac River	Frederick County	May 11, 1880	500
		do	Monocacy River	Mount Pleasant	May 13, 1880	500
		do	Choptank River	Denton	May 14, 1880	500
		Gunpowder River	Chesapeake Bay	Warren	May 17, 1880	500
		Bush Run	Conococheague Creek	Fairview	May 18, 1880	500
		Pond	Patapsco River	Sulphur Springs	do	500
		do	Gunpowder River	York Road	May 24, 1880	500
		do	Patuxent River	Sandy Spring	May 27, 1880	500
		Pond and stream	Northwest River	Stanmore	do	500
Virginia	Wytheville	Gibboney's Spring	Reed Creek (New River)	Near Wytheville	Mar. 20, 1880	300
		South Fork Red Creek	New River	Near Hatchery	Mar. 22, 1880	200
		Barret's Pond	Reed Creek	Near Wytheville	Mar. 25, 1880	4,000
		Lake Spring	Roanoke River	Near Salem	Mar. 29, 1880	250
		New River	Kanawha River	Near Wythe Lead Mines	Mar. 31, 1880	8,000
		North Fork Holston River	Tennessee River	Near Saltville	Apr. 1, 1880	7,000
		Streams	New River	Near Newbern, Pulaski County	Apr. 5, 1880	3,750
North Carolina	Morganton	Pond of B. A. Berry	Catawba River	Near Morganton, Burke County	Mar. 10, 1880	200
		Pond of C. A. Shuping	do	do	Mar. 12, 1880	100
		Mill Creek	do	McDowell County	Mar. 15, 1880	2,000
		Curtis Creek	do	do	do	2,700
		Ponds	French Broad River	Near Asheville, Buncombe County	do	1,000
		Ponds of J. H. Schultz	Dan River	Near Winston, Forsythe County	Mar. 23, 1880	200
		Ponds of Mr. Sellars	Haw River	Guilford County	do	200
		Ponds of David Anderson	Neuse River	Near Raleigh	do	200
		Ponds of W. H. Ragan	Deep River	Near High Point, Guilford County	do	100
		Ponds of Raleigh Fish Culturists' Association.	Neuse River	Near Raleigh	do	400
		Little Alamance Creek	Haw River	North Carolina R. R. Crossing, Guilford Co.	do	500
		Ponds of L. W. Estes	New River	Watauga County	do	1,800
		Upper Creek	Catawba River	Burke County	Mar. 26, 1880	1,000
		John's River	do	do	do	1,000
		Ponds of C. W. Alexander	do	Near Charlotte, Mecklenburgh County	Mar. 28, 1880	200
		Ponds of J. S. Bryant	Yadkin River	Near Salisbury, Rowan County	do	200
		Ponds of Hatchery	Catawba River	Burke County		825
West Virginia	Romney	South Branch	Potomac River	Hampshire County	Apr. 20, 1880	10,000

TABLE IX.—*Statement of the planting of young Schoodic salmon in* 1880—Continued.

State.	Eggs finally hatched at—	Waters in which the fry were placed.	Tributary to what other water.	Locality of deposit.	Date of transfer.	No. of fish.
Ohio	Toledo	Sandusky River	Lake Erie	Fremont, Sandusky County		10,000
		Rapids of Maumee River	do			17,960
	Northville, Mich	Sandusky River	do	Fremont, Sandusky County	May 4, 1880	9,000
Michigan and Indiana.	Pokagon, Mich	Higgins Lake	Muskegon River	Roscommon, Roscommon County, Michigan.	May 4, 1880	} 21,000
	Do	Stoney Lake	No outlet	La Porte, La Porte County, Indiana	May 9, 1880	
Wisconsin	Geneva Lake	Geneva Lake	Fox River	Walworth County, Wisconsin	—— —, 1880	9,000
	Madison	Mendota Lake	Rock River	Madison		(?)
Minnesota	Saint Paul	Prior Lake	No outlet	Scott County	Apr. 7, 1880	3,000
		Lake	do	Houston County	Apr. 14, 1880	2,000
		Zumbro River	Mississippi River	Wabasha County	Apr. 28, 1880	3,000
		Lake Alley	No outlet	Renville County	May 4, 1880	3,500
		Big Stone Lake	Minnesota River	Big Stone County	do	4,000
		Detroit Lake	No outlet	Becker County	May 10, 1880	1,000
		Lake	do	do	do	500
Iowa	Anamosa	Okiboyi Lake	Little Sioux River	Dickerson County	May 30, 1880	5,000
		Clear Lake	Cedar River	Cerro Gordo County	Apr. 9, 1880	5,000
		Shell Rock Lake	do	Butler County	do	3,000
		Storm Lake	Des Moines River	Buena Vista County	Apr. 14, 1880	3,000
		Twin Lakes	do	Calhoun County	do	3,000
Kansas	Ellsworth	Pond	Smoky Hill River	Fort Harker	—— —, 1880	1,000
		do	do	Wilson	—— —, 1880	500
		Ash Creek	do	Near Ellsworth	—— —, 1880	2,000
		Pond	do	do	—— —, 1880	200
		do	do	Venango	—— —, 1880	500
		Bluff Creek	do	Bluffville	—— —, 1880	500
		Spring Creek	do	Harker	—— —, 1880	3,000
		Bradley Springs	do	Bradley Springs	—— —, 1880	300
		Elm Creek	do	Near Terra Cotta	—— —, 1880	300
		Clear Creek	do	Farisville	—— —, 1880	300
		do	do	do	—— —, 1880	300
		Spring Creek	do	Trivola	—— —, 1880	500
New Brunswick	Grand Lake Stream, Maine.	Nickerson's Lake	Saint John River			10,000
		Loch Lomond	Mispeck Stream	10 miles from Saint John		6,000
		Chamcook Lake	Passamaquoddy Bay	Charlotte County		8,000

XXX.—CRAW-FISH CULTURE IN EUROPE.

By H. Rubelius.*

[From "Industrie-Blätter," seventeenth year, No. 31; Berlin; July 29, 1880.]

The attempt to raise craw-fish artificially in inclosed waters is old and has been made repeatedly, but so far none of the methods employed have given entire satisfaction; and at best it requires a number of years before craw-fish culture becomes profitable. It is well known that the common craw-fish, also called river craw-fish (*Astacus fluviatilis*, Rond.), is found throughout nearly the whole of Europe, but especially in North Germany, and that it changes its shell every year. The male craw-fish does this generally in June or in the beginning of July, while the female commences in July. During this period both the male and female craw-fish are very tender, and many of them die. After the craw-fish has thrown off its old shell, a very soft skin forms which begins to harden in a few days. During this time great care must be taken of the craw-fish. The boxes must not be overcrowded, but must be supplied with sufficient food, of which at this time the craw-fish require a double quantity.

The male craw-fish prefer to live together in large numbers in holes high up the bank. The female stays in her hole (*i. e.*, she always returns by day-time to the same hole where she has been before) until the young fry slip out of the eggs which are attached to the abdominal appendages under the tail. A medium-sized craw-fish has, on an average, 150 to 200 eggs, which are hatched in May. The young craw-fish resemble very small worms, and are for some time attached to their mother's tail by fine threads. They are in this way protected against the persecutions of their enemies, the eels, pike, perch, &c.

Some time elapses before the little craw-fish venture out alone. After a year's time they have reached the size of a wasp. They grow so slowly that it takes three to four years before they have reached the length of about 10 centimeters, when they can be brought to market as "soup craw-fish." From the fourth to the sixth year they reach the length of "medium craw-fish" viz, 12 centimeters. A full-sized "table craw-fish" has a length of 15 to 18 centimeters, and is from eight to twelve years old. Their quicker or slower growth depends on the water, its temperature, and their food. Lakes which are situated in moors and are surrounded by mountains generally have warmer water than open lakes and rivers, and are, therefore, more favorable to the development of the

* *Zur Krebszucht*, von H. Rubelius.—[Translated by Herman Jacobson.]

craw-fish than the latter. In tolerably warm water the eggs begin to appear in January, and the young fry in March. These craw-fish do not, as a general rule, grow very large, for they scarcely reach a length of 10 centimeters even at the age of fifteen. By way of experiment I have placed them in other water, *e. g.*, in my craw-fish box in the river Oder, but they did not grow. Such craw-fish, which are generally of a light green color, are not suited for transportation, as they are very apt to die when carried any distance. Lakes like those above described are generally overcrowded with craw-fish. The finest and largest craw-fish are found in rivers, especially small ones, where boats cannot pass, and where the craw-fish are not disturbed by manufacturing establishments, *e. g.*, the Eilang, the Obra, &c. In such waters the craw-fish develop very rapidly, but cannot be used as "soup craw-fish" till they are four to five years old.

The worst enemy of the craw-fish is the eel. It may truly be said that whenever a river or lake contains many craw-fish there will be no eels, and wherever there are no craw-fish the eels will be numerous. The favorite food of the eel is one-year-old craw-fish, and they but rarely eat larger ones.

The craw-fish themselves, however, are bloodthirsty and voracious feeders. As soon as dusk sets in they grow lively and move backwards and forwards with great agility; they swim well, and their sense of sight is very keen. When a craw-fish has eyed its prey, it sneaks up to it and with one bold dash impales the little fish or frog on its "tusk," the long, pointed, horn-like excrescence found between the eyes. As soon as it has secured its prey, it goes to the bottom of the water and devours it, holding it firmly with its two claws. It has been said that the craw-fish will also eat putrefied meat, but this is a disputed point. It will take such meat as it takes pieces of wood and stone, merely to cover itself. When kept imprisoned it lives on fish, meat, turnips, bread, potatoes, &c., but a craw-fish will never seek as food a putrefying animal body, especially if its odor is offensive. One may easily convince himself of this, if in catching craw-fish two nets of equal size and kind are employed, the one baited with fresh fish, the other with decaying fish emitting a strong odor, and are placed in the water not far from each other. The result will be, that the one net will soon have some craw-fish in it, whilst the other will remain empty.

The most common and most profitable way of catching craw-fish is with the so-called "Bolljacken." These consist of two hoops each, with a tube-shaped net attached. On the outside the two hoops are covered with a net-work, and the whole apparatus has the appearance of a cylinder. The hoops are kept open by wooden pegs, a piece of fresh fish or a frog is put inside as a bait, a stone is tied to it, and thus the "Bolljacken" is let down to the bottom.

Another apparatus for catching craw-fish is the so-called "Tellerhamen," a sort of purse-net,—a hoop covered with a net, in the middle of which there is a long stick serveing to keep the hoop, which resembles a plate, at the bottom of the water. In that portion of the net through which the stick passes, the bait is fixed, so that the craw-fish must go on the "plate" if it wishes to seize the bait. The other end of the stick must be long enough to protrude above the water. This stick is then pulled out with the net and the craw-fish sticking to it, and, baited anew, let down again.

Another method of catching craw-fish, the so-called "lighting," is much used by private individuals. During the summer months the craw-fish seek shallow places with a clear bottom. The fishermen use a torch of resinous pine-wood, by means of which they throw a strong light on the bottom. The craw-fish are dazzled by the light and can easily be taken out of the water with the hands; and it has happened more than once that a single person has in this manner caught 900 to 1,200 craw-fish in one night.

After the craw-fish have been caught, the main object of the cultivator is to preserve them, to give them a pure flavor and to fatten them. For a number of years I have succeeded very well in this. Pure running water is the first requisite; the boxes must be made according to the plan given below, and must not be overcrowded. The best food is fresh meat, but not too much at a time. Immediately after having cast its old shell, the craw-fish is very voracious and consequently needs the largest quantity of food, whilst in December it needs the least. In January it gets lively again, its voracity increases, and during its imprisonment the eggs begin to appear at that time. Great care should be taken not to leave old and spoilt pieces of meat in the boxes for any length of time, as this will very soon prove fatal to the craw-fish. I have by way of experiment thrown old and spoilt meat in boxes where there were only few craw-fish, and the consequence has been that most of the craw-fish have died. I would also draw attention to a very important matter, viz, to clean the boxes (at least during summer, when it is very warm), twice a day and throw out all the dead craw-fish, for in summer a craw-fish commences to putrefy in 10 to 12 hours after death, and the exhalation invariably kills the healthy craw-fish. One of the greatest dangers to craw-fish culture and transportation is a thunderstorm. As soon as a thunderstorm has passed over, the boxes should be opened and cleaned, and care should be taken to admit fresh air and water.

I have transported craw-fish in various ways and have finally arrived at a method which has, in most cases, proved successful. I have very frequently sent live craw-fish by mail from Frankfort-on-the-Oder to Alsace-Lorraine, and they have invariably arrived in good and healthy condition, unless a thunderstorm came up during the journey, which, however, did not happen very often. During the shedding-period no craw-fish should be shipped, as then they cannot stand any pressure and die easily. Care should also be taken not to have a dead craw-fish packed among the live ones. The main point in shipping craw-fish is to select good, healthy ones, well fed and properly dried. I generally employ small wicker baskets each holding 60 to 120 craw-fish, so that they are not piled too high on top of one another. First put a layer of straw in the basket and then the craw-fish, one at a time, laying them on their feet, and if the basket should not be quite full, pack it with straw till full. The packing is to prevent the craw-fish from turning when the baskets, as will frequently happen during a long journey, are thrown about a good deal. If the craw-fish falls on its back during the journey, it will die, as it works with its feet till it becomes exhausted. On their arrival at the place of destination the craw-fish are taken out of the baskets and placed, again on their feet, in a large vessel, which should be kept in a cool place, best in acellar, but not be covered up.

It is an old belief that craw-fish are not good in months whose names contain the letter *r;* but I have found that craw-fish when properly cared for and well fed are good at all times, for I have sold and shipped them during every month in the year, and have never had any complaints.

An important question remains to be answered, viz, whether artificial craw-fish culture in basins is remunerative. Experience has taught me that craw-fish increase and develop better when in a free state than in boxes or basins. To start a somewhat remunerative craw-fish establishment entails considerable expense, and does not yield the expected result. In such establishments the cold of winter kills most of the craw-fish, as they cannot find holes and other places of refuge as when in a free condition. If strong ice forms, as happened this year, the craw-fish are suffocated in the basins; the boxes are soon frozen over on the sides and top, and as soon as the admission of fresh air is stopped, the craw-fish die from suffocation.

I would, therefore, recommend the following method: From rivers and lakes containing but few craw-fish the female craw-fish should not be removed; the eels and pike should, if possible, all be caught, and the young craw-fish, large numbers of which will make their appearance in a year or two, must be well and regularly fed with meat and turnips; during the fourth year all craw-fish which have reached the length of 10 centimeters should be caught and placed in large tanks or boxes prepared in the following manner: The bottom and sides are best made of thin boards, which should not be close together, but have narrow interspaces between them, not large enough to let a small craw-fish escape. The object of having such interspaces on the bottom is to give free egress to the slime, mud, sand, &c., which will get into the box, and thus to keep it clean at all times. The interspaces on the sides have this advantage that fresh water will be constantly passing through the boxes, which of course is an essential condition of keeping the craw-fish alive and in good health. In these boxes, through which fresh water must be kept running all the time, the craw-fish are fattened. When ice forms in winter, the boxes must be let down into the water, so that the openings on the sides do not freeze over.

XXXI.—THE RAISING OF SPONGES FROM CUTTINGS.

By Dr. Emil von Marenzeller.*

[Verhandlungen der k. k. zoologisch-botanischen Gesellschaft in Wien—Vienna, 1878.]

The Imperial Ministry of Agriculture in Vienna has placed at the disposal of the society a report by Mr. Gregor Buccich, a telegraph-operator on the island of Lesina, in Dalmatia (made in 1876), on the experiments in raising sponges artificially according to Prof. O. Schmidt's method. Mr. Buccich had himself founded his little establishment, and for some time received an appropriation from the ministry; but from various causes the establishment is not in operation at the present time. The above-mentioned report contained a sort of diary, and gave the results of experiments which had been continued for six years. The directors of the society shared the opinion of the Ministry of Agriculture, that it would be useful to publish this report and thus preserve the principles laid down in it, because it had been fully proved that although the hope to create a new source of income for the poor coast population of Dalmatia had not been realized, the principle that sponges can be raised from cuttings had been fully established. The Imperial Ministry of Agriculture cheerfully granted the request of the society to examine all the other documents on the subject, principally original reports of Prof. O. Schmidt, some of which have appeared in the "Austria," a publication which has ceased to appear. With these sources at my command, I wrote the following article with a view of giving a brief guide to any persons, both at home and abroad, who are interested in the culture of sponges.

Regarding the history of sponge-culture in the Adriatic, a few remarks will suffice. After Prof. O. Schmidt in an article in the *Wiener Zeitung*, and in his work on the sponges of the Adriatic,† had expressed the opinion "that if a perfectly fresh sponge is cut into suitable pieces, and if these pieces, properly protected, are again placed in the sea, they

* *Die Aufzucht des Badeschwammes aus Theilstücken.* Von Dr. Emil von Marenzeller. [Translated by Herman Jacobson.]

† "*Die Spongien des adriatischen Meeres.*" Leipzig, 1862, p. 22. See also, O. Schmidt, "*Supplement der Spongien des adriatischen Meeres.*" Leipzig, 1864, p. 24, and especially, Brehm, "*Thierleben,*" 2d edition, vol. 10. Lower Animals; by O. Schmidt, 1878, p. 534.

will grow,* and finally develop into complete sponges," the government and a number of prominent merchants of Trieste had some experiments made during 1863–1872, and established a station on the bay of Socolizza, at the northeastern point of the island of Lesina, which in May, 1867, was placed under the direction of Mr. Buccich. This establishment was closed in November, 1872, as its continuance became impossible, because, in spite of Mr. Buccich's oral and written remonstrances, it was continually disturbed by the fishing-nets and was actually robbed several times. A species of worm which destroyed the wood-work appeared harmless compared to the hostile attitude of the population, which showed an utter want of respect for the property of other persons, and manifested deep-rooted prejudices against any innovations, as well as a reluctance to break with old habits.

The most favorable season for raising sponges from cuttings is winter. It is true that the growth of the sponge and the new formations on the cut sides goes on slower in winter than in summer, but a high temperature of the air often endangers the entire crop on account of the tendency of the sponges to rot. In winter a sponge may remain on the dry land for several hours, while in summer it will perish in a few minutes especially if it has been injured and if it is not constantly moistened with fresh water. Mr. Buccich exposed sponge cuttings to the air in a shady place for eight hours during February, when the temperature of the air was 48° F., and still they all took root.

The best localities are bays where the waves are not too strong but where the surface is not entirely smooth either, with a rocky bottom covered with green algæ and exposed to a gentle current. It is a well-established principle that the mouth of streams and rivers and of subterranean springs should be avoided. The fresh color of the algæ is a sure indication that the choice of locality has been fortunate. The worst enemy of sponge-culture is mud. Under certain circumstances it would be well to close the entrance to the bay to vessels by a chain.

The sponges which are to be cut should be very carefully gathered by

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*I find that Cavolini was already acquainted with the fact that sponges loosened from their bases and fixed to other objects are able to replace any portions they may have lost; but this interesting fact again fell into oblivion. Filippo Cavolini reports on these experiments on pp. 266–271 of his "*Memorie per servire alla storia de polipi marini*," Naples, 1785, where he endeavors to prove that the sponges are not plants but animals. He took two kinds of *Spugna officinale del Linnæo*, probably a *Euspongia*, also a *Spugna carnosa* ("*poco atta agli usi economisi, perchè difficilmente quella carne colla macerazione si scioglie*," therefore probably a *Sarcotragus*), and a third kind, *Spugna detta alcionio foraminosa dall' Imperato*, put a thread through every one and thereby fastened them to the bottom of simple clay vessels having two holes. These vessels he let down into the sea in the grotto "*che tuona*," near Naples, and took them up again after twelve days. Although, as Cavolini says, the sponges had been very much injured in gathering, they had a complete newly-formed base (which Cavolini describes very well), their wounds were healing and decreasing in number. Two specimens of the third kind had been forced into a rather narrow vessel and were found to have grown not only to the sides of the vessel, but also to have grown together.

experienced persons. They are either taken with tongs or with a drag-net. One arm of the tongs is fastened to a long pole and is immovable; the other can be moved and pressed against the former by means of a string which, as well as the pole, is held by the gatherer. Objects coming between the two arms of the tongs are held firmly in this manner and can be raised from the water, of course from such a depth only as can be reached with the eye and the pole. The sponges are brought up either with their base—and this is the most favorable case—or they must be torn from the base, which operation frequently tends to injure them. Wherever the bottom of the sea is suitable I would recommend the use of the dredge-net. In Lussin and Lesina I often saw my people work with the so-called O. F. Müller's or Ball's dredge-net or with an apparatus resembling the trawl of the English and American deep-sea fisheries, and the sponges which were brought up were invariably in excellent condition. In gathering sponges for cutting it is entirely unnecessary to select nice-looking specimens, for misshaped pieces which would be worthless in trade are just as good for this purpose as beautifully rounded ones. These latter should not be cut, but should be reserved for the trade. Fishing for sponges with tongs has this drawback, that, properly speaking, it can only be successful when the surface of the water is perfectly smooth. As the pouring of oil on a gently curled surface does not answer the purpose, Mr. Buccich constructed a simple apparatus. It is a tin-box 32 centimeters square in whose bottom a sheet of glass is inserted. This box is placed on the surface and through the glass bottom the bottom of the sea is examined*. Mr. Buccich found that it was not expedient to place the sponges as they were gradually gathered into a vessel, to keep them there until they were to be cut, because they are easily injured by pressing against each other or by being shaken too violently. He therefore provisionally fastens them with wooden pegs to the inner side of a sort of fish-box, which is held in tow by the fishing-boat. If the sponges are injured, the injured portions should be immediately removed; the remainder is likewise fastened with wooden pegs, either as it is or subdivided in large pieces.

When the temperature is low during the cold season, the sponges can be prepared for raising as soon as the place is reached where the process is to be carried on, while during the warm season it will be found profitable to wait a little in order to see whether there are any indications of putrefaction. This can be recognized by the darker color and the softening of the respective portions. If anything of the kind is noticed the sponge should be watched to see to what extent the process of disintegration has progressed. Small sponges will almost entirely fall a prey to it, while in large ones the evil may be confined within certain

* The Greek sponge-fishers use the same apparatus in the shape of a cylinder 37 centimeters wide and 50 centimeters high made of tin, its bottom being composed of a sheet of glass, which is half let down into the sea. See G. v. ECKHEL, *Der Badeschwamm.*" Trieste, 1873, p. 12.

limits. The cutting should be done rapidly either with a common knife or—which Mr. Buccich found to be more advantageous—with a blade resembling a fine saw, which is less liable to be injured by the many foreign bodies inclosed in sponges. In cutting, the sponge had best be laid on a small board moistened with sea water. The size of the cuttings is generally about 26 square millimeters. It is well if every piece has as large as possible a surface of intact outer skin. The cuttings should immediately be fastened to those objects where they are expected to grow.

A healthy piece of sponge soon grows firmly on any object with which it is brought in close contact. Sponges which have been cut will again grow together. Those cuttings which have only a single cut surface will soonest grow fast to their new base, stone, wood, &c. Mr. Buccich thinks that during a calm lasting 24 consecutive hours cuttings could simply be sowed on a rocky bottom and would soon grow. He has seen pieces laid on gently slanting rocks grow fast to them during a perfect calm. Induced thereby, and also by the natural occurrence of sponges, Mr. Buccich tried flag-stones, about 53 millimeters thick, as a basis. He bored holes in them and fastened the cuttings by means of wooden pegs, which were driven into the holes; but it soon became apparent that the mud and sand of the bottom, perhaps also the excess of light, was injurious to the further growth of the sponges. Experience has shown that light and mud are among the worst enemies of the sponge, and their influence must by every possible means be avoided or limited. Stones form the natural basis of sponges; they are cheap and are not attacked by the *Teredo*.

Originally, Prof. O. Schmidt used wooden boxes closed on all sides but perforated, to whose inner sides the pieces of sponge were fastened with metal or wooden pegs. This exceedingly simple arrangement did not prove efficient; because the boxes when let down into the deep water became full of mud, and the holes being stopped up no light whatever could enter. The sponges began to look pale and sickly. It is not good to fasten them with metal pegs, for it seemed to retard their growth. The rust which forms very soon causes the pieces of sponge to become loose, and will ultimately destroy them. Laths or boards placed obliquely, on whose upper side there were floating contrivances in the shape of tables, to whose lower side the sponges were fastened, were likewise used.[4] With the former, the want of covering was keenly felt; and with the latter, the rays of the sun proved injurious, as well as all the different little objects floating on the surface of the water which may be grouped together under the collective name "dirt." Mr. Buccich at first prepared an apparatus consisting of two boards crossing each other at right angles with a third board serving as a sort of lid, and after this had proved unsatisfactory he adopted the apparatus

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[4] Prof. O. Schmidt also entertained the idea, which was never carried out however, of merely putting the cuttings on suitably arranged strings.

which I shall now describe, and which he preferred to all others because the cuttings were exposed on all sides to the sea water and assumed the favorite round form. This apparatus consisted of two boards, 63 centimeters long and 40 centimeters broad, one forming the bottom and the other the lid. Both were kept in a parallel position, one above the other, at a distance of about 42 centimeters, by two props about 11 centimeters distant from each other, between which stones may be placed as ballast. On the outer side of the lid there was a handle. Both boards had holes at a distance of 12 centimeters from each other; the total number of holes in each board, therefore, being 24. Mr. Buccich did not fasten the pieces of sponge singly to the apparatus, but he placed several of them on one peg and then stuck the pegs in the holes. For these pegs he used bamboo, whose hard smooth bark defies all attacks of worms. These pegs were 42 centimeters long and perforated horizontally, the holes being at the distance of 12 centimeters from each other, and the lower end was split. Three pieces of sponge were put on each peg and pushed up high enough to be above the horizontal holes, through which a wooden peg was pushed, thus fully securing the sponges.

If the pieces of sponge are simply to be fastened with wooden pegs a three-cornered stiletto will suffice for making the holes in the sponges, but when they are to be strung up on pegs this or any similar instrument cannot be used, because too great a pressure would have to be exercised to make a sufficiently large opening for the passage of the pegs. Any pressure will to some degree injure the sponges, and to limit its extent or force as much as possible should be the first object. Mr. Buccich bored the holes with a trepan 6 millimeters wide, fastened to a vertical turning-table, which was kept in rapid motion by a fly-wheel. One hand pressed the sponge lightly against the trepan, the other turned the wheel, and the operation was finished in a few seconds. The hole in this manner is perfectly smooth, none of the fibers have been pulled out, and none of the sarcode has flowed out. As soon as a peg has been furnished with sponge-cuttings, its split end is stuck in one of the holes of the apparatus and a wedge is driven through the crack. As lid and bottom hold 24 pegs, each with three cuttings apiece, such an apparatus can hold 144 cuttings. During this whole process the sponges should be continually moistened with sea-water, especially during summer. As soon as an apparatus has been filled, it should immediately be let down into the water if the temperature is high, while in winter a delay will not prove injurious. The letting down and raising of the apparatus had best be done by means of a small anchor, and they should be let down to a depth of 5-7 meters. Mr. Buccich does not consider it necessary to have the apparatus suspended from a sort of scaffolding. All the wood-work should be well tarred, as this will prove the only, though by no means always efficient, protection against worms. The *Teredo* does not only cause an increase in the capital to be employed, because it makes new apparatus necessary from time to time, but it also diminishes the results, because the pegs will gradually get loose and fall off. It would therefore be best to dispense with wood altogether, and either construct the apparatus of stone, taking the necessary precautions against mud and excess of light, or construct Mr. Buccich's exceedingly practical apparatus of iron.

If, after three or four weeks, the sponges have grown firmly to their base, they are sure to develop successfully. Their most characteristic tendency is the desire to grow round. In order to facilitate this in all directions Mr. Buccich strung the sponges on pegs. As regards the development of the sponge-cuttings within certain given periods we have only very imperfect information, as it was impossible to make continued undisturbed observations. Mr. Buccich says that the cuttings grow two to three times their original size during the first year. He also mentions that the cuttings grew better during the first and fourth (?) year than during the second and third. It is his opinion that, although some pieces will grow to a considerable size in five years, it will require seven years to raise completely matured sponges which are fit to become an article of merchandise. I cannot pass by the fact that besides well developed and growing sponges there were some which outwardly looked perfectly healthy but had ceased growing.

In conclusion, Mr. Buccich discusses the question whether the enterprise can, on the whole, be called profitable, and says that he must answer it in the affirmative. He thinks that if all the lessons taught by experience are carefully observed the cuttings will always develop successfully, and that the loss would at most be 10 per cent., taking into account unexpected accidents and the stationary character of some of the sponges. Calculating the expense of an establishment for 5,000 sponges at 300 florins and the loss at 10 per cent., the price realized by 4,500 sponges would indicate the profits. Mr. Buccich calculates the value of 4,500 sponges at 900 florins. This sum is, in my opinion, much too high, as the wholesale sponge-dealers in Trieste receive an average price of 8 and a maximum price of 10 florins per kilogram of Dalmatian sponges. Sponges fetching the price given by Mr. Buccich ought to have a very considerable size, and their slow growth justifies the supposition that even after seven years they will not yet have reached that size. It must also be taken into account that the market value of sponges which have been raised on pegs is one-third less than that of naturally-grown ones on account of the hole in the center. The profitableness of sponge-culture would be far more evident if there was not such a long interval between planting and harvesting; in other words, if the sponges would grow more rapidly. This was certainly looked for when the enterprise was started, but it is dispiriting to have to wait for your crop for seven ong years. And in order that when that period has been reached there may be crops every year it will be necessary to invest the same annual amount of capital for a period of seven years. The apparatus, moreover, is not so simple that every fisherman could easily construct it himself, for experience has shown that wood, which would be the easiest material for working, cannot be used on account of the ravages of the *teredo*. As far as our present knowledge goes, it is certain that sponge-culture will not be profitable for poor men, but that it can only be carried on successfully on a very large scale either by wealthy individuals or by joint-stock companies. It would be very encouraging to know more concerning the progressive development of the sponge in its natural condition, and especially to know that this development was just as slow as that of the cuttings. Prof. O. Schmidt inclined to this opinion. But if it should prove erroneous it would be more than questionable whether it is profitable to cut to pieces a sponge which uncut would have quicker reached the same size and weight than all the cuttings together in seven years. Under such circumstances sponge-culture had better be confined to the transformation of flat and therefore worthless sponges into round ones, which, though small, would find a ready market. Possibly several, especially misshaped, pieces of sponge might be made to grow together and form larger and better formed ones. The experiments made by *Cavolini* and Mr. Buccich's own above-mentioned experience show that there is no difficulty in doing this.

VIENNA, *December*, 1878.

APPENDIX F.

MISCELLANEOUS.

XXXII.—DESCRIPTIVE LIST OF THE PUBLICATIONS OF THE UNITED STATES FISH COMMISSION, FROM ITS ORGANIZATION IN 1871 TO DECEMBER 31, 1879.

Compiled by C. W. SMILEY.

1871.

1. [Serial mark $E\frac{B}{2}$.] Letter addressed to fishermen and others living on the shores of Lake Michigan, and announcing that fishes with metallic tags had been liberated at twenty points, and asking for information about their subsequent capture. Circular and 5 questions. 1 page. 16 by 19^{cm}.

1872.

2. [Serial mark $E\frac{B}{4}$.] Memoranda of inquiry. Circular. 1 page.

3. [Serial mark $E\frac{B}{3}$.] Questions relative to the food-fishes of the United States; name, distribution, abundance, size, migrations and movements, relationships, food, reproduction, artificial culture, protection, diseases, parasites, capture, economical value, and application. 88 questions. 7 pp. 9.5 by 17^{cm}.

4. [Serial mark $E\frac{B}{1}$.] Letter to accompany No. 3, inviting information concerning food-fishes. Circular. 1 page. 16 by 14^{cm}.

1873.

5. [Serial mark $E\frac{B}{5}$.] Statistics of the menhaden fisheries. Announcement of a proposed investigation, with questions concerning name, abundance, migration and movements, food, reproduction, enemies and fatalities, capture, economical value, and applications. Circular and 65 questions. 4 pp. 16 by 20^{cm}.

6. [Serial mark $E\frac{A}{1}$.] Part I. Report on the condition of the sea-fisheries of the south coast of New England in 1871 and 1872, by Spencer F. Baird, Commissioner. Pamphlet. 8vo. 47 pp. 11.2 by 19.5^{cm}.

7. Part I. Report on the condition of the sea-fisheries of the south coast of New England in 1871 and 1872, by Spencer F. Baird, Commissioner, with supplementary papers. Cloth. 8vo. Pp. xlvii–852. Plates xxxviii, with 38 leaves explanatory to plates. 2 maps.

1874.

8. [Serial mark $E\frac{A}{2}$.] Part II. Report of the Commissioner for 1872 and 1873. A. Inquiry into the decrease of the food-fishes. B. The propagation of food-fishes in the waters of the United States. Pamphlet. 8vo. 102 pp. 11.2 by 19.5^{cm}.

9. Part II. Report of the Commissioner for 1872 and 1873. A. Inquiry into the decrease of the food-fishes. B. The propagation of food-fishes in the waters of the United States, with supplementary papers. Cloth. 8vo. Pp. cii, 808. Plates xxxvii. 4 maps.

10. [Serial mark 12.] Statistics of the menhaden fisheries. Reprint of No. 5.

1875.

11. [Serial mark $E\frac{C}{2}$.] Statistics of the fishing vessels of the United States. Blank for recording all particulars of vessel, crew, and occupation. Also specimen table. Ruled in 11 columns, 2 pp. 22 by 12^{cm} and 42 by 31^{cm}.

12. [Serial mark 10, $E\frac{C}{1}$.] Statistics of the fishery marine. A circular letter to collectors of customs to accompany No. 11. On reverse is same specimen table that is given in No. 11. 2 pp. 13.5 by 16^{cm} and 20 by 13^{cm}.

1876.

13. [Serial mark $E\frac{A}{3}$.] Part III. Report of the Commissioner for 1873–'74 and 1874–'75. A. Inquiry into the decrease of the food-fishes. B. The propagation of food-fishes in the waters of the United States. Pamphlet. 8vo. 52 pp. 11.2 by 19.5^{cm}.

14. Part III. Report of the Commissioner for 1873–'74 and 1874–'75. A. Inquiry into the decrease of the food-fishes. B. The propagation of food-fishes in the waters of the United States, with supplementary papers. Cloth. 8vo. Pp. lii, 777.

1877.

15. [Serial mark $E\frac{B}{3}$.] Questions relative to the food-fishes of the United States. Reprint of No. 3. Circular and 89 questions. 4 pp. 13.5 by 25^{cm}.

16. [Serial mark $E\frac{B}{6}$.] Statistics of the mackerel fisheries, &c. Circular-letter alluding to the importance of the information desired, and asking replies to questions accompanying (No. 15). 1 p. 13.5 by 13^{cm}.

17. [Serial mark $E\frac{B}{7}$.] Statistics of the cod fisheries, &c. Circular-letter soliciting information. To accompany questions (No. 15). 1 p. 13.5 by 13^{cm}.

18. [Serial mark $E\frac{B}{8}$.] Statistics of the mullet fisheries, &c. Circular-letter for southern coast, soliciting information. To accompany questions (No. 15). 1 p. 13.5 by 11.5^{cm}.

19. [Serial mark $E\frac{C}{3}$.] Statistics of the coast and river fisheries.

Questions concerning fishing vessels, shore and boat fishing, pounds, weirs, traps, and fykes, gill-nets, seines, fish-pots and eel-pots, the three-mile line, disposition of the fish, estimates of annual yield, and address of fishermen. Circular and 55 questions. 4 pp. 13.5 by 26^{cm}.

20. [Serial mark $\frac{C}{101}\ \frac{C}{3}$.] Statistics of the fish trade, New York market. Dealers' statement. Blanks for the number of pounds each of thirty leading kinds of food-fish, received each day during the month. 32 columns, 2 pp. 41.5 by 31.5^{cm}.

21. [Serial mark $E\frac{C}{4}$.] Statistics of the whale fisheries. Census blanks. Blanks for recording the number and kind of vessels, tonnage, and yield of oil. 13 columns, 2 pp. 13.5 by 11^{cm} and 21 by 31^{cm}.

22. [Serial mark A.] Record of hatching operations. Blank for recording temperatures, wind, tide, fish and eggs taken. 22 columns, 2 pp., each 41.5 by 32 ^{cm}.

23. [Serial mark B.] Record of operations of State fish commissioners in hatching and distributing young fish. Blanks for recording number of eggs received, time of journey, condition, loss in unpacking, in hatching, in distributing, place where planted, &c. 18 columns, 2 pp., each 41.5 by 32 ^{cm}.

24. [Serial mark C.] Record of distribution of fish. Blanks for recording date, number, place of introduction, stream, person in charge, &c. 12 columns, 1 p. 41.5 by 32 ^{cm}.

25. Record of collection of eggs.

1878.

26. [Serial mark $E\frac{A}{4}$.] Part IV. Report of the Commissioner for 1875–'76. A. Inquiry into the decrease of the food-fishes. B. The propagation of food-fishes in the waters of the United States. Pamphlet. 8vo. 69 pp. 11.2 by 19.5 ^{cm}.

27. Part IV. Report of the Commissioner for 1875–'76. A. Inquiry into the decrease of the food-fishes. B. The propagation of food-fishes in the waters of the United States, with appendices. Cloth. 8vo. Pp. 69, 1029. Plates vi.

28. [Serial mark $E\frac{B}{5}$.] Questions relative to the cod and the cod fisheries. Circular-letter acknowledging responses to questions on food-fishes and soliciting further information. Questions regarding name, characteristics, distribution, movements, food, reproduction, enemies, fatalities, in-shore fisheries, off-shore fisheries, and the products. 90 questions. 4 pp. 13.5 by 26.5 ^{cm}.

29. [Serial mark $\frac{E}{101}\ \frac{B}{10}$.] Questions relative to the alewife and the alewife fisheries. Circular-letter stating that Mr. C. G. Atkins desires to prepare a report and asking concerning the name, characteristics, abundance, movements, food, reproduction and growth, enemies, fatalities, capture, curing and marketing, sources of information. 82 questions. 4 pp. 13.5 by 26^{cm}.

30. [Serial mark $E\frac{B}{11}$.] Questions relative to the smelt and the smelt

fisheries. Circular-letter soliciting specimens and information. Inquiries concerning name, characteristics, abundance, migrations, food, reproduction, enemies, capture, markets and consumption, sources of information. 69 questions. 3 pp. 13.5 by 26^{cm}.

31. [Serial mark $E\frac{c}{4}$.] Statisticts of the fresh-fish trade, New England markets. Dealers' statements. Blanks for the number of pounds each of 36 different kinds of fish, as received each day during the month. 38 columns, 2 pp. 42 by 32^{cm}.

32. Questions relative to the mackerel and the mackerel fisheries. Reprint of No. $E\frac{B}{12}$. Circular-letter soliciting information, and questions upon name, size, shape and color, migrations and movements, abundance, food, reproduction, enemies and fatalities, off-shore and in-shore fishery, apparatus, and products. 78 questions. 3 pp. 13.5 by 26^{cm}.

1879.

33. Letter of acknowledgment of receipt of returns on the mackerel fishery. Letter in blank. February 8, 1879. 2,000 copies. 1 p. 10 by 15^{cm}.

34. Letter acknowledging menhaden replies to circular of 1873 and cod replies of 1876, and asking full information concerning the mackerel. Circular to accompany No. 32. December, 1878. 1 p. 16 by 17^{cm}.

35. Record of ocean temperatures. Blank for recording time, temperatures, winds, weather, and movements of fishes. 20 columns. 1 p. 43 by 35^{cm}.

36. Application for fish. 13 questions. April 12, 1879. 2,000 copies. 1 p. 10 by 19^{cm}.

37. Part V. Report of the Commissioner for 1877. A. Inquiry into the decrease of food-fishes. B. The propagation of the food-fishes in the waters of the United States. Pamphlet. 8vo. 48 pp. 11.2 by 19.5^{cm}.

38. Part V. Report of the Commissioner for 1877. A. Inquiry into the decrease of the food-fishes. B. The propagation of food-fishes in the waters of the United States. Supplementary papers. Cloth. 8 vo. Pp. 48, and 972.

39. Record of dredging stations. Blanks for ten observations—date, locality, bearing, state of tide and sky, depth of water, temperature at different depths, air, wind, currents, instrument and observer. September, 1879. 31 columns, 2 pp. 43 by 33^{cm}.

40. Circular inviting co-operation. Circular-letter to postmasters and fishermen in coast-towns, to accompany No. 41. July, 1879. 1 p. 16 by 20.5^{cm}.

41. Returns of circular inviting co-operation. 6 questions concerning fishing-vessels, apparatus, fishermen, and fish-markets. July 1, 1879. 1 p. 13.5 by 27^{cm}.

42. Circular relating to the fish trade and consumption of fish. Cir-

cular-letter for every postmaster in the United States. July, 1879. 1 p. 16 by 17 ^{cm}.

43. [Serial mark, 7–032.] Returns of circular relating to fish trade and consumption of fish. Questions upon local fishing, local supply of fresh and salt fish, oysters, lobsters, clams, &c. Check-lists of fishes, and circular-letter of Thomas J. Brady, Acting Postmaster-General. 18 questions. July 14, 1879. 3 pp. 16 by 22.5^{cm}.

44. [Serial mark, 7–040.] Plan of inquiry into the history and present condition of the fisheries of the United States. August, 1879. Pamphlet. 54 pp., 11 by 20^{cm}.

45. Statistics of fishery marine. Note-book for name of vessel, rig, tonnage, construction, value, crew, fishery, stock, profits, catch and sale of fish, and officers. September, 1879. Roan. 60 pp. 11 by 20^{cm}.

46. Statistics of the fishing-vessels of the United States. Second edition of No. 11, revised. Circular form of No. 45. September, 1879. 34 columns. 2 pp. 43 by 35^{cm}.

47. Letter to persons interested in fish-culture, and calling for information. Hektograph. October 20, 1879. 1 p. 18 by 24^{cm}.

48. Fish-cultural returns. Questions upon fish-culture, hatcheries, stocking public waters, articles published, &c. November 6, 1879. 15 questions. 1 p. 16 by 31^{cm}.

49. Circular to practical fish-culturists. Circular-letter. October, 1879.

50. Cheap fixtures for the hatching of salmon. By Charles G. Atkins, assistant, United States Fish Commission. An extract from the annual report. October, 1879. Pamphlet. 25 pp. 11 by 19.5^{cm}.

51. Coast-town index. Blank for fishing statistics of the coast-towns for use in compilation of returns of No 41. October, 1879. 8 columns. 1. p. 20 by 29^{cm}.

52. Letter to Rhode Island postmasters who failed to answer No. 43. Hektograph. November 26, 1879. 5 questions. 1 p. 18 by 24^{cm}.

53. [Serial mark, 7–119.] The river fisheries. Questions concerning fishing towns, periods, distance up the river, tide-water, obstruction, kinds of fish, apparatus used. October, 1879. 8 questions. 1 p. 16 by 33^{cm}.

54. [Serial mark, 7–151]. Circular-letter of D. M. Key, Postmaster-General, and of Thomas J. Brady, Acting Postmaster-General, to all postmasters. October, 1879. 1 p. 16 by 20^{cm}.

55. [Serial mark, 7–149]. Returns of circular relating to fish trade and consumption of fish. Reprint of No. 43. Revised edition. October, 1879. 20 questions. 3 pp. 16 by 23^{cm}.

56. Property record. Blanks for date, number, name, application, description, maker, where used, cost, and remarks. October, 1879. 9 columns, 1 p. 46 by 33^{cm}.

57. Blank for measurements of fishes. Issued 1875 or 1876. 8 columns, 2 pp. 19 by 34^{cm}.

58. [Serial mark, 3179.] Property receipts. Blank for number, articles, condition, value, remarks. Filing blank on reverse. 6 columns, 1 p. 24 by 18^{cm}.

59. Questions relating to the menhaden. Movements, quantity, food, eggs, fatality, parasites, fishing-vessels, quantity of oil made, price, &c. Hektograph. November, 1879. 2 pp. 18 by 30^{cm}.

59 A. Letter to manufacturers of menhaden oil, to accompany No. 59. Hektograph. November 18, 1879. 1 p. 18 by 24^{cm}.

60. Measurements of fishes. Reprint of No. 57. Revised edition. December, 1879. 8 columns, 2 pp. 19 by 34^{cm}.

61. Record of observations at hatching-stations. Blank for recording date, temperature, wind, sky, and tide. December, 1879. 26 columns, 1 p. 51 by 38^{cm}.

62. Record of hatching operations. Reprint of No. 22. December, 1879. 20 columns, 1 p. 51 by 38^{cm}.

63. Record of observations of State Fish Commissioners in hatching and distributing young fish. Reprint of No. 23. December, 1879. 18 columns, 2 pp. 44 by 34^{cm}.

64. Record of distribution of fish. Reprint of No. 24. 18 columns, December, 1879. 1 p. 51 by 38^{cm}.

65. Record of collection of eggs. Book form of No. 25. Blank for operator, date, place and nature of fishery, description of seine, haul, number of each kind of fish taken, number stripped, eggs impregnated, &c. 24 questions. 88 pp. 8 by 19^{cm}.

XXXIII.—LIST OF COLLECTIONS MADE BY THE FISHING VESSELS OF GLOUCESTER AND OTHER NEW ENGLAND SEA-PORTS FOR THE UNITED STATES FISH COMMISSION, FROM 1877 TO 1880.*

The fishes included in the following list were identified by Mr. G. Brown Goode and Dr. T. H. Bean. The Invertebrata were either originally identified or have subsequently been revised by Prof. A. E. Verrill, who is, therefore, to be considered responsible for the accuracy of the names. The nomenclature adopted for the Invertebrata is very nearly that of the Preliminary Check-list of the Marine Invertebrata of the Atlantic Coast, by A. E. Verrill, Edition of 1879.

1. Capt. DANIEL CARROLL. A specimen of the "sea hen," or skua gull (*Stercorarius skua*), from George's Bank, taken about July 9, 1878. This was the first specimen of the species recorded from the coast of the United States.

2. Capt. JOSEPH W. COLLINS, sch. Marion. A grenadier (*Macrurus Fabricii*), the second specimen known from the American coast, and a king of the herrings (*Chimæra plumbea*), the third specimen ever seen by naturalists; taken on a trawl-line in 275 fathoms of water, 30 miles SE. by E. from the eastern light of Sable Island, N. S.

3. PHILIP MERCHANT, sch. Marion. Two new species of bush-corals (*Acanella Normani* and *Keratoisis ornata*), from the same locality as the last; to these were clinging several shells and star fishes, new to science.

4. CHARLES C. CRESSY. A specimen of the oceanic dolphin (*Coryphæna punctulata*); locality not known.

5. Mr. MURPHY. A specimen of the gold-banded bush-coral (*Keratoisis ornata* Verrill); from the Grand Banks.

6. WILLIAM PARSONS, sch. Howard Steele. A specimen of the snipe-

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* When the United States Fish Commission established its station at Gloucester, Mass., in 1878, from which to prosecute its researches into the history and condition of the fisheries, the opportunity of securing the co-operation of the fishermen of the port in collecting the deep-sea animals was gladly embraced. With scarcely an exception, the captains and crews of the vessels engaged in the Banks fisheries undertook to preserve all the miscellaneous objects brought up on their lines or trawls and place them in alcohol furnished by the Commission. Such was the extent and variety of their collections that it was found expedient to keep an agent at Gloucester permanently, at the office occupied at first by the Commission. Mr. R. E. Earll discharged this duty for a number of months after the departure of the Commission, in 1878; and when he left to serve as a census agent, Dr. T. H. Bean took his place during July, August, and September of 1879. Since then Mr. A. Howard Clark has been engaged in the same work.

The amount of rare and new material included in the collections here recorded is very great, and will be published in the various monographs to be prepared for the Commission.—(S. F. BAIRD.)

eel (*Nemichthys scolopacea* (?)), from the stomach of a codfish taken in May, 1875, on the southeastern part of George's Bank, in 45 fathoms. This fish had hitherto been known only from the Island of Madeira and the South Atlantic.

7. Capt. ROBERT H. HURLBURT. Spawn of herring (?), from George's Bank, 35 fathoms, February, 1878.

8. THOMAS BURNS. Specimens of the chimæra (*Chimæra plumbea*) and of the lancet-mouth (*Alepidosaurus ferox*), from George's Bank.

9. Capt. GEORGE H. MARTIN. Five swords of the sword-fish (*Xiphias gladius*), from the South Channel.

10. JOHN PARSONS. Young pipe-fish (*Syngnathus fuscus*), from the stomach of a "daddy sculpin," Gloucester.

11. Capt. JOHN GOWRVILLE, sch. Rebecca Bartlett. Tail of sword-fish (*Xiphias gladius*), from George's Bank.

12. ANTOINE SILVA-TERRA, sch. Rebecca Bartlett. Skins of undetermined species of dogfish.

13. Capt. A. F. RICH, Boston. *Remora* or sucker fish (*Remoropsis brachyptera*), from a sword-fish taken in the South Channel.

14. HIGGINS & GIFFORD, Gloucester. Model of a Gloucester fish-wharf and fish-houses, exhibited by the city of Gloucester at the Philadelphia Exposition of 1876.

15. Capt. R. H. HURLBURT. Shells of the great scollop (*Pecten tenuicostatus*) and parasites of codfish, from George's Bank.

16. A. BARTLETT, New Bedford, Mass. Specimen of the smooth puffer or rabbit-fish (*Tetrodon lævigatus*), from Buzzard's Bay.

17. Capt. GEORGE H. MARTIN, sch. Northern Eagle. Specimen of pipe-fish (*Syngnathus fuscus*), from Provincetown, Mass.

18. W. A. KING. Specimen of great bush-coral (*Primnoa reseda*), taken by the sch. Otis D. Dana, on George's Bank, in 100 fathoms.

19. MICHAEL J. MURPHY, sch. Magic. Specimens of tree coral (*Paragorgia arborea*), from the Grand Banks, and jointed bush-coral (*Acanella Normani*), from Banquereau.

20. Capt. JEROME MCDONALD, sch. G. P. Whitman. A rock covered with bryozoans, from Banquereau.

21. ROBERT DOUGLASS. Specimen of phantom eel (*Leptocephalus*, sp.), from the mouth of Gloucester Harbor.

22. WILLIAM CARRITT, sch. Mary E. A species of shell-fish new to the American coast, from Flemish Cap, 75 fathoms.

23. ALFRED POLSEN, sch. Mary E. Hat-sponge, from Flemish Cap, 75 fathoms.

24. WILLIAM KEARNEY, sch. Marathon. Finger-sponge (*Chalina*), from George's Bank.

25. NICHOLAS CAVENER, sch. Marathon. Finger-sponge (*Chalina*) and dogfish skins, from George's Bank.

26. Sch. Northern Star. Three living hagdons (*Puffinus anglorum*), from George's Bank.

27. Capt. JOSEPH GOSLIN, sch. Shooting Star. Sponge (*Chalina*), from 25 miles SE. of Sankaty Head, Nantucket, 18 fathoms.

28. Sch. Charger. Specimen of the great, spiny spider-crab (*Lithodes maia*), from Marblehead Bank.

29. Sch. Phœnix. Skin of spear-fish (*Tetrapturus albidus*), from South Channel.

30. Sch. Lizzie K. Clark. Shells of *Buccinum cyaneum*, from 30 miles south of Sable Island, in 200 fathoms.

31. Capt. CHARLES ANDERSON, sch. Alice G. Wonson. Two specimens of great bush-coral (*Primnoa reseda*), from the channel between George's and Le Have Banks, about 200 fathoms.

32. Capt. STEPHEN J. MARTIN. Living specimen of hagdon (*Puffinus anglorum*), from George's Bank.

33. J. D. LLOYD, Gloucester. Stones bored by *Saxicava arctica*, some also containing fossils, brought up on fishermen's lines, George's Bank, 70 to 200 fathoms (exhibited at the Centennial); also two cunner-traps, purchased.

34. Capt. WM. BLACKBURN, sch. Charles Carroll. Part of the skull of a whale covered with sponges and bryozoans, from off the western part of George's Bank, 80 fathoms.

35. Capt. JOHN ROWE, Gloucester. Specimens of great bush-coral (*Primnoa reseda*), from Banquereau, 200 fathoms.

36. DANIEL DRISCOLL, sch. Polar Wave. Great bush-coral (*Primnoa reseda*), from eastern part of Banquereau, 150 fathoms.

37. DUNCAN MCDONALD, sch. Polar Wave. A specimen of great bush-coral (*Primnoa reseda*), from the same locality; and specimens of turbot (*Platysomatichthys hippoglossoides*), from eastern Banquereau, 300 fathoms.

38. SLADE GORTON & CO. Salted sword-fish and codfish turned red.

39. Capt. R. H. HURLBURT. A specimen of Günther's midge (*Hypsiptera argentea*), from off Cape May; new to the American coast.

40. FITZ J. BABSON, Jr. Lobster (*Homarus americanus*) with deformed claw.

41. A. VOSS. Devil's claw or box-hook, used in boxing fresh halibut at Gloucester.

42. Miss CARRIE A. RUST, South Harpswell, Me. Barnacles (*Lepas fascicularis*) from Harpswell, Me.

43. Capt. JAMES TARR. French hooks taken from codfish caught on shoal ground off the salvages, in 1856, and Jeffrey's Ledge, 1876.

44. JOHN DOUGLASS, Gloucester. Specimen of ribbon-snake (*Eutænia saurita*).

45. JOHN I. WILSON, sch. Otis D. Dana. Specimens of white-necked gull-chaser, or *Pomarine jæger* (*Stercorarius pomatorhinus*), from south-eastern part of George's Bank, lat. 41° 3′; and barnacles from a turtle caught at sea, by sch. Falcon.

46. SAMUEL HASKELL, East Gloucester. Fossiliferous bowlder from

George's Bank, brought in, January, 1878, by sch. Conductor, Capt. Curtis; also bryozoans and fossiliferous bowlder from the Grand Banks, brought in by sch. Etta E. Tanner, Captain Olsen.

47. E. P. SAYWARD, Jr., East Gloucester. Fossiliferous bowlder from George's Bank, showing burrows of *Saxicava arctica*.

48. Capt. NICHOLAS MURPHY, sch. Franklin S. Schenck. Pebbles covered with bryozoans, from Whaleman's Shoal, off Nantucket, 14 fathoms.

49. JOSEPH NOLAN, sch. Bessie W. Somes. Specimens of great bush-coral (*Primnoa reseda*), from Banquereau, 180 fathoms.

50. JAMES MEEK, sch. Alice G. Wonson. Specimen of tree-coral (*Paragorgia arborea*), from gully between Brown's and George's Banks, 220 fathoms.

51. ARNOLD CARLSEN, sch. Alice G. Wonson. Specimen of jointed bush-coral (*Acanella Normani*), from same locality as 50.

52. Capt. BENJAMIN BLATCHFORD, Gloucester. Specimen of great bush-coral (*Primnoa reseda*), from Banquereau, 215 fathoms.

53. Capt. HENRY WEBB, Milk Island, Rockport. Specimen of lobster-pot, bait-hook, 50 specimens of pollock (*Pollachius carbonarius*), 4 of whiting (*Merlucius bilinearis*), and 2 of Greenland sculpin (*Cottus grœnlandicus*), from Milk Island weir.

54. G. A. BOARDMAN, Calais, Me. Specimen of spotted wry-mouth (*Cryptacanthodes maculatus*), from Calais.

55. JAMES MANSFIELD & SONS, Gloucester. Bowlder containing fossil shells, from George's Bank.

56. H. G. SANFORD, Gloucester. Bowlder similar to last.

57. EVERETT P. WONSON, East Gloucester. Specimens of *Buccinum*, *Fusus*, Iceland scollop (*Pecten Islandicus*), and nullipores, from Newfoundland; a bunch of barnacles (*Balanus porcatus*), large green barnacle (*Balanus Hameri*), from the western part of George's Bank, 50 fathoms (sch. John F. Wonson), and shells from Middle Bank.

58. Capt. JEROME MCDONALD, sch. G. P. Whitman. Two specimens of the lancet-mouth (*Alepidosaurus ferox*), from lat. 42° 13′ N., long. 63° 30′ W., 300 fathoms (through Capt. Benjamin F. Blatchford).

59. GEORGE P. WHITMAN, Rockport. Mounted specimens of Richardson's jæger-gull (*Stercorarius parasiticus*).

60. Capt. WILLIAM MCDONALD, sch. N. H. Phillips. Fragment of tree coral (*Paragorgia arborea*), from Seal Island Bank, 200 fathoms, (through Captain Blatchford).

61. Crew of sch. Alice G. Wonson. Specimens of tree-coral (*Paragorgia arborea*), from the gully between George's and Le Have Banks; lat. 42° 10′ N., long. 65° 38′ W., depth 220 fathoms.

62. Capt. CHARLES A. HOMANS, Gloucester. Specimens of sipo wood, used by the Carib Indians of South America for intoxicating and catching fish; and specimens of codfish from the West Indian market.

63. Capt. GEORGE H. MARTIN, sch. Northern Eagle. Sword-fish (*Xiphias gladius*), taken off Portland (purchased).

64. JOHN H. JELLOW, sch. George P. Whitman. Four specimens of jointed bush-coral (*Acanella Normani*), from lat. 42° 43′ N., long. 63° 30′ W., 300 fathoms, (through Captain Blatchford).

65. JOHN A. LUNDBERG, Gloucester. Sponge (*Chalina oculata*), George's Bank.

66. THOMAS TRESILIAN, Gloucester. Great bush-coral (*Primnoa reseda*), George's Bank.

67. JOHN L. SMITH, Gloucester. Egg-cases of an undetermined species of *Buccinum*, taken by the crew of the sch. Conductor, Grand Banks, and a great bush-coral (*Primnoa reseda*), from George's Bank.

68. Capt. JOHN GOURVILLE, sch. Rebecca Bartlett. A star-fish (*Crossaster papposus*), sponge (*Chalina*), stemmed sea-peach (*Boltenia Bolteni*), shells, spider crabs, cod parasite, sea cucumber (*Thyonidium*) from a cod's stomach, bryozoa, &c.; from eastern part of George's Bank, 50 fathoms.

69. HENRY F. MADDEN, Gloucester. Axis of great bush-coral (*Primnoa reseda*), from off Sable Island.

70. PETER MASON, Gloucester. Shells and hydroids taken by crew of sch. Hattie S. Clark, on Grand Banks.

71. WILLIAM M. GAFFNEY, Gloucester. Bowlder containing fossils, from George's Bank.

72. SIDNEY FRIEND, Gloucester. Bowlder containing fossil shells, and specimens of rock perforated by *Saxicava arctica;* from George's Bank.

73. Crew of sch. Wachusett. Iceland scollop shells (*Pecten Islandicus*), hydroids, and barnacles, from Grand Banks.

74. Crew of sch. Howard Holbrook. Scollop shells from Grand Banks.

75. GEORGE MCCOLLUM, sch. Fitz J. Babson. King of the herrings (*Chimæra plumbea*), from Le Have Bank, 300 fathoms.

76. JOHN ATKINSON, Gloucester. Claw of lobster (*Homarus Americanus*), showing supernumerary claw partially developed.

77. GEORGE F. ROWE, East Gloucester. An interesting eel-pout (*Zoarces*), from off Eastern Point, Cape Ann, 15 fathoms.

78. HENRY E. BURKE, sch. Hattie S. Clark. Bryozoa and egg-cases of *Buccinum*, from Grand Banks, 35 fathoms.

79. Capt. GEORGE W. DIXON, sch. William T. Smith. Gulf-weed incrusted with bryozoa and egg-cases of *Buccinum*, lat. 44° 57′ N., long. 51° 55′ W., 40 fathoms, (through Captain Blatchford).

80. EUGENE F. DIXON, sch. William T. Smith. Hydroids and bryozoa, from 15 miles east-southeast of Virgin Rocks, (through Captain Blatchford).

81. GEORGE W. SCOTT, sch. City of Gloucester. Sample of black dogfish oil.

82. Capt. J. W. COLLINS, sch. Marion. Two large species of *Pen-*

natula, an undetermined species of sea-anemone, a star-fish (*Hippasteria*), several ophiurans, a number of small crustacea (*Caprella*, *Dulichia*, &c.), and halibut parasites; also a number of interesting fishes, among which were eleven specimens of the grenadier (*Macrurus Fabricii*), two chimæras (*Chimæra plumbea*), two specimens of a new species of hake (*Haloporphyrus viola*) blue in color, and a small dogfish, new to America.

83. PHILIP MERCHANT and THOMAS GINNEVAN, sch. Marion. Two large spiny spider-crabs (*Lithodes maia*).

84. GEORGE K. ALLEN, sch. Marion. Fine specimen of the gold-banded bush-coral (*Keratoisis ornata*).

85. PHILIP MERCHANT, sch. Marion. Five specimens of the jointed bush-coral (*Acanella Normani*).

86. WILLIAM BROWN, sch. Marion. Three specimens of a black dog-fish, new to the American coast.

87. JOHN LARKIN, Gloucester. A young hagdon, brought in by sch. George W. Stetson.

88. Capt. WILLIAM DEMSEY, sch. Everett Steele. Parasites of codfish (*Æga psora*), from George's Bank.

89. Crew of sch. Alice G. Wonson. Two specimens of the tree-coral (*Paragorgia arborea*), two of the great bush-coral (*Primnoa reseda*), a specimen of Goode's cup-coral (*Flabellum Goodei*), two specimens of a star-fish, new to science (*Asteropsis grandis*), basket star-fish (*Astrophyton*), small scallop shells of a rare species (*Pecten vitreus*), and a lancet-mouth (*Alepidosaurus ferox*).

90. F. S. ANDREWS, East Gloucester. A specimen of the spiny spider-crab (*Lithodes maia*), brought in by the sch. Clara B. Sweet, from Middle Bank, 40 fathoms.

91. MILES MCDONALD, Gloucester. Sea-mouse (*Aphrodite aculeata*), from Middle Bank.

92. Captain WILLIAM N. WELLS, sch. E. B. Phillips. A lot of shells from Grand Bank, lat. 44° 35′ N., long. 50° 42′ W. (through Captain Blatchford).

93. JAMES G. TARR, Gloucester. Sample of oil from an unknown fish.

94. Capt. G. H. MARTIN, sch. Northern Eagle. Specimens of small fish taken at the surface of the sea; and also goose-barnacles (*Lepas fascicularis*), isopod crustaceans (*Idotea*), sword-fish parasite (*Lernæa*) with hydroids attached, and a small lobster (*Homarus Americanus*); taken between Boon Island and Matinicus Rock, off the coast of Maine.

95. Captain BAKER, sch. Peter D. Smith. Parasites of the cod (*Æga psora*), young dog-fish (*Squalus americanus*), and a lump-fish (*Cyclopterus lumpus*).

96. THOMAS BURNS, Gloucester. Large specimen of star-fish (*Hippasteria phrygiana*), taken 6 miles southeast of Eastern Point Light, Cape Ann, 36 fathoms.

97. Captain BRIGGS GILPATRICK, sch. City of Gloucester. Sample of oil from a fish taken on Grand Banks, 300 fathoms.

98. EVERETT P. WONSON, East Gloucester. Hydroids, bryozoa, and barnacles (*Balanus porcatus*), large green barnacle (*Balanus Hameri*); brought in by the sch. Blue Jay, from South Channel, western part of George's Bank.

99. GEORGE MERCHANT, Jr., sch. Hattie B. West. A very small specimen of a goose-fish (*Lophius piscatorius*), taken off Cape Elizabeth, Maine, in a mackerel seine.

100. Mr. MERCHANT, Rockport. A large specimen of sea-corn (eggs of *Buccinum*), from off Halibut Point, Cape Ann, 45 fathoms.

101. Capt. JAMES D. MORRISEY, sch. Alice M. Williams. Two specimens of jointed bush-coral (*Acanella Normani*), from the Western Bank, 150 fathoms.

102. Capt. JOHN GOURVILLE, sch. Rebecca Bartlett. Two hagdons (*Puffinus anglorum*), parasites of codfish (*Æga psora*), branched sponges (*Chalina* and *Isodictya*), small spider-crabs (*Hyas coarctatus*), and stones covered with bryozoa; from 43 miles east-northeast of George's Shoals, 35 fathoms.

103. SIMON LE BLANC, sch. Rebecca Bartlett. A star-fish (*Crossaster papposus*), from northern edge of George's Bank, 35 fathoms.

104. EDWARD HARVEY, sch. Rebecca Bartlett. Isopod crustaceans (*Idotea robusta*), from George's Bank.

105. TIMOTHY S. ROWE, Gloucester. Specimen of gulf-weed, from the Gulf Stream.

106. Capt. WILLIAM MCDONALD, sch. N. H. Phillips. Five specimens of jointed bush-coral (*Acanella Normani*), with a new species of star-fish attached; southeast part of Le Have Bank, lat. 42° 40′ N., long. 63° 6′ W., 200 fathoms.

107. MICHAEL MCGUINN, sch. N. H. Phillips. Specimens of *Aporrhais* and eggs of sharks, from lat. 42° 44′ N., long. 63° 15′ W., 300 fathoms, (through Captain Blatchford).

108. SMITH & OAKES, Gloucester. Bowlder containing fossils, and burrowed by *Saxicava*, from George's Bank.

109. PETTINGELL & CUNNINGHAM, Gloucester. A large bowlder, similar to the last.

110. Mrs. MARY E. DAVIS, Gloucester. A bowlder filled with fossil shells, brought from Banquereau by Henry Crowell.

111. BENJAMIN S. BRAZIER, East Gloucester. Egg-cases of *Sycotypus canaliculatus*, from Monomoy Beach, and pebbles partly covered with bryozoa, from Stellwagen's Bank.

112. MARTIN BURBANK, Gloucester. A young lobster (*Homarus Americanus*), from Monhegan Island.

113. JAMES BATES, East Gloucester. Rough swell-fish (*Tetrodon turgidus*), picked up on the beach at Rocky Neck, Cape Ann.

114. Capt. WILLIAM THOMPSON, sch. Magic. Stone covered with bryozoa, hydroids, and sponges; young horse-mackerel, and jaw of striped porpoise.

115. CHARLES COLBY, Gloucester. Star-fish (*Hippasteria phrygiana*) and two pipe-fish (*Syngnathus*, sp.), taken 8 miles off Eastern Point, Cape Ann.

116. Crew of sch. Carl Schurz. Two specimens of jointed bush-coral (*Acanella Normani*) and a *Chimæra plumbea*, ♀, from 30 miles south of Sable Island, 300 fathoms.

117. A young green turtle (*Chelonia mydas*), from off Sable Island.

118. BENJAMIN CLARK, sch. Water Spirit. Vase-shaped sponge (*Phakellia*), from eastern part of Brown's Bank, 300 fathoms.

119. THOMAS GOODWIN, sch. Bellerophon. Fragment of limestone containing fossil shells, from Grand Banks, lat. 44° 30′ N., long. 50° 35′ W., 85 fathoms.

120. Crew of sch. Grace C. Hadley. Stone with barnacles and bryozoa attached, from George's Bank.

121. Sch. Carl Schurz. Sword of sword-fish, caught on trawl-lines.

122. EDWARD R. CHILDS, sch. Mary F. Chisholm. Young green turtle (*Chelonia mydas*), found floating on southeast part of Le Have Bank.

123. MORRIS WELSH, sch. Triton. A specimen of finger-sponge (*Chalina*, sp.), from George's Bank, 50 fathoms.

124. Capt. B. A. WILLIAMS, sch. Centennial. Scollop shell with barnacles, bryozoans, and sea-corn upon it; and pebbles with branching bryozoans attached.

125. JOHN H. JELLOW, sch. G. P. Whitman. Three specimens of great bush-coral (*Primnoa reseda*), from Le Have Bank, 250 fathoms; six specimens of sea-snails (*Lunatia heros*), and three valves of the great scollop (*Pecten tenuicostatus*), from George's Bank, 80 fathoms.

126. WILLIAM COLLINS. Jaws of a shark, caught off Monhegan Island.

127. Capt. JOHN Q. GETCHELL, Gloucester. Fish parasites, barnacles, shrimps and skates' jaws, from George's Bank.

128. EDWARD W. HODGKINS, Gloucester. A specimen of the great spiny spider-crab (*Lithodes maia*), caught in Harbor Cove, Gloucester, 1872, and the rock crab (*Cancer irroratus*), of large size, from Annisquam River, Cape Ann.

129. Capt. J. W. COLLINS and crew, sch. Marion. Six black dogfish (*Centroscyllium Fabricii*); wolf-fish (*Anarrhichas latifrons*); 7 rudder-fish (*Palinurichthys perciformis*); one chimæra (*Chimæra plumbea*); a grenadier (*Macrurus Fabricii*); a pug-nosed eel, new to science; one *Argentina* new to the coast, and two blue hake (*Haloporphyrus viola*). Captain Collins also brought in Lamarck's basket-fish (*Astrophyton Lamarckii*), Finmark sea-feather (*Balticina Finmarchica*), sea-cauliflower (*Alcyonium multiflorum*), and a large and valuable collection of other invertebrates, from Banquereau, 200 to 300 fathoms; and about forty specimens of the rarer water birds.

130. Capt. JOHN MCINNIS, sch. M. H. Perkins. Black dogfish (*Centroscymnus cœlolepis*), Sable Island Bank, 200 fathoms.

131. MARTIN PETERSON and DENNIS THELUENG, sch. William Thompson. A large lancet-mouth (*Alepidosaurus ferox*), grenadier (*Macrurus Fabricii*), black dogfish (*Centroscymnus cœlolepis*), and two specimens of coral; from 39 miles south-southwest of northwest light of Sable Island, lat. 43° 9′ N., long. 60° 13′ W., depth 160 fathoms.

132. Capt. GEORGE T. CLINTON, sch. Henry Wilson. Barnacles, bryozoa, egg-cases of gasteropods and gills of cod; from northeast part of Grand Banks, 45 fathoms.

133. Capt. THOMAS GOODWIN, sch. Elisha Crowell. A new species of spiny bush-coral (*Acanthogorgia armata* V.), from Western Banks, 300 fathoms.

134. Capt. BRIGGS GILPATRICK, sch. City of Gloucester. A sucker-fish (*Remoropsis brachyptera*), taken from the gills of a sword-fish.

135. JOHN S. JAMESON, sch. Henry Wilson. Specimens of branching bryozoa, gasteropod egg-cases, and Iceland scollops (*Pecten Islandicus*); from the northeast part of Grand Banks, 45 fathoms.

136. Capt. CHARLES ANDERSON and crew, sch. Alice G. Wonson. Black dog-fish (*Centroscyllium Fabricii*), lamprey (*Petromyzon*, sp.), parasites of halibut (*Æga psora*), gorgonian or spiny bush-coral (*Acanthogorgia armata*), and several species of star-fishes.

137. FRANK SWEENEY, Gloucester. Parasites from the gills of a cod-fish, from off Eastern Point, Cape Ann.

138. J. F. DUNCAN, sch. Mary Low. A very large sponge, from north-western part of George's Bank, 60 fathoms.

139. JOHN CAPRON, sch. Solomon Poole. A large collection of branching stony bryozoa, from the Grand Banks.

140. WILLIAM H. RADCLIFFE, yacht Uncle Sam. Stemmed sea-peach (*Boltenia Bolteni*), taken about 4 miles off Eastern Point, Cape Ann.

141. GEORGE W. SCOTT, sch. Lizzie. Two species of black dogfish (*Centroscyllium Fabricii* and *Centroscymnus cœlolepis*), a chimæra (*Chimæra plumbea*), and rocks covered with hydroids, bryozoans, and barnacles; from lat. 43° 28′ N., long. 60° 10′ W., 300 fathoms.

142. Capt. JAMES WELCH, sch. Martha and Susan. A specimen of branching sponge (*Chalina?*), from the eastern part of George's Bank, 50 fathoms, (through Captain Blatchford).

143. WILLIAM M. GAFFNEY, Gloucester. A rock covered with barnacles and bryozoans, from George's Bank.

144. Capt. JOSEPH SHEMELIN, sch. William H. Raymond. Specimens of branching sponge (*Chalina*), barnacles, hydroids, and bryozoans; from the western part of George's Bank, 55 fathoms.

145. Capt. ROBERT HURLBURT, Gloucester. Egg-cases of the periwinkle, from Cape Henlopen.

146. JOHN CONLEY, Gloucester. A specimen of mackerel shark (*Lamna*, sp.), taken on a trawl seven miles south-southeast of Eastern Point, Cape Ann.

147. WILLIAM A. BANSETT, New Bedford, Mass. A pilot-fish (*Naucrates ductor*).

148. Capt. JOHN GOURVILLE and crew, sch. Rebecca Bartlett. Wolf-fish (*Anarrhichas lupus?*), sculpin (*Triglops*), young Norway haddock (*Sebastes marinus*), and also stones covered with barnacles, sponges, and scollop shells; from the northeast part of George's Bank, 65 fathoms.

149. L. D. STORY, Magnolia. A specimen of *Argyreiosus vomer*, taken at Magnolia, Cape Ann.

150. JOHN ATKINSON, Gloucester. Skull of a codfish (*Gadus morrhua*), found on the beach.

151. Capt. JOHN Q. GETCHELL, sch. Otis P. Lord. Two specimens of hagdons, jaws of barndoor-skate, sea-robin (*Prionotus*), and shells (*Cyprina*), covered with stemmed sea-peach (*Boltenia Bolteni*); from George's Bank and off Cape Cod, 46 fathoms.

152. Capt. ANDREW CURTIS, ship Ida Lilly. Pens of squid from Cadiz Bay, Spain, and a larval lobster (?) taken from the stomach of a bonito.

153. JOHN KIPPIN, sch. Solomon Poole. Branching sponge (*Chalina*), and stones bored by *Saxicava arctica*, from Grand Banks, lat. 45° N., long. 50° W., 34 fathoms.

154. Capt. JAMES D. MORRISEY, sch. Alice M. Williams. Chimæra (*Chimæra plumbea*), black dogfish (*Centroscymnus cœlolepis*), two species of eel-like fishes (*Simenchelys parasiticus* and *Synaphobranchus pinnatus*), and several specimens of jointed bush-coral (*Acanella Normani*), with small scollop shells attached; from lat. 43° 18′ N., long. 60° 45′ W., 150 fathoms, (through Capt. B. F. Blatchford). Captain Morrisey also captured a squid eight feet long, but it was lost during rough weather.

155. Capt. ALFRED SPURR and crew, sch. John F. Wonson. Mussels, hydroids, bryozoa, barnacles, and scollops, from the eastern part of George's Bank, 50 fathoms.

156. JOHN SUTHERLAND, New York City. A land-locked salmon (*Salmo salar* var. *sebago*), caught in the Merrimac River.

157. Capt. GEORGE DOUGLASS, sch. Constitution. Lump-fish (*Cyclopterus lumpus*), dollar-fish (*Poronotus triacanthus*), rock-eel (*Murænoides*), moon-fish (*Argyreiosus vomer*), cunner (*Tautogolabrus adspersus*), pipe-fish (*Syngnathus Peckianus*), and isopod crustacean (*Idotea robusta*); taken on the surface, in Casco Bay, Maine.

158. HENRY WHITING, sch. Webster Sanborn. A large collection of Iceland scollops (*Pecten Islandicus*) with barnacles, and a brachiopod (*Rhynchonella psittacea*); from Grand Banks, lat. 44° 15′ N., 45 fathoms.

159. FRED. HILLIER, sch. Alice M. Williams. Two species of eel-like fishes (*Simenchelys parasiticus* and *Synaphobranchus pinnatus*), and a jointed bush-coral (*Acanella Normani*) with basket-fish (*Astrophyton*) attached; lat. 43° 18′ N., long. 60° 45′ W., 150 fathoms, (through Capt. B. F. Blatchford).

160. Capt. JEROME MCDONALD, sch. G. P. Whitman. Specimens of barnacles and a chimæra (*Chimæra plumbea*); from Le Have Bank, lat. 42° 45′ N., 63° 06′ W., 300 fathoms, (through Capt. B. F. Blatchford).

161. GEORGE W. HOY, sch. Mary F. Chisholm. A species of file-fish (*Balistes capriscus*), taken from the stomach of a halibut, and the axis of a sea-pen, from Le Have Bank, 200 fathoms.

162. Capt. GEO. A. JOHNSON, sch. A. H. Johnson. A large collection of rare fishes, including the grenadier (*Macrurus Fabricii*), chimæra (*Chimæra plumbea*), two species of black dogfish (*Centroscyllium* and *Centroscymnus*), wolf-fish (*Anarrhichas lupus?*), sucker fish (*Remoropsis brachyptera*), lamprey (*Petromyzon*, sp.), &c.; and also jaws of great bank-squid (*Sthenoteuthis megaptera*), eggs of the halibut, a rare sponge, sea-pens, shells, and a number of specimens of sea-anemones; from Sable Island Bank, lat. 43° 22′ N., long. 60° 40′ W., 280 to 300 fathoms.

163. Capt. ANDREW CURTIS, ship Ida Lilly. Specimens of cuttle-bone from the cuttle-fish (*Sepia*, sp. ?); bay of Cadiz, Spain.

164. Capt. DANIEL MCKINNON, sch. Mary F. Chisholm. Specimens of jointed bush-coral (*Acanella Normani*) and barnacles; Le Have Bank, lat. 42° 48′ N., long. 63° 05′ W., 160 fathoms.

165. Capt. WM. THOMPSON, sch. Magic. Sea-anemones, basket-fish, great northern sea-feather (*Pennatula borealis*), fragment of tree-coral (*Paragorgia arborea*), sea-urchins, rock bored by *Saxicava arctica*, and eyes of the grenadier; from Banquereau, 200 fathoms.

166. DAVID ROACH, sch. Lizzie K. Clark. A pipe made from the axis of the tree-coral (*Paragorgia arborea*).

167. Capt. MATTHEW MCDONALD, sch. Lizzie K. Clark. Well-preserved specimens of chimæra (*Chimæra plumbea*) and an eel-like fish (*Synaphobranchus pinnatus*); and, also, the axis of a gold-banded bush-coral (*Keratoisis ornata*), spiny bush-corals (*Acanthogorgia armata*) and jointed bush-coral (*Acanella Normani*), large tube-worm (*Protula media*), shells, sword-fish parasites, great club-sponge (*Cladorhiza grandis*), basket-fish, and egg of shark; from Western Bank, lat. 43° 32′ N., long. 59° 45′ W., 250 fathoms.

168. Capt. THOMAS JEWETT, sch. City of Gloucester. A number of specimens of a rare sponge, base of a gorgonian coral, axis of a gold-banded bush-coral (*Keratoisis ornata*), great northern sea-feather (*Pennatula borealis*), spiny sea-feather (*Pennatula aculeata*), shells, halibut parasites (*Æga psora*), and eel-like fish (*Synaphobranchus pinnatus*); from Le Have Bank, 150 fathoms.

169. Capt. THOS. GOODWIN, sch. Elisha Crowell. Eyes of fishes, base of gorgonian coral, and rare sponge, from Sable Island Bank, 200 fathoms.

170. Capt. LUKE DEVOE, sch. Epes Tarr. Branching bryozoans and gasteropod egg cases from Grand Banks, 100 (?) fathoms.

171. Capt. CHARLES H. NUTE, sch. Edward E. Webster. Two species of branching bryozoa from the Grand Banks.

172. Capt. FITZ. J. BABSON, Gloucester. Two specimens of surf duck (*Œdemia*), taken in Squam River, Cape Ann.

173. JOHN ATKINSON, Gloucester. Rock showing concentric layers, picked up on the beach near Western Avenue, Gloucester.

174. Capt. N. McPhee, sch. Carl Schurz. Fine specimen of the gold-banded bush-coral (*Keratoisis ornata*), great northern sea-feather (*Pennatula borealis*), a pug-nosed eel (*Simenchelys parasiticus*), eel-like fish (*Synaphobranchus*), halibut parasites (*Æga psora*), free-swimming ascidian (*Salpa*), and a warty bush coral (*Paramuricea borealis*); from Sable Island Bank, lat. 43° 25′ N., long. 59° 50′ W., 300 fathoms; also a flying fish (*Exocœtus*, sp.); from lat. 41° 40′ N., long. 62° 28′ W.

175. Andrew Colson, sch. Alice G. Wonson. A grenadier (*Macrurus Fabricii*); from near George's Bank.

176. Capt. Chas. Anderson and crew, sch. Alice G. Wonson. A specimen of tree-coral (*Paragorgia arborea*) and three specimens of a great bush-coral (*Primnoa reseda*); from near George's Bank.

177. George Allen, sch. Schuyler Colfax. Three species of star-fish (*Hippasteria phrygiana*, *Solaster endeca*, and *Crossaster papposus*); black rudder-fish (*Palinurichthys perciformis*); bunches of spawn of an unknown fish, large pebbles taken from the stomach of a cod, a vase-shaped sponge, yellow cake-sponge, eggs of *Buccinum*, small sea-cucumbers (*Thyonidium elongatum ?*), tube-dwelling sea-anemones (*Cerianthus borealis*), and a large number of shells of different species; from between Le Have and Western Bank, 75 fathoms.

178. Capt. Daniel O'Brien, sch. Guy Cunningham. A species of horse-mackerel (*Orcynus alalonga*), taken on a trawl in 250 fathoms, on Grand Banks. (Through Mr. John S. Bickford.)

179. Geo. W. Scott, sch. Lizzie. Four great northern sea-feathers (*Pennatula borealis*); two pug-nosed eels; long-nosed eel (*Synaphobranchus*); dollar-fish (*Poronotus*), taken from the stomach of a cod; sea-spiders; sea-corn (eggs of *Buccinum*); halibut parasites; sponges; base of gorgonian coral; spawn of undetermined fish; sample of oil from the *Chimæra;* and many specimens of jointed bush-coral (*Acanella Normani*), with pecten shells (*Pecten vitreus*) attached; from Banquereau, 300 fathoms. Acknowledgments are also due Mr. Scott for notes taken daily during a trip to the banks for halibut.

180. Daniel McEachern, sch. Guy Cunningham. A specimen of Goode's cup-coral (*Flabellum Goodei*), taken on Grand Banks, in 200 fathoms.

181. Capt. John Gourville, sch. Rebecca Bartlett. Many specimens of a rare species of sea cucumber (*Thyonidium elongatum ?*), taken from the stomach of a cod; long-rayed sea-rose (*Bolocera Tuediæ*); stone barnacles (*Balanus porcatus*); small crabs (*Hyas coarctatus*); and two young gadoid fishes; from eastern George's Bank, 50 fathoms.

182. John Jellow, sch. Laura Nelson. Fragments of gold-banded bush-coral (*Keratoisis ornata*); from Le Have Bank, 200 fathoms.

183. Edward McQuinn, Gloucester. Specimen of sucker-fish (*Remoropsis brachyptera*), brought in by sch. W. H. Perkins, from Grand Banks, 250 fathoms. (The fish had fastened itself to a rock that came up on the trawl.)

184. Capt. ZADOCK HAWKINS, sch. Gwendolen. A Lamarck's basket-fish (*Astrophyton Lamarckii*), variegated serpent-star (*Ophiopholis aculeata*), two specimens of black rudder-fish (*Palinurichthys perciformis*), one slime-eel (*Myxine glutinosa*) found hanging to the vessel's side, small crabs (*Hyas coarctatus*), star-fish (*Ctenodiscus crispatus*), warty sea-rose (*Urticina nodosa*), halibut parasites (*Æga psora*), and a number of species of shells, bryozoa (*Tubulipora crates*), sea cauliflower (*Alcyonium multiflorum*); from St. Peter's and Le Have Banks, 150 to 350 fathoms; also, interesting specimens of rock covered with animal life.

185. RICHARD HERRING, sch. William H. Raymond. A specimen of the gray gannet (?) and specimens of rocks; from northeastern part of George's Bank.

186. JOSEPH P. SHEMELIA, sch. William H. Raymond. Five species of water birds; brought in alive from George's Bank.

187. Capt. A. SIMONS, sch. Defiance. A living specimen of sea-robin (*Prionotus*, sp.); from "The Brewsters," 10 fathoms.

188. EVERETT P. WONSON, East Gloucester. Specimen of the great spiny spider-crab (*Lithodes maia*) and rocks covered with shells, sponges, and barnacles; from Middle Bank.

189. Capt. CHRISTIAN OLSEN and crew, sch. William Thompson. Four basket star-fish, sea-pumpkin (*Pentacta frondosa*), goose barnacles (*Lepas*), from surface, halibut parasite, long-nosed eel (*Synaphobranchus*), lamper-eel (*Petromyzon*), and rocks filled with fossil shells, and others showing "honey-comb" structure; from Le Have Bank, 150 fathoms.

190. Capt. JOHN Q. GETCHELL, sch. Otis P. Lord. A large number of rocks covered with barnacles, shells, sponges, hydroids, bryozoa, &c. Also, a large specimen of sponge, branching sponge (*Chalina*), stone barnacles (*Balanus porcatus*), small sea-cucumber (*Thyonidium elongatum?*), and a rosy, many-rayed star-fish (*Crossaster papposus*); from lat. 41° 56′ N., long. 66° 25′ W., 48 fathoms.

191. THOMAS JEWETT, sch. City of Gloucester. A sea-anemone and large pug-nosed eel; from southeast Le Have Bank, 300 fathoms.

192. Capt. JOSEPH W. COLLINS, sch. Marion. Two species of skates, new to America; Chester's hake (*Phycis Chesteri*), taken from the stomach of a cod; blue hake (*Haloporphyrus viola*), lamper-eel (*Petromyzon*), long-nosed eel (*Synaphobranchus*), eggs of skate, star-fish, great northern sea-feather (*Pennatula borealis*), tube dwelling sea-anemone (*Cerianthus borealis*), warty sea-rose (*Urticina nodosa*), scollop shells, massive sponge (*Halichondria?*), and also three species of water birds; from lat. 43° 55′ N., long. 58° 47′ W., 175 to 300 fathoms.

193. Capt. JAMES D. MORRISEY, sch. Alice M. Williams. Eight specimens of jointed bush-coral (*Acanella Normani*); from Le Have Bank, 200 fathoms.

194. Capt. W. H. GREENLEAF and crew, sch. Chester R. Lawrence. Five specimens of great bush-coral (*Primnoa reseda*) and one of tree-coral (*Paragorgia arborea*); from Banquereau, lat. 44° 24′ N., long. 54° 12′ W., 150 fathoms.

195. Maj. DAVID W. LOW, Gloucester. A collection of fossil-bearing rocks from George's Bank.

196. WILLIAM RILEY, sch. Grace C. Hadley. A living specimen of fulmar petrel, taken on a hook on the eastern part of George's Bank.

197. WILLIAM H. BATSON, sch. Marion. Base of great bush-coral (*Primnoa reseda*); from eastern part of Banquereau, 150 fathoms.

198. JOE. MENEZES, Gloucester. A specimen of herring-gull taken in Gloucester Harbor.

199. Capt. PETER JOHNSON, sch. John Smith. Eggs of *Buccinum*, small sea-cucumber (*Thyonidium elongatum?*) taken from the stomach of a cod, shells (*Pecten*, *Terebratulina*, *Velutina lævigata*, *Modiola modiolus*, *Anomia aculeata*), parasite of cod (*Æga psora*), stone barnacles (*Balanus porcatus*), rosy, many-rayed star-fish (*Crossaster papposus*), and young gadoid fishes, compound ascidian (*Amorœcium glabrum*); from south-eastern part of George's Bank, 45 fathoms.

200. EVERETT P. WONSON, East Gloucester. A sponge, eggs of undetermined fish, star-fish (*Crossaster papposus*), and a rock covered with shells, sponges, and bryozoans. Brought in by Capt. Anderson, sch. Farragut, from eastern part of George's Bank, 60 fathoms.

201. Capt. GEO. A. JOHNSON, sch. Augusta H. Johnson. A small specimen of black dog-fish (*Centroscyllium Fabricii*), pug-nosed eel, long-nosed eel (*Synaphobranchus*), several specimens of a rare barnacle (*Scalpellum*), eggs of skate, beak of squid, and hairy cake-sponge (*Trichostemma hemisphæricum*); from Le Have Bank, 300 fathoms. (Through Captain Blatchford.)

202. CUNNINGHAM & THOMPSON, Gloucester. A large sponge from Le Have Bank.

203. T. J. KNOWLES, Gloucester. A large hake's sound (dried) from a 35-pound fish.

204. FRED. A. PEARCE, Gloucester. Five specimens of star-fish (*Hippasteria phrygiana*), rock covered with shells, &c., and a small bill-fish. Brought in by Capt. McComisky, sch. Wachusett, from Western Bank.

205. JAMES DEVAN, Gloucester. Base of an interesting coral from the extreme eastern part of George's Bank, 180 fathoms.

206. Capt. D. MCKINNON and crew, sch. Mary T. Chisholm. Rare barnacles (*Scalpellum*), jointed bush-coral (*Acanella Normani*), eggs of skate, stickleback (*Gasterosteus biaculeatus*), and three specimens of the long-nosed eel (*Synaphobranchus*); from southeast Le Have Bank, 300 fathoms.

207. DANIEL MCINTIRE, Gloucester. Specimens of gypsum from near the mouth of the river St. Lawrence.

208. Capt. JOHN GOURVILLE, sch. Rebecca Bartlett. Two species of sea-cucumbers, pale sea-orange (*Psolus phantapus*), star-fish (*Solaster endeca?*), eggs of undetermined fish, and a mass of bottom formation; from Eastern George's, 45 fathoms.

209. Crew of sch. Northern Star. A great spiny spider-crab (*Lithodes maia*); from four miles off Eastern Point, 35 fathoms.

210. Capt. GEORGE H. MARTIN, sch. Northern Eagle. Several specimens of lump-fish (*Cyclopterus lumpus*), a two-spined stickleback (*Gasterosteus biaculeatus*), *Fundulus* sp., four-bearded rockling (*Enchelyopus cimbrius*, young,) and an Isopod crustacean (*Idotea robusta*); taken on the surface near Monhegan Island, Maine, in October.

211. JOHN CONLEY, Gloucester. A specimen of finger-sponge (*Chalina*), attached to a brick; from four miles off Eastern Point, Cape Ann, 35 fathoms.

212. DANIEL McEACHERN, sch. Guy Cunningham. Specimen of the great northern sea-feather (*Pennatula borealis*), star-fish (*Ctenodiscus crispatus*), pectens, new hermit-crabs (*Parapagurus pilosimanus*), basket star-fish (*Astrophyton*), large clustered sea-flower (*Epizoanthus paguriphila*), egg-cases of undetermined animal, parasites of halibut (*Æga psora*), a sucker-fish (*Remoropsis brachyptera*), eggs of undetermined fish, Iceland scollop (*Pecten Islandicus*), and four specimens of an undetermined species of fish; from lat. 42° 40′ N., long. 63° 6′ W., 250 fathoms. (Through Capt. B. F. Blatchford.)

213. Mr. GEORGE W. SCOTT, sch. Lizzie. A large specimen of the Finmark sea-feather (*Balticina Finmarchica*), three specimens of *Scalpellum*, Goode's cup-coral (*Flabellum Goodei*), warty sea-rose (*Urticina nodosa*), great club-sponge (*Cladorhiza grandis*), compound ascidian (*Leptoclinum albidum*), a grenadier (*Macrurus Fabricii*), and sea-spiders (*Pycnogonum littorale*); from lat. 42° 44′ N., long. 65° 54′ W., 350–400 fathoms. (Through Capt. B. F. Blatchford.)

214. JOSEPH P. SHEMELIA, sch. William H. Raymond. Small sea-cucumbers (*Thyonidium elongatum ?*), yellow cake-sponge, parasites of cod (*Æga psora*), large pecten shell, red spider-crabs (*Hyas araneus*), rock-crabs (*Cancer irroratus*), rare, webbed star-fish (*Pteraster pulvillus*), eggs of undetermined fish, young hake, and a number of young fishes of different species; from northeast George's, 47 fathoms.

215. THOMAS BURNS, Gloucester. Specimen of gull (*Larus Delawarensis*), taken in Gloucester Harbor.

216. M. R. PETERSON, sch. Guy Cunningham. Gold-banded bush-coral (*Keratoisis ornata*), with a large bunch of barnacles attached, from lat. 42° 48′ N., long. 63° 9′ W., 250 fathoms. Also fossil shark's tooth from South Carolina.

217. FRANK MARBLE, East Gloucester. A finger-sponge (*Chalina*), spawn of undetermined fish, and a king-fish (*Menticirrus nebulosus*) from the stomach of a cod; from off Norman's Woe, Cape Ann, 10 fathoms.

218. Capt. CHARLES ANDERSON and crew, sch. Alice G. Wonson. A specimen of sponge, bases of two species of bush-coral (*Primnoa reseda* and *Acanella Normani*), great northern sea-feather (*Pennatula borealis*), variegated serpent-star (*Ophiopholis aculeata*), large sea-anemones and a sucker-fish (*Remoropsis brachyptera*); from near George's Bank, 150 fathoms.

219. Capt. R. H. HURLBURT, assisted by Capt. R. N. MORRISON and

crew, sch. Laura Nelson. Eight specimens of jointed bush-coral (*Acanella Normani,*) large-flowered coral (*Anthomastus grandiflorus*), warty sea-rose (*Urticina nodosa*), hemispherical papillose ascidian, Lamarck's basket-fish (*Astrophyton Lamarckii*), twining serpent-star (*Astrochela Lymani*), clear scollop (*Pecten vitreus*), scaly worm (*Eunoa spinulosa*), sea worm (*Leodice vivida*), terebelloid worm, slender tubed, serpuloid worm, and, also, a large collection of the rarer deep-water fishes.

220. Capt. JOHN MCKINNON, sch. R. B. Hayes. A great spiny spider-crab (*Lithodes maia*), from 25 miles east by south of Eastern Point, Cape Ann, 45 fathoms.

221. JOHN DULANEY, Gloucester. A specimen of sea-cucumber, from two and one-half miles off Eastern Point, Cape Ann, 18 fathoms.

222. Capt. JOHN Q. GETCHELL, sch. Otis P. Lord. Star-fish (*Crossaster papposus*), stone barnacles (*Balanus porcatus*), small sea-cucumbers (*Thyonidium Dubenii?, Thyonidium elongatum?*), Iceland scollop (*Pecten Islandicus*), and young dogfish (*Squalus americanus*); from lat. 41° 56′ N., long. 66° 37′ W., 44 fathoms.

223. Capt. WILLIAM THOMPSON and crew, sch. Magic. Specimens of Lamarck's basket star-fish (*Astrophyton Lamarckii*), jointed bush-coral (*Acanella Normani*), warty sea-rose (*Urticina nodosa*), red sea-rose (*Urticina crassicornis*), Finmark sea-feather (*Balticina Finmarchica*), great northern sea-feather (*Pennatula borealis*), arctic velvet star-fish (*Archaster arcticus*), feather-star (*Antedon Eschrichtii*), variegated serpent-star (*Ophiopholis aculeata*), sponges (*Phakellia ventilabrum*), and a large fragment of tree-coral (*Paragorgia arborea*), a scaly worm (*Eunoa spinulosa*), compound ascidian (*Amorœcium glabrum*); from 50 miles east of the East Light of Sable Island, 280 fathoms.

224. Capt. MATTHEW MCDONALD, sch. Lizzie K. Clark. Finmark sea-feather (*Balticina Finmarchica*), with sea-anemones (*Urticina*) attached, and a number of shells; from southeast of Sable Island, 170 fathoms.

225. JAMES and JOHN D. MCDONALD, sch. Addison Center. An old-fashioned iron kettle, hauled up from the bottom, near Halifax, N. S.

226. Capt. N. MCPHEE and crew, sch. Carl Schurz. A rare species of Gorgonian, or bush-coral, (*Anthothela grandiflora*), attached to which were several scaly worms, new to the American coast; also a great club-sponge (*Cladorhiza grandis*), Finmark sea-feather (*Balticina Finmarchica*), great northern sea-feather (*Pennatula borealis*), Goode's cup-coral (*Flabellum Goodei*), shell with small, warty sea-roses (*Urticina nodosa*) attached, jointed bush-coral (*Acanella Normani*), Lamarck's basket-fish (*Astrophyton Lamarckii*), variegated serpent-star (*Ophiopholis aculeata*), parasites of halibut (*Ægea psora*), two pug-nosed eels, and a lamper-eel (*Petromyzon*); from near Sable Island Bank.

227. Capt. M. W. CALDERWOOD, sch. Josie M. Calderwood. Perforated rocks with sponge and shells attached; from lat. 43° 22′ N., long. 62° 23′ W., 68 fathoms.

228. Capt. THOMAS GOODWIN, sch. Elisha Crowell. A large specimen of the lancet-mouth (*Alepidosaurus ferox*); from Le Have Bank, 200 to 250 fathoms.

229. Capt. Z. HAWKINS and crew, sch. Gwendolen. Specimens of flesh-colored soft coral (*Alcyonium carneum*), tree-coral (*Paragorgia arborea*), an eel-pout (*Zoarces*), lamper-eel (*Petromyzon*), long-nosed eel (*Synaphobranchus pinnatus*), an embryo shark cut from the egg, Lamarck's basket-fish (*Astrophyton Lamarckii*), large cluster sea-flower (*Epizoanthus paguriphila*), a new hermit-crab (*Parapagurus pilosimanus*), and a fragment of a hydroid (*Tubularia indivisa*); from lat. 42° 23′ N., and long. 62° 20′ W., to 63° 20′ W., 300 to 400 fathoms.

230. Capt. WILLIAM E. SWEET, sch. Grace C. Hadley. Sea-cucumbers (*Thyonidium Dubenii*), star-fish, and parasites of cod (*Æga psora*); from lat. 42° 47′ N., long. 65° 30′ W., 55 fathoms.

231. Capt. CHRIS. ANDERSON, sch. Solomon Poole. A large collection of hydroids (*Sertularella polizonias* var. *robusta*), bryozoa (*Idmonea atlantica, Caberea Ellisii, Cellularia ternata* var. *gracilis*), large green barnacles (*Balanus Hameri*), sponges (*Isodictya palmata*), a sabelloid worm (*Potamilla reniformis*), creeping coral (*Cornulariella modesta*), compound ascidians (*Leptoclinum albidum, Amorœcium glabrum*), stemmed sea-peach (*Boltenia Bolteni*), and *Ascidiopsis complanatus*; from 15 miles east of Pollock Rip light-ship, 65 fathoms.

232. Capt. FITZ J. BABSON, Gloucester. A specimen of duck (*Harelda glacialis*) in fine plumage; shot in Squam River, Cape Ann.

233. GEORGE K. ALLEN, sch. M. H. Perkins. A spiny bush-coral (*Acanthogorgia armata*), *Funiculina armata*, branching sponge, great northern sea-feather (*Pennatula borealis*), spiny sea-feather (*Pennatula aculeata*), Finmark sea-feather (*Balticina Finmarchica*), warty sea-rose (*Urticina nodosa*), compound ascidian (*Leptoclinum albidum*), blue hake (*Haloporphyrus viola*), two long-nosed eels (*Synaphobranchus pinnatus*), and a pug-nosed eel; from 40 miles southwest of the northwest light of Sable Island, 300 to 400 fathoms.

234. Capt. GEORGE A. JOHNSON, sch. Augusta H. Johnson. Four specimens of the pug-nosed eel, two of which were taken alive from a large cavity which they had excavated along the backbone of a halibut near the tail, long-nosed eel (*Synaphobranchus pinnatus*), skipper (*Scombresox saurus*), egg of *Chimæra plumbea* (?), Lamarck's basket-fish (*Astrophyton Lamarckii*), and jointed bush-coral (*Acanella Normani*), bryozoa (*Cellaria fistulosa*), large shrimp (*Pandalus borealis*), spiny, round sponge (*Dorvillia echinata*), creeping coral (*Cornulariella modesta*); from lat. 42° 47′ N., long. 63° 10′ W., 375 fathoms.

235. Capt. JAMES D. MORRISEY, sch. Alice M. Williams. Baird's devil-fish (*Octopus Bairdii*), branching-sponge, jointed bush-coral (*Acanella Normani*), Lamarck's basket-fish (*Astrophyton Lamarckii*), deep-water star-fish (*Archaster Andromeda*), *Alcyonium carneum*, large flowered coral (*Anthomastus grandiflorus*), great sea-cucumber (*Pentacta frondosa*),

eggs of shark, eggs of unknown fish attached to *Acanella*, and parasite of halibut (*Ægа psora*); from lat. 43° 25′ N., long. 60° 20′ W., 170 fathoms.

236. Capt. PETER HAMLIN, sch. Andrew Leighton. A lancet-mouth (*Alepidosaurus ferox*) and a pug-nosed eel; from lat. 42° 45′ N., long. 63° W., 195 fathoms.

237. Capt. JOSEPH W. COLLINS and crew, sch. Marion. One specimen of the grenadier (*Macrurus Fabricii*), three black dog-fish (*Centroscyllium Fabricii*), two black dog-fish (*Centroscymnus cœlolepis*), two lancet-mouths (*Alepidosaurus ferox*), four chimæras (*Chimæra plumbea*), two lamper-eels (*Petromyzon*, sp.), one arctic dab (*Hippoglossoides*), one pug-nosed eel, one blue hake (*Haloporphyrus viola*), and an undetermined eel-like fish. Among the invertebrates were a comatula (*Antedon Sarsii?*), three Finmark sea-feathers (*Balticina Finmarchica*), one great northern sea-feather (*Pennatula borealis*), nineteen spiny sea-feathers (*Pennatula aculeata*), one undetermined sea-pen, nine sea-anemones, and thirteen specimens of a rare species of barnacle (*Scalpellum*). These specimens were from several localities on the Fishing Banks.

238. Capt. J. FRANK DUNTON, sch. Mary Low. A fine specimen of a vase-sponge, from the southwest part of Sable Island Bank; lat. 43° 9′ N., 55 fathoms. (Through Procter Brothers.)

239. Capt. WM. H. GREENLEAF and crew, sch. Chester R. Lawrence. One specimen of blue hake (*Haloporphyrus viola*), long-nosed eel (*Synaphobranchus pinnatus*), pug-nosed eel, lamper-eel, (*Petromyzon* sp.), great northern sea-feather (*Pennatula borealis*); Goode's cup-coral (*Flabellum Goodei*), bush-corals (*Acanthogorgia armata*, *Anthothela grandiflora*, and *Anthomastus grandiflorus*), Lamarck's basket-fish (*Astrophyton Lamarckii*); also a sea-anemone, terebelloid worm, great club-sponge (*Cladorhiza grandis*), and a new coral.

240. Capt. THOMAS F. HODGDON and crew, sch. Bessie W. Somes. Specimens of jointed bush-coral (*Acanella Normani*), a branching-sponge, great northern sea-feather (*Pennatula borealis*), spiny sea-feather (*Pennatula aculeata*), Finmark sea-feather (*Balticina Finmarchica*), warty sea-roses (*Urticina nodosa*), barnacles (*Scalpellum*), parasites of halibut (*Ægа psora*), shells, sponges, and a red velvet star-fish (*Archaster Parellii*); from lat. 43° 34′ N., long. 49° W., 60 fathoms.

241. Capt. CHRIS. OLSEN and crew, sch. William Thompson. A large annelid called the sea-mouse (*Aphrodita aculeata*), eggs of a gastropod mollusk (*Buccinum undatum*), rosy, many-rayed star-fish (*Crossaster papposus*), Hyatt's bob-tailed squid (*Rossia Hyatti*), and rocks covered with worms and hydroids (*Sertularia abietina*, *Sertularella tricuspidata*); from lat. 44° 20′ N., long. 59° W., 60 fathoms.

242. Capt. DANIEL MCKINNON and crew, sch. Mary F. Chisholm. Great northern sea-feather (*Pennatula borealis*), Finmark sea-feather (*Balticina Finmarchica*), with sea-anemone (*Urticina*), great spiny spider-crab (*Lithodes maia*), four Lamarck's basket-fish (*Astrophyton Lamarckii*),

two deep-water star-fish, fragment of a tree-coral (*Paragorgia arborea*), a slime-eel (*Myxine glutinosa*), lamper-eel (*Petromyzon* sp.), and a young Norway haddock (*Sebastes*); from lat. 43° 15′ N., long. 60° 20′ W., 350 fathoms.

243. J. MURPHY, sch. Gertie E. Foster. A fine specimen of sponge, from lat. 42° 16′ N., long. 64° 50′ W., 200 fathoms.

244. ISAAC BUTLER, sch. Esther Ward. Three specimens of a basket-star-fish (*Astrophyton Agassizii*), parasites of cod, (*Æga psora*), sea-mouse (*Aphrodita aculeata*), taken from the stomach of a cod, flesh-colored soft coral (*Alcyonium carneum*), and two specimens of a papillose, yellow cake-sponge; from Brown's Bank, 52 fathoms.

245. JOHN DANFORTH, Gloucester. A flesh-colored soft coral (*Alcyonium carneum*), and a large worm from the shore above low-water mark.

246. ISAAC S. HEWETT, sch. J. J. Clark. A large cluster of stone barnacles (*Balanus porcatus*), from northern edge of Middle Bank, 50 fathoms.

247. Capt. R. MORRISON and crew, sch. Laura Nelson. A sucker-fish (*Petromyzon* sp.), found clinging to the side of a hake, a fragment of tree coral (*Paragorgia arborea*), large flowered sea-feather (*Virgularia grandiflora*), and papillose, yellow cake-sponges; from Le Have Bank, lat. 42° 32′ N., long. 64° 19½′ W., 300 fathoms.

248. DANIEL MCEACHERN, sch. Guy Cunningham. Specimens of sea-anemones, a yellow cake-sponge, nipple sponge (*Polymastia*), a slime-eel (*Myxine glutinosa*), and a small lamper-eel (*Petromyzon* sp.), bryozoa (*Idmonea atlantica*, *Cellaria fistulosa*), sea-potato (*Ascidia mollis*), lamp-shell (*Terebratulina septentrionalis*), common clustered sea-flower (*Epizoanthus Americanus*); from lat. 42° 56′ N., long. 63° 4′ W., 75 fathoms.

249. GEORGE W. SCOTT, sch. Edwin C. Dolliver. A fine specimen of the blue hake (*Haloporphyrus viola*), Chester's hake (*Phycis Chesteri*), a small catfish (*Anarrhichas* sp.), eggs of black dog-fish, a pug-nosed eel, five long-nosed eels (*Synaphobranchus pinnatus*), a chimæra (*Chimæra plumbea*), scaly worm (*Eunoa spinulosa*), devil-fish (*Octopus*), great northern sea-feather (*Pennatula borealis*), spiny sea-feather (*Pennatula aculeata*), Finmark sea-feather (*Balticina Finmarchica*,) fragment of gold-banded bush-coral (*Keratoisis ornata*), jointed bush-coral (*Acanella Normani*), flesh-colored soft-corals (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), Lamarck's basket-fish (*Astrophyton Lamarckii*), and shells; from lat. 43° 23′ N., long. 60° 16′ W., 300 fathoms. Acknowledgments are also due Mr. Scott for a daily log of the entire trip.

250. Capt. JOHN Q. GETCHELL, schr. Otis P. Lord. Two specimens of finger-sponge (*Chalina*), flesh-colored soft coral (*Alcyonium carneum*), and a fragment of rock from Brown's Bank, lat. 42° 50′ N., long. 65° 10′ W., 53 fathoms. Also a great spiny spider-crab (*Lithodes maia*), from lat. 43° 15′ N., long. 69° 50′ W., 70 fathoms.

251. H. C. MOORE, sch. Chester R. Lawrence. Tusk of a walrus, found on the coast of Newfoundland.

252. J. LAKEMAN, Gloucester. A large specimen of the great spiny spider-crab (*Lithodes maia*); from unknown locality.

253. Capt. WILLIAM SWEET, sch. Grace C. Hadley. A fine specimen of a branching bryozoan, a star-fish, and a Norway haddock (*Sebastes marinus*); from George's Bank, 55 fathoms.

254. JAMES GORDAN, sch. Carl Schurz. A number of specimens of the jointed bush-coral (*Acanella Normani*), scallop shells (*Pecten vitreus*), star-fish, and egg-cases of undetermined animal; from Le Have Bank.

255. EDGAR S. SCOTT and GEORGE A. SANDERS, sch. Hattie N. Reed, Capt. Arthur C. Whalen. A china pitcher of foreign workmanship on which was growing a large bunch of stone barnacles (*Balanus porcatus*); taken on a trawl on the southeastern part of Jeffrey's Bank, 75 fathoms. (Through Procter Brothers.)

256. JOHN MCDOUGAL, sch. Polar Wave. Four specimens of a rare pelagic fish (*Scopelus* sp.), washed aboard during a storm, in lat. 42° 17′ N., long. 63° 30′ W., and a long-spined velvet-star (*Archaster tenuispinus*.)

257. GEORGE K. ALLEN, sch. Procter Brothers. Four specimens of Norway haddock (*Sebastes* sp.), three small codfish (*Gadus morrhua*), a number of stomachs of haddocks, several specimens each of two species of star-fish (*Solaster* and *Ctenodiscus*), slender purple star-fish (*Leptasterias compta*), feather-star (*Antedon Eschrichtii*), green sea-egg (*Strongylocentrotus Dröbachiensis*), a crab (*Hyas coarctatus*) taken from the stomach of a cod, flesh-colored soft coral (*Alcyonium carneum*), variegated serpent-star (*Ophiopholis aculeata*), Lamarck's basket-fish (*Astrophyton Lamarckii*), several species of shells, sea-cauliflower (*Alcyonium multiflorum*), two hydroids (*Campanularia verticellata*), *Ascidiopsis complanatus*, hairy cake-sponge (*Trichostemma hemisphæricum*), smooth, round sponge, hairy cake-sponge (*Tethya*), nipple sponge (*Polymastia*, hispid species), and four specimens of an undetermined invertebrate; from 7 to 10 miles southeast of Little Hope Light, Nova Scotia, 35 to 60 fathoms.

258. Capt. PETER HAMLIN and crew, sch. Andrew Leighton. A large specimen of a ghost-fish (*Cryptacanthodes maculatus*); from lat. 42° 45′ N., long. 63° 20′ W., 200 fathoms.

259. Capt. N. MURPHY, sch. Franklin S. Schenck. A large specimen of sea-anemone; from Jeffrey's Bank.

260. BENJAMIN MORAN, Gloucester. The pectoral bone of a fish called by fishermen the "singing-fish"; taken near Buenos Ayres, S. A., in 16 fathoms of water.

261. Capt. THOMAS GOODWIN and crew, sch. Howard. A large specimen of the great northern sea-feather (*Pennatula borealis*), long-nosed eel (*Synaphobranchus pinnatus*), star-fish (*Hippasteria*), and a rock; from lat. 42° 40′ N., long. 60° 50′ to 55′ W., 200 to 300 fathoms.

262. Capt. THOMAS F. HODGDON and crew, sch. Bessie W. Somes. A great northern sea-feather (*Pennatula borealis*), massive sponge (*Halichondria?*), Earll's many-rayed star-fish (*Solaster Earllii*); from Le Have Bank.

263. Capt. JAMES D. MORRISEY and crew, sch. Alice M. Williams. A small pelagic fish (*Scopelus* sp.), washed aboard during a storm. Also, two rocks, from lat. 43° 25′ N., long. 61° 25′ W., 200 fathoms.

264. ANGUS MCNEIL, sch. Marion. A portion of the skull and tusks of a walrus, hooked up on a trawl, in 75 fathoms of water; lat. 42° 53′ N., long. 63° 05′ W.

265. Capt. JOSEPH W. COLLINS and crew, sch. Marion. A smooth bob-tailed squid (*Rossia sublevis*), Baird's devil-fish (*Octopus Bairdii*), five specimens of the great northern sea-feather (*Pennatula borealis*), a pug-nosed eel (*Simenchelys parasiticus*), a slime-eel (*Myxine glutinosa*), and eggs of *Chimæra* (?); from lat. 42° 49′ N., long. 62° 57′ W., 200 to 300 fathoms.

266. Capt. DANIEL MCKINNON and crew, sch. Mary F. Chisholm. Two specimens of lamprey-eels (*Petromyzon*), stone barnacles (*Balanus porcatus*), and jointed bush-coral (*Acanella Normani*); from lat. 43° 14′ N., long. 62° 45′ W., 55 fathoms.

267. Captain and crew of sch. Ida May. A specimen of the great spiny spider-crab (*Lithodes maia*); from 7 miles off Eastern Point, 35 fathoms.

268. CHARLES RUCKLEY, sch. William H. Oakes. A blue hake (*Haloporphyrus viola*), two specimens of *Scopelus* sp., a sand launce (*Ammodytes* sp.), four spiny sea-feathers (*Pennatula aculeata*), a Finmark sea-feather (*Balticina Finmarchica*), a deep-water star-fish (*Asterias stellionura*), a soft coral (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), jointed bush-coral (*Acanella Normani*), shells, and sea-anemones; from latitude 44° 8′ N., long. 53° 20′ W., 300 fathoms.

269. THOMAS LEE, sch. William H. Oakes. A very rare goggle-eyed squid (*Desmoteuthis hyperborea*), taken with a gaff from the vessel's deck, on the northern edge of the Gulf Stream, long. 55° W. Not known before from this coast.

270. GEORGE W. SCOTT, sch. Edwin C. Dolliver. A large deep-water skate (*Raia granulata*), the second specimen obtained, two other skates (*Raia radiata*), two monk-fish (*Lophius piscatorius*), Finmark sea-feather (*Balticina Finmarchica*), and two tube-dwelling sea-anemones (*Cerianthus borealis*); from 36 miles southeast by east of N. E. light of Sable Island, 90 to 150 fathoms.

271. Capt. WILLIAM SWEET, sch. Grace C. Hadley. A young Norway haddock (*Sebastes*), slender purple star-fish (*Leptasterias compta*), red spider-crab (*Hyas araneus*), small sea-cucumber (*Thyonidium Dubenii?*), tree-coral (*Paragorgia arborea*), finger-sponge, red sea-roses (*Urticina crassicornis*), twining serpent-star (*Astrochele Lymani*), variegated serpent-star (*Ophiopholis aculeata*), yellow cake-sponge, crab, and worms; from Brown's Bank, 70 fathoms.

272. MATT. RYAN and others, sch. Lizzie, Capt. R. Grant. Two specimens of a tube-dwelling sea-anemone (*Cerianthus borealis*), two soft corals (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), a

star-fish (*Ctenodiscus*), and two pelagic fishes (*Scopelus* sp.), washed aboard during a storm; from the Grand Banks.

273. ADDISON GOTT, Rockport, Mass. A fragment of limestone containing iron and perforated by *Saxicava arctica;* brought up on George's Bank, in 1876, by the sch. Rival, of Gloucester.

274. Mr. ELDRIDGE, Woodbury, Mass. A vertebra of a whale, hooked up in Ipswich Bay. (Through Mr. Wm. Oakes.)

275. Capt. GEORGE H. MARTIN and crew, sch. Northern Eagle. A large-headed eel-pout (*Zoarces* sp.), the second specimen procured, and a common eel-pout (*Zoarces anguillaris*), several skates, and many shells and star-fish representing several species; from Ipswich Bay, 9 to 16 fathoms.

276. Capt. CHRIS. OLSEN and crew, sch. William Thompson. Four large specimens of soft coral (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), tube-dwelling sea-anemone (*Cerianthus borealis*), and a number of Lamarck's basket-fish (*Astrophyton Lamarckii*); from Grand Banks, 150 fathoms.

277. Capt. S. J. MARTIN, East Gloucester. A young catfish (*Anarrhichas* sp.); from Ipswich Bay, 10 fathoms.

278. JAMES HANSON, sch. Sarah P. Ayer. A fine specimen of tree-coral (*Paragorgia arborea*), to the enlarged base of which is attached a large cluster of stone barnacles (*Balanus porcatus*); from near George's Bank, 135 fathoms.

279. Capt. John Q. GETCHELL, sch. Otis P. Lord. Several young Norway haddock (*Sebastes*), five sand-launces (*Ammodytes*), two stemmed sea-peaches (*Boltenia Bolteni*), parasites of cod (*Æga psora*), sand-dollars, red spider crabs (*Hyas coarctatus*), pale sea-orange (*Psolus phantapus*), small sea-cucumbers (*Thyonidium elongatum?*), a red sea-rose (*Urticina crassicornis*), big-rayed sea-rose (*Bolocera Tuediæ*), two fine specimens of finger-sponge (*Chalina*), ascidian (*Molgula retortiformis*), and a large collection of rocks covered with shells, hydroids (*Sertularia abietina, Clytia*), bryozoans, and sponges; from Brown's Bank.

280. CAPT. R. H. HURLBURT, sch. Sultana. A large specimen of a hydroid, several large pecten shells, ascidians, common star-fish (*Asterias vulgaris*), worm (*Thelepus cincinnatus*), great sea cucumber (*Pentacta frondosa*), stemmed sea-peach (*Boltenia Bolteni*), spawn of unknown fish, and four large mussel-shells covered with hydroids (*Diphasia fallax*), bryozoans, and barnacles, yellow cake-sponge; also, mackerel (*Scomber scombrus*) and cunners (*Tautogolabrus adspersus*) taken from the stomachs of cod (*Gadus morrhua*); from northeast part of George's Bank.

281. DANIEL MCEACHERN, sch. Guy Cunningham. A long-spined velvet star-fish (*Archaster tenuispinus*), four tube-dwelling sea anemones (*Cerianthus borealis*), twelve spiny sea-feathers (*Pennatula aculeata*), two large papillose, yellow cake-sponges, parasites of halibut (*Æga psora*), two warty sea-roses (*Urticina nodosa*), big-rayed sea-rose (*Bolocera Tuediæ*), two grenadiers (*Macrurus Fabricii*), and a small codfish; from latitude 44° 28′ N., long. 53° 35′ W., 128 fathoms.

282. Captain and crew, sch. Polar Wave. Two great northern sea-feathers (*Pennatula borealis*), warty sea-rose (*Urticina nodosa*), sea-corn (eggs of *Buccinum*), cup-sponge (*Isodictya*), slimy sponge (*Raphiodesma lingua*), pug-nosed eel, long-nosed eel (*Synaphobranchus pinnatus*). and rare shells; from the western edge of Grand Banks, lat. 44° 18′ N., 200 to 225 fathoms.

283. Capt. J. W. Collins and crew, sch. Marion. Two rare deep-water skates, one black dog-fish (*Centroscyllium Fabricii*), a pelagic fish (*Scopelus*) washed aboard, sponges, and a rock with sea-anemone attached; from lat. 44° 33′ N., long. 64° 48′ W., 150 fathoms.

284. Capt. James D. Morrisey and crew, sch. Alice M. Williams. A specimen of *Scopelus* washed aboard, and a Norway haddock (*Sebastes*), Finmark sea-feather (*Balticina Finmarchica*), flesh-colored soft coral (*Alcyonium carneum*), and a Lamarck's basket-fish (*Astrophyton Lamarckii*); from near lat. 40° N., long. 55° 50′ W.

285. Henry Wilson, sch. Flash. Several warty sea-roses (*Urticina nodosa*), red sea-rose (*Urticina crassicornis*), eggs of Gasteropod, small velvet-star (*Ctenodiscus crispatus*), sponges, several species of shells, and three gulls (*Rissa tridactyla*); from lat. 49° 9′ N., long. 52° 3′ W., 180 fathoms.

286. Capt. William Thompson and crew, sch. Magic. Great northern sea-feather (*Pennatula borealis*), warty sea-roses (*Urticina nodosa*), sea-mouse (*Aphrodita*), yellow cake-sponge, hairy cake-sponge (*Trichostemma hemisphæricum*), papillose yellow cake-sponge, sea-corn (eggs of *Buccinum*), sea-cauliflower (*Alcyonium multiflorum*), Lamarck's basket-fish (*Astrophyton Lamarckii*), Flora's velvet-star (*Archaster Floræ*), and arock bored by *Saxicava artica*; from lat. 44° 55′ N., long. 52° W., 150 fathoms.

287. Capt. R. Morrison and crew, sch. Laura Nelson. Two specimens of the slime-eel (*Myxine glutinosa*), and sea-cauliflower (*Alcyonium multiflorum*); from lat. 43° 33′ N., long. 52° 10′ W., 300 fathoms.

288. Michael Flaherty, Gloucester. Bones from the head of a shark.

289. Capt. James Nickerson and crew, sch. Commonwealth. An undetermined young shark, taken from the mother, in lat. 45° 7′ N., long. 54° 30′ W., 82 fathoms.

290. George W. Scott, sch. Edwin C. Dolliver. Two black dog-fish (*Centroscyllium Fabricii*), three slime-eels (*Myxine glutinosa*), a blue hake (*Haloporphyrus viola*), grenadier (*Macrurus Fabricii*), two turbot, two great northern sea-feathers (*Pennatula borealis*), two Finmark sea-feathers (*Balticina Finmarchica*), and a deep-water star-fish (*Asterias stellionura*); from lat. 44° 45′ N., long. 53° 54′ W., 400 fathoms. Also a grenadier (*Macrurus Fabricii*), two long-nosed eels (*Synaphobranchus pinnatus*), three star-fish (*Ctenodiscus*), a sponge, and two species of shells; from lat. 44° 23′ N., long. 53° 25′ W., 200 fathoms.

291. Capt. John Kavanagh and crew, sch. Alfred Walen. Spawn of unknown fish, sea-worm (*Nereis pelagica*), variegated serpent-star (*Ophiopholis aculeata*), shells containing hermit-crabs (*Eupagurus bern-

hardus), parasites of cod (*Æga psora*), flesh-colored soft coral (*Alcyonium carneum*), hydroid (*Hydractinia echinata*), red velvet-star (*Archaster Parelii*), and a rock covered with sponges and shells; from George's Bank, 32 fathoms.

292. Capt. THOMAS GOODWIN and crew, sch. Howard. A rare large-flowered sea-feather (*Virgularia grandiflora*), the third specimen discovered. Also two slime-eels (*Myxine glutinosa*), Lamarck's basket-fish (*Astrophyton Lamarckii*), three sea-cauliflowers (*Alcyonium multiflorum*), yellow cake-sponge, and a rock; from Grand Banks, lat. 45° 3′ N., long. 54° 30′ W., 85 fathoms.

293. Captain and crew sch. Davy Crockett. A large rock hauled up on a trawl in lat. 45° 12′ N., long. 54° 30′ W., 85 fathoms.

294. Capt. JOHN Q. GETCHELL, sch. Otis P. Lord. Small Norway haddock (*Sebastes*), alewife (*Pomolobus* sp.), star-fish, shrimps, crabs, sea-cucumbers, sea-urchins, sea-mouse (*Aphrodita*), hydroids, yellow cake-sponge, and other species of sponges, rocks, and several species of shells; from lat. 42° 42′ N., long. 65° 40′ W., 50 fathoms.

295. JAMES MANSFIELD & SONS, Gloucester. Specimens of codfish from Grand Banks, with a number of small fish firmly imbedded in the flesh.

296. DANIEL MCEACHERN, sch. Guy Cunningham. A sea-cucumber (*Pentacta frondosa*) and a basket star-fish (*Astrophyton*); from lat. 44° 12′ N., long. 59° 12′ W., 160 fathoms.

297. Capt. WILLIAM SWEET, sch. Grace C. Hadley. A large pecten shell, two great sea-cucumbers (*Pentacta frondosa*), star-fish (*Asterias*), and a finger-sponge (*Chalina*); from George's Bank.

298. MATT. RYAN, sch. Seth Stockbridge. An undetermined fish found on the vessel's deck while dressing halibut, in lat. 44° 10′ N., long. 52° 35′ W., 130 fathoms.

299. Capt. RUSSELL G. GILL, sch. Maud Gertrude. A large codfish, with the head and back of a light golden color, taken in 16 fathoms of water, in Ipswich Bay, Mass.

300. Capt. WM. GREENLEAF and crew, sch. Chester R. Lawrence. Two slime-eels (*Myxine glutinosa*), a great spiny spider-crab (*Lithodes maia*) and a green sea-egg (*Strongylocentrotus Dröbachiensis*); from the Grand Banks.

301. R. H. HURLBURT, sch. Sultana. A small sculpin (*Cottus*), hydroids, and a finger-sponge (*Chalina*); from George's Bank, 35 fathoms.

302. Capt. THOMAS F. HODGDON and crew, sch. Bessie W. Somes. Specimens of sea-corn (eggs of *Buccinum*) and jointed bush-coral (*Acanella Normani*); from the Grand Banks.

303. Capt. NATHANIEL GREENLEAF and crew, sch. Grace L. Fears. Two large specimens of the fringed star-fish (*Asterias stellionura*), Lamarck's basket-fish (*Astrophyton Lamarckii*), warty sea-rose (*Urticina nodosa*), sponges, hydroids, and rocks; from lat. 44° 7′ N., long. 59° 2′ W., 150 to 200 fathoms.

304. JOSEPH P. SHEMELIA, sch. William H. Raymond. A pecten shell with barnacles attached, and a rock; from Eastern George's, 35 fathoms.

305. CHRISTIAN JOHNSON, sch. William Thompson. A new species of fish (*Alepocephalus Bairdii*) from the Grand Banks. The other species of this genus are confined to the Mediterranean Sea.

306. Capt. GEORGE JOHNSON and crew, sch. Augusta H. Johnson. The jaws of a ground-shark and a number of star-fish (*Ctenodiscus*); from the Grand Banks, 130 fathoms.

307. Capt. JOHN WOODBURY, sch. Barracouta. A rock covered with shells, hydroids, barnacles, and sponges, flesh-colored soft coral (*Alcyonium carneum*); from the northern part of George's Bank, 35 fathoms.

308. CHARLES RUCKLEY, sch. Frederick Gerring, jr., Capt. Edward Morris. Three slime-eels (*Myxine glutinosa*), part of the jaw of a ground-shark, sponges (*Thecophora ibla*), stemmed sea-peach (*Boltenia Bolteni*), sea-anemones, yellow cake-sponge, bryozoa (*Flustra securifrons, Caberea Ellisii, Celleporaria incrassata*), flesh-colored soft corals (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), great bush-coral (*Primnoa reseda*), star-fish (*Crossaster papposus*), common serpent-star (*Ophiacantha bidentata*), green sea-egg (*Strongylocentrotus Dröbachiensis*), red spider-crab (*Hyas coarctatus*), hermit crab (*Eupagurus*), red shrimp (*Hippolyte securifrons?*), parasites of halibut (*Æga psora*), hydroids (*Lafoea, Sertularella polyzonias* var. *robusta, Sertularia argentea*), and rocks with creeping coral attached, sea-worm (*Nereis pelagica*), shells (*Buccinum cyaneum, Natica clausa*), lamp-shell (*Terebratulina septentrionalis*); from Green Bank and the Grand Banks.

309. Capt. JOSEPH W. COLLINS and crew, sch. Marion. A rare deep-water skate (*Raia granulata*), small Norway haddock (*Sebastes*), grenadier (*Macrurus Fabricii*), yellow cake-sponge, and rocks with shells and bryozoans attached; from the Grand Banks.

310. Capt. CHARLES V. MOULTON, sch. Peter D. Smith. A lamper-eel (*Petromyzon marinus*), young hake (*Phycis*), egg of skate, red sea-rose (*Urticina crassicornis*), parasite of cod (*Æga psora*), great sea-cucumber (*Pentacta frondosa*), and hydroids (*Hydrallmania falcata, Sertularella tricuspidata, Sertularia argentea, Sertularia abietina*); from 12 miles southeast by south of Half Moon Shoal, George's Bank, 26 fathoms.

311. Capt. WILLIAM THOMPSON and crew, sch. Magic. A large common basket-fish (*Astrophyton Agassizii*), a deep-water star-fish (*Asterias stellionura*), and a cup-sponge; from lat. 43° 42′ N., long. 55° 10, W., 100 fathoms.

312. Capt. DANIEL MCKINNON and crew, sch. Mary F. Chisholm. Specimens of soft coral (*Alcyonium carneum*), common basket-fish (*Astrophyton Agassizii*), stemmed sea-peach (*Boltenia Bolteni*), hydroid (*Lafoea*), and sponges; from lat. 43° 38′ N., long. 55° 8′ W., 110 fathoms.

313. Capt. JAMES NICKERSON and crew, sch. Commonwealth. A long nosed eel (*Synaphobranchus pinnatus*), slime-eel (*Myxine glutinosa*), two

great northern sea-feathers (*Pennatula borealis*), yellow cake-sponge, warty sea-rose (*Urticina nodosa*), and shells; from the Grand Banks.

314. Capt. Alfred Spurr and crew, sch. John F. Wonson. Sea-corn (eggs of *Buccinum*), basket star-fish, stone barnacles (*Balanus porcatus*), sea-anemones, ascidians, hydroids, and shells; from off Chatham, Mass., 45 fathoms.

315. Capt. John Q. Getchell, sch. Otis P. Lord. Small Norway haddock (*Sebastes*), lant (*Ammodytes*), Lamarck's basket-fish (*Astrophyton Lamarckii*), small sea-cucumbers (*Thyonidium Dubenii?*, *Thyonidium elongatum*), star-fish (*Leptasterias tenera?*), parasites of cod (*Æga psora*), small clustered tube-worm (*Filigrana implexa*), sea-potato (*Ascidia mollis*), yellow cake-sponge, hairy cake-sponge (*Trichostemma hemisphæricum*), crabs (*Hyas coarctatus*), hermit-crabs, shrimps, red sea-rose (*Urticina crassicornis*), shells, barnacles, and hydroids (*Sertularella tricuspidata*, *Sertularella polyzonias* var. *robusta*); from Brown's Bank, 30 fathoms.

316. Capt. Thomas Goodwin and crew, sch. Howard. Two black dog-fish (*Centroscymnus cœlolepis*), chimæra (*Chimæra plumbea*), two rare deep-water skates not yet identified, four long-nosed eels (*Synaphobranchus pinnatus*), a Baird's grenadier (*Macrurus Bairdii*), blue hake (*Haloporphyrus viola*), three of Lamarck's basket-fish (*Astrophyton Lamarckii*), four very rare fringed star-fish (*Asterias stellionura*), fragments of tree coral (*Paragorgia arborea*), large flowered sea-feather (*Virgularia grandiflora*), two brittle stars (*Ophiurans*), jointed bush-coral (*Acanella Normani*), flesh-colored soft coral (*Alcyonium carneum*), warty sea-roses (*Urticina nodosa*), red sea-roses (*Urticina crassicornis*), hairy cake-sponge (*Trichostemma hemisphæricum*), yellow cake-sponge, shells and rocks with sponges, bryozoans, &c., attached; from the Grand Banks, 200 fathoms.

317. Capt. John McInniss and crew, sch. M. H. Perkins. A long-nosed eel (*Synaphobranchus pinnatus*), large flowered sea-feather (*Virgularia grandiflora*), great northern sea-feather (*Pennatula borealis*), jointed bush-coral (*Acanella Normani*), sheet sponge, sea-anemone, parasite of halibut (*Ægya psora*); from 30 miles south of N. W. light of Sable Island, N. S., 200 fathoms.

318. Daniel McEachern, sch. Guy Cunningham. Five specimens of the large flowered sea-feather (*Virgularia grandiflora*), two great northern sea-feathers (*Pennatula borealis*), great club-sponge (*Cladorhiza grandis*), two of Lamarck's basket-fish (*Astrophyton Lamarckii*), sea-spider (*Pycnogonum littorale*), great northern spider crabs (*Chionœcetes opilio*), hermit-crabs (*Eupagurus Kröyeri*), grenadier (*Macrurus Fabricii*), and two slime-eels (*Myxine glutinosa*); from lat. 44° 36′ N., long. 57° 7′ W., 200 fathoms. = 143584

319. Capt. Peter Johnson, sch. John Smith. A small lamper-eel (*Petromyzon*), skate (*Raia radiata*), and a large bunch of gasteropod eggs; from Brown's Bank.

320. George W. Scott, sch. H. A. Duncan. Two grenadiers (*Macrurus Fabricii*), a large Norway haddock (*Sebastes*), blue hake (*Halopor-*

phyrus viola), two slime-eels (*Myxine glutinosa*), black dog-fish (*Centroscyllium Fabricii*), specimens of great bush-coral (*Primnoa reseda*), a large Finmark sea-feather (*Balticina Finmarchica*) with five sea-anemones attached, three basket star-fish, compound ascidian, sea-corn (eggs of *Buccinum*), and four yellow cake-sponges; from lat. 44° 38′ N., long. 57° 9′ W., 200 fathoms.

321. Capt. R. MORRISON and crew, sch. Laura Nelson. A brittle star, flesh-colored soft coral (*Alcyonium carneum*) and a sea anemone (*Urticina*); from Banquereau, 90 to 100 fathoms.

322. Capt. CHARLES ANDERSON and crew, sch. Alice G. Wonson. Five specimens of great bush-coral (*Primnoa reseda*) and fragments of tree-coral (*Paragorgia arborea*), perforated cushion-star (*Tremaster mirabilis*); from near George's Bank, 100 to 250 fathoms.

323. JOSEPH SHEMELIA, sch. William H. Raymond. A number of young fish of different species, small crustacea (*Synidotea nodulosa*), parasites of cod (*Æga psora*), stemmed sea-peach (*Boltenia Bolteni*), hermit-crab, variegated serpent star (*Ophiopholis aculeata*), and four large pecten shells with hydroids and barnacles attached; from George's Bank.

324. Capt. R. J. ROPER, sch. Esther Ward. A large rock covered with shells, barnacles, and hydroids; and a pecten shell covered with barnacles and sponge; from Eastern George's, 48 fathoms.

325. Capt. ANDREW NELSON, sch. Carleton. A finger-sponge (*Chalina*); from Brown's Bank, 46 fathoms.

326. Captain and crew, sch. Farragut. A large star-fish (*Hippasteria*), shells and rocks; from Ipswich Bay, 16 fathoms.

327. JOHN I. WILSON, sch. Polar Wave, Captain Gilpatrick. Species of *Lycodes* until recently known only from the coast of Greenland, pug-nosed eel, seven soft corals (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), large fragment of jointed bush-coral (*Acanella Normani*), large flowered coral (*Anthomastus grandiflorus*), warty bush-coral (*Paramuricea borealis*), four ruffled sea-roses (*Actinernus nobilis*), three of Lamarck's basket-fish (*Astrophyton Lamarckii*), fringed star-fish (*Asterias stellionura*), perforated cushion-star (*Tremaster mirabilis*), sponge (*Thecophora ibla*), worms, and a rock; from lat. 44° 32′ N., long. 57° 9′ W., 220 fathoms. Also a spiny sea-feather (*Pennatula aculeata*), two great northern sea-feathers (*Pennatula borealis*), and three Finmark sea-feathers (*Balticina Finmarchica*); from lat. 43° 8′ N., long. 53° 27′ W., 180 fathoms.

328. Capt. THOMAS F. HODGDON and crew, sch. Bessie W. Somes. A great northern sea-feather (*Pennatula borealis*), and a Finmark sea-feather (*Balticina Finmarchica*) with a sea-anemone (*Urticina*) attached; from the Grand Banks.

329. Capt. JOHN GOURVILLE, sch. Rebecca Bartlett. A small eel-pout (*Zoarces anguillaris*), two slime-eels (*Myxine glutinosa*), and a hermit-crab; from the eastern part of George's Bank, 46 fathoms.

330. Capt. CHARLES V. MOULTON, sch. Peter D. Smith. A lamper-

eel (*Petromyzon marinus*), sabelloid worm, a compound ascidian, and a stemmed sea-peach (*Boltenia Bolteni*); from George's Bank.

331. Capt. OTIS JOHNSON, sch. Helen M. Dennis. A finger-sponge (*Chalina*), and a flesh-colored soft coral (*Alcyonium carneum*); from Brown's Bank, 46 fathoms.

332. Capt. JOHN VIBERT and crew, sch. Argonaut. Two species of nipple-sponge (*Polymastia*), small clustered tube-worm (*Filigrana implexa*), six specimens of sea-corn (eggs of *Buccinum*), three flesh-colored soft corals (*Alcyonium carneum*), great bush coral (*Primnoa reseda*), and flat sea-urchins; from Western Bank, 30 to 50 fathoms.

333. Capt. DANIEL MCKINNON and crew, sch. Mary F. Chisholm. A new species of star-fish, long-spined velvet-star (*Archaster tenuispinus*), a green sea-egg (*Strongylocentrotus Dröbachiensis*), and slime-eels (*Myxine glutinosa*); from lat. 45° 2′ N., long. 56° 11¾′ W., 130 to 160 fathoms.

334. GEORGE K. ALLEN, sch. George P. Rust. A portion of the skull of a fish (probably the blackfish); from near Sable Island, N. S.

335. Capt. JOSEPH W. COLLINS and crew, sch. Marion. Two large blue hake (*Haloporphyrus viola*), four grenadiers (*Macrurus Fabricii*), two long nosed eels (*Synaphobranchus pinnatus*), Norway haddock (*Sebastes*), black dog-fish (*Centroscyllium Fabricii*), great northern sea-feather (*Pennatula borealis*), sponge, a number of star-fish and rocks; from the Grand Banks.

336. Capt. D. E. COLLINS and crew, sch. Gussie Blaisdell. Two species of star-fish (*Hippasteria phrygiana* and *Solaster endeca*), variegated serpent-star (*Ophiopholis aculeata*), sea-cucumbers (*Thyonidium elongatum*), pale sea-orange (*Psolus phantapus*), a bunch of large green barnacles (*Balanus Hameri*), stone barnacles (*Balanus porcatus*, *Balanus crenatus*), and bryozoa (*Caberea Ellisii*); from Western Bank, 45 to 52 fathoms.

337. Capt. JOHN Q. GETCHELL, sch. Otis P. Lord. Slime-eel (*Myxine glutinosa*), eggs of skate, small crabs (*Hyas*), shrimp (*Axius serratus*, *Hippolyte aculeata*), sea-cucumbers, parasites of cod (*Æga psora*), yellow cake-sponge, sea-mouse, flat sea-urchins, shells, bryozoa (*Escharopsis rosacea*), and hydroids of several species; from George's Bank.

338. Capt. D. C. MURPHY and crew, sch. Alice M. Williams. A long-nosed eel (*Synaphobranchus pinnatus*), three new ruffled sea-roses (*Actinernus nobilis*), soft coral (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), yellow cake-sponge, shells, and the base of a great bush-coral (*Primnoa reseda*); from lat. 44° 29′ N., long. 57° 9′ W., 250 fathoms.

339. Capt. JOHN SHEHAN, boat Ida May. A large lump-fish (*Cyclopterus lumpus*); from Kettle Island, Cape Ann.

340. A. F. HOLBROOK, Swampscott. A large sea-cucumber (*Pentacta frondosa*); from off Cape Cod.

341. Capt. JOHN GOURVILLE, sch. Rebecca Bartlett. Two butter-fish (*Murænoides*), a *Liparis* (?), sea-cucumber, pale sea-orange (*Psolus phantapus*), a bunch of stemmed sea-peaches (*Boltenia Bolteni*), with hy-

droids (*Diphasia rosacea, Sertularella tricuspidata, Sertularella polyzonias* var. *robusta, Eudendrium*), and bryozoans attached, and a horse mussel (*Modiola modiolus*); from 25 miles E. S. E. of Sankaty Head, Nantucket, 21 fathoms.

342. Capt. WILLIAM KIRBY and crew, sch. William V. Hutchings. A large and hitherto unknown fish (*Lopholatilus chamæleonticeps*), taken on a codfish trawl, in lat. 40° N., long. 70° W., 84 to 110 fathoms.

343. Capt. BRIGGS GILPATRICK and crew, sch. Herbert M. Rogers. Long-nosed eel (*Synaphobranchus pinnatus*), slime-eel (*Myxine glutinosa*), twining serpent-star (*Astrochele Lymani*), Lamarck's basket-fish (*Astrophyton Lamarckii*, yellow cake-sponge, shells, jointed bush-coral (*Acanella Normani*), hydroids (*Lafoea, Sertularella tricuspidata*), and warty sea-rose (*Urticina nodosa*), with eggs of an unknown fish attached; from lat. 44° 18′ N., long. 58° 24′ W., 150 fathoms.

344. Capt. JOHN MCINNISS and crew, sch. M. H. Perkins. A sand-eel (*Ammodytes*), slime-eel (*Myxine glutinosa*), sheet sponge, two star-fish (*Hippasteria* and *Ctenodiscus*), two large flowered sea-feathers (*Virgularia grandiflora*), and a great northern sea-feather (*Pennatula borealis*).

345. Capt. S. W. SMITH and crew, sch. S. R. Lane. Two species of sea-feathers (*Virgularia grandiflora* and *Balticina Finmarchica*), sea-spider, (*Nymphon Strömii*), warty sea-rose (*Urticina nodosa*), worm (*Micrura affinis*), yellow-cake sponge, variegated serpent-star (*Ophiopholis aculeata*), Lamarck's basket-fish (*Astrophyton Lamarckii*), sea-cauliflower (*Alcyonium multiflorum*), star-fish, hydroids (*Lafoea, Clytia*), parasites of halibut (*Æga psora*), lamp-shell (*Terebratulina septentrionalis*), and a long-nosed eel (*Synaphobranchus pinnatus*).

346. Capt. CHARLES ANDERSON and crew, sch. Alice G. Wonson. Seven specimens of great bush-coral (*Primnoa reseda*), large branch of tree coral (*Paragorgia arborea*), Earll's many-rayed star-fish (*Solaster Earllii*), and a long-nosed eel (*Synaphobranchus pinnatus*); from near George's Bank, 250 fathoms.

347. Capt. THOMAS OLSEN and crew, sch. Epes Tarr. Two large pug-nosed eels, a long-nosed eel (*Synaphobranchus pinnatus*), jointed bush-coral (*Acanella Normani*), great bush-coral (*Primnoa reseda*), fragment of tree-coral (*Paragorgia arborea*), Finmark sea-feather (*Balticina Finmarchica*) with warty sea-rose (*Urticina nodosa*) attached, great northern sea-feathers (*Pennatula borealis*), spiny sea-feather (*Pennatula aculeata*), three ruffled sea-roses (*Actinernus nobilis*), Lamarck's basket-fish (*Astrophyton Lamarckii*), parasites of halibut, and shells (*Buccinum cyaneum ?*); from lat. 43° 18′ N., long. 60° 24′ W., 250 fathoms.

348. G. H. PROCTER, Gloucester. A small flounder, with both the upper and lower sides nearly white; taken in Squam River by Mr. Simeon Merchant.

349. DANIEL MCEACHERN, sch. Guy Cunningham. Specimens of sponge (*Tethya ?*), hairy nipple-sponge (*Polymastia*), soft corals (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), fringed star-fish

(*Asterias stellionura*), variegated serpent-star (*Ophiopholis aculeata*), Goode's cup-coral (*Flabellum Goodei*), green sea-eggs (*Strongylocentrotus Dröbachiensis*), shell (*Anomia aculeata*), lamp-shell (*Terebratulina septentrionalis*), yellow cake-sponge, worms (*Thelepus cincinnatus, Spirorbis lucidus*), large tube-worm (*Protula media*), parasites of halibut, stone barnacles (*Balanus porcatus*), large green barnacle (*Balanus Hameri*), and Gasteropod eggs.

350. Capt. PETER HAMLIN and crew, sch. Andrew Leighton. Specimens of the variegated serpent-star (*Ophiopholis aculeata*), large flowered sea-feathers (*Virgularia grandiflora*), great northern sea-feathers (*Pennatula borealis*), jointed bush-coral (*Acanella Normani*), and warty sea-rose (*Urticina nodosa*); from lat. 44° N., long. 59° 3′ W., 150 fathoms.

351. M. E. PERKINS, sch. Grace L. Fears, Capt. N. Greenleaf. An undetermined star-fish, three species of star-fish (*Asterias stellionura, Ctenodiscus crispatus*, and *Hippasteria phrygiana*), eighteen Lamarck's basket-fish (*Astrophyton Lamarckii*), five sea-cauliflowers (*Alcyonium multiflorum*), six warty sea-roses (*Urticina nodosa*), parasites of halibut (*Æga psora*), two of Baird's devil-fishes (*Octopus Bairdii*), compound ascidian (*Leptoclinum albidum*), small sea-cucumber (*Thyonidium Dubenii*), stemmed sea-peaches (*Boltenia Bolteni*), great felt-sponge (*Phakellia?*), sheet sponge, three species of sea-feathers (*Virgularia grandiflora, Pennatula aculeata*, and *Pennatula borealis*), tube-worm (*Vermilia serrula*), shells (*Buccinum cyaneum?*), rocks with bryozoans attached, two slime-eels (*Myxine glutinosa*), and a rare spiny lump-fish (*Eumicrotremus spinosus*) taken from the stomach of a cod; from lat. 44° 17′ N., long. 58° 10′ W., 110 to 120 fathoms.

352. Capt. GEORGE A. JOHNSON and crew, sch. Augusta Johnson. One large black dogfish (*Centroscymnus cœlolepis*), two-horned black dogfish (*Centroscyllium Fabricii*), four grenadiers (*Macrurus Fabricii*), two pug-nosed eels, long-nosed eel (*Synaphobranchus pinnatus*), three fringed star-fish (*Asterias stellionura*), small velvet-star (*Ctenodiscus crispatus*), purple velvet-star (*Astrogonium granulare*), two spiny sea-feathers (*Pennatula aculeata*), fragment of Finmark sea-feather (*Balticina Finmarchica*), yellow cake-sponge, hairy cake-sponge (*Trichostemma hemisphæricum*), hairy nipple sponge (*Polymastia*), compound ascidian (*Amorœcium glabrum*), tube-dwelling anemones (*Cerianthus borealis*), jointed bush-coral (*Acanella Normani*), hydroid (*Lafoea*), Iceland scallop (*Pecten Islandicus*), shell (*Anomia aculeata*) and sea-potato (*Ascidia mollis*); from Banquereau.

353. Capt. MATTHEW PARKS and crew, sch. Davy Crockett. Pug-nosed eel, long-nosed eel (*Synaphobranchus pinnatus*), sea-mouse (*Aphrodita*), sea-spider (*Nymphon Strömii?*), great northern spider-crabs (*Chionœcetes opilio*), salve bugs, and sea-worms (*Nereis pelagica*); from lat. 44° 28′ N., long. 56° 24′ W. to 59° 6′ W., 170 to 200 fathoms.

354. Capt. JOHN F. CRITCHETT and crew, sch. Commonwealth. Large flowered sea-feather (*Virgularia grandiflora*), great bush-coral (*Primnoa reseda*), and star-fish (*Ctenodiscus*); from lat. 44° 26′ N., long. 57° 12′ W., 150 fathoms.

355. Mr. EVERETT P. WONSON, East Gloucester. A large flowered sea-feather (*Virgularia grandiflora*).

356. MATT. RYAN, sch. Seth Stockbridge. Seven sea-anemones and a great northern sea-feather (*Pennatula borealis*); from Green Bank.

357. Capt. AUGUSTUS CUNNINGHAM, sch. Geo. A. Upton. A sea-mouse (*Aphrodita aculeata*) taken from the stomach of a codfish, off Pubnico, N. S.

358. Capt. JOHN Q. GETCHELL, sch. Otis P. Lord. Lump-fish (*Cyclopterus lumpus*), four-bearded rocklings (*Enchelyopus cimbrius*), young dog-fish (*Squalus acanthia*), lant (*Ammodytes*), several species of crabs, sea-mouse (*Aphrodita*), shells, large bunches of stone barnacles (*Batanus porcatus*), finger-sponges (*Chalina*), and rocks covered with sponges, barnacles, shells, bryozoans, and hydroids; from Clark's Bank.

359. Capt. GREENWOOD and crew, sch. Sultana. Stemmed sea-peaches (*Boltenia Bolteni*), great sea-cucumbers (*Pentacta frondosa*), variegated serpent-star (*Ophiopholis aculeata*), hermit-crab, red spider-crab (*Hyas coarctatus*), small lobster, soft coral, yellow cake-sponge, hydroids (*Diphasia rosacea*, *Sertularella tricuspidata*, *Sertularia argentea*), and bryozoa (*Caberea Ellisii*, *Gemellaria loricata*); from Clark's Bank, 80 fathoms.

360. Capt. GEORGE H. CURTIS and crew, sch. Conductor. Two new branching sponges, great club-sponge (*Cladorhiza grandis*), large flowered sea-feathers (*Virgularia grandiflora*), common serpent-star (*Ophiacantha bidentata*), sea-anemones, sea-spiders (*Pycnogonum littorale*, *Nymphon*), hydroids (*Sertularella polyzonias* var. *robusta*), and rocks with rare bryozoans attached.

361. R. H. HURLBURT, sch. Franklin S. Schenck. A large finger-sponge (*Chalina*); from 12 miles off Sankaty Head, Nantucket, 15 fathoms.

362. Capt. WILLIAM HERRICK, sch. Augusta Herrick. A mackerel-midge (*Phycis*, sp.); found on the vessel's deck, after dressing mackerel, in lat. 38° 13′ N., long. 73° 56′ W.

363. Capt. CHARLES V. MOULTON, sch. Peter D. Smith. Lant (*Ammodytes*), black clams (*Glycimeris siliqua*) taken from the stomach of cod, rare small star-fish (*Leptasterias Grönlandica*), red spider-crabs (*Hyas coarctatus*), stone barnacles (*Balanus porcatus*), and sponges; from Western George's Bank.

364. JOHN I. WILSON, sch. Polar Wave, Captain Gilpatrick. Horned black dog-fish (*Centroscyllium Fabricii*), a small ground-shark (*Centroscymnus cœlolepis*), long-nosed eel (*Synaphobranchus pinnatus*), four specimens of bush-corals (*Primnoa reseda* and *Acanella Normani*), fragments of tree-coral (*Paragorgia arborea*), a specimen of *Acanthogorgia armata*, soft coral (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), a hydroid (*Cladocarpus*), small feather-star (*Antedon Sarsii*), and yellow cake-sponge; from lat. 44° 30′ N., long. 57° 8′ W., 200 fathoms.

365. Capt. THOMAS GOODWIN and crew, sch. Howard. A fine collec-

tion of large flowered sea-feathers (*Virgularia grandiflora*), including fourteen specimens of various sizes, two great northern sea-feathers (*Pennatula borealis*), spiny sea-feather (*Pennatula aculeata*), orange cushion-star (*Porania spinulosa*), three other species of star-fish (*Hippasteria, Crossaster papposus*, and *Astrophyton*), bryozoa (*Flustra securifrons*), the second specimen recorded from American waters, rare gorgonian (*Anthomastus?*), yellow cake-sponge, rocks and shells covered with corallines, a deformed codfish, eel pout (*Zoarces*), and a rock-eel (*Murænoides*); mostly from lat. 45° 25′ N., long. 57° 10′ W., 170 fathoms.

366. Capt. DANIEL MCKINNON and crew, sch. Mary F. Chisholm. Goode's cup-coral (*Flabellum Goodei*), soft coral (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), Lamarck's basket-fish (*Astrophyton Lamarckii*), compound ascidian (*Leptoclinum albidum*), hairy cake-sponge (*Trichostemma hemisphæricum*), and warty sea-roses (*Urticina nodosa*); from lat. 44° 6′ N., long. 52° 54′ W., 220 fathoms.

367. Mr. MCCAULEY, sch. Wachusett, Capt. John A. McCormack. Two species of sea-feathers (*Pennatula borealis* and *Balticina Finmarchica*), jointed bush-coral (*Acanella Normani*), gold-banded bush-coral (*Keratoisis ornata*), large-flowered coral (*Anthomastus grandiflorus*), warty sea-rose (*Urticina nodosa*), feather-stars (*Antedon Sarsii?*), Lamarck's basket-fish (*Astrophyton Lamarckii*), 6-armed serpent-star (*Ophiacantha anomala*), twining serpent-star (*Astrochele Lymani*), and variegated serpent-star (*Ophiopholis aculeata*). Also sea-cucumbers, scaly-stemmed barnacle (*Scalpellum Strœmii*), tube-worms (*Vermilia serrula, Spirorbis*), scaly worm (*Eunoa spinulosa*), green sea-egg (*Strongylocentrotus Dröbachiensis*), shells (*Neptunea despecta, Buccinum cyaneum*), clear scallop (*Pecten vitreus*), lamp-shell (*Terebratulina septentrionalis*), two long-nosed eels (*Synaphobranchus pinnatus*), and slime-eel (*Myxine glutinosa*).

368. Capt. JOSEPH W. COLLINS and crew, sch. Marion. The skin and eggs of an enormous ground-shark, weighing over 2,000 pounds, and having a total length of 15 feet. Also a long-nosed eel (*Synaphobranchus pinnatus*), eel-pout (*Zoarces anguillaris*), soft-coral, star-fish (*Ctenodiscus*) and shells; from Banquereau, 190 fathoms.

369. Capt. WILLIAM KIRBY, sch. William V. Hutchings. Two species of star-fish (*Crossaster papposus* and *Solaster endeca*), rare sea-cucumber, pale sea-orange (*Psolus phantapus*), stone barnacles (*Balanus porcatus*), large green barnacle (*Balanus Hameri*), yellow cake-sponge, and a ghost-fish (*Cryptacanthodes*); from lat. 41° 35′ N., long. 69° 5′ W., 80 fathoms.

370. Capt. CHARLES ANDERSON and crew, sch. Alice G. Wonson. Six specimens of great bush-coral (*Primnoa reseda*), with Lamarck's basket-fish (*Astrophyton Lamarckii*) attached, three basket-star-fish, large green barnacles (*Balanus Hameri*), and shells (*Anomia aculeata*); from near George's Bank.

371. E. F. HOYT, Gloucester. A small sea-bass (*Centropristis*) taken in Wonson & Atwood's weir, off Norman's Woe. This is the first recorded instance of its capture since 1866. Also great felt-sponge (*Phakellia?*).

372. Capt. D. C. MURPHY and crew, sch. Alice M. Williams. Specimens of Hyatt's bob-tailed squid (*Rossia Hyatti*), Baird's devil-fish (*Octopus Bairdii*), a small specimen of cod, small crustacea (*Caprella, Astacilla*), hydroids (*Cladocarpus Lafoea*), warty sea-rose (*Urticina nodosa*), shells (*Buccinum cyaneum*), and scaly-stemmed barnacle (*Scalpellum Strœmii*); from off Miquelon Islands, 7 fathoms.

373. Capt. SEWELL W. SMITH and crew, sch. S. R. Lane. Two large Lamarck's basket-fishes (*Astrophyton Lamarckii*), common star-fish (*Crossaster papposus*), variegated serpent-stars (*Ophiopholis aculeata*), common serpent-star (*Ophiacantha bidentata*), one-sided star-fish (*Stephanasterias albula*), a sea-spider (*Nymphon*), specimens of *Alcyonium carneum*, and hydroids (*Lafoea*); from off the western coast of Newfoundland, lat. 49° 20′ to 30′ N., long. 58° 10′ W.

374. Capt. JOHN MCINNISS and crew, sch. M. H. Perkins. Two species of star-fish (*Hippasteria phrygiana* and *Asterias stellionura*), and two hairy cake-sponges (*Trichostemma hemisphœricum*); from 8 miles S. S. W. of Ramea Island, Newfoundland, 150 fathoms.

375. Capt. BRIGGS GILPATRICK and crew, sch. Herbert M. Rogers. A specimen of the lancet-mouth (*Alepidosaurus*); taken with a gaff while swimming at the surface, lat. 44° 30′ N., long. 57° 13′ W.

376. Capt. CHARLES V. MOULTON, sch. Peter D. Smith. A sea-robin (*Prionotus*), young dog-fish (*Squalus acanthius*), worms (*Thelepus cincinnatus, Spirorbis lucidus*), hydroids (*Diphasia fallax*), and bryozoa (*Gemellaria loricata, Cellularia ternata* var. *gracilis*); from Clark's Bank, 80 fathoms.

377. WM. E. PERKINS, sch. Grace L. Fears, Capt. N. Greenleaf. Fringed star-fish (*Asterias stellionura*), cup sponges (*Isodictya*), warty sea roses (*Urticina nodosa*), stemmed sea-peaches (*Boltenia Bolteni*), soft corals (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), Lamarck's basket-fish (*Astrophyton Lamarckii*), and variegated serpent-star (*Ophiopholis aculeata*); from 30 miles off Ramea Island, Newfoundland.

378. Capt. JOHN Q. GETCHELL, sch. Otis P. Lord. A small squid, shrimps, sea-anemones, hydroids, crabs, and finger-sponge; from George's Bank.

379. NATHANIEL D. CROOKS, sch. Helen M. Dennis. Eggs of an undetermined mollusk; from the northwest part of George's Bank, 103 fathoms.

380. CHARLES RUCKLEY, sch. William A. Pew. Two bunches of hydroids, pectens, and rocks covered with shells, hydroids, and bryozoans; from George's Bank.

381. Capt. BENJAMIN JOHNSON, sch. Alaska. Two sea-mice (*Aphrodita aculeata*), taken from the stomach of a codfish; from George's Bank.

382. Capt. THOMAS OLSEN and crew, sch. Epes Tarr. A large specimen of a new species of perforated cushion-star (*Tremaster mirabilis*), belonging also to a new genus, and specimens of hydroids (*Cladocarpus cornutus*); taken in lat. 47° 6′ N., long. 58° 15′ W., 150 fathoms.

383. Capt. THOMAS MURPHY and crew, sch. William H. Oakes. A slime-eel (*Myxine glutinosa*), Lamarck's basket-fish (*Astrophyton Lamarckii*), Finmark sea-feather (*Balticina Finmarchica*), eight specimens of the great bush-coral (*Primnoa reseda*), sealy stemmed barnacles (*Scalpellum Strœmii*), and a warty sea-rose (*Urticina nodosa*); from Banquereau, 150 fathoms.

384. Capt. WILLIAM THOMPSON and crew, sch. Magic. Thirteen specimens of capelin (*Mallotus villosus*); from the south shore of Newfoundland. Also a plumed sea-feather (*Virgularia grandiflora*), a jointed bush-coral (*Acanella Normani*), sea-corn, and a large pug-nosed eel; from Banquereau.

385. DANIEL MCEACHERN, sch. Rutherford B. Hayes. A small flying-fish (*Exocœtus*).

386. Capt. JOHN GORMAN and crew, sch. George S. Boutwell. A spotted turbot (*Lophopsetta maculata*), bill-fish (*Scomberesox*), small sea-raven (*Hemitripterus*), hermit-crab (*Eupagurus bernhardus*), shells (*Lunatia heros*, *Crepidula plana*), and a large sea-mouse (*Aphrodita*); from Western Bank.

387. Capt. JOHN CRITCHETT and crew, sch. Commonwealth. Two great spiny spider-crabs (*Lithodes maia*), and two rare deep-water star-fishes; from lat. 47° 7′ N., long. 58° 15′ W., 150 fathoms.

388. Capt. MICHAEL WELLS and crew, sch. Water Spirit. A purple, many-rayed star-fish (*Solaster endeca*), and a sea-spider (*Nymphon Strömii*); from Western Bank.

389. Capt. ANDREW NELSON, sch. Carleton. Rock, with barnacles and bryozoans attached; from George's Bank.

390. Capt. JOSEPH W. COLLINS and crew, sch. Marion. A fourteen-pound Norway haddock (*Sebastes*), chimæra (*Chimæra plumbea*), long-nosed eel (*Synaphobranchus pinnatus*), two star-fishes (*Hippasteria* and an undetermined species), rare gorgonian coral (*Paramuricea borealis*), ruffled sea-rose (*Actinernus nobilis*), several sponges, *Alcyonium*, and *Astrophyton*; from Banquereau.

391. Capt. DANIEL MCKINNON and crew, sch. Mary F. Chisholm. A great scarlet cushion-star (*Hippasteria phrygiana*), and a yellow cake-sponge; from Banquereau.

392. Capt. CHARLES ANDERSON and crew, sch. Alice G. Wonson. Eight specimens of great bush-coral (*Primnoa reseda*), jointed bush-coral (*Acanella Normani*), large green barnacle (*Balanus Hameri*), scaly stemmed barnacle (*Scalpellum Strœmi*), tube-worm (*Vermilia serrula*), 6-armed serpent-star (*Ophiacantha anomala*), common serpent-star (*Ophiacantha bidentata*), and a piece of coarse granite; from east of George's Bank, 250 fathoms.

393. Capt. THOMAS GOODWIN and crew, sch. Howard. Three species of star-fish (*Asterias stellionura*, *Solaster endeca*, and *Crossaster papposus*), brittle star (*Ophiuran*), warty sea-rose (*Urticina nodosa*), sea-mouse (*Aphrodita aculeata*), and the pens of several squids; from 10 to 15 miles off N. W. light, Sable Island, N. S.

394. GEORGE FRIEND, Gloucester. Two split and dried specimens of the tile-fish (*Lopholatilus chamæleonticeps*); brought in by Captain Kirby.

395. ALBERT DOUGLAS, East Gloucester. A web-fingered sea-robin (*Prionotus carolinus*); taken in his fish-weir at Norman's Woe, July 19. This is the first recorded instance of its capture near Gloucester.

396. WILLIAM PEEPLES, sch. Addison Centre. A large rock, with bryozoans attached; from lat. 43° 30′ N., long. 59° 50′ W.; 250 fathoms.

397. JEFFREYS J. LAVENDER, sch. Addison Centre. A fine specimen of spiny bush-coral (*Acanthogorgia armata*); from lat. 43° 30′ N., long. 59° 50′ W., 250 fathoms.

398. Capt. JOHN GOURVILLE and crew, sch. Rebecca Bartlett. Three specimens of a wolf-fish (*Anarrhichas lupus*), a rare holothurian, and a pale sea-orange (*Psolus phantapus*); from lat. 42° 50′ N., long. 65° 50′ W., 85 fathoms.

399. WM. E. PERKINS, sch. Grace L. Fears, Captain Greenleaf. A Baird's grenadier (*Macrurus Bairdii*), taken from the stomach of a halibut; a jointed bush-coral (*Acanella Normani*), with barnacles (*Scalpellum Strömii*) attached, great bush-coral (*Primnoa reseda*), an undetermined hydroid, and sponges; from lat. 44° 25′ N., long. 67° 20′ W., 200 fathoms.

400. GEORGE BROWN, Gloucester. A spotted flounder (*Lophopsetta maculata*), and a small crab (*Hyas coarctatus*); from Gloucester Harbor.

401. Capt. SEWELL SMITH, sch. S. R. Lane. Specimens of a red spider-crab (*Hyas araneus*) and two capelin (*Mallotus villosus*); from Boone Bay, Newfoundland.

402. Capt. MCCORMACK and crew, sch. Wachusett. A fine specimen of the gold-banded bush-coral (*Keratoisis ornata*), large-flowered bush-coral (*Anthothela grandiflora*), large-flowered sponge coral (*Anthomastus grandiflorus*), great northern sea-feathers (*Pennatula borealis*), Finmark sea-feathers (*Balticina Finmarchica*), flesh-colored soft coral (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), great club-sponge (*Cladorhiza grandis*), red sea-rose (*Urticina crassicornis*), warty sea-rose (*Urticina nodosa*), Goode's cup-coral (*Flabellum Goodei*), Iceland scallop (*Pecten Islandicus*), tube of an unknown worm, a long-nosed eel (*Synaphobranchus pinnatus*), and spiral egg-cases; from lat. 43° 17′ N., long. 60° 58′ W., 180 fathoms.

403. Capt. WILLIAM H. GREENLEAF, sch. Chester R. Lawrence. Jaw of a porpoise caught on the passage from Gloucester to Banquereau.

404. Capt. G. H. CURTIS and crew, sch. Conductor. Specimens of jointed bush-coral (*Acanella Normani*), arm of star-fish (*Crossaster papposus*), small sea-feathers, tube of unknown worm, *Alcyonium*, a fine specimen of the gold-banded bush-coral (*Keratoisis ornata*), large-flowered sponge-coral (*Anthomastus grandiflorus*), and some rocks from the bottom; lat. 44° 10′ N., long. 58° W., 300 fathoms. Also a brook-trout (*Salvelinus fontinalis*) from Newfoundland, and a *Scopelus* washed aboard on the passage.

405. SIMON BOUDROT, sch. Rebecca Bartlett. Through Capt. John

Gourville.) A specimen of *Chalina*, with *Terebratulina* attached, from 35 miles southeast by south of Cape Sable, lat. 43° 5′ N., long. 65° 10′ W., 85 fathoms.

406. From unknown source. A rock-eel (*Murænoides gunellus*), 6¾ inches long, caught at Fort Wharf, Gloucester.

407. Capt. WILLIAM DEMSEY, sch. Clara F. Friend. Nine fresh specimens of the tile-fish (*Lopholatilus chamæleonticeps*); from 50 miles south by east of No Man's Land, lat. 40° 10′ N., long. 70° 55′ W., 75 fathoms. This is only the second time this species of fish has been brought to Gloucester. The only preserved specimen known is in the U. S. National Museum. Captain Demsey has furnished interesting particulars concerning its structure.

408. Capt. WILLIAM H. KIRBY, sch. William V. Hutchings. Clusters of ascidians with eggs of *Buccinum* attached, Greenland basket-fish (*Astrophyton eucnemis*), rosy, many rayed star (*Crossaster papposus*), Sars's serpent-stars (*Ophioglypha Sarsii*), sea-anemones, green sea-eggs (*Strongylocentrotus Dröbachiensis*), sea-corn (*Buccinum* eggs), holothurian, shells with stone barnacles (*Balanus crenatus*) and flesh-colored soft coral (*Alcyonium carneum*) attached, bryozoans, sea-mouse (*Aphrodita*) 6 inches long, eel-pout or mutton-fish (*Zoarces anguillaris*), and a rare blue shark (*Prionodon glaucus*); from lat. 44° 28′ N., long. 59° to 59° 20′ W., 50 fathoms.

409. Capt. EDWARD TREVOY, sch. Procter Brothers. A very large long-nosed eel (*Synaphobranchus pinnatus*), three young pug-nosed eels (*Simenchelys parasiticus*), a lamprey (*Petromyzon*), a scaly worm, and a crustacean (*Munna Fabricii*), crab (*Geryon quinquedens*); from about lat. 43° 20′ N., long. 59° 30′ W., 200 fathoms.

410. Capt. GEO. A. JOHNSON and crew, sch. Augusta H. Johnson. A fine specimen of the spiny bush-coral (*Acanthogorgia armata*) with mollusk and skate eggs attached, jointed bush-coral (*Acanella Normani*), great northern sea-feather (*Pennatula borealis*), spiny sea-feather (*Pennatula aculeata*), large flowered sea-feather (*Virgularia grandiflora*), rare star-fish, great club-sponge (*Cladorhiza grandis*), a large grenadier (*Macrurus Fabricii*), a large Norway haddock (*Sebastes marinus*), blue hake (*Haloporphyrus viola*), long-nosed eel (*Synaphobranchus pinnatus*), pug-nosed eel (*Simenchelys parasiticus*), and a chimæra (*Chimæra plumbea*); from Western Bank, lat. 43° 15′ N., long. 60° 20′ W., 200 fathoms.

411. ALBERT DOUGLASS, Gloucester. A large torpedo or cramp-fish (*Torpedo occidentalis*), caught in a trap at Kettle Island, Cape Ann.

412. Capt. R. MORRISON, sch. Laura Nelson. A species of *Fusus* with warty sea-rose (*Urticina nodosa*) attached, isopod (*Idotea*), deep-sea shrimp, worm (*Spirorbis*), a fine specimen of Finmark sea-feather (*Balticina Finmarchica*), large-flowered sponge coral (*Anthomastus grandiflorus*), and shells (*Neptunea Spitzbergensis*); from lat. 44° 04′ N., long. 59° 06′ W., 300 fathoms.

413. WM. COLBY, East Gloucester. Two fresh specimens of Norway

haddock (*Sebastes*), from 3½ miles southeast of Eastern Point, Cape Ann.

414. Capt. AMOS N. RACLIFF, sch. Fleetwing. A rare sucking-fish (*Remoropsis branchyptera*), taken from a sword-fish about 15 miles southeast of Matinicus Rock, coast of Maine.

415. Capt. WM. MCDONALD, sch. N. H. Phillips. Specimens of jointed bush-coral (*Acanella Normani*), tree-coral (*Paragorgia arborea*), Earll's many rayed star-fish (*Solaster Earllii*), basket star-fish (*Astrophyton*), Iceland scallops (*Pecten Islandicus*), great northern sea-feather (*Pennatula borealis*), and a skate's egg with small barnacles attached; from lat. 44° 4′ N., long. 59° 6′ W., 300 fathoms.

416. CHARLES RUCKLEY, sch. H. A. Duncan. Specimens of flesh-colored soft coral (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), *Æga psora* (parasitic on the halibut), stout devil-fish (*Octopus obesus*) from stomach of halibut, small crustacea (*Caprella*, *Asselodes alta*), warty sea-roses (*Urticina nodosa*), sea-feather (*Pennatula aculeata* and *Balticina Finmarchica*), one-sided star-fish (*Stephanasterias albula*), Lamarck's basket-fish (*Astrophyton Lamarckii*), variegated serpent-star (*Ophiopholis aculeata*), spiny serpent-star (*Ophiacantha spectabilis?*), common serpent-star (*Ophiacantha bidentata*), sponges, jointed bush-coral (*Acanella Normani*), tree-coral (*Paragorgia arborea*), perforated rocks, a quantity of oil made from the livers of Greenland dog-fish (*Centroscyllium Fabricii*), Norway haddock (*Sebastes marinus*) taken from a halibut's stomach, and two specimens of a Greenland grenadier (*Coryphænoides Strömii*) not hitherto discovered in American waters. This collection is from 36 miles east of the northeast light of Sable Island, 160 to 300 fathoms.

417. Capt. THOMAS OLSEN, sch. Epes Tarr. Sea-feathers (*Balticina Finmarchica* and *Pennatula borealis*), warty sea-rose (*Urticina nodosa*), large-flowered sponge-coral (*Anthomastus grandiflorus*), and an undetermined polyp; from lat. 43° 20′ N., long. 60° W., 220 fathoms.

418. Capt. JAMES NICKERSON, sch. Bellerophon. Specimens of common basket-fish (*Astrophyton Agassizii*), Lamarck's basket-fish (*Astrophyton Lamarckii*), sea-corn (*Buccinum* eggs), ruffled sea-rose (*Actinernus nobilis*), warty sea-rose (*Urticina nodosa*), flesh-colored soft coral (*Alcyonium carneum*), sea-pen (*Pennatula*), brittle stars (*Ophioglypha*), undetermined coral, gold-banded bush-coral (*Keratoisis ornata*), jointed bush-coral (*Acanella Normani*), large-flowered bush-coral (*Anthothela grandiflora*), and blue hake (*Haloporphyrus viola*); from lat. 44° 13′ N., long. 58° 2′ W., 175 fathoms.

419. SAMUEL MCQUIN and CHARLES GERRING, East Gloucester. A French "bill-fish" (*Scombresox saurus*) that leaped into the dory while they were rowing in Gloucester Harbor.

420. Capt. MELVIN GILPATRICK, sch. Polar Wave. Sea-feathers (*Pennatula borealis* and *Balticina Finmarchica*), Gorgonian or bush-corals (*Acanella Normani* and *Paramuricea borealis*), warty sea-rose (*Urticina nodosa*), a branching sponge, tubes of an unknown worm, and two speci-

mens of the pug-nosed eel (*Simenchelys parasiticus*); from lat. 43° 27′ N., long. 60° W., 150 fathoms.

421. Capt. JOHN F. CRITCHETT and crew, sch. Commonwealth. A Baird's devil-fish (*Octopus Bairdii*), fine specimens of Lamarck's basket-fish (*Astrophyton Lamarckii*), brittle star-fish (*Ophioglypha*), tree-coral (*Paragorgia arborea*), one with *Astrophyton* attached, great northern sea-feather (*Pennatula borealis*), and an undetermined hydroid; from the eastern part of Banquereau, 300 fathoms.

422. CHARLES H. MARTIN, East Gloucester. Two black rudder-fish (*Palinurichthys perciformis*) and a hake (*Phycis tenuis*); caught on a hook with clam bait at Parson's wharf, East Gloucester.

423. FRANK MAKER, East Gloucester. A young bonito (*Sarda pelamys*); taken in a weir at East Gloucester.

424. FRANK MAKER, East Gloucester. Specimens of "monk-fish" (*Lophius piscatorius*), "dollar-fish" (*Poronotus triacanthus*), and cod (*Gadus morrhua*), caught in his weir. The other species taken in the same haul were as follows: *Pomolobus æstivalis*, *Pomolobus vernalis*, *Pollachius carbonarius*, *Cottus octodecimpsinosus*, *Tautogolabrus adspersus*, *Scomber scombrus*, and *Pleuronectes americanus*.

425. Capt. S. J. MARTIN, East Gloucester. Tinker mackerel (*Scomber scombrus*), $3\frac{1}{2}$ to $4\frac{1}{4}$ inches long; caught with a dip-net in Gloucester Harbor, August 8.

426. Capt. JOS. W. COLLINS and crew, sch. Marion. Several specimens of flesh-colored soft corals (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), gorgonian or bush-corals (*Acanella Normani* and *Keratoisis ornata*), large flowered sponge-coral (*Anthomastus grandiflorus*), Finmark sea-feather (*Balticina Finmarchica*), sponges, ascidians, long-rayed velvet-star (*Archaster Andromeda*), compound ascidian (*Leptoclinum albidum*), tube-dwelling sea-anemone (*Cerianthus borealis*), warty sea-rose (*Urticina nodosa*), brittle stars (*Ophioglypha*), Goode's cup-coral (*Flabellum Goodei*), large scaly stemmed barnacle (*Scalpellum*), lamp-shell (*Terebratulina septentrionalis*), eggs of a skate (supposed to be *Raia granulata*), and a pug-nose eel (*Simenchelys parasiticus*); from lat. 44° 15′ N., long. 58° 3′ W., 250–300 fathoms. Also, a perfect specimen of the lancet-mouth (*Alepidosaurus ferox*); from lat. 42° 48′ N., long. 63° W. 130 fathoms.

427. JOHN SHEAN, Gloucester. Specimen of the sea-mouse (*Aphrodita aculeata*); caught 4 miles south of Eastern Point, Cape Ann, on a trawl.

428. Capt. J. MCDONALD, sch. Magic. A specimen of flesh-colored soft coral (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), and a Finmark sea-feather (*Balticina Finmarchica*); from lat. 42° 45′ N., long. 50° 25′ W., 160 fathoms.

429. Capt. JOS. W. COLLINS and crew, sch. Marion. Fresh specimens of black dog fish (*Centroscymnus cœlolepis*), chimæra (*Chimæra plumbea*), and Canada turbot (*Platysomatichthys hippoglossoides*); from lat. 44° 15′ N., long. 58° 52′ W., 250–300 fathoms.

430. HENRY COLBY, East Gloucester. A living specimen of the web-fingered sea-robin (*Prionotus carolinus*); caught in a mackerel gill-net in Gloucester Harbor.

431. JOHN SHEAN, Gloucester. A specimen of leaf-sponge taken on a trawl, 3½ miles southeast of Eastern Point, Cape Ann, in about 24 fathoms.

432. Capt. BENJAMIN JOHNSON, sch. Alaska. Two star-fishes, a scaly worm, a halibut parasite (*Æga psora*), a rock-eel (*Murænoides*), and a blenny (*Eumesogrammus* sp.); from Brown's Bank, 37 fathoms.

433. Capt. JEROME McDONALD, sch. G. P. Whitman. Hermit-crabs (*Eupagurus Krœyeri*), a large scaly worm (*Nephthys paradoxa ?*), sand-launce (*Ammodytes dubius*), and an undetermined species of fish; from lat. 43° 30′ N., long. 60° 25′ W., 50 fathoms.

434. Capt. JOHN McKINNON and crew, sch. Rutherford B. Hayes. Common basket star-fish (*Astrophyton Agassizii*), common star-fishes (*Crossaster papposus*, *Solaster endeca*, *Ctenodiscus crispatus*, and *Asterias*), variegated serpent-star (*Ophiopholis aculeata*), warty sea-rose (*Urticina nodosa*), holothurian, Iceland scallops (*Pecten Islandicus*), eggs of *Buccinum*, large shells (*Neptunea decemcostata*, *Modiola modiolus*), green sea-eggs (*Strongylocentrotus Dröbachiensis*), parasites from the common flat-fish and other species, large green barnacle (*Balanus Hameri*), a small sea-pen (*Pennatula*), a rock-crab (*Cancer irroratus*), tube-worm (*Vermilia serrula*) embryonic "monk-fish" (*Lophius piscatorius*), and a flatfish (*Pleuronectes americanus*); from the western part of Western Bank.

435. Capt. SEWELL W. SMITH and crew, sch. S. R. Lane. Jointed bush-coral (*Acanella Normani*), with variegated serpent-star (*Ophiopholis aculeata*), clear scallops (*Pecten vitreus*), shells (*Anomia aculeata*) and rare scaly stemmed barnacles (*Scalpellum Strœmii*) attached, *Æga psora*, parasitic on halibut, large sea-anemones, small velvet-star (*Ctenodiscus crispatus*), Greenland basket-fish (*Astrophyton eucnemis*), Lamarck's basket-fish (*Astrophyton Lamarckii*), scaly worm, sea-feathers (*Balticina Finmarchica*, *Pennatula borealis*, and *Pennatula aculeata*), a lamprey eel (*Petromyzon*), long-nose eel (*Synaphobranchus pinnatus*), and a black dogfish (*Centroscymnus cœlolepis*); from lat. 43° 25′ N., long. 60° W., 180 fathoms.

436. Capt. PETER HAMLIN and crew, sch. Andrew Leighton. A ruffled sea-rose (*Actinernus nobilis*), two specimens of *Acanthogorgia armata*, a long-nosed-eel (*Synaphobranchus pinnatus*), and two fresh chimæras (*Chimæra plumbea*); from lat. 44° N., long. 58° 30′ W., 160 fathoms.

437. Mr. WILLIAM M. GAFFNEY, Gloucester (through Capt. Jos. W. Collins). A large crayfish, from the New England coast; exact locality unknown.

438. Capt. BENJAMIN JOHNSON, sch. Alaska. A fine specimen of *Chalina*; from Brown's Bank, 57 fathoms.

439. Capt. SAMUEL PEEPLES, sch. Addison Centre. Bryozoans, branching sponge, jointed bush-coral (*Acanella Normani*), large flowered sponge-

coral (*Anthomastus grandiflorus*), gold-banded bush-coral (*Keratoisis ornata*), flesh-colored soft coral (*Alcyonium carneum*), long-rayed velvet-star (*Archaster Andromeda*), Lamarck's basket-fish (*Astrophyton Lamarckii*), sea-cauliflower (*Alcyonium multiflorum*), brittle-stars (*Ophioglypha*), sea-corn (*Buccinum* eggs), ascidians, pug-nose eels (*Simenchelys parasiticus*), and a Greenland fish (*Stomias ferox*) not hitherto taken on our coast; from lat. 44° 12′ N., long. 58° 56′ W., 230 fathoms.

440. Capt. R. MORRISON and crew, sch. Laura Nelson. A great northern sea-feather (*Pennatula borealis*) and a lamprey eel (*Petromyzon*); from lat. 44° 5′ N., long. 63° 50′ W., 160 fathoms.

441. Capt. JOHN A. MCCORMACK, sch. Wachusett. A large warty sea-rose (*Urticina nodosa*), cluster of barnacles taken at surface, great northern sea-feather (*Pennatula borealis*), and a specimen of warty bush-coral (*Paramuricea borealis*); from lat. 43° 19′ N., long 60° 36′ W., 250 fathoms.

442. Capt. G. H. CURTIS and crew, sch. Conductor. A warty sea-rose (*Urticina nodosa*), lamprey eel (*Petromyzon*), long-nose eel (*Synaphobranchus pinnatus*), and pug-nose eel (*Simenchelys parasiticus*); from lat. 43° 5′ N., long. 61° 3′ W., 150 fathoms.

443. J. F. FOWLES, Gloucester, engineer of steamer Geo. H. Bradley. A hydroid and a young hake (*Phycis*) taken at the surface off the coast of Maine; a skull of the dogfish (*Squalus acanthias*) from Pemaquid Beach, a star-fish, young codfish (*Gadus morrhua*), and piece of conglomerate from Pemaquid Bay, Maine; a "parakeet" from Great Egg Rock, Maine; and a specimen of *Squilla* caught off Nearit Light, in Providence River, June 2, 1879, 8 fathoms.

444. Capt. JOS. TUPPER, sch. Madawaska Maid. A large pipe-fish (*Syngnathus*), and a shell (*Buccinum*, sp.); from Townsend Harbor, Maine.

445. Capt. RANDAL PINKHAM, sch. Henry L. Phillips. A fresh codfish (*Gadus morrhua*), gray and yellow mottled; caught on the eastern part of George's Bank.

446. Capt. EDWARD TREVOY, sch. Procter Brothers. Specimens of bush-coral (*Acanella Normani*), large scaly stemmed barnacles (*Scalpellum*), skates' eggs, pug-nose eel (*Simenchelys parasiticus*), long-nose eel (*Synaphobranchus pinnatus*), lancet mouth (*Alepidosaurus ferox*), and "albicore" (*Orcynus thynnus*?); from lat. 42° 33′ N., long. 64° 20′ W., 300 fathoms; also a barn swallow which came aboard the vessel at the same locality.

447. Mr. CHARLES RUCKLEY, sch. H. A. Duncan. Specimens of flesh-colored soft coral (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), jointed bush-coral (*Acanella Normani*), large flowered sponge coral (*Anthomastus grandiflorus*), parasites (*Æga psora*), branching sponges, sea-feathers (*Balticina Finmarchica*, *Pennatula borealis*, and *Pennatula aculeata*), rare shells (*Buccinum cyaneum*), two rare species of star-fish, long-rayed velvet-star (*Archaster Andromeda*), long-spined

velvet-star (*Archaster tenuispina*), Lamarck's basket-fish (*Astrophyton Lamarckii*), great club-sponge (*Cladorhiza grandis*), eggs of black dog-fish, and spiral egg cases; from the south-central part of Western Bank. Also a bunch of rockweed covered with barnacles from the same place, and a potato dropped overboard one day and found in a halibut's stomach the next.

448. Capt. GEO. A. JOHNSON and crew, sch. Augusta H. Johnson. A rare species of crab, black dog-fish (*Centroscymnus cœlolepis*), Greenland dog-fish (*Centroscyllium Fabricii*), lancet-mouth (*Alepidosaurus ferox*), chimæra (*Chimæra plumbea*), mackerel shark (*Lamna cornubica*), skate (*Raia granulata?*), long-nose eel (*Synaphobranchus pinnatus?*), pug-nose eels (*Simenchelys parasiticus*), and a lamprey (*Petromyzon*); from lat. 42° 37′ N., long. 62° 55′ W., 200 fathoms.

449. Capt. KNUD MARKUSON and crew, sch. Notice. A fine specimen of the lancet-mouth (*Alepidosaurus ferox*), from about the same locality as the preceding.

450. GEORGE SAWYER, East Gloucester. A pipe-fish (*Syngnathus*), caught at Wonson's wharf, Gloucester.

451. Capt. JOHN MCINNISS and crew, sch. M. H. Perkins. A fine specimen of the lancet-mouth (*Alepidosaurus ferox*); from lat. 43° 6′ N., long. 61° 18′ W., 200 fathoms.

452. GEO. W. SCOTT, sch. Ocean King. Numerous specimens of Lamarck's basket-fish (*Astrophyton Lamarckii*), common star-fish (*Asterias vulgaris*), star-fishes (*Crossaster papposus, Astrophyton eucnemis*), Sars's serpent-stars (*Ophioglypha Sarsii*), black clams (*Glycimeris siliqua*), holothurian, sponge, internal parasites of codfish and a sand dab (*Hippoglossoides platessoides*); from Sable Island Bank, 9 miles northeast of the northeast light of Sable Island, 60 fathoms.

453. GEO. W. SCOTT, sch. Ocean King. Basket star-fish (*Astrophyton*), rosy, many-rayed star (*Crossaster papposus*), fringed star-fish (*Asterias stellionura*), green sea-eggs (*Strongylocentrotus Dröbachiensis*), flesh-colored soft coral (*Alcyonium carneum*), red spider-crabs (*Hyas coarctatus, Hyas araneus*), ascidians, Iceland scallops (*Pecten Islandicus*), Greenland round clam (*Serripes Grœnlandica*), and other mollusks, worms (*Aphrodita*, &c.), rock perforated by boring shells and with bryozoans attached, stone barnacle (*Balanus crenatus*), algæ taken from a cod stomach, common flat-fish (*Pleuronectes americanus*), and a "lant" (*Ammodytes dubius?*); from the Grand Banks, Virgin Rock bearing N. E. by N. 30 miles, 40 fathoms, June 25 and 26, 1879; also a sculpin (*Cottus scorpius* subspecies *grönlandicus*), a rare blenny (*Gymnelis viridis*), male and female capelin (*Mallotus villosus*) and their spawn, and some brook trout (*Salvelinus fontinalis*); from Miquelon Island; also male capelin from Cape Breton, N. S.

454. Capt. JOSEPH W. COLLINS, sch. Marion. A large specimen of the gold-banded bush-coral (*Keratoisis ornata*); from lat. 44° 14′ N., long. 58° 3′ W., 300 fathoms.

455. JOHN J. RYAN, Gloucester. (Brought in by sch. Madame Roland.) A rock with large green barnacles (*Balanus Hameri*) and sponge attached, and an Iceland scallop (*Pecten Islandicus*); from George's Bank.

456. Capt. JOHN KAVANAGH and crew, sch. Alfred Walen. A large bowlder, with barnacles attached, from George's Bank, 40 fathoms.

457. Capt. THOMAS OLSEN, sch. Epes Tarr. Specimens of jointed bush-coral (*Acanella Normani*), a large shrimp, slime-eel or hag (*Myxine glutinosa*), and long-nose eel (*Synaphobranchus pinnatus*); from lat. 43° 10′ N., long. 61° 10′ W., 250 fathoms.

458. Capt. WM. MCDONALD and crew, sch. N. H. Phillips. Specimens of jointed bush-coral (*Acanella Normani*), sea-feathers (*Balticina Finmarchica*, *Pennatula borealis*), a branch of the gold-banded bush-coral (*Keratoisis ornata*), *Alcyonium*, great club-sponge (*Cladorhiza grandis*), great spiny spider-crab (*Lithodes maia*), gastropod eggs, eggs of unknown skate, and a long-nose eel (*Synaphobranchus pinnatus*); from Banquereau, 300 fathoms.

459. Capt. MICHAEL WELLS and crew, sch. Water Spirit. A purple, many-rayed star-fish (*Solaster endeca*), perforated rock, needle fish (*Aspidophoroides monopterygius*), and many specimens of the black rudder-fish (*Palinurichthys perciformis*); from Western Bank, lat. 42° 27′ N., long. 61° W., 30 to 45 fathoms. The rudder-fish were caught with herring bait.

460. Capt. WM. HERRICK, sch. Augusta Herrick. Specimens of young hake (*Phycis*) and dollar-fish (*Poronotus triacanthus*); taken off Nausett, June 13, 1879.

461. Capt. JOHN GOURVILLE and crew, sch. Rebecca Bartlett. A brittle star (*Ophioglypha*), star-fish (*Hippasteria phrygiana*), lamp-shells (*Terebratulina septentrionalis*), *Aporrhais*, *Comatula*, and a Norway haddock (*Sebastes*); from the eastern part of Le Have Bank, 50 fathoms.

462. Capt. JOHN F. CRITCHETT and crew, sch. Commonwealth. A dollar-fish (*Poronotus triacanthus*) and lump-fish (*Cyclopterus lumpus*); caught about 15 miles off Matinicus Rock, Maine.

463. SILAS JEWETT, sch. Annie E. Lane. A perforated rock and a substance resembling cannel coal, the latter having been taken from a codfish stomach; from northeastern part of Middle Ground, 28 fathoms.

464. SAMUEL KNOWLES, Gloucester. The head of an 82-pound codfish (*Gadus morrhua*).

465. Capt. THOS. R. WHARFF, sch. Willie Jewell, Provincetown. Fine specimens of gastropod eggs.

466. Capt. JAMES MORRISEY and crew, sch. Plymouth Rock. A large marine worm, gastropod eggs, young hake (*Phycis*), rock eel (*Murænoides*), capelin (*Mallotus villosus*), and sand launce (*Ammodytes*); from the Grand Banks, 45 to 50 fathoms.

467. Capt. JOHN Q. GETCHELL and crew, sch. Otis P. Lord. Specimens of star-fish (*Crossaster papposus*, *Asterias vulgaris*, &c.), Iceland round clams (*Cyprina Islandica*), holothurians, shrimps, crabs, barnacles, *Æga*

psora, brittle stars, hydroids, fish eggs, young red-fish (*Sebastes*), rock-eel (*Murænoides*), and a mailed sculpin (*Triglops Pingelii*); from George's Bank, 40 to 50 fathoms.

468. EVERETT P. WONSON, East Gloucester. A live striped or garter snake (*Eutænia sirtalis*), caught in East Gloucester.

469. Capt. JAMES NICKERSON and crew, sch. Bellerophon. A fine specimen of the great northern sea-feather (*Pennatula borealis*); from Banquereau, 250 fathoms.

470. Capt. FRANK WHEELER and crew, sch. Orient. Perfect specimen of the Gorgonian coral, *Acanthogorgia armata*, and a brittle star; from Banquereau, 250 fathoms.

471. CHARLES D. COOK, Provincetown. A specimen of fossiliferous limestone from the Grand Banks, taken February, 1876.

472. Capt. MELVIN GILPATRICK and crew, sch. Polar Wave. A specimen of jointed bush-coral (*Acanella Normani*), large flowered sponge coral (*Anthomastus grandiflorus*), a compound actinian, fine specimens of sea-feathers (*Pennatula borealis* and *Balticina Finmarchica*) with sea-anemones attached, a finned devil-fish (*Stauroteuthis syrtensis*), a species of *Scopelus*, a sucker or lamprey (*Petromyzon*), and a long-nose eel (*Synaphobranchus pinnatus*); from lat. 43° 54′ N., long. 58° 44′ W., 250 fathoms.

473. Capt. WILLIAM DAVIS, sch. Shooting Star, Rockport. A sword-fish sucker (*Remoropsis brachyptera*); taken from the gill-cover of a sword-fish, near the Isles of Shoals, Gulf of Maine.

474. GEORGE WILLIAM HOY, sch. Mary F. Chisholm, Capt. Daniel McKinnon. A fine specimen of the tree-coral (*Paragorgia arborea*), 4 feet 6 inches high, 2 feet 6 inches broad, and several of Lamarck's basket-fish (*Astrophyton Lamarckii*); from lat. 43° 54′ N., long. 58° 40′ W., 250 fathoms.

475. Capt. D. E. COLLINS and crew, sch. Gussie Blaisdell. A specimen of branching sea-corn (eggs of *Buccinum undatum*) 19 inches high, Earll's many-rayed star-fish (*Solaster Earllii*), green sea-eggs (*Strongylocentrotus Dröbachiensis*), ascidian with bryozoans attached, rock with stone barnacles (*Balanus crenatus*), bryozoans, stemmed sea-peaches (*Boltenia Bolteni*), and *Molgula retortiformis* attached; barnacles, large mass of sponge, hydroids (*Lafoea*). The sea-corn came from lat. 46° 40′ N., long. 50° W.; the sponge from lat. 45° 12′ N., long. 51° 20′ W., 40 to 50 fathoms.

476. Capt. GEORGE OLSEN and crew, sch. Willie M. Stevens. Two specimens of the great northern sea-feather (*Pennatula borealis*) several of Lamarck's basket-fish (*Astrophyton Lamarckii*) warty sea-rose (*Urticina nodosa*), large flowered bush-coral (*Anthothela grandiflora*), Earll's many-rayed star-fish (*Solaster Earllii*), *Comatula*, several small brittle star-fish, piece of scaly worm, tube of unknown worm, whelk, large shells (*Neptunea despecta*), clear scallop (*Pecten vitreus*), pug-nosed eel (*Simenchelys parasiticus*), long-nosed eel (*Synaphobranchus pinnatus*), a lamprey (*Petromyzon*), small fish (*Scopelus*) from the stomach of a halibut, a cat-fish (*Anarrhichas latifrons*), a female chimæra (*Chimæra plumbea*) with eggs, and also a male chimæra, and spiral egg-cases; from Banquereau, 250 fathoms.

477. Capt. BRIGGS GILPATRICK and crew, sch. Herbert M. Rogers. Two species of sea-feathers (*Pennatula borealis* and *Balticina Finmarchica*), star-fish, and a long-nose eel (*Synaphobranchus pinnatus*); from Banquereau, 250 fathoms.

478. Capt. NATHANIEL GREENLEAF and crew, sch. Grace L. Fears. Specimens of Lamarck's basket-fish (*Astrophyton Lamarckii*), Finmark sea-feather (*Balticina Finmarchica*), fragment of tree coral (*Paragorgia arborea*), a piece of felt sponge, a perforated rock, and a Norway haddock (*Sebastes marinus*); from Banquereau, 200 fathoms.

479. WILLIAM LURVEY, Gloucester. Specimen of eggs of *Buccinum undatum.*

480. VINAL MCCALEB, East Gloucester. A young blue-fish (*Pomatomus saltatrix*); caught with a mackerel hook in Gloucester Harbor, September 16, 1879.

481. Captain CURZON, sch. Mist. Vertebra of a whale, from lat. 47° 20′ N., long. 50° W., 48 fathoms.

482. Capt. JOHN MCKINNON and crew, sch. Rutherford B. Hayes. A fringed star-fish (*Asterias stellionura*), specimens of small velvet star-fish (*Ctenodiscus crispatus*), brittle sea-egg (*Schizaster fragilis*), piece of scaly worm, isopod crustaceans (*Idotea*), several large shrimps (*Pandalus borealis*), stone barnacles (*Balanus porcatus*), lamp-shells (*Terebratulina septentrionalis*), lump-fish (*Cyclopterus lumpus*), a young Norway haddock (*Sebastes marinus*); from lat. 43° 44′ N., long. 63° 54′ W., 91 fathoms.

483. Capt. S. W. SMITH and crew, sch. S. R. Lane. Specimens of the Finmark sea-feather (*Balticina Finmarchica*), ruffled sea-rose (*Actinernus nobilis*), spiny bush-coral (*Acanthogorgia armata*), with eggs of unknown fish attached, lamp-shells (*Terebratulina septentrionalis*), skate egg, chimæra (*Chimæra plumbea*), slime-eel (*Myxine glutinosa*), and two specimens of the sucker or lamper (*Petromyzon*); from lat. 43° 32′ N., long. 60° 21′ W., 250 fathoms.

484. Capt. SAMUEL PEEPLES and crew, sch. Addison Center. A great northern sea-feather (*Pennatula borealis*), jointed bush-coral (*Acanella Normani*), deep-sea anemone (*Urticina nodosa*), large whelk with sea-anemones attached, great felt-sponge (*Phakellia*), two long-nosed eels (*Synaphobranchus pinnatus?*), two pug-nosed eels (*Simenchelys parasiticus*); from lat. 43° 42′ N., long. 59° 10′ W., 300 fathoms.

485. Capt. CHARLES ANDERSON and crew, sch. Alice G. Wonson. Specimens of star-fish, large shrimps (*Pandalus borealis*), great bush-corals (*Primnoa reseda*), some with barnacles and other animals attached, and two specimens of the rudder-fish (*Palinurichthys perciformis*); from lat. 42° 6′ N., long. 63° 15′ W., 200 fathoms.

486. Capt. JOHN MCINNISS and crew, sch. M. H. Perkins.. Specimens of sea-feathers (*Pennatula borealis* and *Balticina Finmarchica*), with warty sea-rose (*Urticina nodosa*) attached, dog-fish eggs, and a piece of rock from 300 fathoms; from lat. 43° 46′ N., long. 63° 15′ W., 200 fathoms.

487. Capt. PETER HAMLIN and crew, sch. Andrew Leighton. A speci-

men of the lamprey eel (*Petromyzon*); from the eastern part of Banquereau, 150 fathoms.

488. Capt. JAMES MCDONALD and crew, sch. Magic. Specimens of jointed bush-coral (*Acanella Normani*), fragment of rock with flesh-colored soft coral (*Alcyonium carneum*) and sponges attached, deep-sea cup-coral (*Flabellum Goodei*), and cup-sponge (*Phakellia?*); from the edge of the Grand Banks, 250 fathoms.

489. WILLIAM A. PEEPLES, sch. Addison Center, Capt. Samuel Peeples. Specimens of the gold-banded bush-coral (*Keratoisis ornata*), jointed bush-coral (*Acanella Normani*), with *Terebratulina septentrionalis* attached, and a fragment of great felt-sponge (*Phakellia ventilabrum*); from lat. 43° 42′, long. 59° 8′ W., 300 fathoms.

490. Capt. DAVID CAMPBELL and crew, sch. Admiral. A fine specimen of warty bush-coral (*Paramuricea borealis*), Finmark sea-feather (*Balticina Finmarchica*) with sea-anemone attached, flesh-colored soft coral (*Alcyonium carneum*), tube of an unknown worm, a species of *Scopelus*, an unidentified fish from the stomach of a halibut, hag or slime-fish (*Myxine glutinosa*), a lamprey eel (*Petromyzon*), a long-nosed eel (*Synaphobranchus pinnatus*), and a cat-fish (*Anarrhichas minor*) 4 feet long; from eastern part of Banquereau, 200 fathoms.

491. Capt. N. MCPHEE and crew, sch. Carl Schurz. A Finmark sea-feather (*Balticina Finmarchica*), warty sea-anemone (*Urticina*), jointed bush-coral (*Acanella Normani*), large flowered sponge-coral (*Anthomastus grandiflorus*), with sea-anemone attached, Lamarck's basket-fish (*Astrophyton Lamarckii*), and a great scarlet cushion-star (*Hippasteria phrygiana*); from the western part of Banquereau, 200 fathoms.

492. Capt. PHILIP MERCHANT and crew, sch. Marion. Specimens of sea-feathers (*Pennatula borealis* and *Balticina Finmarchica*), star-fishes (*Solaster Earllii*, *Solaster endeca*, *Asterias*, *Hippasteria phrygiana*), stones with sea-anemones, sea-cauliflower (*Alcyonium multiflorum*) and sponges attached, a branching sponge, small squid, eggs of skates and of unknown fish adhering to a warty bush-coral (*Paramuricea borealis*), a Baird's grenadier (*Macrurus Bairdii*) taken from the stomach of a halibut, two pug-nosed eels (*Simenchelys parasiticus*), three long-nosed eels (*Synaphobranchus pinnatus*), two specimens of blue hake (*Haloporphyrus viola*), a male chimæra (*Chimæra plumbea*), and a skate (*Raia*); from near Banquereau, lat. 44° 2′ N., long. 59° W., 325 fathoms.

493. Capt. PHILIP MERCHANT, sch. Marion. Branch of bush-coral (*Paramuricea borealis*); from lat. 44° 2′ N., long. 59° W., 300 fathoms.

494. JOHN J. RYAN, Gloucester. A specimen of perforated rock; from George's Bank.

495. JOHN SHEAN, sch. Ida May. Specimens of male and female sea herring (*Clupea harengus*); caught off Norman's Woe, Gloucester Harbor, September 24, 1879.

496. Capt. GEO. H. MARTIN and crew, sch. Northern Eagle. A specimen of the pilot-fish (*Seriola zonata*), with a lump-fish (*Cyclopterus lum-*

pus) and another, undetermined species in its mouth; caught with a dip net in Newport Harbor, R. I., September 5, 1879.

497. Capt. KNUD MARKUSON and crew, sch. Notice. Specimens of the great northern sea-feather (*Pennatula borealis*), large flowered sea-feather (*Virgularia grandiflora*), flesh-colored soft coral (*Alcyonium carneum*), sea-cauliflower (*Alcyonium multiflorum*), with Lamarck's basket-fish (*Astrophyton Lamarckii*) attached; a rock with *Alcyonium*, sponges, and *Terebratulina septentrionalis* attached; and a fine specimen of grenadier (*Macrurus Fabricii*); from lat. 44° 3′ N., long. 58° 26′ W., 250 fathoms.

498. CHARLES MARTIN, East Gloucester. A specimen of rock-eel (*Murænoides gunellus*); caught at East Gloucester, September 25, 1879.

499. Capt. EDWARD TREVOY and crew, sch. Procter Brothers. Stone barnacles (*Balanus porcatus*), large scaly-stemmed barnacles (*Scalpellum*), a ruffled sea-rose (*Actinernus nobilis*), and a horse mackerel or albicore (*Orcynus thynnus*), weighing 400 pounds; from lat. 44° 3′ N., long. 58° 26′ W., 250 fathoms.

500. Capt. GEORGE H. CORLISS and crew, sch. Conductor. Specimens of bush-coral (*Acanthogorgia armata*), small sea-pens (*Pennatula*), stemmed barnacles (*Conchoderma*), and *Penella;* from lat. 44° 3′ N., long. 58° 26′ W., 250 fathoms.

501. Capt. D. C. MURPHY and crew, sch. Alice M. Williams. Specimens of jointed bush-coral (*Acanella Normani*) with a ruffled sea-rose (*Actinernus nobilis*) and serpent-star (*Ophiacantha*) attached; gold-banded bush-coral (*Keratoisis ornata*) with sea-corn, ophiuran, clear scallop (*Pecten vitreus*), and lamp-shells (*Terebratulina septentrionalis*) attached; great northern sea-feather (*Pennatula borealis*), sea-anemone, scaly worm (*Eunoa spinulosa*), sabelloid worm, Baird's devil-fish (*Octopus Bairdii*), shark's egg, and a pug-nosed eel (*Simenchelys parasiticus*); from lat. 43° 14′ N., long. 61° 7′ W., 250 fathoms.

502. Capt. GEORGE A. JOHNSON and crew, sch. Augusta H. Johnson. Seven specimens of the grenadier (*Macrurus Fabricii*), Baird's grenadier (*Macrurus Bairdii*), and a bill-fish or skip jack (*Scombrescox saurus*); from lat. 44° 3′ N., long. 58° 26′ W., 250 fathoms.

503. JOS. E. HOLBROOK and crew, sch. Jennie P. Phillips, of Swampscott. A cramp-fish or torpedo (*Torpedo occidentalis*), weighing 250 pounds; caught 10 miles south of Gloucester Harbor, September 26, 1879.

504. J. B. GOLDSMITH, Rockport. Specimens of fungus (*Phallus impudicus*); from Rockport.

505. Capt. WILLIAM MCDONALD and crew, sch. N. H. Phillips. A fine specimen of great bush-coral (*Primnoa reseda*), with basket star-fish attached; a nipple-sponge (*Polymastia*), warty sea-rose (*Urticina nodosa*), scaly worm, grenadier (*Macrurus Fabricii*), and a rare fish (*Lycodes Vahlii*), the third specimen taken on the United States coast; from lat. 44° 32′ N., long. 59° W., 225 fathoms.

506. Capt. THOMAS OLSEN and crew, sch. Epes Tarr. A pug-nosed eel (*Simenchelys parasiticus*), from lat. 43° 48′ N., long. 59° W., 300 fath-

oms; and a lump-fish (*Cyclopterus lumpus*), from Liverpool Harbor, Nova Scotia.

507. Capt. GILMAN GILPATRICK, sch. Seth Stockbridge. Stones with sponges, bryozoa (*Tubuliporia simplex?*, *Porella rosacea*), and corals attached, and a red spider-crab (*Hyas coarctatus*); from Banquereau, 250 fathoms.

508. THOMAS MCKINNON, Gloucester. A spotted sand flounder (*Lophopsetta maculata*).

509. Capt. JOHN Q. GETCHELL and crew, sch. Otis P. Lord. Specimens of rock-crabs (*Cancer irroratus*), halibut, parasites (*Æga psora*), hydroids (*Sertularella polyzonias* var. *robusta*), shells (*Saxicava rugosa*, *Modiola modiolus*, *Anomia aculeata*), nipple sponge (*Polymastia*), sea-cucumber (*Thyonidium elongatum*), stone barnacles (*Balanus porcatus*), large green barnacle (*Balanus Hameri*), great scallop (*Pecten tenuicostatus*), stemmed sea-peach (*Boltenia Bolteni*), bryozoa (*Caberea Ellisii*), and a young striped sea-robin, (*Prionotus evolans*); from the eastern part of George's Bank, 50 fathoms.

510. Capt. JOHN MCKINNON and crew, sch. Rutherford B. Hayes. A hook with petrified bait, large shrimp, crab (*Cancer*), unidentified fish from the stomach of a cod, slime-fish (*Myxine glutinosa*), eel (*Zoarces*), and silver hake or whiting (*Merlucius bilinearis*); from lat. 42° 58 N., long. 69° 14′ W., 46 fathoms.

511. SAMUEL G. WONSON, sch. John S. McQuin. Samples of the food of mackerel (*Scomber scombrus*); taken during the summer months off the coasts of Maine and Massachusetts.

512. Capt. MICHAEL WELLS, sch. Water Spirit. A great spiny spider-crab (*Lithodes maia*), from 15 miles southeast of Seguin, Me.

513. Capt. BRIGGS GILPATRICK and crew, sch. Herbert M. Rogers. Earll's many-rayed star-fish (*Solaster Earllii*), lamprey (*Petromyzon*), a pug-nosed eel (*Simenchleys parasiticus*), rudder-fish (*Palinurichthys perciformis*), lancet-mouth (*Alepidosaurus ferox*), and twenty-five young dog-fish (*Centroscymnus cœlolepis*), each 6 inches long, and taken from the parent; from lat. 42° 46′ N., long. 63° 18′ W., 200 fathoms.

514. Capt. SAMUEL PEEPLES and crew, sch. Addison Center. A twin-gilled eel (*Synaphobranchus pinnatus*); from lat. 42° 41′ N. long. 62° 58′ W., 150 fathoms.

515. LEWIS MCDONALD, North Haven, Me. A large perforated rock covered with crustaceans and hydroids; found by the sch. Nevada, Capt. B. L. Tracey, in North Bay, 17 fathoms.

516. GEO. W. SCOTT, sch. Mary Story. Specimen of stone barnacles (*Balanus porcatus*), large green barnacle (*Balanus Hameri*), scallops (*Pecten vitreus* and *Pecten tenuicostatus*), horse mussel (*Modiola modiolus*), bank clam (*Cyrtodaria siliqua*), *Anomia aculeata*, cockles, gastropod eggs, crabs (*Hyas* and *Cancer*), hermit crabs, parasites (*Æga psora*), nipple sponge (*Polymastia*), coral, star-fish (*Asterias*), variegated serpent-stars (*Ophiopholis aculeata*), hydroids (*Sertularella tricuspidata*, *Ser-*

tularia argentea), bryozoa (*Tubulipora simplex? Bugula Murrayana, Discopora ventricosa, Alcyonidium rubrum*), scaly worm, sand eel (*Ammodytes americanus*), dollar-fish (*Argyreiosus vomer*), Norway haddock (*Sebastes marinus*), and two fine specimens of albicore, or horse mackerel (*Orcynus thynnus*); from lat. 41° 58′ N., long. about 66° 30′ W., 45 fathoms. Also several blue crabs (*Callinectes hastatus*), spotted sand flounders (*Lophopsetta maculata*), and American sole (*Achirus lineatus*), from Providence River, R. I.; and a small bluefish (*Pomatomus saltatrix*), from Vineyard Sound.

517. CHARLES RUCKLEY, sch. Electric Flash. Specimens of amphipods, common northern squid (*Ommastrephes illecebrosus*), lump-fish (*Cyclopterus lumpus*), dollar-fish (*Argyreiosus vomer*), young hake (*Phycis*), spotted flounder (*Lophopsetta maculata*), stickleback (*Gasterosteus aculeatus*), a small fish (*Phycis*, sp.), and mackerel stomachs; from off Seguin, Me., about 50 fathoms.

518. Capt. JOHN GOURVILLE and crew, sch. Rebecca Bartlett. Stone barnacles (*Balanus porcatus*), and a cat-fish (*Anarrhichas lupus*); from lat. 42° 10′ N., long. 66° 30′ W., 50 fathoms.

519. Capt. NATHANIEL GREENLEAF and crew, sch. Grace L. Fears. Specimens of bush-corals (*Acanella Normani* and *Acanthogorgia armata*), tree-coral (*Paragorgia arborea*), large flowered sponge-coral (*Anthomastus grandiflorus*), red sea-rose (*Urticina crassicornis*), lamp-shells (*Terrebratulina septentrionalis*), amphipods, hydroids, variegated serpent-stars (*Ophiopholis aculeata*), Lamarck's basket-fish (*Astrophyton Lamarckii*), scallops (*Pecten vitreus*), scaly worm, twin-gilled eel (*Synaphobranchus pinnatus*), and a pug-nosed eel (*Simenchelys parasiticus*); from lat. 43° 48′ N., long. 59° W., 250 fathoms.

520. FRANK WILLIAMS, through Procter Brothers, Gloucester. Specimen of bill-fish (*Scombresox saurus*); caught in Squam River, October 15, 1879.

521. EDWARD F. HOYT, Gloucester. A specimen of pipe-fish (*Syngnathus*).

522. Capt. OSCAR W. ALDEN and crew, sch. Andrew Leighton. A rock with crustaceans attached, and a ruffled sea-rose (*Actinernus nobilis*); from lat. 43° 30′ N., long. 59° 42′ W., 325 fathoms.

523. Capt. S. W. SMITH and crew, sch. S. R. Lane. A sea-feather (*Balticina Finmarchica*), sea-cauliflower (*Alcyonium multiflorum*), flesh-colored soft coral (*Alcyonium carneum*), Lamarck's basket-fish (*Astrophyton Lamarckii*), shark's egg, specimens of lamprey eels (*Petromyzon*), twin-gilled eel (*Synaphobranchus pinnatus*), and blue hake (*Haloporphyrus viola*); from lat. 43° 41′ N., long. 59° 15′ W., 200 fathoms.

524. DAVID SAWYER, sch. Constitution. Ovaries of a blue shark; from Middle Bank.

525. Capt. W. H. GREENLEAF and crew, sch. Chester R. Lawrence. Branches of tree-coral (*Paragorgia arborea*), and of the gold-banded

bush-coral (*Keratoisis ornata*); from the eastern part of Banquereau, 250 fathoms.

526. Capt. Geo. Olson and crew, sch. Willie M. Stevens. Warty sea-rose (*Urticina nodosa*), Goode's cup-coral (*Flabellum Goodei*), sponge, compound ascidian (*Amoroœcium glabrum*), variegated serpent-star (*Ophiopholis aculeata*), sea-worm, sabelloid worm, rudder-fish (*Palinurichthys perciformis*), pug-nosed eel (*Simenchelys parasiticus*), wolf-fish (*Anarrhichas*), and leopard-fish (*Anarrhichas minor*); from lat. 43° 52′ N., long. 59° 9′ W., 200 fathoms.

527. Capt. John McKinnon and crew, sch. Rutherford B. Hayes. A mackerel stomach taken from the stomach of a haddock, and two small unidentified fish found swimming near the surface; in lat. 42° 53′ N., long. 69° 14′ W., 46 fathoms.

528. Capt. Chas. Anderson and crew, sch. Alice G. Wonson. A fine specimen of the great bush-coral (*Primnoa reseda*), ascidian (*Pyrosoma*), scaly worm (*Eunoa spinulosa*), small red star-fish, velvet-star (*Poramia*) and a tubular, sponge-like structure 18 inches long; from lat. 42° 6′ N., long. 65° 35′ W., 200 fathoms.

529. Charles Wilson, Gloucester. Eggs of unknown mollusk; from Providence River, Rhode Island.

530. Capt. John McInnis and crew, sch. M. H. Perkins. Great northern sea-feather (*Pennatula borealis*), Flora's velvet-star (*Archaster Floræ*), fishermen's devil-fish (*Octopus piscatorum*), sucker or lamprey (*Petromyzon*), and a lancet-mouth (*Alepidosaurus ferox*), from the western part of Le Have Bank, 120 fathoms.

531. Capt. Charles Murphy and crew, sch. Alice M. Williams. Sea-rose (*Urticina nodosa*), polyps, variegated serpent-stars (*Ophiopholis aculeata*), scallops (*Pecten vitreus*), and a great northern sea-feather (*Pennatula borealis*); from the "Stone Fence," lat. 44° 27′ N., long. 57° 14′ W., 190 fathoms.

532. Capt. Medeo Rose and crew, sch. Hiram Powers. A fine specimen of Norway haddock (*Sebastes marinus*); from Jeffrey's Bank, Gulf of Maine, 45 fathoms.

ALPHABETICAL INDEX.*

*For special indexes to the reports on New England Marine Algæ, by Farlow, and on the Cephalopoda, by Verrill, see pages 202 and 453, respectively.

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