UNITED STATES COMMISSION OF FISH AND FISHERIES.

PART XVII.

REPORT

OF

THE COMMISSIONER

FOR

1889 to 1891.

[FROM JULY 1, 1889, TO JUNE 30, 1891.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1893.

Resolved by the Senate (the House of Representatives concurring therein), That the Report of the Commissioner of Fish and Fisheries, covering the operations of the Commission for the fiscal years 1889–90 and 1890–91, be printed; and that there be printed 8,000 extra copies, of which 2,000 shall be for the use of the Senate, 4,000 for the use of the House of Representatives, and 2,000 for the use of the Commissioner of Fish and Fisheries; the illustrations to be obtained by the Public Printer under the direction of the Joint Committee on Printing.

Agreed to by the Senate March 23, 1892.

Agreed to by the House May 10, 1892.

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ON ENTOZOA FROM YELLOWSTONE NATIONAL PARK.

REPORT

OF THE

UNITED STATES COMMISSIONER OF FISH AND FISHERIES

FOR THE

FISCAL YEARS 1889-90 AND 1890-91.

In accordance with the resolution of Congress, the accompanying report presents the work of the Commission for the period commencing July 1, 1889, and ending June 30, 1891.

The appropriations for the current expenses of the work of the Commission during the two fiscal years covered by this report were as follows:

Appropriation.	1889-90.	1890-91.
Compensation of Commissioner	$5,000	$5,000
Propagation of food-fishes	150,000	150,000
Distribution of food-fishes	35,000	50,000
Maintenance of vessels	53,900	53,900
Inquiry respecting food-fishes	20,000	20,000
Statistical inquiry	10,000	20,000
Maintenance of Neosho Station, Missouri	5,000	....
Total	278,900	298,900

As required by law, detailed reports of the expenditures under these appropriations were presented to Congress December 1, 1890 (Mis. Doc. No. 5, House of Representatives, Fifty-first Congress, second session) and December 1, 1891 (Mis. Doc. No. 16, Senate, Fifty-second Congress, first session). These reports exhibit the expenditures for the conduct of each of the Commission's stations, and also for the special lines of inquiry conducted by the Commission.

INQUIRY RESPECTING FOOD-FISHES AND THE FISHING-GROUNDS.

A full account of the operations of the division conducting these investigations will be found in the accompanying report of Mr. Richard Rathbun, assistant in charge (pages 97 to 171).

My last report contains an outline of the preliminary investigations respecting the fishing-grounds of the North Pacific region, begun by the steamer *Albatross* in the summer of 1888, and which it was proposed to extend to all the waters adjacent to the territory of the United States on the western coast. During the past two years these surveys have been completed between the Straits of Juan de Fuca and the Mexican boundary line, or off the coasts of Washington, Oregon, and California, and a partial examination has been made of the shallow-water area composing the eastern part of Bering Sea.

Lieut. Commander Z. L. Tanner, U. S. Navy, who has commanded the *Albatross* ever since she was placed in commission at the beginning of 1884, has been in direct charge of the conduct of these inquiries, and it is a pleasing duty to make official record of the uniformly capable and efficient services rendered by him in this connection. As commanding officer he has displayed rare seamanship, and at the same time such tact and discretion under difficult and often perplexing conditions of administration as to merit the strongest commendation.

During July, 1889, the *Albatross* was placed at the disposal of the U. S. Senate Committee on Indian Affairs, and was used in visiting the principal Indian settlements in the southeastern part of Alaska. Subsequently the fishery investigations were resumed to the south of Cape Flattery and were carried southward as far as Cape Mendocino. During the following winter the region between Point Arena and Point Conception was examined, and in the autumn of 1890 the remaining section of the coast from Cape Mendocino to Point Arena.

The summer of 1890, beginning in May, was spent entirely in Bering Sea, where it was found that the principal banks frequented by the cod are located off the northern side of the Alaska Peninsula, commencing at Unimak Pass and extending, with only a single break, parallel with the coast to near the head of Bristol Bay. Kulukak Bay also furnishes several smaller grounds. Only two banks are recognized in the southern part of Bristol Bay, both of which afford excellent fishing in moderate depths of water. The most western one, called Slime Bank, is peculiarly infested during the summer season with immense numbers of a large jelly-fish, which are said to remain near the bottom and to greatly interfere with fishing operations during that period. Baird Bank, which lies to the eastward of, and nearly adjoins, Slime Bank, is the largest fishing-ground which has yet been discovered in Alaskan waters, its size being slightly greater than that of

Georges Bank, in the Northern Atlantic. The best fishing-spots occur in the region adjacent to Port Moller and Herendeen Bay, two important inlets for shelter during stormy weather, of which the entrance to the former and the channel through the latter were surveyed and mapped. A coal mine had been opened near the head of Herendeen Bay just previous to the visit of the *Albatross*, which took the first output of coal and found the same of good quality for steaming purposes. The starting of this new enterprise marks a decisive step toward the development of this region, and should it result in the establishment of a permanent settlement it can not fail to advance materially the interests of the neighboring fisheries.

The season proved too short to complete the investigations in Bering Sea as originally planned, outside of the fishing-ground above referred to, and it will be necessary to resume the work at some future time. The position of the western margin of the continental platform was defined, however, for a considerable distance, and a good beginning has been made toward a knowledge of those physical and biological features of the sea which relate to the habits and distribution of the fur seal and other aquatic mammals.

By the surveys of the coasts of Washington, Oregon, and California, the contour of the continental border has been developed from the shore line into depths of 200 fathoms as far south as Point Conception, the region between the latter place and San Diego having been previously explored. A great wealth of hydrographic information of value to navigation has thereby been obtained, in addition to a very fair knowledge of the fishery resources. Very few defined fishing-banks were discovered, but food-fishes of many species, and of good quality, were generally distributed along the coast. Halibut were taken as far south as Heceta Bank, off the coast of Oregon, but they are apparently nowhere sufficiently abundant south of Cape Flattery to induce the sending out of vessels equipped solely for their capture. Several kinds of flounders and of rock-cod are very plentiful, however, and only the lack of suitable markets stands in the way of the organization of an extensive fishery almost anywhere northward of the region tributary to San Francisco, where much activity has now prevailed for a number of years.

A very careful series of temperature and density as well as biological observations in different parts of San Francisco Bay, by Mr. C. H. Townsend, the naturalist of the steamer *Albatross*, seems to indicate that the waters of that region are not, as has hitherto been supposed, unsuited to the breeding of the Atlantic coast oysters, and further investigations regarding this matter are awaited with much interest. Should the establishment of self-sustaining beds of the larger and better quality of oyster prove possible in this bay, it would certainly tend to stimulate the development of an important industry.

Under authority from the President of the United States, the Commissioner has been gratified to assign the steamer *Albatross* to a special scientific investigation of the waters lying off the western coast of America, between Cape San Francisco and the Galapagos Islands, on the south, and the Gulf of California, on the north. This inquiry, which took place during the early part of 1891, was planned and personally directed by Prof. Alexander Agassiz, director of the Museum of Comparative Zoölogy at Harvard University, who also paid a large proportion of the running expenses of the cruise. Scarcely anything had previously been learned regarding the physical or natural-history characteristics of the region, and the expedition proved entirely successful, promising results of an important character. The materials and observations obtained have been placed in Prof. Agassiz's charge for elaboration, and three reports bearing upon the same have already been published.

The most extensive and important operations on the Atlantic coast have been conducted in the interest of the oyster industry. A complete survey has been made of the coast waters of South Carolina, which, it is expected, will direct attention to the abundant resources contained within the boundaries of this State. The oysters are almost exclusively of the raccoon type, seldom growing upon the bottom, but forming narrow ledges or flats along the borders of the bays and of the numerous winding tidal channels, between the levels of high and low tide, wherever the conditions are favorable for their existence. The cause of this surface distribution has not yet been entirely explained, but the observations so far made suggest that possibly the relatively high specific gravity of the water prevents the spat from sinking below the surface. Should this prove to be the case, the establishment of self-sustaining beds below the level of low tide may be impossible, but further investigations are required before passing finally upon this question. In any event an important industry is insured in the use of the raccoon oysters as seed, which, when planted in suitable localities, grow to a good shape, and improve greatly in flavor and consistency. This method of oyster farming is already practiced successfully in two or three places, but only on a very limited scale, and the business is susceptible of extensive development.

The States of Maryland and Virginia have both become greatly concerned regarding the future prosperity of their oyster fisheries. The fact that the oyster beds of Chesapeake Bay have apparently been deteriorating for a number of years has led to the very general conviction that some radical changes in the management of the industry are necessary in order to prevent a very serious depletion. In the spring of 1891 the steamer *Fish Hawk* began an investigation of this region, the principal object of which was to obtain as much accurate information as possible respecting the present condition of the beds, and the practicability of extending the area of production by artificial plantings, as has been done in Long Island Sound. The survey was first taken up in Tangier Sound, where a similar inquiry had been conducted by the Coast Survey about twelve years before, in the expectation that the results obtained would afford the data for a very instructive comparison. By July 1, 1891, the delineation of the beds had been about completed, and the dredging work was soon to be commenced.

During both summers the oyster beds of Long Island Sound have been subjected to extensive investigations, and much information has been secured regarding the natural features of the region, the habits of starfishes and of other enemies of the oyster, and the conditions of spatting during the two seasons. The summer of 1890 was chiefly spent in making a physical and chemical examination of the waters of the sound, the former inquiry being undertaken with the coöperation of the Superintendent of the Coast Survey. This had for its object to ascertain, by a series of careful current observations, the extent of the movement of water through the sound and the adequacy of the flow to prevent stagnation and consequent harm to the oyster beds. The chemical studies consisted in making tests of the waters in all parts of this area, both in inclosed and exposed positions, to determine its sanitary condition. The result of these researches proves very conclusively that no damage need be apprehended from the present condition of the waters, and that a sufficient flow takes place to insure, under existing circumstances, the prompt removal of polluting matters; but it is not to be denied that the sewage and other sources of contamination might be so increased as greatly to endanger the welfare of the oyster-grounds.

Dr. Bashford Dean, of Columbia College, New York, an expert on the subject of oyster-grounds, who left this country near the close of the last fiscal year for an extended visit in Europe, has been commissioned to study the methods of oyster-culture now practiced in European countries, and to prepare an illustrated series of reports regarding those matters, which, it is expected, will be at least suggestive to American oyster-growers.

The physical inquiries in the mackerel region off the southern New England coast under the direction of Prof. William Libbey, jr., referred to in the last annual report, were conducted during a part of July and August, 1889, and again during the summer of 1890. The former season the work was performed by means of the schooner *Grampus* alone, but during the latter the Coast Survey steamer *Blake* was detailed to act in coöperation with the *Grampus*, and, through the courtesy of the Light-House Board, a party of observers was also stationed on the Nantucket New South Shoal light-ship. Parallel lines of observing stations were carried seaward from the coast for distances of 130 to 150 miles, the lines being 10 minutes of longitude apart and the stations 10 miles apart. At each of these stations, which numbered several hundred in the course of the two seasons, the temperature of the water was taken at regular intervals between the surface and bottom, or down to depths of 300 to 500 fathoms, where the depth of water exceeded that amount, and at the same time a full set of meteorological observations was recorded. The result has been to furnish a large series of vertical temperature sections through the water which show very clearly the relations of the Gulf Stream with the colder waters of the Arctic current, and the surface variations are accompanied by very complete meteorological data, with which, it is hoped, a correlation may ultimately be rendered possible. These observations will undoubtedly throw much light upon the habits of several species of pelagic fishes, of which the mackerel is most conspicuous, and even the movements of such bottom fishes as the tile-fish will probably find their explanation in a knowledge of these physical characteristics.

Dr. H. V. Wilson, a graduate of Johns Hopkins University, was appointed resident naturalist at the Woods Holl Station in the spring of 1889, and has served in that capacity during the past two years. The laboratory at this place has, therefore, been kept constantly open during this entire period, and in the summer months a large number of biologists have been present, as in former years. Dr. Wilson's studies have been directed toward the practical needs of the fish-cultural operations, and have related chiefly to the sea bass, the cod, and the Atlantic salmon. A comprehensive study of the life history of the lobster has also been taken up for the Fish Commission by Prof. F. H. Herrick. Important observations regarding the natural history of many fishes and experiments relating to the artificial propagation of several of these have been made by Mr. V. N. Edwards. His investigations, moreover, have furnished conclusive proof that the hatching work of the Fish Commission has been exceptionally successful in increasing the supply of cod on the southern New England coast, and show that the larger fish resulting from these plantings will to some extent enter more shallow waters than are generally frequented by the cod, schools of this species now often making their appearance in places where they were never seen before. Experiments relative to the propagation of the Spanish mackerel and inquiries regarding its embryology were in progress in the lower Chesapeake Bay during the latter part of June, 1891, being conducted by a party on board the steamer *Fish Hawk*.

The investigations respecting the interior waters of the country have been conducted upon a very extensive scale and with important practical results, having reference mainly to the fish-cultural needs of the regions which have been examined. They have covered, to a greater or less extent, twelve different States and Territories, as follows: The Yellowstone National Park, in Wyoming; Colorado, Utah, Missouri, Arkansas, Iowa, Wisconsin, Indiana, Ohio, Kentucky, Florida, and

Alaska. The Alaskan survey, the preparations for which were described in my last report, was specially authorized by Congress and was executed during the summer of 1889, the work being in charge of Dr. Tarleton H. Bean, the ichthyologist of the Commission. The objects of the inquiry were to study the natural history of the salmon and the physical characteristics of their environment, to obtain information regarding the methods, statistics, and conditions of the fishery, and to ascertain the necessities and advantages of Alaskan waters for the artificial propagation of these species. Owing to the difficulties in the way of reaching their working grounds, the party did not arrive at Kadiak until the last of July, and was thereby prevented from extending its observations beyond that island and Afognak. Considering, however, that Karluk River, on Kadiak Island, furnished at that time about one-half the entire yield of the territory in canned salmon, and that ample opportunities were afforded there for making a very thorough study of the subject, the expedition was entirely successful in its mission. The results were reported to Congress during the winter of 1889–90, and in that connection the Commissioner recommended that action be taken to prohibit obstructions impeding or preventing the ascent of salmon in the Alaskan rivers to their spawning-grounds and to prevent destructive methods of fishing, or that a system of leasing fishery privileges under fixed regulations be inaugurated. It was also suggested that additional legislation might provide for an increased production of salmon by fish-cultural methods, thus avoiding the enormous waste of eggs and young fish under their natural conditions, and repairing to some extent the injury caused by overfishing.

In the majority of the other inland investigations the Commissioner has had the advice and coöperation of Dr. David S. Jordan, president of the Indiana University, who has also participated personally in the explorations of Colorado, Utah, and the Yellowstone National Park during the summer of 1889. During the next summer Prof. S. A. Forbes, director of the laboratory of natural history of the State of Illinois, and Prof. Edwin Linton, of Washington and Jefferson College, Pennsylvania, undertook for the Fish Commission a very detailed investigation of the invertebrate fauna of the Yellowstone National Park from the standpoint of the natural food supply for fishes. It was considered that the planting of fishes in this region would be largely dependent for its success upon the abundance of these lower organisms, and it is very gratifying to be able to announce that the observations in this respect were attended with entirely satisfactory results.

METHODS AND STATISTICS OF THE FISHERIES.

The conduct of this division has continued under the direction of Mr. J. W. Collins, assistant in charge, but since his designation, in August, 1890, as the representative of the Commission on the Government Board of Control and Management of the World's Columbian Exposition, much of the supervision of the work has devolved upon Dr. Hugh M. Smith, the principal assistant in the division, to whose accompanying report (pages 173–204) reference is made for a detailed account of the nature, scope, purposes, and results of the work during the period under consideration.

The inquiries have been mainly confined to the collection and compilation of the statistics of the fisheries of the United States, giving the quantity and value of the products, the capital invested, the number and nationalities of persons employed, and to the study of the methods and relations of the fisheries with a view to their improvement.

The limited appropriation and the consequent small force available for this work preclude the possibility of an annual investigation of the fisheries of the entire coast and inland waters of the country; even if this should be attempted, it is open to question whether the variations in the fisheries from year to year are generally sufficiently marked, or whether at this time the results would be of sufficient importance to warrant the largely increased expenditures that would be required to properly conduct the work. Comparative statistics are more valuable when they relate to definite intervals of time than when they cover successive years. The researches of the Commission, which have been addressed to every section of the coast, furnish data for the comparison of conditions at intervals of three or four years and the determination of the influences of the methods and means employed upon the prosperity of the fisheries. Thus pursued, they furnish important material which has been or may be useful as the basis for the regulation, protection, maintenance, and improvement of the fisheries, and for advancing the physical and financial conditions of the fishermen.

The investigations undertaken during the two years covered by this report were more extensive than had previously been carried on. Field work was done in twenty-two States; complete studies of the coast fisheries were made in Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas; inquiries begun during the previous year were brought to a close in New York and California; and special investigations were made in Maryland, Virginia, Pennsylvania, Oregon, Washington, and elsewhere.

The inquiry on the Pacific coast placed the office in possession of definite information concerning the results which have attended the introduction of shad and striped bass to that region and disclosed a very satisfactory outlook for the establishment of important fisheries for these species. Shad are now found along the entire coast from Monterey Bay to Puget Sound, and are caught for market in each State. In 1888, without the use of special apparatus, over 100,000 pounds of shad were taken, and the following year the catch was considerably larger. Recent advices show that the shad is annually increasing in abundance, and in places has already become one of the most important food-fishes. The striped bass is more restricted in its distribution than the shad, and seems to be found chiefly in San Francisco Bay; it has not yet reached the commercial prominence of the shad.

The important fisheries of the New England States were carefully canvassed in the early part of the fiscal year 1890. No other investigation of this region had been made since 1880; and in view of the changes that had taken place in the extent and methods of the fisheries it was considered desirable to secure full and precise information regarding them, because of the international questions in relation thereto then pending or likely to arise. The inquiry covered the ocean, shore, and river fisheries of the region and the shore industries related to or dependent on the fisheries. Special studies were made of the more important branches, as the sardine industry, smoked-herring trade, lobster-canning business, etc., and at Boston and Gloucester a comprehensive canvass was conducted regarding the extent and methods of the wholesale trades in fresh, salted, and smoked fish, lobsters, and oysters. The decrease in the fishing industry of this section which has occurred since 1880 has been largely in the whale and mackerel fisheries, while the general branches are fully as successful as formerly.

The researches in the South Atlantic and Gulf States indicate a very marked development of the fisheries since the last general investigations were made, the advance in certain lines being phenomenally large. The resources of both these regions are only partly utilized, and the fisheries are no doubt destined to undergo still further improvement in the near future. Especially worthy of notice are the recent increase in the shad and oyster fisheries and the attention which the subject of oyster cultivation is receiving in every State.

A number of important papers relating to the fisheries were published during the year, an analysis of which will be found in the report of the division, which also contains remarks on certain important features of the fisheries during 1889 and 1890, as well as an account of the miscellaneous relations and work of the office.

FISH-CULTURE.

The work of this division has continued under the immediate direction of the Commissioner. During the year ending June 30, 1890, the stations operated were:

1. Schoodic Station, Me.
2. Craig Brook Station, Me.
3. Green Lake Station, Me.
4. Gloucester Station, Mass.
5. Woods Holl Station, Mass.
6. Cold Spring Harbor Station, N. Y
7. Gloucester City Station, N. J.
8. Battery Island Station, Md.
9. Fort Washington Station, Md.
10. Central Station, Washington, D. C.
11. Fish Ponds, Washington, D. C.
12. Wytheville Station, Va.
13. Sandusky Station, Ohio.
14. Northville Station, Mich.
15. Alpena Station, Mich.
16. Duluth Station, Minn.
17. Quincy Station, Ill.
18. Neosho Station, Mo.
19. Leadville Station, Colo.
20. Baird Station, Cal.
21. Fort Gaston Station, Cal.
22. Clackamas Station, Oregon.

During the following year the same stations were continued with the exception of that at Sandusky, the work conducted there being transferred to the Commission's new station on the island of Put-in Bay, Ohio. The fish-cultural work of the Commission during these years was increased over that prosecuted during the year 1889 by the operation of stations at Green Lake, Me., Gloucester City, N. J., Neosho, Mo., Leadville, Colo., and Fort Gaston, Cal.

The following tables show the work done at the respective stations during the two fiscal years:

Summary of production by stations.

Species and source of supply.	1889-90.			1890-91.		
	Eggs.	Fry.	Adults and yearlings.	Eggs.	Fry.	Adults and yearlings.
Schoodic, Me.:						
Landlocked salmon	635,000	214,000	......	456,900	113,000	......
Craig Brook, Me.:						
Landlocked salmon	......	......	17,380	......	5,289	7,367
Atlantic salmon	890,000	......	91,395	......	......	123,835
Von Behr trout	......	......	......	......	......	3,580
Rainbow trout	......	......	747	......	......	......
Loch Leven trout	......	......	......	......	......	11,297
Brook trout	......	......	1,022	......	4,251	......
Green Lake, Me.:						
Landlocked salmon	10,000	150,000	......	......	3,000	......
Gloucester, Mass.:						
Cod	......	14,957,500	......	......	18,968,000	......
Pollock	......	14,899,000	......	......	14,827,500	......
Haddock	......	5,192,000	......	......	78,500	......
Woods Holl, Mass.:						
Sea bass	......	3,893,500	......	......	......	......
Scup	......	396,000	......	......	......	......
Squeteague	......	227,500	......	......	......	......
Mackerel	......	688,500	......	......	......	......
Tautog	......	732,500	......	......	......	......
Cod	......	6,826,000	......	......	36,416,000	......
Haddock	......	528,000	......	......	......	......
Flatfish	......	4,086,500	......	......	3,350,500	......
Lobster	250,000	4,511,000	......	......	3,533,500	......

Summary of production by stations—Continued.

Species and source of supply.	1889–90.			1890–91.		
	Eggs.	Fry.	Adults and yearlings.	Eggs.	Fry.	Adults and yearlings.
Cold Spring Harbor, N. Y.:						
Atlantic salmon		506, 400				
Landlocked salmon		80, 000				
Lake trout		470, 000			482, 622	
Loch Leven trout					18, 015	
Gloucester City, N. J.:						
Shad		6, 204, 000			6, 155, 000	
Battery Island, Md.:						
Shad	12, 637, 000	12, 248, 000		8, 250, 000	37, 747, 000	
Fort Washington, Md.:						
Shad	34, 446, 000	356, 000		32, 361, 000	170, 000	
Central Station, Washington, D. C:						
Shad		23, 493, 000		8, 140, 000	14, 972, 000	
Rainbow trout					11, 981	
Brook trout		30, 500			20, 744	
Lake trout					87, 588	
Von Behr trout					16, 467	
Landlocked salmon		18, 200			25, 274	
Whitefish		4, 300, 000			3, 600, 000	
Smelt					400, 000	
Yellow perch		754, 000				
Fish Ponds, Washington, D. C.:						
Shad						800, 000
Carp			28, 700			337, 040
Goldfish			15, 972			23, 029
Tench			24			1, 650
Wytheville, Va.:						
Rainbow trout	158, 000		39, 276	195, 000		37, 990
Von Behr trout			237			
Brook trout			1, 145			
Carp			2, 330			6, 931
Goldfish			1, 535			1, 911
Black bass						810
Rock bass			3, 484			4, 427
Sandusky, Ohio:						
Whitefish	22, 000, 000	30, 628, 000				
Pike perch	19, 000, 000	36, 200, 000				
Put-in Bay, Ohio:						
Whitefish				71, 625, 000	10, 000, 000	
Pike perch				58, 000, 000	60, 000, 000	
Lake trout					192, 000	
Northville, Mich.:						
Whitefish	28, 460, 000					
Lake trout	2, 600, 000		13, 132	2, 285, 000	600, 000	187, 805
Rainbow trout	12, 500		19, 143			4, 053
Von Behr trout	58, 000		6, 175	226, 000		18, 655
Loch Leven trout	162, 000		10, 000	80, 000		14, 775
Brook trout	265, 000	10, 000	7, 800	110, 000		16, 795
Alpena, Mich.:						
Whitefish		33, 600, 000		20, 500, 000	24, 060, 000	
Duluth, Minn.:						
Landlocked salmon					20, 000	
Lake trout		935, 000			358, 000	235, 000
Von Behr trout					15, 000	
Brook trout		28, 000				100
Whitefish		24, 850, 000			11, 330, 000	
Pike perch		580, 000		12, 000, 000	10, 100, 000	
Quincy, Ill.:						
Catfish			11, 116			
Brook pike			70			
Buffalo			2, 215			
Yellow perch			16, 323			9, 958
Pike perch			1, 000			
White bass			10, 604			
Fresh-water drum			200			
Black bass			63, 145			44, 405
Crappie			18, 575			21, 901
Rock bass			2, 854			10, 802
Sunfish			6, 973			2, 435
Neosho, Mo.:						
Rainbow trout						21, 039
Von Behr trout						11, 925
Lake trout						500
Carp						1, 782
Tench						9, 907
Goldfish						17, 007
Rock bass						1, 368

Summary of production by stations—Continued.

Species and source of supply.	1889–90.			1890–91.		
	Eggs.	Fry.	Adults and yearlings.	Eggs.	Fry.	Adults and yearlings.
Leadville, Colo.:						
Brook trout	75,000	126,881		5,000		59,000
Baird, Cal.:						
Quinnat salmon	1,554,000	84,000		2,988,000	722,000	
Fort Gaston, Cal.:						
Quinnat salmon					55,000	
Clackamas, Oregon:						
Quinnat salmon	1,000,000	2,776,475		700,000	4,901,525	
Connecticut River, car No. 3:						
Shad		765,000				
Steamer Fish Hawk:						
Shad	3,669,000	20,596,000				
Spanish mackerel					776,000	
Collections in Idaho:						
Black-spotted trout			1,000			
Collections in Montana:						
Whitefish			3,000			
Germany, gift of Herr von dem Borne:						
Von Behr trout	34,000					
Saibling	13,000					
Loch Leven trout	15,000					
Germany, gift of Herr von Behr:						
Von Behr trout	56,000			29,750		
New York Fish Commission:						
Brook trout				20,000		
Von Behr trout				100,000		

DISTRIBUTION OF FOOD-FISHES.

The results obtained by stocking public waters with species of fish which are indigenous to them have been difficult of exact determination; that good has followed is shown by the continued increase in the value of the fisheries, demonstrated by carefully collected statistics. In those waters where species not indigenous were placed it is clearly shown what is possible of accomplishment. For information relative to the acclimation of the shad and striped bass on the Pacific Coast reference is made to page 175 of this report. Many of the streams and lakes of the Yellowstone National Park, formerly barren of food-fish, are also now furnishing an abundance of trout and whitefish, the result of plantings of former years.

The following table summarizes the work of distribution of various species of food-fishes during the two years covered by this report. The large increase over former years in the number of adult and yearling fishes distributed is the result of systematic efforts in rearing. This feature will continue to receive attention, it being applicable to fresh-water, marine, and anadromous species. The advantage of stocking waters with fish of a size large enough to protect themselves or to escape from their enemies will be very readily appreciated. The details of distribution will be found in Tables A and B, pages 75 to 96 of this report.

Summary of distribution.

Species.	Year ending June 30, 1890.				Year ending June 30, 1891.			
	Eggs.	Fry.	Adults and yearlings.	Total.	Eggs.	Fry.	Adults and yearlings.	Total.
Catfish	....	....	11,068	11,068	....	....	....	....
Carp	....	....	26,316	26,316	....	....	338,809	338,809
Tench	....	....	....	....	....	....	11,385	11,385
Goldfish	....	....	16,005	16,005	....	....	36,561	36,561
Buffalo	....	....	2,195	2,195	....	....	....	....
Shad	2,264,000	*68,401,000	....	70,665,000	837,000	†67,035,000	800,000	68,672,000
Quinnat salmon	2,454,000	2,940,475	....	5,394,475	3,677,900	5,678,525	....	9,356,425
Atlantic salmon	190,000	503,150	91,395	784,545	....	....	113,835	113,835
Landlocked salmon	345,000	462,100	17,380	824,480	325,000	166,289	7,367	498,656
Loch Leven trout	85,000	....	9,989	94,989	40,000	18,000	25,772	83,772
Rainbow trout	145,500	....	57,635	203,135	150,000	11,981	56,380	218,361
Von Behr trout	76,000	....	6,279	82,279	139,750	31,400	33,760	204,910
Black-spotted trout	....	....	1,000	1,000	....	....	....	....
Brook trout	177,500	195,381	9,866	382,747	50,000	24,831	74,153	148,984
Lake trout	1,075,000	1,405,000	13,001	2,493,001	985,000	1,658,641	416,611	3,060,252
Saibling	8,000	....	....	8,000	....	....	....	....
Whitefish	18,210,000	93,378,000	3,000	111,591,000	75,925,000	48,702,000	10,000	124,637,000
Smelt	....	....	....	....	....	400,000	....	400,000
Brook pike	....	....	70	70	....	....	....	....
Yellow perch	....	754,000	15,402	769,402	....	....	9,568	9,568
Pike perch	19,000,000	36,730,000	1,000	55,731,000	70,000,000	62,400,000	....	132,400,000
Sea bass	....	3,893,500	....	3,893,500	....	....	....	....
White bass	....	....	10,004	10,004	....	....	....	....
Black bass	....	....	62,157	62,157	....	....	43,731	43,731
Crappie	....	....	18,068	18,068	....	....	20,454	20,454
Rock bass	....	....	5,097	5,097	....	....	15,504	15,504
Sunfish	....	....	6,815	6,815	....	....	2,262	2,262
Scup	....	396,000	....	396,000	....	....	....	....
Fresh-water drum	....	....	200	200	....	....	....	....
Squeteague	....	227,500	....	227,500	....	....	....	....
Mackerel	....	688,500	....	688,500	....	....	....	....
Spanish mackerel	....	....	....	....	....	776,000	....	776,000
Tautog	....	732,000	....	732,000	....	....	....	....
Cod	....	21,783,500	....	21,783,500	....	55,381,000	....	55,384,000
Pollock	....	14,899,000	....	14,899,000	....	14,827,500	....	14,827,500
Haddock	....	5,720,000	....	5,720,000	....	78,500	....	78,500
Flatfish	....	4,086,500	....	4,086,500	....	3,350,500	....	3,350,500
Lobsters	250,000	4,511,000	....	4,761,000	....	3,533,500	....	3,533,500
Total	44,280,000	261,706,606	383,942	306,370,548	152,129,650	264,076,667	2,016,152	418,222,469

* In addition to these 2,144,000 were deposited for rearing in the fish ponds, Washington, D. C.
† Besides these 2,054,000 were deposited for rearing in the fish ponds, Washington, D. C.

In addition to the foregoing there were furnished for distribution, but lost in transit, during the two years:

In 1889–90:

6,731,000 shad fry, 50,000 pike perch fry, and the following adults and yearling fish: 48 catfish, 810 carp, 20 buffalo, 3,250 Atlantic salmon, 100 landlocked salmon, 11 Loch Leven trout, 1,531 rainbow trout, 133 Von Behr trout, 101 brook trout, 131 lake trout, 921 yellow perch, 560 white bass, 988 black bass, 507 crappie, 1,241 rock bass, and 158 sunfish; a total of 6,791,510.

In 1890–91:

5,508,000 shad fry, 7,700,000 pike perch fry, 288,000 whitefish fry, 61,569 lake trout fry, and the following adults and yearling fish: 6,944 carp, 5,386 goldfish, 172 tench, 10,000 Atlantic salmon, 300 Loch Leven trout, 6,702 rainbow trout, 400 Von Behr trout, 1,742 brook trout, 6,694 lake trout, 325 perch, 1,415 black bass, 1,440 crappie, 173 sunfish, 328 rock bass; a total of 13,599,590.

STATION REPORTS.

SCHOODIC STATION, MAINE (CHARLES G. ATKINS, SUPERINTENDENT).

1889–90.

This station was conducted jointly by the United States and Maine and New Hampshire. Operations were begun September 1, 1889, and 871 landlocked salmon were caught and impounded. Of these, 557 were females, from which 1,215,455 eggs were obtained by November 24. The losses were 163,005, there remaining in February, 1890, 1,052,450 good eggs, of which the State of Maine received 48,000, New Hampshire 73,000, and the United States 931,450. Of those belonging to the United States, 635,000 were distributed to various State fish commissions and other hatcheries, as mentioned in the details of distribution (pages 75 to 96). One shipment of 20,000, sent to Fort Gaston Station, California, was a total loss, as a result of detention while en route, the losses on the other twenty shipments amounting to but 4,246 eggs. The 296,450 eggs retained produced 214,000 fry, which were able to take food at the time of their release in local waters, in June, 1890.

Table of spawning operations at Schoodic Station, Maine, 1889–90.

Date.	Temperature, 7 a. m.		Fish at first handling.							Females spawned.			Eggs taken.		
					Females.										
	Air.	Water.	Total.	Males.	Total.	Ripe.	Unripe.	Spent.	Diseased.	First time.	Second time.	With some bad eggs.	Weight.		Number.
1889.	°F.	°F.											Lb.	Oz.	
Oct. 27	47	47	18	13	5	2	3	....	....	2	......	1	0	2	1,932
28	50	51	19	14	5	......	5	....	....	......	2	......	0	8	1,288
29	40	47	28	19	9	1	7	1	1	1	......	1	0	11	1,771
30	38	47	96	41	55	1	54	....	....	2	2	......	0	12	1,932
31	38	44	44	21	23	2	21	....	1	2	......	......	1	15	4,993
Nov. 1	38	44	15	9	6	1	4	1	....	4	2	......	3	12	9,666
2	35	45	34	23	11	3	8	....	....	9	5	......	6	1	15,629
3	50	48	14	7	7	3	4	....	....	3	8	......	4	0	10,312
4	40	47	31	19	12	1	11	....	....	10	4	2	8	0	20,624
5	42	46	23	13	10	4	6	....	....	6	10	1	4	4	10,956
6	35	45	20	10	10	4	6	....	....	19	6	3	12	12	32,868
7	36	44	13	8	5	3	2	....	....	21	17	7	14	7	37,219
8	39	44	37	15	22	12	10	....	1	33	21	2	27	13	71,699
9	40	42	39	14	25	14	11	....	....	25	34	9	26	5	67,833
10	33	42	66	12	54	23	26	5	1	37	26	8	29	9	76,211
11	34	42	30	6	24	14	10	....	....	34	34	2	28	6	73,150
12	40	43	39	6	33	13	18	2	....	24	35	4	21	9	55,587
13	46	44	38	9	29	12	13	4	....	38	24	9	32	3	82,979
14	44	44	66	8	58	16	33	9	....	40	37	7	31	14	82,169
15	32	43	51	4	47	18	26	3	....	40	40	11	35	7	91,357
16	21	37	63	4	59	23	31	5	3	49	37	2	39	7	101,667
17	24	37	6	1	5	1	1	3	....	17	51	4	20	15	53,975
18	33	38	4	1	3	2	1	....	....	30	21	3	22	6	57,682
19	31	38	3	......	3	......	......	3	....	6	33	2	10	14	28,034
20	39	39	8	1	7	1	4	2	....	8	6	......	8	10	22,234
21	46	41	5	......	5	3	1	1	....	19	7	......	12	6	31,902
22	38	40	6	1	5	3	......	2	....	21	22	2	17	6	44,792
23	38	41	5	1	4	1	1	2	....	6	21	......	38	14	100,218
24	36	40	......	......	......	......	......	....	....	11	6	......	9	7	24,774
			821	280	541	181	317	43	7	517	512	80	471	5	1,215,455

The weighing and measuring of 825 mature salmon (312 males and 513 females) gives the following:

Average weight of males..pounds.	3.98	Average length of males..inches.	21.30
Average weight of females..do...	3.91	Average length of females..do...	20.60
Weight of heaviest male....do...	6.00	Length of longest male.....do...	26.00
Weight of heaviest female..do...	5.50	Length of longest female....do...	24.00
Weight of lightest male.....do...	1.91	Length of shortest male....do...	16.00
Weight of lightest female,..do...	2.00	Length of shortest female...do...	17.00

At the close of the fishing season in November, 1889, a new departure was made, being the restripping of the fish prior to their liberation from the inclosures. Most of the females were found to contain eggs, the aggregate amounting to 33 pounds, or about 75,000 in number. In development these eggs proved to be quite as good as those taken previously.

1890–91.

Active work was begun October 29, 1890, and between that date and November 18, 510 landlocked salmon were captured. Of this number 371 were females, which yielded 778,796 eggs. In March, 1891, there remained 649,906 good eggs, of which 163,000 were retained for hatching and liberation in local waters, and 29,000 turned over to the Maine fish commissioners. The remainder, 456,900 eggs, were mainly consigned to various fish-hatcheries, national, State, and private, enumerated in the details of distribution; the eggs reserved were hatched, and in June the fry were released in local waters, with the exception of 50,000, which were held in rearing troughs beyond the present year. Two thousand of the fry retained were derived from eggs taken at the final stripping of the brood salmon prior to their release in November, 1890, and were placed apart for purposes of observation. They were discovered to suffer a less mortality during June than the others; the death rate during that month among the larger number being 15 to each 2,000, while the loss of these 2,000 fish obtained from the late eggs was but 3. A portion of the eggs which produced the fry under consideration must have remained in the parent fish nearly a month subsequent to the dates when the brood fish were first relieved of their spawn.

CRAIG BROOK STATION, MAINE (CHARLES G. ATKINS, SUPERINTENDENT).

In the report for 1889 reference was made to the intention to establish a permanent station at this point and to purchase the property then under lease. Congress by act approved March 2, 1889, having appropriated $11,000 "for the purchase of ground, construction of buildings and ponds, and purchase of equipment of fish-hatchery and rearing stations near Craig Brook, Reed Pond, and Branch Pond, Maine;" and the agreement of the owner of the Craig Brook property to sell the same to the United States having been obtained, the Attorney-General was requested to have the title examined and the proper transfer made.

This was done, and the site became vested in the United States by deed of Thomas Partridge, dated September 4, 1889.

Active operations in construction were immediately commenced. During the year ending June 30, 1890, the principal items were, a one-story building 24 feet by 50 feet for the rearing of live food (maggots) for the young fish; for use in connection therewith, an ice-house 11 feet by 13 feet; a storage-house 12 feet by 20 feet; a cellar 20 feet by 20 feet for the wintering of the live food; two small buildings 15 feet by 31 feet, and 15 feet by 20 feet, one for use as a mess-house for the employés of the station and the other as an office and quarters for the station's foreman; a shed 20 feet by 50 feet, with cellar, and fitted with hogshead tanks for the wintering of fish; a timber dam at Craig Pond, with penstock running 60 feet into the pond, permitting the water to be drawn from the pond at a depth of 4 feet below the surface; a stone dam across the brook, above the hatchery, to which the water was led by an 8-inch aqueduct about 425 feet long; a stand of 100 outdoor rearing troughs; a stone foundation for superintendent's dwelling; a number of ponds, grading, etc.

During the year ending June 30, 1891, plans and specifications were prepared for the superstructure of the superintendent's dwelling and office and a stable, and a call for proposals for the construction of the same was duly advertised on September 16, 1890, but no response thereto was received at the date fixed for their opening, October 15. Owing to the lateness of the season readvertisement was deferred till January 13, 1891. In answer to this three bids were received. The lowest bid was that of Carlton McGown, of Ellsworth, Me., at $3,970 for the dwelling and $995 for the stable. In view of the limited funds for this work the building of the stable was deferred and contract was made, under date of March 5, 1891, for the dwelling only. The plans called for a neat two-story cottage of ten rooms, with woodshed, etc., in the rear. Work on the same was promptly begun. The farmhouse on the property when purchased has received some repairs and is available for quarters for the employés. The series of rearing ponds on the slope of the south bank of the brook, commenced in the fall of 1890, was completed. They are about 15 feet by 50 feet in size and nineteen in number, and receive their water supply from the brook through a pipe conduit. A road from the station to the town road was constructed and other improvements tending to the development of the station were made.

An additional appropriation of $14,000 was made for these special constructions at Craig Brook and Green Lake by the act approved August 30, 1890.

The active fish-cultural work of the station during the period covered by this report follows.

1889-90.

During this year the fish-cultural work embraced the propagation of the Atlantic and landlocked salmons and the brook and rainbow trouts, the Swiss lake trout, the saibling, and the Loch Leven trout. The adult Atlantic salmon, purchased jointly by the United States and the State of Maine in the summer of 1889, 410 in number, were inclosed at Dead Brook, and in the following October, the commencement of the spawning season, 292 were recovered. Of these, 186 were females, which produced 1,904,000 eggs. In February, 1890, there remained 1,733,675 good eggs, which were divided between the subscribers, Maine receiving 600,000 and the United States 1,137,159. Of these latter, 890,000 were consigned to various State and other hatcheries, and 247,159 retained for hatching and subsequent liberation in local waters.

Besides the Atlantic salmon eggs produced there were received and developed eggs as follows: 3,500 of the saibling and 7,400 of the Swiss lake trout, presented by Herr Max von dem Borne, of Germany; 18,300 of the Loch Leven trout, transferred from the Northville Station, Michigan, and 56,300 of the landlocked salmon from the Schoodic Station, which were hatched and reared for the stations at Green Lake and Craig Brook. To accommodate the fry anticipated from this large number of eggs from June till October, 1890, 100 new troughs were built, increasing their total to 163. These troughs were 8 inches deep, 12¾ inches wide, and 10 feet long, with a capacity of 2,000 fry. Only 11 of the troughs were under shelter, but those in the open air were provided with double lids, which form a peak when closed.

The incubation of the eggs was without event until the yolk stage was reached, May, 1890, when they were attacked by a disease hitherto unknown here and by which 30 per cent of the stock was destroyed in sixty days. The epidemic first appeared among the Atlantic salmon, but ultimately affected, and with greater fatality, the landlocked salmon, saibling, and Swiss lake trout. Prior to the appearance of the disease the fry had been counted and set apart in lots of 1,000 to 4,000, and while some lots were wholly destroyed, others were but partially, and still others escaped entirely.

The rearing operations were successful. Of the original stock of 144,256 fish, chiefly of the previous year's hatching, 113,139 were on hand October and November, 1889, when most of them were liberated in local waters. The percentages saved are shown below:

Kind.	Age at start.	Number at start.	Number at close.	Per cent saved.
Atlantic salmon	One year	1,520	1,356	89
Do	In the egg	109,965	91,856	83
Landlocked salmon	One year	80	78	97
Do	In the egg	26,191	17,630	68
Rainbow trout	do	2,500	947	38
Brook trout	do	4,000	1,272	32
Total		144,256	113,139	78

The heaviest losses having occurred among the species derived from eggs received from a distance, viz, the rainbow and brook trout, it is inferred that packing and transportation were factors in the greater mortalities shown, especially since the smallest loss occurred among the Atlantic salmon, which were produced from eggs taken at the station.

When liberated, the Atlantic salmon were deposited in neighboring brooks. The landlocked salmon, with the exception of a few hundred, were taken across the country and placed in Green Lake. Of the 113,139 reared fish, 14,139 were still further retained for winter feeding, among them some of each kind and age. These were placed in special tanks, with the exception of a few which were kept in the open-air troughs till late in the winter. The mortality during this period was small.

1890–91.

The collection of Atlantic salmon eggs was conducted with the coöperation of the States of Maine and Massachusetts. It having been determined to devote more attention to the rearing feature, it was decided to reduce the egg-collecting to a scale commensurate with the capacity of the station, but a smaller number of eggs was obtained than was desired, owing to the scarcity of adult salmon, only 133 being secured. At the spawning time, October 1890, 77 of these remained alive in the inclosures, of which 52 were females, yielding 553,400 eggs. The good eggs remaining in January were divided, Maine receiving 264,000, Massachusetts 133,000, and the United States 134,218. The share of the United States was increased by the Maine commissioners, who contributed 183,000 for purposes of hatching and rearing.

In addition to the salmon eggs, there were also produced 23,146 of the brook trout from fish artificially reared. These and other eggs received at the station are noted in the list below:

Kind.	Source.	Original number of eggs.	Number hatched.
Atlantic salmon	Produced at station	317, 218	316, 308
Landlocked salmon	Grand Lake Stream Station	21, 906	21, 824
Brook trout	Produced at station	23, 146	14, 524
Loch Leven trout	Northville Station	16, 583	16, 457
Von Behr trout	Germany	15, 119	13, 824
Scottish sea trout	Scotland	12, 374	9, 367
Total		406, 346	392, 304

Both the Von Behr and Loch Leven trout eggs arrived in poor condition, having already commenced hatching, and gave practically no results. All other eggs were good, and the epidemic usually incident to the months of May and June of former years did not occur. About 150,000 fish of the hatching of 1890 were cared for in rearing troughs till the present fiscal year, all being liberated in October, 1890, except

14,736 Atlantic salmon, 490 landlocked salmon, 31 saibling, 490 Swiss lake trout, and 490 Loch Leven trout, which were further held for observation during the winter months. Their history while subjected to rearing methods, from June to October, 1890, is shown below:

Kind.	Stock July 1.	Stock October 1.	Per cent saved.
Atlantic salmon	247, 159	124, 267	50
Landlocked salmon	56, 363	7, 849	14
Saibling	2, 635	41	2
Swiss lake trout	6, 821	3, 916	57
Loch Leven trout	17, 889	11, 797	66
Total	330, 867	147, 870	45

In addition, there were brought over from the last fiscal year 1,471 fish, 1 and 2 years old, which are included in the following statement:

Kind of fish.	Original number.	Locally distributed.	Transferred.	Reserved and on hand July 1, 1891.
Atlantic salmon of 1888	73			66
1889	713	675		
1890	124, 267	103, 226	20, 329	100
1891	316, 308			289, 249
Landlocked salmon of 1888	78			68
1889	180			126
1890	7, 849	7, 397	10	429
1891	21, 824		5, 289	12, 166
Rainbow trout of 1889	180			176
Brook trout of 1889	240			218
1891	14, 524		4, 251	1, 381
Saibling of 1890	41		10	19
Swiss lake trout of 1890	3, 916	3, 580		179
Loch Leven trout of 1890	11, 797	11, 297	10	480
1891	16, 457			10, 862
Von Behr trout of 1891	13, 824			1, 085
Scottish sea trout of 1891	9, 367			97
Total	541, 645	125, 780	29, 869	316, 701

In July, 1890, the water temperature rose to a maximum of 72° F. in rearing troughs fed from Craig Brook. In conduits supplied in part by spring water the temperature was 69°, and after passing through four rearing troughs in succession it was 72°. In August the water in the hatchery was 58° to 76°; in open-air troughs, 59° to 75°; and in the ponds 58° to 74½°. Experimental lots of salmon fry were kept in two neighboring streams, and in one of them, at East Orland Bridge, the water rose August 4 to 82° without injuring them. The September temperature was 69° to 53°; October, 63° to 46°; November, as low as 37°, from 24th to 29th; January, 32½° to 35°, with nearly all the fish remaining in the open-air troughs; February, 32½° to 36°, with weather comparatively mild and the ice on Alamoosook Lake 29½ inches thick.

GREEN LAKE STATION, MAINE (C. G. ATKINS AND H. H. BUCK, SUPERINTENDENTS).

By act approved March 2, 1889, to which reference has been made under Craig Brook Station, Congress directed the establishment of a fish-hatchery near Reed Pond or Branch Pond, Maine. On August 22, 1889, Mr. Charles G. Atkins, superintendent of Craig Brook Station, was instructed to proceed to the localities mentioned, with a view to their examination and the submitting of a report, with recommendations as to the site desirable to be acquired. Reed Pond, or Green Lake, was reported as being the best location, and one to which landlocked salmon are native. The stream in which they spawn (Great Brook) is one of the finest in that region. Branch Pond failed to furnish the necessary requirements for fish-cultural work, and its further consideration was waived. Mr. Atkins recommended, therefore, that the location of the permanent station be in the vicinity of Green Lake, calling attention to sites at Great Brook, the spawning-ground of the landlocked salmon, about the center of the lake, and at Mann Brook, near the station on the Maine Central Railroad, at its extreme northwestern end.

After due consideration of the recommendations, the Commissioner determined upon the site at Great Brook, and on December 6 directed that negotiations be opened for the purchase of the necessary land and water privileges. The site selected takes in the whole of the stream of Great Brook on both sides, running from Rocky Pond to Green Lake, securing the outlet to Rocky Pond, with all privileges of damming, etc., and embracing a territory of about 820 acres. Definite proposal to sell was received on April 25, 1890, and on the 20th of the following month the papers were referred to the Attorney-General, with the request that the title to the property be examined and arrangements made for the transfer of the same to the United States. In accordance with agreement with the owners, a survey of the property for the determination and establishment of its bounds was made in August, 1890. The examination of the title was completed in May, 1891, and the purchase money passed. Plans and specifications were prepared for the construction of the dwelling house, stable, and box flume to bring the necessary supply of water from Rocky Pond to the hatchery. Advertisements calling for proposals, to be opened on May 21, 1891, were published, commencing April 23. The lowest bids received were those from Mr. Carlton McGown, for the construction of the flume, at 97¾ cents per running foot, and from Mr. Austin M. Foster, for the hatchery, dwelling house, stable, etc., both of these gentlemen doing business in Ellsworth, Me. Mr. McGown, however, owing to ill health, declined to execute the contract for the flume, and one was entered into with Mr. Foster, at the rate given in the bid of Mr. McGown, who made good to Mr. Foster the difference between their bids. On account of this declination to execute the contract some delay was caused, but on the 20th of June it was duly signed by Mr. Foster. For the hatchery the price was $4,174.80; for the dwelling house, $3,007; and for the stable and tool-house, $1,317, contract for which was made June 13, 1891. The flume, which will have a length of nearly 7,050 feet, will aggregate a cost of about $6,800.

1889-90.

Pending the acquirement of a site, it was decided to begin fish-cultural operations at Green Lake in the fall of 1889. A camp was established on the lower part of Great Brook for the collection of eggs, arrangements being made by erecting barriers to prevent the further ascent of the salmon and an inclosure for their retention till ready to spawn. For the development of the eggs secured a cheap structure containing the necessary trough space was put at Mann Brook.

Operations in spawn-taking were begun November 4, and in eleven days 294,700 eggs were produced from 75 females, the catch of males being 50. The eggs developed slowly, the water being very cold. On April 8, 1890, 10,000 eggs were forwarded to Cold Spring Harbor, N. Y., and from those remaining there were produced 150,000 fry, which were liberated in Green Lake, in June. In October, 1889, a consignment of landlocked salmon and rainbow trout, which had been held at Craig Brook Station till 7 months old, was received and liberated in Green Lake and tributaries.

Upon weighing and measuring the Green Lake salmon it was found that they were twice the size of those of Grand Lake Stream, 69 full-roed females averaging 7.8 pounds in weight and 25.5 inches in length; the average weight of 50 males being 5.01 pounds, and their length 22.3 inches. One female weighed 11 pounds 9 ounces and measured 30 inches; another, 11 pounds 6 ounces in weight, was 30½ inches long; one male reached 13 pounds 8 ounces in weight and was 31 inches long.

1890-91.

The production of landlocked salmon eggs between October 31 and November 21, 1890, was 185,000. The fry from these, with the exception of 3,000 released June 10, 1891, on account of fungus, were kept in rearing troughs beyond the termination of the present fiscal year. The adult fish captured, 46 females and 21 males, were again found to be of large size, the former averaging 7 pounds in weight and 25.2 inches in length, and the latter 6 pounds 9 ounces in weight and 25.1 inches in length, while 3 females and 4 males were in excess of 10 pounds weight each. At the close of spawn-taking, in November, the barriers were removed and these brood fish set free in the lake. Another consignment of reared fish, 7 months old, consisting of Swiss lake trout, landlocked salmon, and Loch Leven trout, was received in October, 1890, from Craig Brook Station and placed in Green Lake and its tributaries.

Kittery Point. After storms the turbid water caused the sinking of many eggs, which were discharged overboard; but upon testing a lot of eggs which were too heavy to float at the time of their receipt, it was found that with care they hatched with good results. The question of impregnation was usually determined by the use of the microscope when the eggs were first received.

The surface temperature on the collecting grounds, about 45° F. at the commencement of the season, gradually fell to 33° by December 25, from which time till March it ranged from 34° to 37°.

During the whole period of operations copepods were abundant in the water used for developing the eggs and were considered injurious.

Below is a condensed statement of operations:

Kind.	Period of operations.	No. of females spawned.	No. of eggs taken.	No. of fry released in local waters.	No. of eggs shipped to Woods Holl Station.	No. of eggs put overboard.
Cod	Nov. 26–Mar. 18	228	110, 112, 300	18, 968, 100	43, 514, 300	1, 785, 200
Haddock	Jan. 29–Mar. 9	16	1, 154, 100	78, 600		85, 100
Pollock	Oct. 31–Dec. 2	151	38, 546, 200	14, 827, 900		
Total		395	149, 811, 600	33, 874, 600	43, 514, 300	1, 870, 300

WOODS HOLL STATION, MASSACHUSETTS (JOHN MAXWELL, SUPERINTENDENT).

1889–90.

The fish-cultural work of this station covers a period of eight months, and was conducted chiefly by the resident employés of the station. In the propagation of cod the force was increased by the assignment of Mr. Richard Dana, who was placed in charge, the period of active work being from October 14, 1889, to April 4, 1890.

Cod.—As a source of egg supply, 3,403 adult codfish were obtained from fishermen October 22 to November 19, 1889, and placed in live-cars and in one of the tidal basins. Here, under as natural conditions as practicable, the brood fish were held to await maturity, when they were stripped of their eggs every two or three days until the supply was exhausted. Many of the adult fish died immediately after being placed in the inclosures, the temperature being then 55° F., and some died each day until the water temperature fell to 46°. A great many became blind, and it was supposed to be caused by the glare of the sunlight, the water being shallow.

In the two months following 91 fish yielded 8,545,700 eggs, and from these there were hatched and liberated in local waters, when from three to six days old, 5,861,100 fry. At the termination of the spawning season there were remaining on hand 1,000 of the brood fish, which were retained in one of the tidal basins to determine their value as spawn-producers the succeeding fall. On February 11, 1890, 2,374,200 eggs received from Gloucester Station were put in process of hatching, with the result of 584,700 fry, and a second consignment, April 14, of 621,500 eggs, from the same source, produced 416,300 fry.

Haddock.—A consignment of 1,138,200 haddock eggs from Gloucester, Mass., April 14, produced 528,000 fry.

Flatfish.—The eggs of the flatfish were secured after February 3, 1890, 87 ripe females being taken in fyke nets in the harbor near the station. The yield of eggs was 5,841,100, and the fry produced and liberated in local waters, 4,086,700. The adult fish were obtainable in abundance, except when driven into deeper water by cold weather.

Lobsters.—Brood lobsters were collected from the pots of local fishermen, November to May, and placed in inclosures to await maturity, some, however, being marked and released after their eggs had been stripped, in order to determine, if possible, the frequency of spawning under natural conditions. The eggs were taken subsequent to April 16 from 723 adults, the yield being 8,317,600 and the production of fry 4,511,100, or 54 per cent. The fry were released in local waters when 2 to 4 days old, except a few which were experimentally held in the jars six weeks and afterwards transferred to the aquaria. The hatching was conducted in the Chester tidal jar, the improved McDonald tidal box, and in the universal hatching jar. Eggs taken April 22 (water temperature 45°) hatched June 4 (water temperature 59°), a period of 42 days. A lot of eggs brought in by a local fisherman and thought to be on the eve of hatching, remained in process of development 99 days. When they were received the embryos were well developed and the water temperature 36°, but no further growth was observed till the temperature rose to 54°, May 18, when the eggs hatched.

For consignment to Galveston Harbor, Texas, 745 healthy lobsters, 7 to 10 inches long, were collected and packed in sea moss in 105 wooden crates, prepared at the station. Among them were 385 females, of which 37 bore impregnated eggs, estimated at 250,000 in number. The adult lobsters all died before reaching their destination, but the eggs were planted on the Gulf side of Galveston Harbor breakwater, about 4 miles from the shore.

Other fish.—After May 23, sea bass, mackerel, squeteague, tautog, and scup eggs were successfully handled to the extent of several millions, all of them being of the floating character and collected from the pound nets of local fishermen.

The following table exhibits the fish-cultural work of the station during the year:

Kind.	Spawning period.	No. of eggs taken.	No. of fry produced.	Average No. hours hatching.	Temperature.
Cod	Nov. 18–Jan. 18	8,545,700	5,861,100	351	47° to 35°
Do		*621,588	416,300		
Do	Feb. 2–11	*3,201,400	548,700		37° 39°
Haddock		*1,338,200	528,100		
Flatfish	Feb. 3–Apr. 24	5,848,100	4,086,700		37° 46°
Lobster	Apr. 16–June 13	8,317,600	4,511,100	573	50° 62½°
Scup	June 14–20	443,900	396,300	83	61½° 62½°
Sea bass	May 23–June 20	4,271,209	3,893,700	104	56° 64°
Mackerel	June 2–11	2,915,000	688,700	90	59° 61°
Squeteague	June 6	237,600	227,600	65	60°
Tautog	May 21–June 24	807,600	732,200	87	56° 64°

* From Gloucester Station.

Kittery Point. After storms the turbid water caused the sinking of many eggs, which were discharged overboard; but upon testing a lot of eggs which were too heavy to float at the time of their receipt, it was found that with care they hatched with good results. The question of impregnation was usually determined by the use of the microscope when the eggs were first received.

The surface temperature on the collecting grounds, about 45° F. at the commencement of the season, gradually fell to 33° by December 25, from which time till March it ranged from 34° to 37°.

During the whole period of operations copepods were abundant in the water used for developing the eggs and were considered injurious.

Below is a condensed statement of operations:

Kind.	Period of operations.	No. of females spawned.	No. of eggs taken.	No. of fry released in local waters.	No. of eggs shipped to Woods Holl Station.	No. of eggs put overboard.
Cod	Nov. 26–Mar. 18	228	110, 112, 300	18, 968, 100	43, 514, 300	1, 785, 200
Haddock	Jan. 29–Mar. 9	16	1, 154, 100	78, 600		85, 100
Pollock	Oct. 31–Dec. 2	151	38, 546, 200	14, 827, 900		
Total		395	149, 811, 600	33, 874, 600	43, 514, 300	1, 870, 300

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* From Gloucester Station.

Experiments were made by Mr. Vinal N. Edwards for the purpose of determining the times of spawning of different fishes, and the period of incubation and character of their eggs, etc., the results of which are shown in the following table:

Kind of fish.	Date.			Eggs.			Temperature when eggs were taken.	Temperature when eggs were hatched.
	When eggs were taken.	When eggs were hatched.	No. of days hatching.	Number handled.	Character.	Number to linear inch.	°	°
Flatfish	Apr. 12	Apr. 29	17	192,000	Adhesive, sinking.	22	38	46
4-spotted flounder	May 12	May 20	8	50,000	Floating	26	51	56
Sand dab	...do	...do	8	100,000	....do	24	51	56
Tautog	May 21	May 26	5	221,000	....do	26	56	56
Sea bass	June 4	June 9	5	412,000	....do	26	59	60
Squeteague	June 6	June 8	2	297,000	....do	28	60	60
Mackerel	...do	June 9	3	159,000	....do	24	60	60
Squid	May 13	June 10	26	3,000	Sinking		51	61
Cunner	May 22	May 27	5	100,000	Floating	26	56	56
Toadfish	May 28	June 28	31	200	Sinking	5	56	65
Scup	June 14	June 18	4	158,000	Floating	26	61	63
Lamprey eel	June 2	June 17	15	300	Sinking		*70	70
Skate	June 23	Sept. 27	96	1	....do		64	66
Codfish					Floating	18		
Bonito					....do	20		
Lobster					Sinking	15		

* Hatched in fresh water.

The mean of the salt-water temperatures and densities during the period of egg devolopment is given by months below:

Month.	Temperature.	Density.
December	43.1	1.0255
January	39.3	1.0256
February	36.4	1.0255
March	36.1	1.0255
April	43.3	1.0255
May	53.4	1.0255
June	62	1.0255

Collections of specimens of marine plants and animals were made throughout the cooler months and forwarded by express to the aquaria at Central Station, Washington, D. C., one consignment transferred by the steamer *Fish Hawk* comprising 600 fishes, crustaceans, etc., representing forty species.

1890–91.

Mr. Alexander Jones was in immediate charge of hatching the cod and flatfish, but being temporarily detached before the lobster season opened, the manipulation of that species was directed by the superintendent.

Cod.—Through the agency of Mr. I. Spindel, 3,000 selected brood cod were procured, principally from Nantucket Shoals, and, as in previous years, held in inclosures till the spawning season. They suffered less mortality than those impounded the preceding season, but on January

8, 1891, 300 died from the effects of slush ice, which formed inside the live-cars from snow that fell between the wooden slats. Besides having their gills choked up, many were found to contain in their stomachs lumps of ice as large as walnuts. Less blindness occurred, probably on account of greater care in handling the fish at the time of their capture, a feature being the avoidance of the usual custom of thrusting a finger into the eye socket of the fish when removing the hook.

Of the brood fish only 587 yielded eggs, these being 67,399,000 in number and producing 36,266,100 fry. Eggs were stripped about every other day, from November 17 to February 7.

Consignments of eggs, by rail, were received from Gloucester Station to the number of 43,168,500, from December 16 to January 19, but of these only 16,332,000 were thought to be good twelve hours subsequent to arrival, and their total production was but 150,000 fry.

Observations during hatching this year led to the conclusion that those eggs which sink within five or six days after being taken are defective in their fertilization. The results of attempts made at impregnation by the dry method, though not conclusive, were unsatisfactory. The eggs that sunk were transferred from jars to boxes, and *vice versa*, and close attention given them. Those placed in jars would in a short time become milky and glutinous and so foul that cleansing by washing was impracticable; while those in boxes, without turning milky, would adhere together and to the hatching vessels, finally perishing.

The profuse abundance of copepods in the hatching vessels throughout the season was thought to be injurious to the eggs and fry, since they were seen densely congregated about dead eggs and the weaker fry, and were in constant friction with the live eggs and fry in their crowded condition. Attempts to exclude them by means of cheese-cloth strainers were ineffectual, owing to their minuteness. Another unfavorable element was the employment of hatching boxes which had been used during the summer preceding for the live storage of medusæ and other low forms of animal life which exude slime and poisonous substances. It was found that eggs kept in the boxes which had been used for this purpose were invariably attended with a high death rate, but if early removed to other vessels they immediately recovered. Vigorous efforts to cleanse the infected boxes failed.

Hatching was one to three days earlier in the tidal boxes than in the inverted tidal jars, owing, presumably, to the greater circulation and light afforded the eggs. The fry produced were liberated in neighboring waters when they were 12 to 48 hours old.

Flatfish.—Adult flatfish to the number of 71 were taken with a fyke net in Woods Holl Harbor and yielded 4,689,700 eggs, which produced 3,350,800 fry. The spawning period of the flatfish was between February 3 and March 7.

Lobster.—In the hatching of the lobster greater success than formerly was met, by the substitution of the universal hatching jar for the tidal jar, whereby the clotting of the eggs was greatly diminished. The productive period was from April 28 to June 30, during which time from 482 lobsters were taken 4,353,800 eggs, yielding 3,533,900 fry, or 81 per cent. The eggs were obtained from lobsters captured in pots operated by the employés of the station and from local fishermen, who coöperated in the work, saving all the ripe eggs from among the lobsters handled by them.

The monthly mean temperatures and densities of the salt water used in hatching operations of the station were as follows:

Month.	Temperature.	Density.
December	36.4	1.0252
January	33.1	1.0274
February	34.1	1.0308
March	35.7	1.0274
April	44.3	1.0256
May	52.1	1.0271
June	61.2	1.0259

COLD SPRING HARBOR STATION, NEW YORK (FRED. MATHER, SUPERINTENDENT).

This station has continued in operation as in previous years. Most of the eggs received and consigned as foreign exchanges passed through it, where they were examined and, if necessary, were repacked before they were forwarded to their destination. A considerable number of Atlantic salmon eggs were hatched here for the Hudson River, the production of that and other species for the two years being as follows:

Kind.	Source.	Eggs received.	Fry produced.
1889–90.			
Atlantic salmon	Craig Brook Station	600,000	506,400
Landlocked salmon	Schoodic Station	85,000	80,000
Lake trout	Northville Station	500,000	470,000
1890–91.			
Loch Leven trout	Northville Station	20,000	18,000
Lake trout	do	500,000	482,600

GLOUCESTER CITY STATION, NEW JERSEY (JOHN GAY, IN CHARGE).

1889–90.

The propagation of shad by the Commission has been confined mainly to its stations on the Susquehanna and Potomac rivers, though some attention has been given to work on the Delaware River through the use of the steamer *Fish Hawk* and one of the distributing cars. In the spring of 1890 Mr. W. J. Thompson, of Gloucester City, who is largely interested in the fisheries of the Delaware River, offered to erect on his property a hatchery building for the Commission, free of expense, the Commissioner, however, to furnish the necessary equipment. Mr. John Gay, inspector of stations, was directed to examine the location, and on his report and recommendation the offer of Mr. Thompson was accepted. Immediate steps were taken to equip the station, and active operations were inaugurated. On April 22, 1890, the steamer *Fish Hawk* arrived with the necessary materials, and her crew speedily fitted up the building. By May 12 the establishment was ready for the receipt of eggs, the water being derived from the supply of Gloucester City.

The first eggs received were those transferred from the *Fish Hawk*. The spawn-takers commenced taking eggs May 13, visiting the fisheries daily by the launch *Petrel*. Their collections for the season closed May 28, 1890, amounting to 6,396,000 eggs, which were obtained from seines, as follows: Gloucester Point, 30,000; Faunce's, 1,752,000; Rice's, 922,000; and Howell Cove, 3,792,000. These eggs, together with the 3,654,000 transferred from the *Fish Hawk*, made a total of 10,150,000, and produced 6,204,000 fry, which were liberated in Big Timber Creek, New Jersey, a stream near Gloucester City. The water temperature in the hatchery was 58° May 12; 60° May 15 to 23; and 63° May 31.

Further details concerning the operations at Gloucester, N. J., will be found in the account of the operations of the *Fish Hawk*, pages 55 and 56.

1890-91.

In the previous year's work it was found that the water used was of too low a temperature and also contained injurious ingredients. In order to obtain supplies of a more suitable character for the work, a pumping plant was put in with a suction pipe laid to the Delaware River, connection still being maintained with the city supply for cases of emergency. The steam launch *Petrel* was again assigned here. The *Fish Hawk* being needed for other work, the propagation of shad on the Delaware River was conducted by this station only. The collection of eggs began April 30, 1891, and was continued till June 2, resulting in a total of 12,465,000. Fry produced from these eggs amounted to 6,155,000, of which 4,930,000 were turned over to messengers for distribution and 1,225,000 deposited locally in Big Timber Creek. The seines attended for spawn were those at Gloucester Point, Faunce's, and Howell Cove. The largest day's production of eggs, 1,242,000, was on May 1, the Howell Cove seine furnishing 973,000 of these. During the season but one ripe shad was obtained at Gloucester Point, a source of 2,500,000 eggs the year preceding.

The weather was abnormal and the river being low from a drought in the headwaters was made lower by prevailing winds from the north and northwest. There were snow flurries May 6. The catch of shad was within 25 per cent of the usual number, but spawning fish were very scarce, and ripe bucks of such infrequent occurrence that it was at all times difficult to secure enough milt for purposes of fertilization. A great many shad moved upward to headwaters, many being seen in the vicinity of Egypt Mills, Pike County, Pa., and in New York State, as much as 300 miles above the ocean, higher than known since the building of the dam at Lackawaxen in the year 1823. The headwaters were made accessible to the spawning shad by the construction in 1889 of a fishway at the dam by the joint action of New York and Pennsylvania. Fishing operations ceased June 3, and the station was closed June 6.

Battery Island Station, Maryland (W. de C. Ravenel, Superintendent).

1889–90.

As in previous years, in addition to the operation of the Commission's station on Battery Island, the canning house of Mr. S. J. Seneca, at Havre de Grace, was rented for the season and equipped with 100 hatching jars of a capacity of 8,000,000 eggs. This auxiliary hatchery being located in the proximity of the railroad station proved a valuable adjunct to the work of distribution. The collection of spawn began April 21 and continued till May 20, 1890, the aggregate number of eggs secured by the two establishments being 32,405,000. Of these, 12,637,000 were transferred to the cars for hatching en route; from the remainder 12,248,000 fry were produced, which were also mainly distributed by the messenger service. To procure the eggs, 60,600 fathoms of seine haul and 179,925 fathoms of gill net were attended, the number of seined shad examined being 22,800 and of those from gill nets, 16,700, a total of 39,500, of which 985 were stripped.

Early in May continued heavy rains caused muddy water and backed the run of shad down the bay, so that the seine catch was reduced to one-third of that of the previous year and the gill-net catch to one-half. Of the entire production of eggs, more than three-fourths were obtained prior to the freshet period, commencing May 7. The eggs, though scarce, were of unusually good quality and afforded fry of superior vigor.

1890–91.

Shad hatching was again conducted both at Battery Island and at the auxiliary hatchery at Havre de Grace. On April 17, 1891, twenty spawn-takers began operations, and from that time until June 6 were interrupted by storms but two nights. By the 1st of May 26,370,000 eggs had been secured, and by the end of the season a total of 63,110,000. Of these, 837,000 were turned over to the Delaware Fish Commission and 7,413,000 to the Fish Commission's cars for hatching en route to the places of deposit. From the remainder were produced 37,747,000 fry. The eggs obtained on each of nine days were over a million, on twelve days over two millions, and on three days over three millions. The water in the vicinity of the station was so extraordinarily clear that seines could be hauled with any advantage at night only; operations were therefore suspended the first week in May, one month earlier than customary, with one-half the usual catch, the catch by gill fishermen being about two-thirds.

The attendance of the spawn-takers was on 49,600 fathoms of seine and 224,700 fathoms of gill net, which afforded 35,200 adult shad for examination, about equally divided between the two classes of nets. The number of fish stripped was 2,013.

The average water temperature during the last fifteen days in April was 60.8° F., during the month of May 62.1°, and the first nine days in June 70.8°.

When fry accumulate in large numbers between deliveries to messengers they are kept in large storage tanks rather than in the collector aquaria, this method having been found so advantageous that its application is general in the station. The tanks are 96 inches long by 18 wide and 16 deep, partitioned midway between the ends to form two separate compartments, which are provided with guard screens at their outlet ends. The water circulation is derived from two one-fourth-inch jet cocks, to which gum tubing is attached, under 10 pounds pressure to a square inch. As many as 300,000 to 400,000 fry are supported in each subcompartment, the variation in number being regulated in accordance with temperature.

An experiment was made of holding shad in standing water, 25,000 fry being placed in a 12-gallon can and one-fourth the water changed every four hours. At the end of twelve days the loss was 4,185, and of these 40 per cent occurred in the first sixty hours. The temperature of the water at the beginning of the experiment was 56°, but gradually rose till on the twelfth day it was 70°; on the following five days it dropped to 52°, when heavy mortality occurred.

The purchase of this station, at the head of Chesapeake Bay, Maryland, which had been occupied under lease by the Commission for a number of years, was provided for in an act approved March 3, 1891. By direction of the United States Attorney-General, an examination of the title to the property was made by the United States district attorney for Maryland, who, on June 26, 1891, reported the same good in Mr. T. B. Ferguson, by whom a deed transferring the same to the United States was duly executed.

FORT WASHINGTON STATION, MARYLAND (S. G. WORTH, SUPERINTENDENT).

1889-90.

This station, lying on the Potomac River, about 12 miles below Washington, was open during April and May, 1890, and produced during the egg-collecting period of thirty-two days, commencing April 15, 35,202,000 eggs. The catch of shad in this vicinity was less than one-half that of the four preceding years. Of the eggs obtained (35,202,000) 34,446,000, after being held thirty-six hours, were measured and forwarded on the river steamers to Central Station, and 756,000 of inferior quality were held and hatched, producing 356,000 fry, which were liberated in the Potomac River at the station. The eggs were derived from sources as follows: Fort Washington seine, 10,224,000; Chapman Point seine, 2,842,000; Tulip Hill seine, 3,835,000; Moxley Point seine, 1,078,000; gill-net fishermen, 17,223,000.

The weather of the preceding winter and of the spring months of 1890 was unusually mild, effecting no advancement in the spawning period of the shad, but probably accounting for the abnormal presence of large numbers of young shad, alewives, and sturgeon in the upper waters of the Potomac. Several schools of fingerling shad and alewives were hauled nearly ashore at different times by the seines at Fort Washington and Moxley Point. Many sturgeon, 12 to 18 inches long, were daily captured by the Fort Washington seine. The water temperature April 15 was 57° F.; April 30, 60°; May 15, 68°.

The equipment of this station was improved by the introduction of a larger steam boiler and pump, which were obtained by transfer from other stations, and a larger water tank.

1890-91.

The production of shad eggs during the season, April 21 to May 17, 1891, was, by measurement thirty-six hours subsequent to fertilization, 32,544,000. These were forwarded on trays to Central Station, except 183,000 retained for hatching, producing 170,000 fry, which were released in the Potomac River. For two months preceding the commencement of operations there were continuous freshets in the Potomac, culminating March 28 in an extreme flood which overflowed the Fort Washington wharf and freshened the water in the lower river to such an extent as to destroy thousands of acres of oyster beds. Upon the cessation of freshets the water became clear, as in the previous year, and being held at a low temperature by the prevailing cold weather, the conditions favored the spawning of the shad in the wide waters many miles below the station. In the vicinity of Fort Washington all fishing by daylight was unremunerative, as on the Susquehanna River, the catch being but two-fifths to one-half that of ordinary seasons. The operations of three of the best egg-yielding seines and many gill nets were suspended on May 15, thus terminating the collecting season. The eggs collected amounted to only 57 per cent of the average of the four preceding seasons. The water temperature at the station differed from previous years, becoming lower instead of higher as the season advanced. On April 22 to 26 it was 66.6° F.; May 1 to 5, 66.2°; May 9 to 13, 64.8°.

The following is a statement of the egg yield from the operation of the Fort Washington seine and the shad catch during the years 1887 to 1891, inclusive:

Catch for 7 days ending—	1887.	1888.	1889.	1890.	1891.
April 13	83	382	484	873	....
April 20	1,600	485	929	1,484	939
April 27	778	1,536	1,904	1,031	1,254
May 4	2,270	2,898	150	796	714
May 11	2,053	3,196	1,614	191	211
May 18	2,817	984	1,070	231	20
May 25	747	1,107	66	....	....
June 2	....	624	....	....	....
Total catch	10,348	11,212	6,217	4,606	3,138
Seine production of eggs for the year	20,956,000	22,657,000	17,738,000	10,262,000	5,276,000

For the removal of loose stone which obstructed the hauling of the Fort Washington seine an 8-foot beam trawl, in connection with the seine capstans, was successfully employed. A useful fixture for removing the fish scales from the eggs was also devised and put into practical operation. This consisted of two 18-inch flared tin pans with handles, one nesting within the other, 2 inches of the bottom of the interior one being evenly cut off and covered with quarter-inch stretched twine netting. It was operated by filling the lower pan with water above the netting, and gently ladling in 2 or 3 gallons of eggs, when they would drop through the meshes, leaving the scales behind.

An advance was made in transferring the eggs to Washington, by changing the time of shipment from evening to early morning, by which the afternoon heat was avoided.

Central Station, Washington, D. C. (S. G. Worth, Superintendent).

1889–90.

The scope of work of this station has continued as in previous years. The operations in hatching were as follows:

Species.	Received from—	Number of eggs.	Number of fry hatched.
Brook trout	Northville Station	37,500	30,500
Whitefish	Sandusky Station	5,000,000	4,400,000
Landlocked salmon	Schoodic Station	30,000	18,200
Shad	Fort Washington Station	31,220,000	23,493,000
Yellow perch	Central Station	956,000	754,000
Total	....	....	28,695,700

In addition to the receipt and preparation of fingerling fish for distribution, there were received and distributed the following eggs: 2,500 of the brook trout, from Northville Station; 80,000 of the rainbow trout from Wytheville Station, which were repacked and forwarded to France, England, Germany, and Belgium; 3,226,000 eggs of the shad, which were partially developed and then transferred to the cars for completion of hatching en route to the places of planting.

The following table exhibits the distribution of fingerling fish:

Species.	Received from—	Number.
Carp	Fish ponds, Washington	28,700
Do	Wytheville Station	1,078
Goldfish	Fish ponds, Washington	15,972
Tench	do	24
Golden ide	do	19
Rainbow trout	Wytheville Station	1,582
Rock bass	do	1,511
Black bass	Quincy Station	1,219
Crappie	do	1,000
Spotted catfish	do	80
Yellow perch	do	375
Total		51,560

The hatching of the yellow perch was of an experimental character. Details will be found in the Bulletin of the U. S. Fish Commission for 1890, pages 331–334.

The following are the mean temperatures of the city hydrant water used at the station by months:

1889.	° Fahr.	1890.	° Fahr.
July	75	January	45
August	75	February	43
September	70	March	45
October	62	April	55
November	52	May	64
December	45	June	74

1890–91.

The hatching work proper at this station was as follows:

Species.	Received from—	Eggs.	Number of fry hatched.
Rainbow trout	Wytheville Station	25,000	11,980
Brook trout	Northville Station	25,000	20,700
Lake trout	do	100,000	87,500
Von Behr trout	do	28,000	16,400
Whitefish	do	1,122,000	722,000
Landlocked salmon	Schoodic Station	30,000	25,200
Smelt	Cold Spring Harbor Station	1,000,000	400,000
Shad	Fort Washington Station	18,800,000	14,972,000
Total fry hatched			16,255,780

There were received from Wytheville Station and forwarded to England, Germany, and Switzerland, 75,000 eggs of the rainbow trout; from the Northville Station, 20,000 Von Behr trout eggs, which were transferred to the Wytheville Station, and 2,878,000 whitefish eggs, which were transferred to one of the cars for hatching en route to Sacketts Harbor, for stocking Lake Ontario. In addition, 8,140,000 shad eggs from Fort Washington Station were turned over to cars Nos. 2 and 3 for hatching en route to places of deposit.

The fingerling fish received and forwarded were as follows:

Species.	Received from.	Number.
Carp	Fish ponds, Washington, D. C	331,391
Goldfish	do	18,493
Tench	do	5,156
Rainbow trout	Wytheville Station	12,166
Rock bass	do	1,560
Black bass	Quincy Station	262
Crappie	do	170
Sunfish	do	135
Rock bass	do	59
Yellow perch	do	6
Pike	do	4
Rainbow trout	Northville Station	266
Brook trout	do	50
Goldfish	Neosho Station	2,077
Total		371,795

An account of the operations of the Aquaria at Central Station will be found on pages 54 and 55.

Fish Ponds, Washington, D. C. (R. Hessel, Superintendent).

1889–90.

On May 31 and June 1, 1889, the station was completely submerged by a disastrous freshet in the Potomac River, and nearly all the fish in the ponds escaped.

In November the ponds were drawn, and the fish of fingerling size available for distribution were as follows: Leather carp, 29,450; scale carp, 1,029; blue leather carp, 167; blue scale carp, 70; tench, 25; golden ide, 20; goldfish, 15,415.

On April 25 and May 5, 1890, 2,144,000 shad fry were received from Central Station and placed in the west pond for rearing.

Much care and expense was involved in repairing the damage resulting from the June overflow, and in eliminating the river fish and objectionable water plants that found unavoidable lodgment in the ponds on that occasion.

1890-91.

The ponds were drawn in October and November, 1890. The fish produced, by actual count, were: Scale carp, 50,000; leather carp, 290,000; blue leather carp, 503; blue mirror carp, 490; blue scale carp, 1,129; tench, 1,678; golden ide, 12; goldfish, 23,100.

In addition to these, a conservative estimate gave 800,000 young shad, averaging 3 to 5 inches in length, as the product of the fry placed in the ponds the previous spring. In view of the success met with, a further planting of 2,054,000 fry was made from Central Station in April, 1891.

WYTHEVILLE STATION, VIRGINIA (GEORGE A. SEAGLE, SUPERINTENDENT).

1889-90.

The tenure of the station has continued as in previous years under lease from the State of Virginia. The work embraced the propagation of the rainbow, brook, and Von Behr trouts, the black bass, rock bass, carp, and goldfish.

Of the rainbow trout there were obtained from brood fish held at the station 310,000 eggs. Of these, 158,000 were distributed to other hatcheries, as noted in the details of distribution, and from the remainder were produced 61,000 fry, which were held at the station for rearing, being reduced by July 1, 1890, to 43,960. The period of egg-taking was from November 28, 1889, to the end of the following March. The distribution of rainbows reared from the take of the previous season was begun on September 18, 1889, continuing till the close of the following March. The output was 38,796 yearlings and 480 adults. There were also distributed 900 yearling and 245 adult brook trout, and 230 Von Behr trout. The adult fish of these varieties were from three to four years old.

Fish of a summer's growth produced for distribution were: 3,484 rock bass, 2,330 carp, and 1,535 goldfish. Supplies of black bass and rock bass for brood fish were obtained from Wolf and Reed creeks in the vicinity of the station. Of the pond fish, the goldfish spawned early in April and the black bass and rock bass a month later. The first goldfish hatched in ten days and the first carp in fourteen days.

1890-91.

The spawning of the rainbow trout commenced November 10, 1890, and by March 4, 1891, there was a yield of 400,000 eggs. Of these, 195,000 were transferred to other hatcheries, and the remainder retained at the station for hatching and rearing, the survivors on July 1, 1890, being 60,000. The distribution of yearlings was commenced in the fall, and 37,990 were consigned to applicants in Virginia and adjoining States.

The fingerling fish derived from the ponds comprised 810 black bass, 4,427 rock bass, 6,931 carp, and 1,911 goldfish. A consignment of 75 adult black-spotted trout was received June 9, 1890, from the Leadville Station. Owing to injuries received in transit, only twenty of them survived the heat of the first summer, but these were in good condition July 1, 1891. A shipment of 5,000 eggs of this species arriving July 29, 1890, from the same station, hatched immediately, about one-half of the fry dying during the first week. The remainder were further reduced in numbers by the escape of some from the ponds, but several hundred were preserved in good condition.

There was the usual lack of success with brook trout. Twenty thousand eggs arriving from the Northville Station January 18, 1891, immediately hatched; 7,600 fry died in the troughs by March 1, and the remainder soon after perished in the ponds.

Unfavorable results also attended the handling of Von Behr trout eggs and fry. Of a consignment of 20,000 eggs from the Northville Station, received February 2, 1891, many were found either hatched or dead on arrival. A second consignment of 20,000 arrived in good condition February 20, 1891, but they underwent 20 per cent loss in hatching, and the fry perished, though apparently healthy—a portion in the troughs and the remainder in the ponds subsequent to transfer, April 9. Muddy water during the hatching season and the presence of lime in the station water supply are supposed to have been the obstacles to successful operations with this species and the brook trout.

SANDUSKY STATION, OHIO (HENRY DOUGLAS, SUPERINTENDENT).

1889-90.

The agreement with the Ohio State Fish Commission, under which the operation of its hatchery at Sandusky was conducted by this Commission, was renewed.

Eggs of the whitefish and pike perch were obtained from islands in the western part of Lake Erie, and from Port Clinton and Toledo. Those of the whitefish were collected during the month of November, 1889, to the number of 62,100,000. Of these, 10,000,000 were shipped to the Pennsylvania hatchery at Erie; 6,000,000 to the Wisconsin State fish commissioners; and 6,000,000 to Central Station, Washington, D. C. The remainder were hatched at the station, producing 30,628,000, all of which were liberated in Lake Erie except 100,000, sent to Warren, Ind., at the request of the Indiana State Fish Commission.

Pike-perch operations covered the period between April 12 and 26, 1890, during which 81,000,000 eggs were obtained. Of these the Pennsylvania hatchery at Erie was given a consignment of 18,000,000 and the New York Fish Commission 1,000,000. From the remainder, 36,200,000 fry were produced and liberated the first week in May.

PUT-IN BAY STATION, OHIO (J. J. STRANAHAN, SUPERINTENDENT).

The sundry civil bill approved March 2, 1889, provided $20,000 "for the purpose of establishing and equipping a station at some convenient point on Lake Erie, to be designated by the Commissioner of Fish and Fisheries, for taking spawn and the propagation of whitefish." An examination and consideration of the facilities offered by the different places contiguous to the spawning-grounds of the whitefish demonstrated the advisability of establishing the station at Put-in Bay, Ohio. Through the efforts of Mr. Valentine Doller, of Put-in Bay, the citizens of that place donated to the United States a site on the south shore of Peach Point, and containing about three-fourths of an acre. On August 31, 1889, the Attorney-General certified to the sufficiency of the deeds given to vest a valid title to the property in the United States. Cession of jurisdiction over the property having been given by an act of the legislature of Ohio, passed April 10, 1889, and the plans and specifications for the required hatchery having been prepared pending the examination of the title, advertisement calling for proposals to construct the same was made September 6. The lowest bid received in response thereto was that of Mr. George E. Gascoyne, of Put-in Bay, with whom a contract was entered into on October 12. For the erection of the necessary steam and water plant, a contract was made with Messrs. Shaw, Kendall & Co., of Toledo, Ohio, on March 11, 1890. The erection of the hatchery was completed on August 11, 1890, and on September 16 the machinery was ready for use.

The act approved September 30, 1890, provided an appropriation of $10,000 for the completion of the equipment of the station, including the purchase of a steam launch for use in the collection of the eggs of the whitefish. Plans and specifications for this vessel were prepared by the chief engineer of the Commission, Mr. W. B. Bayley, U. S. N., and after due advertisement for proposals for her construction, a contract was made with the Craig Ship Building Company, of Toledo, Ohio.

1890–91.

On July 1, 1890, Mr. J. J. Stranahan was appointed superintendent of the station. On November 5 active measures in the propagation of whitefish were begun; 157,500,000 eggs were obtained from local fishermen; 200,000 were received from the Commission's station at Alpena. Of the eggs collected, 47,500,000 were transferred to the Ohio State hatchery, Sandusky, Ohio; 10,000,000 to the Wisconsin commissioners; 14,000,000 to the Erie station of the Pennsylvania Fish Commission; and 125,000 to Mr. Carl G. Thompson, at Warren, Ind. From the eggs retained, 10,000,000 fry were produced and placed in Lake Erie. The hatching occurred in March, 1891, and the fry were liberated toward the end of that month.

About 150,000 whitefish eggs were fertilized with the product of male lake herring, the result being a fair percentage of hybrids. Late in the season a small number of herring eggs were secured and impregnated, these producing a small percentage of fry.

On February 11, 1891, 200,000 lake trout eggs were received from the Northville Station, and produced 192,000 fry, which were liberated about the end of March, at points in the lake in the vicinity of the station.

The collection of pike perch eggs was begun April 14, 1891, they too being taken by the fishermen; 149,000,000 eggs were obtained, of which 58,000,000 were sent to the Erie hatchery of the Pennsylvania Fish Commission. In the collection of these Mr. William Buller, superintendent of the Erie hatchery, rendered active assistance. The eggs held at the station produced 60,000,000 fry, which were liberated in the lake prior to May 20, 1891, the season's operations in fish-culture terminating with their release. Experiments were made with the pike perch eggs looking to the separation of those that mass in lumps. The method pursued consisted in detaching the lumps from the eggs already free, by means of a screen. The lumps were then rubbed between the palms of the hands, separating the eggs. It was found that eggs so treated hatched with no greater loss than those naturally free. Attempts to hatch the eggs when in lumps, however, resulted in almost total loss.

NORTHVILLE STATION, MICHIGAN (FRANK N. CLARK, SUPERINTENDENT).

1889–90.

Whitefish.—The collection of whitefish eggs for this station was limited to Lake Erie, 10,000,000 being derived from the vicinity of Monroe and 25,000,000 from Sandusky. These were carefully prepared for shipment and distributed to other hatcheries for hatching. The disposition of the good eggs, 28,460,000, is given in the details of distribution.

The success heretofore attending the partial trial of graveled troughs, as practiced during the three preceding seasons in developing trout eggs, led to the adaptation of the method to all the trout eggs handled at the station, and with results highly gratifying. This consisted in spreading as evenly as possible 10,000 to 12,000 eggs over a space of gravel bottom 12 by 15 inches. The eggs were allowed to remain on the gravel until the eye spots were clearly developed (a period of about forty days), being then taken up and placed on wire trays for hatching.

Von Behr trout.—The readiness with which the Von Behr trout has become acclimated, together with its hardiness and rapid growth, has greatly encouraged its further propagation. From the brood stock 163,400 eggs were obtained, of which 58,000 were transferred and 75,000 held for hatching at the station. The spawning season began October 21, 1889, and continued seventy-three days. From 75 females, 3 and 4 years old, the production of eggs was 85,700, and from 239 females, 2 years old, 77,700. Of this species brought over from the previous season, there were 6,175 yearlings delivered for distribution.

Brook trout.—The spawning of the brook trout covered a period of eighty-five days, commencing October 14, 1889, the number of eggs obtained being 322,000. In addition to these there was a consignment of 25,000, received January 25 from the Leadville Station. The eggs from brood fish were derived as follows: From 478 females 2 and 3 years old, 269,300; and from 224 others 18 months old, 52,700. These were transferred in ten shipments 265,000 eggs. In addition to these, 75,000 were retained at the station, of which 25,000 were for stocking the waters of the Yellowstone National Park. The inconsiderable loss in hatching operations is ascribed to the development of the eggs in the earlier stages on gravel. Of brook trout yearlings, 7,800 were delivered for liberation in various waters.

Loch Leven trout.—From 300 females maintained at the station 291,100 eggs were obtained October 25 to December 30, 1889. Commencing January 20, and continuing thirty-five days, 162,000 of these eggs were transferred, and 75,000 others were held for rearing. A consignment of 13,000 eggs was received from Germany on March 11, 1890, but these developed only about 25 per cent of fry. The distribution of yearlings commenced September 17, 1889, 10,000 being liberated.

Lake trout.—The eggs taken amounted to 3,954,000, an excess of 600,000 over any previous season. The transfers from these eggs amounted to 2,600,000, and 200,000 were held to be hatched. Of those transferred, 1,000,000 were sent to Duluth Station; of those retained, 100,000 were held for the Yellowstone National Park. In February, 1890, 13,132 yearlings were turned over to car messengers for liberation.

Rainbow trout.—Results with the rainbow trout, as in preceding years, were unsatisfactory. From 2,500 brood fish, one-fifth of which were 3 and 4 years of age and the remainder 2 years of age, only 119,000 eggs were secured, and of these only 52,600 survived to the age when the eye spots are visible. 12,500 eggs were sent to the Wyoming Fish Commission, and from the remainder only 5,000 fry were produced. 19,143 yearlings were distributed through the messenger service.

Landlocked salmon.—A consignment of eggs from Schoodic Station, received February 28, 1890, was wholly without results.

1890–91.

This station, one of the first established by the Commission, and at which the work of the propagation of whitefish on the Great Lakes was inaugurated, has for many years been occupied under rental. The company owning the property having decided to sell the same, the Commission was given the opportunity to buy it. In view of its advantages, Congress was asked to make the necessary provision for its purchase. This request was met by an item in the sundry civil bill, approved August 30, 1890, appropriating $15,000 "for the purchase of the grounds and buildings located at Northville, Mich., now occupied by the U. S. Fish Commission, under lease as a fish-hatching station, and for the purchase of additional grounds adjacent to those now occupied and used as such fish-hatching station." An appropriation of $5,000 was also made by the same bill for the erection of new buildings on the property. Deeds transferring the property already under lease and the additional adjacent grounds deemed necessary for the station, as also the right of way over contiguous lands for a pipe line and the control of certain water rights, were passed in February, 1891. These were referred to the Attorney-General, and toward the end of the following month was received his certification as to their sufficiency to vest in the United States a valid title to the property. The houses on the property being sufficient for the immediate needs of the station, it was the intention of the Commissioner to proceed at once with the construction of additional ponds, the introduction of an increased water supply, etc., to meet the expense of which the appropriation of $5,000 for new buildings was supposed to be applicable. The First Comptroller of the Treasury, however, deciding that the money could be expended only for new buildings, as defined in common parlance, the work had to be deferred till Congress could be asked to modify the phraseology of the appropriation so as to permit its use in the way desired.

The brood fish on hand at the commencement of the fiscal year were found to be as follows: Brook trout, 945; Loch Leven trout, 4,545; Von Behr trout, 2,075; rainbow trout, 4,053.

Whitefish.—The propagation of the whitefish at this station was discontinued and an expansion of the work made at Duluth and Put-in Bay stations. This permits the application of all available water supply and space to the hatching and rearing of trout, and will obviate the necessity, by reason of insufficient space for their care, of liberating the fingerlings in advance of the regular season of distribution.

Von Behr trout.—Eggs were taken during sixty-five days following October 24, 1890, and numbered 324,900, of which 226,000 were transferred. The fingerlings and yearlings furnished for distribution were 18,655. There were received from Germany, through the Cold Spring Harbor Station, in February and March, two consignments of eggs of this species aggregating 31,000.

Brook trout.—Eggs were taken through a period of seventy-three days following October 7, 1890, the number obtained being 240,200, of which 110,000 were transferred to other hatcheries. Fingerling and yearling brook trout to the number of 16,795 were furnished for liberation, commencing September, 1890.

Loch Leven trout.—The collection of eggs of this species continued during the months of November and December, 1890, the number obtained being 222,200, of which 80,000 were transferred. Fingerlings and yearlings furnished for distribution numbered 14,775.

Lake trout.—Eggs to the number of 4,901,000 were forwarded from the Alpena Station, the production being greater by 1,000,000 than in any previous year. To stations of the Commission, State commissioners, and foreign countries, 2,285,000 of these eggs were reshipped, and from the remainder were produced 1,200,000 fry. In April, 1891, more than 600,000 fry were liberated in inland lakes of Michigan, 513,000 being held for rearing. The number of lake trout fingerlings and yearlings distributed from August 1, 1890, to May 18, 1891, amounted to 187,805, an increase of 100 per cent over previous seasons.

Rainbow trout.—The rainbow trout heretofore used as breeders were transferred, the water at the station having been found but poorly adapted to this species.

Landlocked salmon.—A shipment of 26,000 landlocked salmon eggs from Schoodic Station produced no results, all the fry perishing.

Alpena Station, Michigan (Frank N. Clark, Superintendent).

1889–90.

The collections of the lake trout eggs which were handled at Northville Station this year were made principally through Alpena Station.

The collection of whitefish eggs began November 5, and continued into December, lakes Huron and Michigan affording about 43,000,000; about 40 per cent of the spawning fish were obtained from gill nets. Snowstorms and gales were encountered as usual in this work.

The production of fry was 33,600,000, which were mainly liberated in lakes Michigan and Huron. On account of the mild winter the eggs were fifteen to twenty days earlier in hatching. The temperature of the water in November was 38½° F. During the four months preceding April 2 the water temperature varied but one degree from 34° F. On April 8 the temperature was 38°; April 30, 42°; April 15, 52°.

1890–91.

The whitefish eggs collected this season were mainly from Lake Huron, in the vicinity of the station. The taking of spawn began October 4 and was concluded December 6, 1890, the result being nearly 51,000,000, of which about one-third were from fish taken in gill nets. Most of the eggs were from the first run of fish, the greater portion being obtained within a period of eight days. There were transferred to other stations 20,500,000. Hatching occurred April 10 to 30, 1891, and fry to the number of 24,060,000 were liberated during April and the early part of May.

The collection of lake trout eggs commenced September 23, 1890, in the vicinity of Beaver Islands, the entire number, nearly 5,000,000, being forwarded to Northville Station.

The water temperature September 30 was 60° F.; October 31, 45°; during three months following November 30 it was 32½° to 33°; during March, 34°; on April 15, 36°; on May 5, 46°.

The immediate supervision of the station has been under Mr. S. P. Wires, foreman.

DULUTH STATION, MINNESOTA (R. O. SWEENY, SR., SUPERINTENDENT).

1889–90.

Operations consisted principally in developing eggs transferred from other stations, though a number of pike perch eggs were collected.

Whitefish.—About 26,250,000 whitefish eggs, in seven consignments of two cases each, received from Northville Station January 4 to 31, 1890, produced 24,850,000 fry. Some of the eggs hatched prematurely, owing to the high temperature attained during their transfer, resulting in the release of about 7,000,000 fry from January to March, inclusive, in advance of the normal hatching, which commenced about April 15. The fry were placed in Lake Superior, off the mouth of Lester River.

Brook trout.—Eggs to the number of 30,000, received from Northville February 3, 1890, began to hatch March 21, and 27,000 fry were released June 12, in Baptism River; 1,000 fry were held over to the succeeding fiscal year for further rearing.

Lake trout.—1,000,000 eggs received from Northville January 5, 1890, in four cases, produced 935,000 fry; of these, 400,000 of premature hatching were liberated in Lake Superior in April. There were also 300,000 released in June. The balance were held for further rearing. The normal hatching of the eggs commenced March 21.

Loch Leven trout.—There were 12,000 Loch Leven trout eggs received from Northville February 27, and from these 11,000 fry were on hand, in rearing troughs, June 30, 1890.

Von Behr trout.—Eggs to the number of 8,000 were received from Northville February 27. The fry produced therefrom, and on hand June 30, 1890, amounted to 7,280. A consignment of eggs from Cold Spring Harbor, New York, was without result, they being dead on arrival.

Landlocked salmon.—There were 48,000 landlocked salmon on hand in troughs and rearing ponds June 30, 1890, which were the product of 60,000 eggs received from Schoodic Station in March.

Pike perch.—On May 5, 1890, 600,000 pike perch eggs were collected, the fry produced therefrom amounting to 580,000, which were released May 9 to 25, at the mouth of Lester River.

The water temperature, after remaining at 32° F. for four months, rose to 34° April 10, 1890, the mean morning temperature during April being $34\frac{1}{16}$°, and during May $45\frac{2}{3}$°. In February the mean air temperature was $12\frac{1}{2}$°, maximum 40°, and minimum 16° below zero.

1890–91.

During this year many improvements were made looking to the completion of the station. In consequence of the denudation of the land areas along Lester River (caused by disastrous forest fires, the operations of lumbermen, and the clearing incident to the suburban growth of the city of Duluth) it was found that the gravity supply of water to the hatchery from that stream could no longer be relied upon. When the hard freezing weather occurred the stream was dried up, and the lake was drawn upon, water being obtained by pumping.

Whitefish.—On February 6, 1891, 12,000,000 eggs were received from the Alpena Station, and hatched April 15 to May 19 following, the product in fry being 11,330,000.

Lake trout.—There were also received from Northville 500,000 lake trout eggs, which produced 486,000 fry, a part being liberated April 28 to June 30, and 128,000 being retained for rearing.

Von Behr trout.—15,000 Von Behr trout were produced from 20,000 eggs received from Northville, the fry being released in Baptism River and other local waters, in June, 1891, except 400, which were retained.

Landlocked salmon.—50,000 eggs from Schoodic Station produced 30,000 healthy fry, which were retained for rearing.

Pike perch.—On April 29, 1891, 47,000,000 pike perch eggs were collected by the station employés at Fond du Lac, a point 30 miles distant. There were 12,000,000 of the fertilized eggs placed overboard at the spawning-grounds, and 35,000,000 put in process of hatching, the universal jar being used in their development. The fry obtained amounted to 10,100,000, which were liberated May 15 to 23.

Carp.—610 carp were distributed, these being the survivors of a shipment of 1,000 received from Washington, D. C.

Of fingerling fish, brought over from the spring of 1890, there were released in local waters 100 brook trout, 20,000 landlocked salmon, and 235,000 lake trout.

The first rainfall of 1891 at this station occurred April 10, when the water again commenced to flow through the flume from Lester River. The general thaw setting in at this time furnished an abundance of water by gravity, which, however, was turbid and unsatisfactory. The temperature of the Lester River water in October was 40$\frac{2}{3}$° F., and in November, 32° without variation. In July, 1891, it reached a maximum of 75°, the minimum being 69°.

QUINCY STATION, ILLINOIS (S. P. BARTLETT, SUPERINTENDENT).

The work of collecting and distributing the native food-fishes of the Mississippi Basin from the overflow ponds and lakes formed during the seasons of high water, inaugurated in the summer of 1888, was continued during the period covered by this report. The kinds and number of fishes collected during the two years were as follows:

Kinds.	Season of 1889–90.	Season of 1890–91.
Catfish	11,116	
Buffalo	2,215	
Brook pike	70	
Perch	16,323	9,958
Fresh-water drum	200	
Pike perch	1,000	4
White bass	10,604	
Black bass	63,145	44,405
Crappie	18,575	21,901
Rock bass	2,854	10,802
Sunfish	6,973	2,435
Total	133,075	89,505

NEOSHO STATION, MISSOURI (WILLIAM F. PAGE, SUPERINTENDENT).

As stated in the report for the year 1889, the early work at the Neosho Station was confined to the laying out of the grounds and their inclosure, the building of the necessary ponds, and the introduction of the water supply. In October, 1889, was begun the construction of the hatching house, a one-story building, 19 by 37 feet, with a two-story tower, 13 feet square, on the northeast corner. Owing to the desirability of getting the station ready for active work at an early date, the building was erected by the purchase of the necessary materials and the employment of temporary labor, instead of under contract. An appropriation of $4,000 having been made by Congress on September 30, 1890, for the completion of the station and its equipment, plans and specifications were prepared for a dwelling for the superintendent of the station and for a hatchery annex, containing an ice-house and workshops, and in February, 1891, advertisement was made calling for proposals for their construction. Contracts were awarded to the lowest bidders, that for the superintendent's dwelling being given to Mr. James T. Broughal, of Joplin, Mo., at $3,790, and that for the hatchery annex to Mr. James Robinson, of Neosho, at $890. Work on these buildings was begun in April, and at the end of the year they were rapidly nearing completion. The appropriation of $4,000, above referred to, proving insufficient for the purpose, a further appropriation of $1,000 was made by Congress by act approved March 3, 1891.

1889–90.

October, 1889, marked the commencement of fish-cultural operations at this station, 600 black bass, for breeding purposes, being received at that time from Quincy, Ill. There were received at the same time a number of crappie, which failed to thrive, and others were obtained from Indian Territory. In December, 1889, 42 carp of a summer's growth were received from Washington, D. C. Such rapid growth followed their introduction into the ponds that they spawned twice during the next summer. Other breeding fishes introduced were the tench, golden ide, and goldfish, which were derived from other stations, and channel catfish obtained from the Grand River, Indian Territory.

The fry from 25,000 lake trout eggs received from Northville Station in January, 1890, were attacked by a disease which was accompanied by a white spot in the yolk sack. Only 750 of the young survived, but these were healthy.

A consignment of 25,000 brook trout eggs from Northville Station January 16 arrived in good condition, but the fry perished during the absorption of the yolk sack, being affected in the same manner as the lake trout fry.

About 12,000 Von Behr trout fry of inferior quality were obtained from 20,000 eggs received from Northville Station February 11, With the rainbow trout better results were secured, more than 22,000 fry being on hand June 30, 1890, as the product of 25,000 eggs received from Wytheville February 12.

The earliest observed spawning date of the goldfish was March 12; of the carp, May 5; of the tench, May 23.

Predatory birds and other animals were very numerous, and many were destroyed.

1890-91.

The fish available for distribution in October, 1890, consisted of the production of the previous fiscal year. These numbered 63,570, and were as follows: Rainbow trout, 21,051; Von Behr trout, 11,937; lake trout, 506; rock bass, 1,380; carp, 1,782; tench, 9,907; goldfish, 17,007.

The black bass commenced building their nests in the ponds toward the end of March, 1891, and more than fifty were observed. By June 30, 1891, many of the young had attained a length of 1½ inches.

Crappie, carp, tench, golden ide, rock bass, and goldfish, as well as the black bass, reproduced by natural methods, in the ponds, the young being retained there until the season for distribution in the subsequent fall months. An addition of 23 brood crappie was obtained through the Missouri fish commissioners.

During cold weather it was observed that the carp and tench in the ponds remained active, the channel catfish, however, being dormant.

The golden ide received as fingerlings in December, 1889, made such rapid growth that they were of an average length of 18 inches by June 30, 1891. They were at first very wild, but were rendered gentle by the methods used in their feeding.

The rock bass held as stock fish commenced spawning April 21, 1891, a chain of nests being formed around the margin of the pond in water 4 to 6 inches deep. The nests were oblong hollows, the size of a hat crown, and were covered with coarse gravel. There were 1,500 to 1,800 eggs in each, of a deep straw color, somewhat smaller than shad eggs, and slightly adhesive, though not in lumps. The nests were closely guarded by the male parents, the period of hatching being eight to ten days.

A thousand rainbow trout, hatched in the spring of 1890, were retained as brood fish and have made rapid growth.

On January 17, 1891, 17,400 rainbow trout eggs were received from Wytheville Station, which afforded more than 13,000 fry for transfer to the rearing ponds.

A consignment of 17,000 brook trout eggs arrived from Northville Station January 25, 1891. The fry from these underwent a loss while in the yolk stage, as in the preceding year, but on April 1 more than 11,000 remained on hand for rearing. By June 1 some of them were 3 inches long.

A consignment of 19,000 Von Behr trout eggs, received from Northville February 5, 1891, produced satisfactorily, there being more than 17,000 fry on hand April 1. A second consignment of 6,900 eggs from the same source also produced well, there being 5,500 fry on hand May 11. These, in addition to the 17,000, were retained for rearing.

Vigilance was required to protect the stock of fish against predatory animals, and during the year there were killed 168 birds, 21 mammals, and 98 reptiles, not including frogs.

In addition to the constructions provided under the specific appropriations before mentioned, there was built, for the use of the Commission's distributing cars, a siding from the Kansas City, Fort Smith and Southern Railway. A connection was also made with the water main of Neosho for supplying the station, as well as the distribution cars while occupying the railway siding.

LEADVILLE STATION, COLORADO (E. M. ROBINSON AND H. D. DEAN, SUPERINTENDENTS).

In the report for 1888 mention was made of the location of a station near Leadville, Colo., for the breeding and rearing of trout, and of the appropriation by Congress of $15,000 for the necessary constructions. As soon as this sum became available, July 1, 1889, plans and specifications for a fish-hatchery were prepared and proposals for its erection invited by advertisement. But one bid being received, and that for a sum greater than the appropriation, a second call was made, resulting in the receipt of three bids, the lowest being that of Mr. L. G. Hunt, of Pueblo, Colo., at $12,672. This was accepted, and on October 14, 1889, formal contract for the construction of the building was made. Work was immediately begun, but owing to many causes, chiefly bad weather and roads, the building was not completed till October, 1890, final acceptance of the structure not being given till November 1.

In view of the failure to receive suitable proposals in response to the first call, and the delay that would ensue before new proposals could be obtained and the contract let, which would have resulted in the loss of a year's time in the active work of propagation, it was decided to erect a frame building which could be used as a temporary hatchery and afterward as a rearing-house for fry. A box flume, some 740 feet in length, was laid to bring, by gravity, from springs on the hillside, a supply of water to the hatchery. Active work was commenced on September 9, 1889, and the structure was ready for the reception of eggs about the middle of October. In the meantime, by permission of the owner, Dr. John Law, 8,000 brook trout were taken from the Evergreen Lakes and held in ponds till ready to spawn. From these fish 568,000 eggs were obtained and placed in troughs in the temporary hatchery. The erection of this temporary hatchery was under the general direction of Mr. John Gay, inspector of stations, assisted by Mr. William

P. Sauerhoff, an expert carpenter, who had had many years' experience in the fish-cultural work of the Commission. On September 21, Mr. E. M. Robinson, for a number of years connected with the Commission, and who had been in charge of fish-cultural work at several of its stations, was appointed superintendent.

An additional appropriation of $20,000 having been made August 30, 1890, for the completion and equipment of the station, plans and specifications were prepared for a superintendent's dwelling and stable. After due advertisement, contracts were made in May, 1891, at $5,887.93 for the dwelling, with Messrs. Baldwin & Chronister, and at $1,820 for the stable and wagon house, with Mr. W. W. Cable, both contractors doing business in Leadville. The supervision of the work of construction was placed in charge of Mr. George H. Tolbert, under the general direction of Mr. H. D. Dean, who was appointed superintendent on April 15, 1891, succeeding Mr. Robinson, who had resigned to take charge of a private fish-cultural establishment.

1889-90.

The period of active fish-cultural operations extended from November, 1889, to June 30, 1890, the collection of eggs being 568,000 of the brook trout previously referred to, and 12,000 of the black-spotted trout. In addition to these there were 25,000 brook trout eggs and 20,000 Loch Leven trout eggs forwarded from the Northville Station.

The distribution of brook trout eggs included 50,000 to Fort Gaston Station, California, and 25,000 to Northville Station, Michigan. The remainder of the eggs were retained for hatching and rearing, with the exception of 126,800 fry, which were given to Dr. John Law, in exchange for the use of his stock fish.

There were collected from Twin Lakes 1,014 black-spotted trout for breeding purposes, and from Rock Creek, 32; 100 of these were forwarded to Wytheville Station. From Rock Creek there were collected 58 brook trout.

1890-91.

The eggs obtained this year from the stock brook trout of Dr. John Law amounted to 180,000. They were of the later yield, and defective in fertilization, as a result of the scarcity of milt. From these a shipment of 5,000 was made to the Wyoming Fish Commission, at Laramie. The eggs retained hatched at different times, and a high mortality occurred among the fry as a result of cannibalism. The number remaining on hand May 1, 1891, was but 41,000.

In addition to the eggs taken by the station, 20,000 brook trout eggs were obtained from Caledonia, N. Y., January 31, 1891. On May 1 the fry from these amounted to 14,000.

A consignment of 100,000 eggs of Von Behr trout was presented by the New York Fish Commission, the young therefrom being 68,000 on May 1, On June 30, 1891, in addition to the fish already mentioned, there were on hand the following: 149 brook trout, 1,000 black-spotted trout, and 5 rainbow trout, all breeders; of yearlings, 19,000 brook trout, 700 black-spotted trout, and 500 Loch Leven trout. Of the black-spotted trout there were also 800 fry and 50,000 eggs.

The distribution of fish took place between September 16 and November 21, 1890, when 20,000 yearling trout were furnished to Nebraska, 16,000 to South Dakota, and 23,000 to Colorado waters.

The construction of the new hatchery was sufficiently advanced by January, 1891, to permit the introduction of the water supply, and about the middle of February the eggs were transferred thereto from the temporary hatchery.

The temperature of the water supply in December and January was 44° F. without variation, and in April 43° without change. During eleven days in January, 1891, the air was below zero.

BAIRD STATION, CALIFORNIA (GEORGE B. WILLIAMS, JR., SUPERINTENDENT).

1889-90.

The act approved March 2, 1889, appropriated the sum of $4,000 "for the construction of a quarters building at the U. S. Fish Commission Station, Baird, California, and its equipments." Plans and specifications were prepared for a 1½-story building 30 by 40 feet, with two 12-foot additions. Owing to the isolation of the station it was found impossible to contract for the construction of the building, and it became necessary to do the work by the purchase of materials and the employment of such men as could be secured in the vicinity. The cost of the building, including the compensation of the employés, was $3,882.58, and for its equipment and incidental expenses, $117.42.

The construction of this building was begun October, 1889, and was completed late in April, the slow progress being caused by continued rains, which prevented the prompt delivery of materials. The building is substantial and comfortable.

On July 1, 1889, preparations were begun for the capture of the adult quinnat salmon. The high water in the preceding March having destroyed the piers, stringers, and racks of the dam in the McCloud River, built for obstructing the ascent of the salmon, the erection of a practically new structure was made necessary. Two new spawning sheds and salmon corrals were built, new seining apparatus provided, the seine-haul cleaned, the roads repaired, the buildings overhauled and painted, and a rotary pump geared to a water wheel, so that a supply of 7,000 gallons of water per hour was obtained.

By driving the salmon upward from the shallows situated below the dam, and the constant use of the seine in conjunction therewith, a sufficient number of fish was secured in the first run, August 27 to September 26, 1889, to produce 1,105,000 eggs. The captures amounted to 1,129 males and 382 females, 252 of the latter being in spawning condition. The small production was the result of the decreased run of adults.

Of the eggs taken, 974,000 were shipped to the hatchery of the California Fish Commission at Sisson, where they were hatched and the fry released in the Sacramento River. Those retained produced 60,000 fry, which were liberated in McCloud River.

On October 7, 1889, stormy weather began and rising waters made imperative the lifting of the obstructing racks, thereby permitting the free passage and escape of the adult salmon into the head streams. Fishing for the late run was resumed October 16, but another rise in the river, five days later, submerged and washed out a portion of the dam and endangered the safety of the power wheel and buildings. Large numbers of salmon again passed on above. Receding water permitted the renewal of the dam November 5, but there were very few brood fish subject to capture remaining in the lower stream. From November 9 to 19, something over 600,000 eggs were secured. These were from a catch of 94 males and 170 females, 119 of the latter having ripe spawn. Freshets continued every month till June, 1890, the height of the water reaching 15 feet in February. On December 2 the wheel boats requiring to be dropped into an eddy for safety, the water supply was obtained by means of the steam pump.

On December 14, 1889, 125,000 eggs were forwarded to New York, for shipment to France and Norway; on December 16, 100,000 to Fort Gaston Station; and on December 17, 355,000 to the California fish commissioners at Sisson. From those retained, 24,000 fry were produced and liberated in McCloud River, 1,000 being held till March, and successfully nourished on corn-meal mush boiled with beef. The total loss on the 1,709,000 eggs taken was 71,000, or about 4 per cent.

The early run of salmon yielded their eggs in water at about 60° F., the temperature descending as low as 50° on one day; the late run spawned in a temperature ranging from 45° to 50°.

1890–91.

In consequence of damages sustained from the high water of the previous spring, it was again necessary to renew the obstructing dam and accessories. Its rebuilding was commenced July 1, 1890, native timbers, cut in May by the station employés, being utilized.

Everything was in readiness August 27, when the schools of spawning salmon arrived. Between this date and September 23, 1890, 912 fish yielded 3,652,000 eggs. Of these, 50,000 were forwarded to E. Cházari, City of Mexico, and 2,838,000 to the California fish commissioners, from September 24 to October 10, further shipments being discontinued on the receipt of a message that their hatchery was filled. The remaining eggs were developed at Baird Station, the production of fry being 582,000.

Seining for the fish of the late run was commenced November 6, 1890. The continued low water of the river, however, permitted uninterrupted fishing by cannery operators on the Sacramento River below, and only a small number escaped their nets to reach the station. The season of collecting terminated November 25, with the obtainment of 64 ripe females, which produced 263,000 eggs. Of these eggs, 100,000 were forwarded December 31, via New York, to France. The remainder were hatched at the station and produced 140,000 fry, which, with the 582,000 fry of the earlier hatching, were liberated in McCloud River and its tributary, the Pit River. The total loss of eggs at the station was 205,000, or about 5 per cent. In releasing the 722,000 fry the seine skiff was used with much advantage, the cans being placed therein and the fry put out in small numbers at various shallows in the river occurring in a distance of about 5 miles.

Fort Gaston Station, California (Capts. W. E. Dougherty, U. S. Army, and Frank H. Edmunds, U. S. Army, in charge).

In view of the urgent and many requests received from citizens in the regions of the Rocky Mountains and the Pacific coast to stock their waters with suitable food-fishes, and the difficulties and cost attending shipments from the eastern stations of the Commission, the question of locating fish-cultural stations on the military reservations of those regions was considered, and Lieut. Commander J. J. Brice, U. S. Navy, who was employed under detail from the Navy Department, was directed to make a reconnaissance. Upon his report and recommendations the reservation at Fort Gaston, Humboldt County, Cal., was decided upon as offering the necessary requirements; and, in compliance with the request of this office, the Secretary of War, on October 16, 1889, gave instructions permitting the use of a portion of the same by the Fish Commission. The organization of the station was intrusted to Mr. Brice, who arrived at the place the latter part of November with some of the equipment. The use of a building, 32 feet by 16 feet, into which an abundant supply of pure, cold water was led by gravity, was granted by the commandant of the post, Capt. W. E. Dougherty, U. S. Army, who also undertook the general charge of the conduct of the station. Mr. W. H. Morgan, who was serving as fish-culturist at one of the eastern stations of the Commission, was assigned as foreman. Capt. Dougherty remained in charge of the work till October 1, 1890, when he was succeeded by Capt. F. H. Edmunds, U. S. Army, who had been placed in command of the post.

1889–90.

In December, 1889, 100,000 quinnat salmon eggs were received from Baird Station. These were developed in universal hatching jars and hatched from January 5 to 25, 1890. The fry commenced feeding in February, and were transferred in March to ponds, in which they remained till the end of June, when the water temperature becoming rather high they were released in Trinity River. They were about 4 inches long and were 90,000 in number.

High water in Trinity River prevented the establishment of the proposed barrier dam in advance of the upward movement of the spring run of salmon, consequently no eggs were derived from this source.

1890–91.

Dams and traps for stopping and capturing the salmon and trout were constructed both in the Trinity and Redwood rivers. On the latter stream at Redwood, a point 13 miles distant from Fort Gaston, an auxiliary station was established.

The collecting of the eggs of the quinnat and steelhead salmon was begun in November, 1889, and continued three months. A dry season caused low water in the streams, and but a comparatively small number of fish ascended to the usual spawning-grounds. At Fort Gaston there were secured 45,000 eggs, producing 40,000 fry, 30,000 of which were liberated in Supply Creek, a tributary of Trinity River, and 10,000 retained for rearing. These latter were liberated subsequent to June 30, 1891. At the auxiliary station at Redwood 30,000 salmon eggs were collected, and produced about 25,000 fry, which, at the age of 1 month, were released in Minor Creek, a tributary of Redwood River, where they remained in schools for some weeks.

During the development of the eggs the temperature of the water was 38° to 45°, and the period of incubation fifty-seven days.

There were three new rearing ponds constructed. In one of these about 200 breeding rainbow trout were held till after June 30, 1891.

A water supply independent of that of the military reservation was obtained by means of a trench which was constructed along the mountain side over a distance of about a fourth of a mile.

CLACKAMAS STATION OREGON (WALDO F. HUBBARD, SUPERINTENDENT).

1889–90.

By July 1, 1889, many quinnat salmon had collected below the obstructing dam across Clackamas River.

The station was visited by the Commissioner September 5, 1889, when it was decided to purchase a steam pumping plant rather than attempt to rebuild the reservoir dam on Cedar Creek. Pending the introduction of the pumping machinery, which was in operating condition by

September 19, a temporary hatchery was built for the earlier take of eggs, the building being supplied with water by gravity from a small brook.

From August 19 to September 11 four slat traps were constructed, one being placed in the Clackamas dam and the others on the shallows below, at the lower end of the ripple, in the swiftest water, and in such a position that the current passed through, leaving the fish stranded. Wings were extended from the trap mouths upward at an angle, throwing nearly the entire volume of the stream through the slats. The fish were then surrounded by a seine, which, being drawn downward, forced them into the trap. Fish were also captured by means of dip nets and the seine.

The period occupied in collecting eggs was from August 28 to November 6, 1889, the production being 4,314,000 from 957 fish. The largest day's operations, September 27, yielded 208,000 eggs, the smallest day's production being 4,000. There were only two days when no eggs were taken. No record was made of the number of male fish caught; they were, however, largely in excess of the females.

Mr. Reed, of the Oregon Fish Commission, received 1,000,000 of the eggs late in October, 1889. These were hatched and released, under State supervision, at the Cascades on the Columbia River. All other eggs taken were hatched at the station, and the fry, 8 to 10 weeks old, deposited in Clackamas River and Cedar Creek. The distribution of fry extended from November 5 to April 15, 1,000,000 being conveyed 7 to 10 miles up the stream and put out in small lots in the rapids. The fry liberated amounted to 85 per cent of the eggs retained at the station.

All eggs were measured in a cup of 1,000 capacity and remeasured just prior to hatching.

On November 7 the brook had increased in volume, in consequence of rainfall, and the pumping outfit was but little used in the subsequent operations.

From January 2 to 8, 1890, there was snowfall and such cold weather that it was with difficulty the hatching troughs were prevented from filling with ice, the thermometer registering as low as zero. Another cold spell prevailed late in February, when the water in the station was down to 31° F. On February 1 the river rose 14 feet, covering to a depth of 3 inches the grounds occupied by the hatchery and quarters buildings.

1890-91.

An additional steam pump, as a reserve in case of accident, was provided. In the month of July, 1890, the obstruction rack was placed in the dam to arrest the upward passage of the adult salmon. A gate with sheerbooms, for facilitating the onward passage of drift timber on high water, was introduced into the dam. Five days were consumed in removing the saw logs, which had grounded in the seining area, but all could not be cleared out, and the strong current incident to their presence being a barrier to successful operations in hauling, it became necessary to use gill nets in the capture of the adult fish. Owing to the construction of a dam in the river below the station and the operation of nets by commercial fishermen, the ascent of a great number of fish was hindered.

The collection of the eggs was commenced September 16, 1890, and the first hatching took place about the end of October. Eggs continued to be taken until November 16, the total from 1,094 females amounting to 5,860,000. Of these, 700,000 were delivered October 22 and November 5, 1890, to the Oregon fish commissioners. The remainder were hatched at the station and the fry placed in Clackamas River and its tributaries. The fry produced were 4,902,000 or about 95 per cent of the eggs retained.

In January, 1891, the hatching took place so rapidly that use had to be made of the troughs of the improvised hatchery of the previous year, to prevent suffocation among the fry. Hatching terminated in February, the fry having been liberated from week to week, within a river scope of 3 miles, as they arrived at the age to begin to take food. About 1,000,000 were released subsequent to March 1. In the months of May and June, 1891, the rack and traps were again overhauled and put in position for the operations of the coming season.

Aquaria at Central Station, Washington, D. C. (W. P. Seal, in charge).

1889-90.

In July, 1889, a new hot-air engine, equipped with vulcanized rubber pump and piping, was introduced for circulating the salt water, the brass piping being laid aside. By February, 1890, the water was rendered so clear by means of filters that all objects could be distinctly seen. The salt water lost by leakage was made up by supplies produced at the station by dissolving Turk Island salt in filtered water at the proper density; 1,000 gallons of sea water from Chesapeake Bay were furnished by the steamer *Fish Hawk*.

Collections of salt-water objects were received throughout the year, principally from Woods Holl Station, some being received from Gloucester Station, Mass., and others from Portland, Me., and the New Jersey coast. Fresh-water specimens were derived from the fish ponds, Washington, D. C., the Potomac River, creeks in Virginia accessible to the station by wagon, and from Fort Washington Station, Md.

Spawning was observed in the fresh-water aquaria as follows: Yellow perch, fifteen deposits of eggs from December to April, inclusive; three mussels in March and April; rainbow and tessellated darters in April. Yearling rainbow trout were held through the month of May in a temperature of 72° to 76° F.

In the salt water a rainbow trout spawned in March, 1890, after having deposited eggs a month previous in fresh water; several nests were built by the two-spined sticklebacks in April and May; several common killifish spawned in April; and in June king crab eggs were received and hatched. From unknown causes mollusca, hermit-crabs, anemones, starfish, and sea-urchins could not be successfully kept.

Colored and plain sketches were made by Mr. S. F. Denton illustrating the spawning habits of mussels and of rainbow and tessellated darters.

1890–91.

Two collecting trips were made down the Chesapeake Bay, and specimens were also obtained from Woods Holl Station, Cold Spring Harbor, and from other sources through the distribution cars. Young shad, 3 to 4 inches long, received from the fish ponds, Washington, D. C., in October, 1890, were with partial success held in the salt-water aquaria. Atlantic and quinnat salmon, and rainbow, brook, and lake trout yearlings were successfully kept in the salt water. About November 1, 1890, a large female skate was received and placed in a salt-water tank; in January several eggs were deposited, which, on May 12, were found to contain living embryos. Both the common newt and top-minnow reproduced in April in fresh water.

In December, 1890, the salt-water temperature fell to 48° F., when artificial heat was introduced into the tank room, which maintained a temperature of 50° to 54° during the remainder of the winter. In June the temperature went up to 80°.

STEAMER FISH HAWK (LIEUT. ROBERT PLATT, U. S. N., COMMANDING).

1889–90.

After the establishment of the shore station at Gloucester City the *Fish Hawk*, as in previous years, entered upon the propagation of shad on the Delaware River. The vessel was anchored off Gloucester, the water supply used in hatching operations being taken directly from the river. The crew began taking eggs April 30, using the launch *Petrel*. The river temperature was 57° F. By May 15 the water had risen to 63°, when the collections of eggs amounted to 27,234,000. On May 23 they amounted to 33,915,000, when the work closed, the temperature being 64°. There were produced 20,596,000 fry, which were liberated principally in the headwaters of the Delaware River. In addition, 3,654,000 eggs were transferred to the land station, for lack of space, and 15,000 forwarded to H. H. Fields, Museum of Comparative Zoölogy, Cambridge, Mass., for biological study.

The Gloucester Point seine afforded 2,488,000 eggs, which produced 81 per cent in fry; Faunce's seine, 10,566,000 eggs, which produced 70 per cent in fry; and Howell Cove seine, 20,861,000, which yielded 65 per cent in fry. The number of days when eggs were obtainable from these seines was 12, 14, and 17, respectively. More than 1,000,000 eggs per day were procured during five days at Faunce's; at Howell Cove more than 1,000,000 a day for five days and more than 2,000,000 a day during five other days. The average production of eggs to each fish was 49,000, which is largely in excess of the yield at the Susquehanna and Potomac river stations.

1890–91.

On June 17, 1891, operations were commenced in the propagation of Spanish mackerel, the locality selected being Cape Charles, Virginia. At the end of the fiscal year covered by this report, June 30, 1891, the work was in progress, the results to that date being embodied in tabular form. Subsequently, 1,364,000 eggs were obtained. These were collected on sixteen days between July 7 and 30, the fry produced and liberated therefrom being 410,000. The total eggs obtained were 2,494,000 and the total output of fry 776,000.

The ova were derived from adults taken in trap nets, which were regularly used in market fishing. The most forward eggs produced fry in 21½ hours, the longest period of hatching being 32¾ hours, and the average period about 26 hours. The fry were released in Chesapeake Bay.

Table showing operations in the propagation of the Spanish mackerel.

Date.	Fish stripped.		Number of eggs taken.	Hour of—		Date of release.	Number of fry released.
	Males.	Females.		Impregnation.	Hatching.		
1891.							
June 17	15	5	240,000	7:30 a. m.	5 a. m. June 18.	June 19	80,000
18	10	7	300,000	8 a. m.	5 a. m. June 18.	....	....
19	3	3	315,000	8:15 a. m.	5 p. m. June 20.	June 21	200,000
23	5	3	80,000	5:30 a. m.	8 a. m. June 24.	25	20,000
25	1	1	60,000	7 a. m.	8 a. m. June 26.	27	20,000
25	3	3	20,000	8 a. m.	9 a. m. June 26.	....	....
29	7	5	115,000	5 a. m.	8 a. m. June 30.	June 30	46,000
Total..	44	27	1,130,000	....	....	....	366,000

ADDITIONAL FISH-CULTURAL STATIONS.

New York.—In response to a resolution of the United States Senate of December 18, 1890, directing the U. S. Fish Commissioner to report to it upon the desirability of the Government's establishing a fish-hatchery in northern New York, near the St. Lawrence River, the following communication was addressed to the President of the Senate:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., January 26, 1891.

SIR: In obedience to Senate resolution of December 18, 1890, directing the U. S. Commissioner of Fish and Fisheries to report to the Senate as to the desirability of the establishment of a fish-hatchery in northern New York, near the St. Lawrence River, I have the honor to report as follows:

The basin of the St. Lawrence, including Lake Ontario and Lake Champlain and the innumerable smaller lakes and tributary streams which drain into these, comprises fully one-half of the area of the State of New York, about one-fourth of the State of Vermont, and on the Canadian side a more considerable drainage area.

In Lake Ontario whitefish were formerly very abundant. The value of this fishery has declined year by year, and at present the production is relatively insignificant compared with the whitefish fisheries of Lake Erie, Lake Huron, and Lake Michigan.

In the waters referred to a like decline was in progress, but those who were interested in those fisheries were prompt to recognize the necessity of legislation to restrain and regulate the methods and apparatus and seasons of capture.

Artificial propagation was also systematically resorted to to supplement and reinforce natural reproduction, and whitefish hatcheries were established by the States of Michigan, Ohio, and Wisconsin and by the Canadian Government. Entering the field at a later date, the U. S. Commission has established stations for the collection and hatching of whitefish at Alpena, Mich., Duluth, Minn., and Put-in Bay, Ohio.

The result of the coöperative fish-culture work by the Canadian, State, and United States Fish Commissions has been not only to arrest the alarming decline that was in progress, but to determine a marked increase in the catch of whitefish in those waters in which fish-cultural work has been carried on.

The marked contrast between the present conditions of the whitefish fisheries of Lake Erie and Lake Ontario sharply defines and emphasizes the necessity of artificial propagation as a means of maintaining and improving our important commercial fisheries and of creating such in waters where they have not before existed.

We can not afford to neglect so important an economic resource—one which gives such substantial and valuable returns for moderate expenditures.

We can not expect individual enterprise to undertake such work in public waters in the expectation of private gain. Men, however public-spirited, will not sow the seed of a harvest which all men may gather. Our lakes and rivers and coast waters must be farmed by the Government for the general use and under such regulations as will establish and maintain the largest production.

Another important commercial species which formerly existed in Lake Ontario in marvelous abundance, but which is now so rare as to be an object of curious interest when seen, is the Atlantic salmon. Sixty years ago each season it ascended the St. Lawrence in vast numbers and swarmed in all its tributaries. Following both shores of Lake Ontario it ascended all the smaller streams which fall into it and which afford suitable spawning-grounds for the mature fish and favorable nurseries for the fry during their period of river life.

The following extract from the annual report of the department of marine and fisheries of Canada for the year ending June 30, 1869, will be instructive as well as suggestive.

[Special report of Messrs. Whitcher and Venning on fish-breeding at New Castle, Ontario.]

"We proceeded yesterday to New Castle, Ontario, in compliance with your directions, and made a personal inspection of the fish-breeding establishment there under charge of Mr. Wilmot. The premises are situated on Baldwin or Wilmot Creek, a small stream traversing the township of Clarke, in the county of Durham, and discharging into Lake Ontario, about 40 miles east of Toronto. This creek is well situated for salmon, as it forms a natural inlet of the sheltered bend of the lake between Bendhead and Darlington.

"Although at the entrance into the lake it passes through a marshy lagoon, the bed of the stream farther inland is of a gravelly nature and the water is pretty clear, regular, and lively in its flow.

"In early times it was famous for salmon, great numbers of which frequented it every autumn for the purpose of spawning. They were so plentiful forty years ago that men killed them with clubs and pitchforks, women seined them with flannel petticoats, and settlers bought and paid for farms and built houses from the sale of salmon. Later they were taken by nets and spears, over 1,000 being often caught in the course of one night.

"Concurrently with such annual slaughter manufactories and farming along the banks had obstructed, fouled, and changed the creek from its natural state and made it less capable of affording shelter and spawning.

"Their yearly decreasing numbers at length succumbed to the destruction practiced upon them each season from the time of entering the creek until nearly the last straggler had been speared, netted, or killed."

The history of the salmon fisheries of Wilmot Creek, so graphically told by the Canadian commissioners, has been repeated in every stream of the State of New York which drains into Lake Ontario and the St. Lawrence River. All were frequented by the salmon, and from each, each season, went out a numerous colony of parr and smolts, which descended the St. Lawrence to the gulf, where they remained until they had attained size and maturity, when, obeying the impulse of reproduction, they ascended the St. Lawrence and distributed themselves to all the tributaries of lake and river, carrying back to these inland waters the rich harvest of the sea which they had garnered.

This magnificent fishery has ceased to be. Did it exist to-day, and were the conditions which made such a fishery possible prevailing to-day, a hundred streams now barren would afford salmon fishing as attractive as the more favored waters of Canada, and the catch by net in the lake itself would furnish the motive of a valuable commercial fishery.

The cause of the disappearance, practically, of salmon from the streams of the St. Lawrence Basin has been chiefly and primarily the erection of obstructions in all of the rivers, which have prevented the salmon from reaching their spawning-grounds, and so natural reproduction has been absolutely inhibited.

The restoration and maintenance of the whitefish fisheries of Lake Erie, or of the salmon fishery of the lake and rivers, would either of them furnish sufficient motive for liberal expenditures on the part of the Government, if we consider the matter from a purely practical and economic standpoint. It is not only possible, it is entirely practicable, to restore and maintain these fisheries, by adequate recourse to means and agencies entirely within our control.

The regeneration of the fisheries must be accomplished through fish-cultural work, systematically and persistently pursued. Their maintenance must be assured by concurrent regulation of the lake fisheries by the United States and Canada and by the enforcement on the part of the State of New York of such regulations and requirements as will permit the salmon to ascend to their spawning-grounds. In the absence of such regulations and requirements it will not be reasonable to expect that the results of fish-cultural work will be permanent or compensating, however extensive such work may be.

A fish-cultural station planned to meet all the requirements must be very extensive and complete in all its appointments, and will involve larger expenditure than would be required for a station devoted exclusively to the production of whitefish or the salmonidæ. The hatchery must be commodious, providing at once for the hatching of 100,000,000 of whitefish and for the incubation of 1,000,000 salmon ova. It must also provide trough accommodations for holding 1,000,000 salmon fry for some weeks after they begin feeding. Quarters, offices, storage rooms, and shops must be erected; an extensive system of ponds for rearing the salmon must be constructed, for none would be released in open waters until they were of sufficient size to have comparative immunity from capture by other fish.

At the first installation of the station and for several years it would be necessary to draw our supplies of whitefish ova from our collecting stations on the upper lakes and our salmon ova from Maine. With the improvement of the fisheries we should expect to find our eventual source of supply in Ontario waters, and the location of the station should be with reference to this. Wherever placed it should be convenient to transportation routes, and should control a gravity water supply which should be without stint or measure.

The cost of such a station as I have indicated, complete in all its appointments, would not be less than $20,000, exclusive of cost of site and water franchises, and for its maintenance there would be required an appropriation of $9,000 per annum.

Respectfully,

MARSHALL MCDONALD,
U. S. Commissioner of Fisheries.

Hon. LEVI P. MORTON,
Vice-President.

A consideration of the report resulted in an appropriation of $5,000 in the bill approved March 3, 1891, providing for the sundry civil expenses of the Government during the fiscal year ending June 30, 1892. This appropriation not being available till July 1, 1891, action in the matter was necessarily deferred.

Vermont.—On January 12, 1891, Hon. W. W. Grout, Representative from Vermont, introduced in the House of Representatives a bill providing the sum of $15,000, "for the purchase of ground, construction of buildings and ponds, and the purchase of the equipment for a fish-hatchery and rearing station to be established in the State of Vermont, at a place to be designated by the United States Fish Commissioner." The bill was referred to the Committee on Commerce, by which it was returned to the House on January 30, with the recommendation that it pass. The bill as presented failed to become a law, though provision for the station was made in the sundry civil bill approved March 3, 1891. The appropriation not being available till July 1, 1891, no action could be taken till after that date.

Montana and Gulf States.—Congress, by act approved March 3, 1891, provided the sum of $2,000 "for investigation respecting the advisability of establishing a fish-hatching station in the Rocky Mountain region in the State of Montana or Wyoming, and also a station in the Gulf States." Instructions were prepared covering the extent and character of the investigations and early in the following July, when the appropriation became available, Prof. B. W. Evermann, assistant in the Division of Scientific Inquiry, was charged with the same.

RAILROAD SERVICE.

The following statement exhibits the mileage of cars and detached messengers in the work of distribution:

Items.	Carp.	Shad.	Salmon and trout.	White-fish.	Pike perch.	Other fish.	Other work.	Total.
Fiscal year 1889-90:								
Car No. 1		683	9,014	719	2,775	18,104		31,295
Car No. 2		4,503	4,798			11,642		20,943
Car No. 3	9,455	5,483					8,136	23,074
Car No. 101, Philadelphia, Wilmington and Baltimore R. R.								
Messengers	284	12,233	20,615	1,647		15,230		50,009
	9,739	22,902	34,427	2,366	2,775	44,976	8,136	125,321
Fiscal year 1890-91:								
Car No. 1		932	9,451	773	2,652	23,547		37,355
Car No. 2	9,045	8,239	21,458	1,002		5,591		45,335
Car No. 3	1,564	7,881	6,879	2,540		20,149		39,013
Car No. 101, Philadelphia, Wilmington and Baltimore R. R.		3,281						3,281
Messengers	10,385	17,252	19,860		1,127	6,642		55,266
	20,994	37,585	57,648	4,315	3,779	55,929		180,250

Thanks are due to the following-mentioned railroads, which have furnished free transportation for the cars of the Commission:

Name of railroad.	1890.	1891.	Name of railroad.	1890.	1891.
	Miles.	*Miles.*		*Miles.*	*Miles.*
Atchison, Topeka and Santa Fe	1,689	2,136	Louisville, New Albany and Chicago	755	632
Burlington and Missouri River in Nebraska	354		Louisville, St. Louis and Texas		170
Burlington, Cedar Rapids and Northern	1,063	1,818	Louisville and Nashville	262	
Canada Southern	251		Michigan Central	2,546	5,627
Chicago, Burlington and Quincy	6,558	10,086	Missouri Pacific	770	985
Chicago, Milwaukee and St. Paul	34		Missouri, Kansas and Texas	2,175	234
Chicago and Iowa		124	Mobile and Ohio	70	28
Chicago and Northwestern	397	226	Montana Central	90	
Chicago and West Michigan		352	Montana Union		45
Chicago, Burlington and Northern	2,575		Northern Pacific	4,119	11,465
Chicago, Rock Island and Pacific		206	Ohio and Mississippi	202	
Cleveland, Cincinnati, Chicago and St. Louis	307	904	Oregon Railway and Navigation Company	211	
Delaware and Hudson		128	Pittsburg, Cincinnati, Chicago and St. Louis		136
Denver and Rio Grande		72	St. Louis, Arkansas and Texas	186	
Detroit, Bay City and Alpena	210	1,260	St. Louis, Iron Mountain and Southern	198	490
Detroit, Lansing and Northern		886	St. Louis, Keokuk and Northwestern	1,149	822
Duluth, South Shore and Atlantic	410	2,898	St. Paul, Minneapolis and Manitoba	4,292	
Duluth and Iron Range		12	St. Louis and San Francisco	987	1,598
Flint and Pere Marquette	1,331	3,545	Texas Pacific	648	612
Fremont, Elkhorn and Missouri Valley	452	1,057	Toledo, Ann Arbor and North Michigan		36
Grand Rapids and Indiana	758	1,374	Toledo, Peoria and Western		64
Grand Trunk		22	Union Pacific		15,379
Hannibal and St. Joe	1,808		Utah Central	74	
Illinois Central	441	431	Wabash	2,795	4,933
International and Great Northern		360	Wisconsin Central	462	962
Jacksonville Southeastern	262	362	Total	41,339	73,344
Kansas City, Fort Scott and Memphis		646			
Kansas City, Fort Smith and Southern		120			
Lake Shore and Michigan Southern	448	101			

GENERAL ADMINISTRATION.

In the conduct of the routine of the office and matters of administration the Commission has continued to receive the efficient aid of the chief clerk, Mr. J. J. O'Connor, and the disbursing agent, Mr. Herbert A. Gill.

INVESTIGATION BY UNITED STATES SENATE.

During the latter part of the fiscal year 1890 there appeared in the public press a number of articles adversely criticising the administration of the Commission, and making charges of inefficiency, extravagance, and dishonesty on the part of its personnel. These charges were given such a wide circulation that the Commissioner deemed it proper to call them to the attention of Congress, and at his request the following resolution was introduced in the Senate by Senator Edmunds on June 3, 1890:

Resolved, That the Committee on Fish and Fisheries be, and it is hereby, instructed to make an early inquiry into the administration of the affairs of the United States Fish Commissioners's office, and especially in respect to the changes in the force, compensation paid to employés, and any alleged favoritism, or other undue administration, and report to the Senate thereon.

Resolved, That the said committee have power to send for persons and papers.

On June 5, 1890, the resolution was agreed to, and the investigation was placed in the charge of a subcommittee consisting of Senators Stockbridge, Squire, and Blodgett. The first session of the committee was held on June 13, 1890, and was continued at intervals until September 15, 1890. The testimony (Mis. Doc. No. 77, U. S. Senate, Fifty-first Congress, second session) embraced 666 octavo pages of printed matter, and the report of the committee (Report No. 2361, U. S. Senate, Fifty-first Congress, second session), with a synopsis of the testimony, 86 pages additional. The report is as follows:

The Committee on Fish and Fisheries of the Senate, to whom was referred the resolution of June 3, 1890, as follows:

> *Resolved,* That the Committee on Fish and Fisheries be, and it is hereby, instructed to make an early inquiry into the administration of the affairs of the United States Fish Commissioner's office, and especially in respect of the changes in the force, compensation paid to employés, and any alleged favoritism, or other undue administration, and report to the Senate thereon.
>
> *Resolved,* That the said committee have power to send for persons and papers.

Beg leave to make the following report:

The passage of the foregoing resolution was owing to the publication of certain charges of a rather sensational character which appeared in the press of the country, seriously reflecting, not only upon the administration of the affairs of the Fish Commission, but also upon the character and integrity of some of the officials connected therewith.

The charges so made, having been brought to the attention of the Commissioner, he very promptly asked an investigation.

The maladministration charged included among other things:

(*a*) Entire lack of system and proper discipline in every department of the Commission, resulting in a greatly increased and useless expenditure of money.

(*b*) That the Commissioner and other officials, taking advantage of their positions, at the expense of the Government used the boats and fish-hatchery stations of the Commission as a means of private enjoyment for themselves and friends.

(*c*) That the employés of the Commission were addicted to the use of intoxicating liquors to the extent of neglecting their duties and disgracing the service.

(*d*) That falsified statements of numbers of fish planted in the various lakes and rivers of the country had been prepared under the direction of the Commissioner, with the deliberate purpose in view of using the same before the committees of Congress in order to influence more liberal appropriations than might otherwise be made.

(*e*) That political considerations were governing the matter of appointments within the Commission.

(*f*) That the Commissioner was guilty of nepotism.

(*g*) That under the present régime the rule was, increased appropriations and an extravagant expenditure of money in all branches of the work of the Commission; among other things an unwarranted increase in the salaries of certain favored employés.

(*h*) That the time of certain employés was being taken up, and material belonging to the Government used, in perfecting certain patents solely for the personal benefit of the Commissioner.

(*i*) That the present force of clerks and assistants in the Commission had been very greatly increased, with a corresponding expenditure of money, while the practical and scientific results do not compare favorably with those attained under Prof. Baird.

The charges summed up can be best expressed in three words, viz, inefficiency, extravagance, dishonesty.

Your committee at its first meeting after the passage of the resolution of investigation appointed a subcommittee, consisting of its chairman and Senators Blodgett and Squire, to investigate the affairs of the Fish Commission in respect to the charges referred to. Every person whose name was known to the committee as being in any way connected with the publication or dissemination of the said charges was notified that the committee would give him an opportunity to be heard and would also be glad to have him submit the names of any persons whom he desired subpœnaed; also that any material and relevant interrogatories which he might desire to have propounded to witnesses would be so propounded upon filing the same in writing with the clerk of the committee.

The hearings of the subcommittee were not public; neither were those who stood in the light of prosecuting the charges nor any member of the Fish Commission permitted to be present or represented by attorney.

In all, 63 witnesses were sworn and examined, a very great majority of whom were subpœnaed at the special instance of the persons appearing to have charge of the case against the Fish Commission. In every instance the committee accepted all the interrogatories filed, and although many were of doubtful relevancy, they were propounded to the witnesses designated, and also upon request of the same individuals subpœnas were issued for every person whose name was furnished where it was in the least made to appear that the testimony of such persons would be at all relevant to the subject-matter of the investigation, and great care was exercised to secure a full and impartial investigation of the pending charges without favor to anyone.

The testimony so taken and submitted with this report comprises over 650 printed pages, so that, in order to facilitate an examination of the same, your committee have prepared, and herewith submit as a part of this report, a synopsis of the testimony, indexed and arranged under separate topics, with references by page to the printed volume of testimony, which, as your committee believe, renders any lengthy detailed report entirely unnecessary.

It will suffice to say, in a general way, that not one of the charges affecting the administration of the affairs of the Commission, or the standing and integrity of any official connected therewith, has been proven to have any foundation in fact whatever; further, that after a most searching examination into the administration of the affairs and methods of the Commission, your committee are satisfied that there has not been extravagance, dishonesty, or inefficiency in its conduct; but, on the contrary, throughout the entire Commission the most perfect system and discipline prevail, resulting in an economical and judicious expenditure of the appropriations made by Congress.

The profligate use of money, as complained of, is not a charge which can be made against the present Commissioner and be sustained. The increase of the expenses of the Commission is entirely due to the enlarged field of work.

And right here your committee beg to call particular attention to the testimony (pp. 339 to 346) for a full statement of the work of the Commission in the past and what it is doing to-day.

We find that the Commissioner has not used the boats, fish-hatchery stations, or other property of the Government for purposes not within the scope of the work of the Commission. It is true that members of Congress and others have been invited to visit the stations and inspect the work of the Commission, but such visits have resulted in no expense to the Government, and it appears from abundant proof that where entertainment has been provided upon the occasion of these visits it has been at the private expense of the Commissioner.

The charges of intemperance, when fully examined, narrowed down practically to a specific charge that one certain official, upon a single occasion, drank liquor and became intoxicated. The testimony is not of such a character as to create the impression upon the minds of the respective members of the committee that the official was in the habit of using, even occasionally, stimulants to an excess, or in any such way as to unfit him for his duties. The party himself denies the charge of ever being intoxicated, and a number of reputable witnesses who had been intimately associated with him swear unqualifiedly that the man was not of intemperate habits.

Respecting the allegation that the records of the Commission have been falsified for the purpose of showing a greater number of fish planted in the lakes and rivers than was actually the case, your committee have to say that the records of the Commission in the matter of the distribution of fish and eggs are kept in such a manner as to almost preclude a possibility of anything of the kind, but beyond that, it satisfactorily appears from the showing made that the records respecting this branch of the work have been kept with a conscientious regard for the truth. Equally groundless are the charges that the Commissioner has been governed by political considerations in the matter of appointments to positions in the Commission, or that he is guilty of the charge of nepotism.

It is true, as has been charged, that the force of assistants employed in connection with the work of the Commission has been increased over the number employed in former years, and that there has been a corresponding increase in the cost of maintaining it; but it must be remembered that during the fiscal year ending June 30, 1887, there were but twelve fish-hatching stations in operation, while during the year ending June 30, 1890, there were twenty-one; also, that the production of eggs, fry, and yearling fish for the fiscal year ending June 30, 1887, was 259,000,000, while for the year ending June 30, 1890, it was 358,000,000, or an increase of 99,000,000.

It should also be remembered that the amount of money available for the propagation of food-fishes and for the general administration was, in 1887, $136,614.92, while in 1890 it was only $160,000. We feel warranted in saying that the practical and scientific results of the work of the Commission exceed anything heretofore attained and that with a very moderate increase in cost to the Government over former years.

In conclusion, your committee, in view of the great importance to the country of the work of the Commission and the urgent necessity for its continuance, ask a careful examination of the testimony herewith presented, believing that it is sufficient to convince all fair-minded persons that there is no just cause to criticise the policy of the Commission or the course of the Commissioner and his subordinates in the matter of administration, but, on the contrary, that they deserve commendation for the conscientious work which they are performing.

FRANCIS B. STOCKBRIDGE.
WATSON C. SQUIRE.
RUFUS BLODGETT.

PUBLICATIONS AND LIBRARY.

The editing of the publications of the Commission and their supervision through the press has continued under the direction of Dr. T. H. Bean, the ichthyologist of the Commission. These publications consist of "Reports" and "Bulletins." In the former are published the reports of the operations of the Commission; and in the latter, such articles as are "relative to new observations, discoveries, and applications connected with fish-culture and the fisheries." Prior to 1888 the Bulletin was chiefly composed of short articles, extracts, etc., from the official correspondence, and translations of foreign publications. Since then, however, the increase of the operations of the Commission has made it possible to apply this publication almost exclusively to the results of the Commission's work. The law authorizing the Bulletin limits the number of its pages to 500, and permits its distribution in parts. The articles composing the Reports have likewise been published and issued prior to the completion of the volume as a whole, resulting in the early dissemination of the knowledge acquired by the investigations made by the Commission. The law authorizing these two volumes provides for their distribution by the United States Senate and House of Representatives, and a small quota by the Commission. From the number assigned to the Commission, the policy is to supply various public libraries and institutions of learning, and such persons who, by reason of their professions or occupations, are specially interested in the subject-matter.

During the fiscal year 1889–90 the following papers were issued:

The report proper of the Commissioner for 1886 (Report for 1886, pp. I to LVII).

The beam-trawl fishery of Great Britain, with notes on beam-trawling in other European countries, etc. By J. W. Collins. (Bulletin, 1887, pp. 289 to 407.)

The aquarium: A brief exposition of its principles and management. By William P. Seal. (Bulletin, 1887, pp. 274 to 282.)

Explorations of the fishing-grounds of Alaska, Washington Territory, and Oregon during 1888, by the U. S. Fish Commission steamer *Albatross*, Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. (Bulletin, 1888, pp. 1 to 95.)

Report of explorations made during the summer and autumn of 1888 in the Allegbany region of Virginia, North Carolina, and Tennessee, and in western Indiana, with an account of the fishes found in each of the river basins of those regions. By David Starr Jordan. (Bulletin, 1888, pp. 97 to 173.)

Suggestions for the employment of improved types of vessels in the market fisheries, with notes on British fishing steamers. By J. W. Collins. (Bulletin, 1888, pp. 175 to 192.)

Notes on fishes collected at Cozumel, Yucatan, by the U. S. Fish Commission, with descriptions of new species. By Tarleton H. Bean. (Bulletin, 1888, pp. 193 to 206.)

The most recent methods of hatching fish eggs. By William F. Page. (Bulletin, 1888, pp. 207 to 218.)

During the year 1890–91, there appeared—

Review of the fisheries of the Great Lakes in 1885. Compiled by Hugh M. Smith and Merwin-Marie Snell; with introduction and description of fishing vessels and boats, by J. W. Collins. (Report, 1887, pp. 1 to 333 and 45 plates.)

A report upon the fishes of Kalamazoo, Calhoun, and Antrim counties, Mich, By Charles H. Bollman. (Bulletin, 1888, pp. 219 to 225.)

Notes on fishes from the lowlands of Georgia, with a description of a new species (*Opsopœodus bollmani*). By Charles H. Gilbert. (Bulletin, 1888, pp. 225 to 229.)

The sturgeon and sturgeon industries of the eastern coast of the United States, with an account of experiments bearing upon sturgeon-culture. By John A. Ryder. (Bulletin, 1888, pp. 231 to 328.)

A review of the genera and species of *Serranidæ* found in the waters of America and Europe. By David Starr Jordan and Carl H. Eigenmann. (Bulletin, 1888, pp. 329 to 441.)

Report on the proposed introduction of the Jamaica mountain mullet into the United States. By Tarleton H. Bean. (Bulletin, 1888, pp. 443 to 451.)

The transplanting of lobsters to the Pacific Coast of the United States. By Richard Rathbun. (Bulletin, 1888, pp. 453 to 472.)

Preliminary report upon the invertebrate animals inhabiting lakes Geneva and Mendota, Wisconsin, with an account of the fish epidemic in Lake Mendota in 1884. By S. A. Forbes. (Bulletin, 1888, pp. 473 to 487.)

Report of explorations in Colorado and Utah during the summer of 1889, with an account of the fishes found in each of the river basins examined. By David Starr Jordan. (Bulletin, 1889, pp. 1 to 40.)

On two species of larval dibothria from the Yellowstone National Park. By Edwin Linton. (Bulletin, 1889, pp. 65 to 79.)

The artificial propagation of sturgeon in Schleswig-Holstein, Germany. (Translated from the German.) (Bulletin, 1889, pp. 81 to 90.)

On certain wart-like excresconces, occurring on the short minnow, *Cyprinodon variegatus*, due to psorosperms. By Edwin Linton. (Bulletin, 1889, pp. 99 to 102.)

Notes on the crab-fishery of Crisfield, Md. By Hugh M. Smith. (Bulletin, 1889. pp. 103 to 112.)

Report of explorations made in Missouri and Arkansas during 1889, with an account of the fishes observed in each of the river basins examined. By Seth Eugene Meek. (Bulletin, 1889, pp. 113 to 141.)

Report of explorations made in Alabama during 1889, with notes on the fishes of the Tennessee, Alabama, and Escambia rivers. By Charles H. Gilbert. (Bulletin, 1889, pp. 143 to 159.)

Report on the salmon and salmon rivers of Alaska, with notes on the conditions, methods, and needs of the salmon fisheries. By Tarleton H. Bean. (Bulletin, 1889, pp. 165 to 208.)

The fishing-grounds of Bristol Bay, Alaska: A preliminary report upon the investigations of the U. S. Fish Commission steamer *Albatross* during the summer of 1890. By Lieut. Commander Z. L. Tanner, U. S. Navy. (Bulletin, 1889, pp. 279 to 288.)

Notes on an improved form of oyster-tongs. By Hugh M. Smith. (Bulletin, 1889, pp. 161 to 163.)

A contribution to the life-history of *Dibothrium cordiceps* Leidy, a parasite infesting the trout of Yellowstone Lake. By Edwin Linton, PH. D. (Bulletin, 1889, pp. 337 to 358.)

The collections made by the Fish Commission steamer *Albatross* during the years 1887, 1888, and 1889 will, in accordance with law, be deposited in the U. S. National Museum, under direction of the Smithsonian Institution. The following papers giving the results of the study of the collections, were published in the Proceedings of the U. S. National Museum under the general title, "Scientific Results of Explorations by the U. S. Fish Commission steamer *Albatross*." They are:

No. I. Birds collected on the Galapagos Islands in 1888. By Robert Ridgway, curator of the department of birds. (Proc. U. S. N. M., 1889, pp. 101 to 128.)

No. II. Birds collected on the island of Santa Lucia, West Indies, the Abrolhos Islands, Brazil, and at the Straits of Magellan, in 1887–88. By Robert Ridgway, curator of the department of birds. (Proc. U. S. N. M., 1889, pp. 129 to 139.)

No. III. Report on the batrachians and reptiles collected in 1887–88. By E. D. Cope. (Proc. U. S. N. M., 1889, pp. 141 to 147.)

No. IV. Descriptions of new species of fishes collected at the Galapagos Islands and along the coast of the United States of Colombia, 1887–88. By David Starr Jordan and Charles Harvey Bollman. (Proc. U. S. N. M., 1889, pp. 149 to 183.)

No. V. Annotated catalogue of the insects collected in 1887–88. By L. O. Howard, acting curator of the department of insects. (Proc. U. S. N. M., 1889, pp. 185 to 216.)

No. VI. List of the plants collected in Alaska in 1888. By Dr. George Vasey. (Proc. U. S. N. M., 1889, pp. 217 to 218.)

No. VII. Preliminary report of the collection of mollusca and brachiopoda obtained in 1887–88. By William Healy Dall, A. M., curator of the department of mollusks. (Proc. U. S. N. M., 1889, pp. 219 to 362.)

No. VIII. Description of a new cottoid fish from British Columbia. By Tarleton H. Bean, ichthyologist, U. S. Fish Commission. (Proc. U. S. N. M., 1889, pp. 641 to 642.)

No. IX. Catalogue of fishes collected at Port Castries, St. Lucia, by the steamer *Albatross*, November, 1888. By David Starr Jordan. (Proc. U. S. N. M., 1889, pp. 645 to 652.)

No. X. On certain mesozoic fossils from the islands of St. Paul and St. Peter, in the Straits of Magellan. By Charles A. White. (Proc. U. S. N. M., 1890, pp. 13, 14.)

No. XI. New fishes collected off the coast of Alaska and the adjacent region southward. By Tarleton H. Bean. (Proc. U. S. N. M., 1890, pp. 37 to 45.)

No. XII. A preliminary report on the fishes collected by the steamer *Albatross* on the Pacific coast of North America during the year 1889, with descriptions of twelve new genera and ninety-two new species. By Charles H. Gilbert, professor of zoölogy, University of Indiana. (Proc. U. S. N. M., 1890, pp. 49 to 126.)

No. XIII. Catalogue of skeletons of birds collected at the Abrolhos Islands, Brazil, the Straits of Magellan, and the Galapagos Islands, in 1887–88. By Frederic A. Lucas, assistant curator of the department of comparative anatomy. (Proc. U.S.N.M., 1890, pp. 127 to 130.)

No. XIV. Birds from the coasts of western North America and adjacent islands, collected in 1888-89, with descriptions of new species. By Chas. H. Townsend, resident naturalist of the steamer *Albatross*. (Proc. U. S. N. M., 1890, pp. 131 to 142.)

No. XV. Reptiles from the Clarion and Socorro islands and the Gulf of California, with descriptions of a new species. By Chas. H. Townsend, resident naturalist of the steamer *Albatross*. (Proc. U. S. N. M., 1890, pp. 143, 144.)

No. XVI. Plants collected in 1889 at Socorro and Clarion islands, Pacific Ocean. By Dr. Geo. Vasey and J. N. Rose, botanist and assistant botanist, Department of Agriculture. (Proc. U. S. N. M., 1890, pp. 145 to 149.)

No. XVII. Descriptions of new West American land, fresh-water, and marine shells, with notes and comments. By Robert E. C. Stearns, adjunct curator of the department of mollusks. (Proc. U. S. N. M., 1890, pp. 205 to 225).

No. XVIII. Lists of fishes obtained in the harbor of Bahia, Brazil, and in adjacent waters. By David Starr Jordan, president of the University of Indiana. (Proc. U. S. N. M., 1890, pp. 313 to 336.)

No. XIX. A supplementary list of fishes collected at the Galapagos Islands and Panama, with descriptions of one new genus and three new species. By Charles H. Gilbert, professor of zoölogy, University of Indiana. (Proc. U. S. N. M., 1890, pp. 449 to 455).

During the period covering the months from February to May, 1891, the Fish Commission steamer *Albatross*, by special authorization of the President, made an extended cruise along the west coast of Central America and the Galapagos Islands, including also the west coast of Mexico and the Gulf of California. The scientific work of the vessel was under the direction of Prof. Alexander Agassiz, of the Museum of Comparative Zoölogy, Cambridge, Mass. The specimens collected were taken in charge by him, and groups distributed to specialists for examination and report, and the results will be duly published.

The distribution of the publications of the Commission consisted of 1,953 copies of the Reports, 2,045 copies of the Bulletins, and about 6,500 copies of articles, in pamphlet form, extracted from the Reports and Bulletins. In addition to these there were issued 1,372 copies of the reports prepared by the Commission in conjunction with the Tenth Census on the "Fisheries and Fishery Industries of the United States," and 1,278 copies of the report from the Committee on Merchant Marine and Fisheries of the House of Representatives in an "Investigation of the Fur-Seal and other Fisheries of Alaska" (Report No. 3883, House of Representatives, Fiftieth Congress, second session), of which a number were assigned by act of Congress to this Commission.

The accessions to the library, mainly obtained through gift and exchange for the publications of the Commission, embraced 1,694 volumes, including pamphlets and periodicals. Of these 457 related to fish, fish-culture, and the fisheries, and 1,237 to geology, botany, zoölogy, and the natural sciences in general.

ERECTION OF FISHWAYS AT THE GREAT FALLS OF THE POTOMAC.

By act of Congress approved February 1, 1888, an additional appropriation of $25,000 was made for completing the construction of the fishways at the Great Falls of the Potomac, there being already available for this purpose $5,042.32, the balance of the previous appropriation of $50,000 made by act approved July 12, 1882. In pursuance of instructions from the Chief of Engineers, U. S. Army, Col. J. M. Wilson, then in charge of the Washington Aqueduct, addressed me under date of June 4, 1889, as follows:

OFFICE OF THE WASHINGTON AQUEDUCT,
Washington, D. C., June 4, 1889.

SIR: I have the honor to inform you that I have this day received from the Chief of Engineers your letter of the 14th ultimo to the Secretary of War, with various indorsements thereon, together with copies of the letter of the 31st ultimo to you from the Acting Secretary of War.

The Chief of Engineers has directed me as follows:

"Col. Wilson will place himself in communication with the Commissioner of Fish and Fisheries with a view to having detailed plans and specifications prepared, contracts drawn, and an inspector nominated. After approval by this office, the work will be carried out under the direction of said inspector, Col. Wilson confining his supervision to seeing that the dam is not injured and that the disbursement of the money is properly made."

In view of the foregoing order I have the honor to request that you will please cause to be prepared and sent to me, at your convenience, plans and specifications in detail of the proposed fishways, and that you will nominate as inspector such person as you may deem fit to inspect this important work.

It has been the custom of this office to pay ordinary inspectors about $100 per month, but in view of the character of your work, which will probably require the services of an expert, I think his salary should be higher, probably from $120 to $140 or $150 per month, depending upon his skill and capacity.

The plans and specifications should be complete, the latter entering into the minutest detail, as they become a part of the contract, and any omission, however trifling, may lead to complications with contractors.

As soon as these plans and specifications reach me, I will prepare advertisements inviting proposals, and after the work is awarded will, subject to the approval of the Chief of Engineers, enter into contract for the work.

As soon as the contractor is ready to begin, I will notify you, and your inspector can then be appointed and assigned to duty.

In all payments upon vouchers, I shall request your certificates as to quantity of materials received, time employed, etc., and, based upon them, will make payments as required by order of the Secretary of War.

If agreeable to you, I will be glad to see you at this office any day between 11 a. m. and 12:30 p. m., to consult in reference to this matter; or, if you prefer it, I will take pleasure in coming to your office any day you may mention after 4 p. m.

I am, sir, very respectfully, your obedient servant,

JOHN M. WILSON,
Colonel, U. S. Army.

HON. MARSHALL MCDONALD,
Commissioner of Fish and Fisheries, Washington, D. C.

After conference with Col. Wilson and acting in accordance with his suggestions, the work of preparing the necessary plans and specifications was assigned to Mr. C. E. Gorham, the engineer officer of the Commission.

During the winter of 1889–90, the plans and specifications were carefully studied and revised and were ready for transmission in April, 1890, but owing to various delays and the difficulty of finding a suitable person to designate as inspector, were not transmitted until after the close of the fiscal year covered by this report.

WORLD'S COLUMBIAN EXPOSITION.

Section 16 of the act of Congress approved April 25, 1890, "To provide for celebrating the four hundredth anniversary of the discovery of America by Christopher Columbus by holding an international exhibition of arts, industries, manufactures, and the products of the soil, mines, and sea, in the city of Chicago, in the State of Illinois," directs—

That there shall be exhibited at said Exposition by the Government of the United States, from its executive departments, the Smithsonian Institution, the U. S. Fish Commission, and the National Museum, such articles and materials as illustrate the function and administrative faculty of the Government in time of peace and its resources as a war power, tending to demonstrate the nature of our institutions and their adaptation to the wants of the people; and to secure a complete and harmonious arrangement of such a Government exhibit, a board shall be created to be charged with the selection, preparation, arrangement, safe keeping, and exhibition of such articles and materials as the heads of the several departments and the directors of the Smithsonian Institution and National Museum may respectively decide shall be embraced in said Government exhibit. The President may also designate additional articles for exhibition. Such board shall be composed of one person to be named by the head of each executive department, and one by the directors of the Smithsonian Institution and National Museum, and one by the Fish Commission, such selections to be approved by the President of the United States. (U. S. Stat. 26, pp. 62 *et seq.*)

In pursuance of law, the Commissioner named Mr. J. W. Collins, assistant in charge of the Division of Fisheries, as the representative of the Commission on the Government Board of Control and Management, and his designation having been approved by the President, Mr. Collins entered upon his duties in August, 1890. No active work was undertaken until April, 1891, when certain of the personnel were appointed, a building at 210 Tenth street, N. W., Washington, was leased and fitted up for offices and work shops, and the preparations commenced.

In response to a communication from the Secretary of the Treasury requesting an estimate of the money and space required for an adequate exhibit of the fisheries and fishery resources of the United States at the World's Columbian Exposition, the Commissioner of Fisheries replied as follows:

In compliance with your request, I have the honor to transmit herewith estimates of the cost of preparing, placing, caring for, and returning such an exhibit of the fisheries and fishery resources of the United States as should in my judgment be made at the World's Fair in Chicago in 1893.

Such an exhibit should not only be an exposition of our fishery resources, and of the present conditions, methods, and results of the fisheries, but should also show the origin, progress, present conditions, methods, and results of the inquiry in regard to food-fishes and the fishing-grounds—an inquiry which has been most fruitful in results, economic as well as scientific, and which has served as a model, a stimulus, and an inspiration to other nations seeking the best means for the utilization of the resources of their waters.

The exhibit should show also the beginning and progress, as well as the present condition, of the commercial fisheries, and the development of methods, apparatus, vessels, and boats to meet the new conditions or exigencies arising from time to time. It should show the origin and development of public fish-culture in the United States, and the present conditions, methods, and results of the work of the U. S. Fish Commission.

The exhibit, in its essential features, would illustrate an industrial and economic evolution, probably as distinctively characteristic of the genius of our people as is the evolution of our social and political institutions.

Detailed estimates, aggregating $150,000, were submitted as necessary to carry out the plans of the exhibit proposed, and an allotment of 40,000 feet of floor space indicated as requisite to provide for the convenient and proper display of the exhibit contemplated. In the estimates submitted to the Secretary of the Treasury provision was made for a limited aquarial display in the Government building, having for its object an exhibit of a series of the economic fishes of the country, more especially those which have been bred artificially for the purpose of stocking new waters or the improvement of the fisheries in those waters to which the species are indigenous, but which had been depleted by improvident fishing.

The suggestion that an aquarial display was contemplated awakened general interest and commanded such approval and expectation that it was determined, if practicable, to enlarge greatly the plans first contemplated, and make an extensive and systematic exhibit of the water resources of our entire country, both marine and fresh. These plans required the erection of an expensive building with suitable plant for installation and maintenance. It was recognized that it was not proper to expect the General Government to appropriate so much money to a building for temporary uses. The subject was brought to the attention of the Director-General by the Commissioner of Fisheries, and the difficulties of the enterprise discussed. In view of the interest and instructiveness of the exhibit suggested, the directory of the Exposition determined to erect a suitable building according to the plans of the Commissioner of Fisheries and to equip it with the necessary plant. The Government Board of Control and Management undertook, in conjunction and coöperation with the Commissioner of Fisheries, to install and maintain the exhibit during the period of the Exposition. The display thus arranged for by the liberality of the management and the coöperation of the U. S. Fish Commission will doubtless be one of the most novel, attractive, and interesting features of the Exposition.

STATE FISH COMMISSIONS.

The Commission has continued to coöperate with the fish commissions of the States and Territories in stocking our waters with suitable kinds of food-fishes. The accompanying table exhibits this association:

Statement showing the kinds and number of eggs and fish furnished to State and Territorial fish commissions during the fiscal years 1890 and 1891.

State or Territory.	Species.	1890.		1891.	
		Eggs.	Fish.	Eggs.	Fish.
Arizona	Carp				500
Arkansas	...do				3, 000
California	Quinnat salmon	1, 329, 000		2, 837, 900	
Colorado	Rainbow trout	20, 000			
	Carp				5, 000
Delaware	Von Behr trout	8, 000		8, 500	
	Whitefish	1, 000, 000			
	Shad	2, 249, 000		837, 000	2, 200, 500
	Carp		400		4, 000
	Black bass		125		
	Rock bass		75		450
Georgia	Carp				3, 000
Illinois	Pike perch		*†7, 170, 000		*†8, 000, 000
	Carp		1, 500		6, 690
	Black bass		*13, 040		*11, 782
	Crappie		*7, 631		*5, 535
	Yellow perch		*6, 075		*1, 495
	White bass		*6, 380		
	Catfish		*5, 670		
	Sunfish		*4, 408		*995
	Pike perch		*1, 000		
	Buffalo		*1, 760		
	Brook pike		*70		
	Rock bass				3, 159
Indiana	Landlocked salmon	10, 000			
	Whitefish	10, 000	*†100, 000		
	Pike perch		†500, 000		
Iowa	Black bass		900		
Kansas	Carp				5, 000
Kentucky	Crappie				820
	Rock bass				520
	Yellow perch				390
Maine	Landlocked salmon	50, 000			
Massachusetts	...do			25, 000	
Michigan	...do	50, 000			
	Lake trout	16, 000			
	Loch Leven trout	30, 000			
Minnesota	Landlocked salmon	40, 000		20, 000	
	Lake trout	250, 000		150, 000	
	Carp		1, 500		2, 000
	Von Behr trout			20, 000	
Missouri	Carp				45, 000
Nebraska	Lake trout	200, 000		50, 000	
	Crappie		2, 000		
	Black bass		1, 200		
	Yellow perch		300		
	Von Behr trout			10, 000	
	Loch Leven trout			10, 000	
Nevada	Landlocked salmon	25, 000		20, 000	
New Hampshire	Atlantic salmon	40, 000			
	Landlocked salmon	20, 000		50, 000	
	Rainbow trout	25, 000		10, 000	
	Lake trout	59, 000		500, 000	
	Loch Leven trout	25, 000		10, 000	
	Saibling	4, 000			
New Jersey	Von Behr trout	5, 000			
	Lake trout				†62, 400
New York	Atlantic salmon	600, 000			
	Landlocked salmon	15, 000		50, 000	
	Loch Leven trout	30, 000		20, 000	
	Saibling	4, 000			
	Whitefish	1, 000, 000		4, 000, 000	
	Pike perch	1, 000, 000			
	Lake trout		1, 082	500, 000	
	Von Behr trout			12, 750	
	Carp				5, 200
	Black bass				200
	Crappie				200

*Deposited by the U. S. Fish Commission in waters designated by the State Commissioners. †Fry.

Statement showing the kinds and number of eggs and fish furnished to State and Territorial fish commissions, etc.—Continued.

State or Territory.	Species.	1890.		1891.	
		Eggs.	Fish.	Eggs.	Fish.
Ohio	Brook trout				500
	Von Behr trout				1,425
	Loch Leven trout				800
	Catfish				50
	Whitefish			47,500,000	
Oregon	Quinnat salmon	1,000,000		700,000	
Pennsylvania	Atlantic salmon	100,000			
	Whitefish	10,000,000		14,000,000	
	Pike perch	18,000,000		58,000,000	
	Shad		†2,000,000		
	Carp		2,000		5,000
	Landlocked salmon			40,000	
	Crappie				*1,350
	Rock bass				*425
	Black bass				*200
Rhode Island	Atlantic salmon	10,000			
	Landlocked salmon	10,000			
	Lake trout			20,000	
Utah	Carp		1,700		2,000
	Black bass				1,718
	Yellow perch				636
Vermont	Landlocked salmon	25,000		25,000	
	Lake trout	325,000			
	Von Behr trout	10,000			
	Carp		600		500
	Rainbow trout			20,000	
West Virginia	Carp		100		1,000
Wisconsin	Von Behr trout	20,000			
	Whitefish	6,000,000		10,000,000	
	Carp				25,000
Wyoming	Rainbow trout	12,500			
	Lake trout	200,000		100,000	
	Brook trout			20,000	5,000
	Carp				5,000
	Black bass				710
	Crappie				1,470
	Sunfish				290

* Deposited by the U. S. Fish Commission in waters designated by the State commissioners. † Fry.

COURTESIES EXTENDED AND RECEIVED.

RELATIONS WITH OTHER GOVERNMENT DEPARTMENTS.

The work of the Fish Commission was very much facilitated by the coöperation of the other offices of the Government.

The Light-House Board granted permission to place observers and physical apparatus on board the light ship at Nantucket New South Shoal, to make temperature observations.

The Navy Department furnished officers and crews for the steamers and granted facilities to the vessels at the various navy-yards.

A dredging outfit was furnished to the eclipse expedition to West Africa in 1889.

The Superintendent of the Census, after conferring with the Commissioner, appointed Capt. J. W. Collins and Mr. Charles W. Smiley to take charge of the fishery census. Free use of the records in the Division of Fisheries was granted to the census employés and desk room was furnished to several clerks. At the request of the Superintendent of the Census, the statistics gathered by the Commission concerning the whale, porpoise, seal, and walrus fisheries of the United States were furnished to the Census Office.

The Secretary of War authorized the location of a fish-hatchery on the military reservation at Fort Gaston, Cal., and continued the privilege of allowing Fort Washington, on the Potomac River, to be used as a shad-hatchery.

Acknowledgments are due to the Government Printing Office for the excellent manner in which the publications of the Commission have been handled and for many courtesies extended in the matter of prompt compliance with requests for other official printing and binding.

To the Signal Office we are indebted for records of temperature observations on the North Atlantic Coast.

The Agricultural Department furnished flowers and grass seed for the Neosho Station.

The health officer of the District furnished monthly statistics of the Washington fish markets.

The steam launch *Blue Wing* was loaned to the District Commissioners while the police boat was being repaired.

The steamer *Albatross* brought animals from the Galapagos Islands for the National Zoölogical Park, Washington, D. C.

RELATIONS WITH FOREIGN COUNTRIES.

Belgium.—In February, 1890, 25,000 eggs of the rainbow trout were forwarded to Maj. W. Turner, Florinville, in exchange for 25,000 eggs of the Von Behr trout, which were received during that month.

Canada.—During the fall of 1890 100 carp were sent to the inspector of fisheries at Winnepeg, Manitoba, and during the winter of 1890–91 10,000 eggs of the Von Behr trout, 10,000 eggs of the Loch Leven trout, and 10,000 landlocked salmon eggs were forwarded to Mr. W. P. Greenough, Portneuf, Quebec.

France.—100,000 eggs of the California salmon were sent to the Société Nationale d'Acclimatation, Paris, in January, 1890, and 90,000 in January, 1891. Both of these shipments were received in excellent condition.

Germany.—In the fall and winter of 1889, crawfish, catfish, sunfish, white perch, and tortoises were sent to Max von dem Borne. Of these 90 crawfish, 3 catfish, 14 sunfish, and 3 tortoise were received alive. In May of 1890 and in the winter of 1890–91 white perch, sunfish, and strawberry bass were sent to him, but all except two white perch died before reaching their destination.

To Herr von Behr, president of the Deutsche Fischerei Verein, were sent, in 1890, 20,000 brook trout eggs and 40,000 landlocked salmon eggs; and in 1891, 100,000 whitefish eggs, 10,000 rainbow trout eggs, and 20,000 landlocked salmon eggs.

In January, 1890, 10,000 rainbow trout eggs were sent to Herr Carl Schuster, Freiburg.

There were received from Max von dem Borne, in January, 1890, 50,000 eggs of the Alpine variety of the Von Behr trout and 20,000 saibling eggs, and in March 15,000 eggs of the Loch Leven trout which had been obtained from Seeweise. In April of the same year 10 large golden tench were also received from him.

About the middle of February 70,000 Von Behr trout eggs arrived by the steamer *Aller*, 60,000 being given by the Deutsche Fischerei Verein and 10,000 by Herr Carl Schuster. Of these about 56,000 proved to be in good condition. In the following winter there were also received from this society 70,000 eggs of the Von Behr trout, of which 60,000 were in good condition.

The 300,000 whitefish eggs and 30,000 Von Behr trout eggs sent by this society in February and March were an entire loss.

Great Britain.—To the Midland Counties Fish Culture Establishment the following shipments were made: In the winter of 1889–90, 15,000 rainbow trout eggs, 200,000 whitefish eggs, and 15,000 landlocked salmon eggs; in the winter of 1890–91 200,000 whitefish eggs and 15,000 rainbow trout eggs.

In July, 1890, 13 garfish, 3 or 4 inches long, were sent to the Brighton Aquarium.

Mexico.—In response to an application from the Mexican Government, 50,000 lake trout eggs were sent to Señor Esteban Cházari in January, 1890, and 50,000 in January, 1891; 25,000 rainbow trout eggs and 10,000 Von Behr trout eggs were also sent to him in January, 1891.

Norway.—Twenty-five thousand eggs of the California salmon were sent to Walter E. Archer, Stavanger, on December 28, 1889.

Switzerland.—At the request of Mr. Alfred de Claparède, the Swiss minister at Washington, 30,000 eggs of the rainbow trout were sent to Switzerland in January, 1890; these were followed in January, 1891, by a shipment of 40,000 more.

MARSHALL MCDONALD,
Commissioner.

A.—*Details of distribution, 1889–90.*

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Catfish:			
Indian Creek, New Albany, Ind			500
Silver Creek, New Albany, Ind			500
Sangamon River, Decatur, Ill			1,745
Pistaqua Lake, McHenry, Ill			900
Fox Lake, McHenry, Ill			1,585
Pond of Chicago, Burlington and Quincy Railroad, Galesburg, Ill			1,100
City Reservoir, Belleville, Ill			200
Island Lake, Waterloo, Ill			50
Schoor Lake, Waterloo, Ill			50
Mill pond, Red Bud, Ill			40
Creve Cœur Lake, Creve Cœur, Mo			2,160
Echo Lake, Kansas City, Mo			79
Pond, Little Blue, Mo			800
Independence, Mo			800
Soldiers' Home, Leavenworth, Kans			79
Sibley Lake, Concordia, Kans			400
Chappawaunsee Creek, Quantico, Va			80
Carp:			
Applicants in Alabama			260
Arizona			80
Arkansas			210
California			30
Colorado			100
Connecticut			200
Delaware			660
Florida			200
Georgia			495
Idaho			180
Illinois			1,602
Indian Territory			50
Indiana			130
Iowa			190
Kansas			965
Kentucky			210
Louisiana			112
Maine			70
Maryland			204
Massachusetts			40
Michigan			160
Minnesota			1,640
Mississippi			140
Missouri			190
Montana			500
Nebraska			80
Nevada			20
New Hampshire			20
New Jersey			54
New Mexico			90
New York			330
North Carolina			370
North Dakota			230
Ohio			570
Oregon			10
Pennsylvania			3,719
Rhode Island			10
South Carolina			60
South Dakota			80
Tennessee			575
Texas			200
Utah			1,900
Vermont			610
Virginia			1,220
Washington			90
West Virginia			240
Wisconsin			110
Wyoming			7,010
Manitoba			100
Goldfish:			
Applicants in Alabama			395
Arkansas			6
Connecticut			12
Delaware			168
District of Columbia			5,450
Florida			100
Georgia			507
Idaho			6
Illinois			1,308
Indiana			138
Indian Territory			6
Iowa			242

A.—*Details of distribution, 1889-90*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Goldfish—Continued.			
Applicants in Kansas			67
Kentucky			49
Louisiana			216
Maryland			592
Massachusetts			90
Michigan			78
Minnesota			284
Missouri			124
Mississippi			146
Montana			4
Nebraska			112
New Hampshire			12
New Jersey			566
New Mexico			22
New York			1,372
North Carolina			198
Ohio			135
Oregon			18
Pennsylvania			776
Rhode Island			400
South Carolina			280
Tennessee			332
Texas			48
Utah			324
Vermont			6
Virginia			1,193
West Virginia			88
Wisconsin			60
Wyoming			75
Buffalo:			
Indian Creek, New Albany, Ind			50
Silver Creek, New Albany, Ind			50
Sangamon River, Decatur, Ill			1,010
Ponds of Chicago, Burlington and Quincy Railroad Company, Galesburg, Ill			450
City reservoir, Belleville, Ill			300
Creve Cœur Lake, Creve Cœur, Mo			85
Private pond, Frost, Tex			100
Athens, Tex			150
Shad:			
Scantic River, Sun Mill, Conn		152,000	
Farmington River, Poquantic, Conn		411,000	
Connecticut River, Windsor Locks, Conn		167,000	
Holyoke, Mass		35,000	
Delaware River, Gloucester, N. J		6,204,000	
Connecticut River, Warehouse Point, Conn		4,026,000	
Housatonic River, New Milford, Conn		2,254,000	
Hudson River, West Point, N. Y		2,619,000	
Newburg, N. Y		375,000	
Catskill, N. Y		1,952,000	
Delaware River, Callicoon, N. Y		3,557,000	
Lambertville, N. J		3,272,000	
Lackawaxen, Pa		500,000	
Gloucester, N. J		521,000	
Delaware Water Gap, Pa		799,000	
Mullica River, Elwood, N. J		500,000	
U. S. Fish Commission station, Gloucester, N. J	(3,654,000)		
Harvard University	15,000		
U. S. Fish Commission, Central Station, Washington, D. C	a(34,446,000)	356,000	
Patuxent River, Laurel, Md		1,500,000	
Patapsco River, Relay Station, Md		1,518,000	
U. S. Fish Ponds, Washington, D. C		b(2,144,000)	
Potomac River, Wide Water, Va		720,000	
Quantico Creek, Quantico, Va		1,180,000	
Rapidan, Rapidan River, Va		1,207,000	
Mattaponi River, Milford, Va		2,470,000	
Little River, Taylorsville, Va		909,000	
Rivanna River, Charlottesville, Va		500,000	
Appomattox River, Petersburg, Va		326,000	
Rappahannock River, Fredericksburg, Va		1,162,000	
Occoquan Creek, Woodbridge, Va		506,000	
Cedar Run, Catletts, Va		471,000	
Stony Creek, Stony Creek, Va		1,000,000	
Meherrin River, Belfield, Va		1,489,000	

a Distributed as fry from Central Station.
b Deposited for rearing and distribution in fall of 1890.

A.—*Details of distribution, 1889–90*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Shad—Continued.			
Neuse River, Goldsboro, N. C		1,328,000	
Pasquotank River, Elizabeth, N. C		1,042,000	
Six Runs, Clinton, N. C		497,000	
Hurricane Creek, Blackshear, Ga		388,000	
Withlacoochee River, Quitman, Ga		650,000	
Ocklocknee River, Thomasville, Ga		650,000	
Chattahoochee River, West Point, Ga		300,000	
Alabama River, Montgomery, Ala		1,290,000	
Escambia River, Flomaton, Ala		400,000	
Tombigbee River, Demopolis, Ala		400,000	
Taunton River, East Taunton, Mass		1,505,000	
Hudson River, Newburg, N. Y		1,420,000	
Jones Creek, Dover, Del		500,000	
Susquehanna River, Havre de Grace, Md		1,256,000	
Susquehanna River, Fites Eddy, Pa		985,000	
Bush River, Bush Station, Md		850,000	
Elk River, Elkton, Md		1,317,000	
Gunpowder River, Gunpowder Station, Md		1,600,000	
North-East River, North-East, Md		1,700,000	
James River, Richmond, Va		200,000	
Savannah River, Augusta, Ga		2,000,000	
Ocmulgee River, Macon, Ga		2,565,000	
Ogeechee River, Midville, Ga		1,000,000	
Flint River, Reynolds, Ga		900,000	
Big Whitewater Creek, Butler, Ga		1,000,000	
Delaware Fish Commission	2,249,000		
Quinnat salmon:			
California Fish Commission	1,329,000		
Société Nationale d'Acclimation, Paris, France	100,000		
Walter E. Archer, Stavanger, Norway	25,000		
U. S. Fish Commission Station, Fort Gaston, Cal	*a* (100,000)		
McCloud River, near Baird, Cal		84,000	
Trinity River, near Fort Gaston, Cal		90,000	
Oregon Fish Commission	1,000,000		
Clackamas River and tributaries		2,766,475	
Atlantic Salmon (*Salmo salar*):			
New Hampshire Fish Commission	40,000		
Rhode Island Fish Commission	10,000		
Pennsylvania Fish Commission	100,000		
Benjamin Lincoln, Dennysville, Me	40,000		
U. S. Fish Commission Station, Cold Spring Harbor	*b* (600,000)		
U. S. Fish Commission Station, Fort Gaston, Cal	(100,000)		
Alamoosook Lake, tributary to Penobscot River, Maine			23,884
Craig Brook, tributary to Alamoosook Lake, Maine			21,056
Meadow Brook, tributary to Alamoosook Lake, Maine			12,511
Colton Brook, tributary to Alamoosook Lake, Maine			1,802
Wardwell Brook, tributary to Alamoosook Lake, Maine			3,765
Leach Brook, tributary to Alamoosook Lake, Maine			1,738
Toddy Pond, tributary to Alamoosook Lake, Maine			5,642
Canary Brook, tributary to Toddy Pond, Maine			959
Harriman Brook, tributary to Toddy Pond, Maine			8,784
Sucker Brook, tributary to Toddy Pond, Maine			3,639
Heart Pond, tributary to Toddy Pond, Maine			4,166
Grays Brook, tributary to Toddy Pond, Maine			3,449
Raymond Brook, tributary of Hudson River, New York		49,700	
Balm of Gilead Brook, tributary of Hudson River, New York		49,800	
Carr Brook, tributary of Hudson River, New York		49,500	
Thirteenth Brook, tributary of Hudson River, New York		49,750	
Minerva Brook, tributary of Hudson River, New York		49,800	
Deer Creek, tributary of Hudson River, New York		49,400	
Clendon Brook, tributary of Hudson River, New York		49,750	
Whipple Brook, tributary of Hudson River, New York		49,600	
Eleventh Brook, tributary of Hudson River, New York		49,500	
Wallkill River, tributary of Hudson River, New York		26,350	
Nussequage River, tributary of Long Island Sound		30,000	
Landlocked Salmon:			
Maine Fish Commission	50,000		
New Hampshire Fish Commission	20,000		
Vermont Fish Commission	25,000		
Rhode Island Fish Commission	10,000		
New York Fish Commission	15,000		
Indiana Fish Commission	10,000		
Michigan Fish Commission	50,000		
Minnesota Fish Commission	40,000		
Nevada Fish Commission	25,000		
E. R. Hewitt, Ringwood, N. J	10,000		
Geo. W. Hooker, Brattleboro, Vt	25,000		
Megantic Fish and Game Club, New York	10,000		
Herr von Behr, Schmaldow, Germany	40,000		

a Distributed as fry from Fort Gaston Station.
b Distributed as fry from Cold Spring Harbor Station.

A.—*Details of distribution, 1889-90*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Landlocked salmon—Continued.			
Midland Counties' Fish Culture Association, Malvern Wells, England	15,000		
U. S. Fish Commission Station, Northville, Mich	(30,000)		
Fort Gaston, Cal	(20,000)		
Duluth, Minn	*a*(60,000)		
Cold Spring Harbor, N. Y	*b*(85,000)		
Washington, D. C	*c*(30,000)		
Green Lake, Me	*d*(60,000)		
Bucksport, Me	(5,000)		
Grand Lake Stream, tributary to Schoodic River, Maine		214,000	
U. S. Fish Commission Station, Cold Spring Harbor, N. Y	10,000		
Great and Mann brooks, tributary to Green Lake, Maine		150,000	
Green Lake, tributary to Union River, Maine			16,980
Eastern River, tributary to Penobscot River, Maine			400
Tributaries of Lake George near Caldwell, N. Y		5,000	
Mianus River in Westchester County, New York		20,000	
Pleasant Lake in Sullivan County, New York		23,000	
Silver Lake in Sullivan County, New York		23,000	
E. P. Thorn, Plainfield, N. J		9,000	
Deer Creek, near Bel Air, Md		17,650	
Hazel Run, near Fredericksburg, Va		450	
Loch Leven trout:			
Michigan Fish Commission	(30,000)		
New Hampshire Fish Commission	(25,000)		
New York Fish Commission	(30,000)		
U. S. Fish Commission Station, Fort Gaston, Cal	(25,000)		
Leadville, Colo	(20,000)		
Craig Brook, Me	(20,000)		
Duluth, Minn	(12,000)		
Pine Lake, near LaPorte, Ind			500
Madison River, Yellowstone Park, Wyo			995
Caldwell Creek, near Cresco, Iowa			750
Light Springs, near Cresco, Iowa			750
Colfax Lake, near Hart, Mich			500
Star Lake, near Baldwin, Mich			1,500
Crooked Lake, near Baldwin, Mich			494
Esall Lake, near Alpena, Mich			1,000
Turtle Lake, near Alpena, Mich			1,000
Zukey Lake, near Hamburg Junction, Mich			1,000
Indian River, Indian River, Mich			1,500
U. S. Fish Commission Station, Northville, Mich	15,000		
Rainbow trout:			
Green Lake, near Dedham, Me			747
Colorado State Fish Commission	20,000		
New Hampshire State Fish Commission	25,000		
Henry Stewart, Walhalla, S. C	8,000		
The Government of Switzerland	30,000		
Midland Counties Fish Culture Establishment, Malvern Wells, England	15,000		
Carl Shuster, Freiburg, Germany	10,000		
Major W. Turner, Florenville, Belgium	25,000		
U. S. Fish Commission Station, Neosho, Mo	(25,000)		
Mountain Creek, near Carlisle, Pa			2,000
Running Mountain Stream, near Carlisle, Pa			800
Yellow Breeches Creek, near Mechanicsburg, Pa			1,100
Trindles Run, near Mechanicsburg, Pa			300
Hoglands Run, near Williamsport, Pa			1,500
East Deer Creek, near Stewardstown, Pa			500
West Deer Creek, near Stewardstown, Pa			500
Ebaugh Creek, near Stewardstown, Pa			500
Bowman Creek, near Stewardstown, Pa			500
Sutton Run, near Stewardstown, Pa			480
Thompson Run, near Stewardstown, Pa			1,000
Fuller Brook, near Bradford, Pa			1,000
North Branch, near Houtzdale, Pa			1,000
Officer Run, near Parkersburg, Pa			120
Doe Run, near Parkersburg, Pa			115
Buck Run, near Parkersburg, Pa			115
Dennis Run, near Ercildoun, Pa			500
Dipping Pond Stream, near Brooklandville, Md			2,235
Staley Creek, near Marion, Va			1,000
Wheat and Gunstock Creeks, near Liberty, Va			500
Clear Fork Creek, near Rocky Gap, Va			800
Peach Bottom Creek, in Grayson County, Va			1,500
Clinch River, near Tazewell C. H., Va			1,000
Elk Creek, near North Branch, Va			1,500
Fox Creek, near Seven Mile Ford, Va			1,450

a Distributed as fry, from Duluth Station, Minnesota.
b Distributed as fry, from Cold Spring Harbor Station, New York.
c Distributed as fry, from Central Station, Washington, D. C.
d Distributed as fry, from Green Lake Station, Maine.

A.—*Details of distribution, 1889-90*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Rainbow trout—Continued.			
Little Calf Pasture River, near Goshen, Va			2,000
Calf Pasture River, near Goshen, Va			1,975
Cripple Creek, near Beverly Furnace, Va			400
Reed Creek, near Wytheville, Va			480
Applicants in Virginia			576
Newberry Fork of Catawba River, near Old Fork, N. C			500
Nantahalia River, near Jarretts, N. C			1,000
Valley River, near Westfield, N. C			200
Running Creek, near Asheville, N. C			500
Tuckasege River, near Dillsboro, N. C			1,500
Applicants in North Carolina			750
Clear Fork River, near Robbins, Tenn			500
Horse Creek, near Bethel, Tenn			250
Applicants in Tennessee			1,250
Curtiss Manufacturing Company's Dam, near Baltimore, Md			450
Applicants in Maryland			2,200
Beaver Dam Creek, near Alexandria, Va			350
Pike Branch, near Alexandria, Va			75
Difficult Creek, near Hunters, Va			250
Applicants in Pennsylvania			407
U. S. Fish Commission Station, Northville, Mich			157
Wyoming Fish Commission	12,500		
Gibbon River, Yellowstone National Park			990
Rattlesnake Creek, near Petersburg, Ohio			100
Rocky Fork Creek, near Petersburg, Ohio			100
Harden Creek, near Petersburg, Ohio			200
Fall Creek, near Petersburg, Ohio			100
Applicants in Ohio			518
Pinchen Creek, near Dover, Del			200
Tyler and Poplar creeks, near Elgin, Ill			490
Applicants in Illinois			100
Tippecanoe River, near Monticello, Ind			1,000
Fall Creek, near Indianapolis, Ind			250
White River, near Indianapolis, Ind			250
Brandywine Creek, near Shelbyville, Ind			368
Big Blue River, near Shelbyville, Ind			368
Little Blue River, near Shelbyville, Ind			368
Conns Creek, near Shelbyville, Ind			368
Flat Rock River, near Shelbyville, Ind			358
Flat Rock River, near St. Paul, Ind			1,800
Applicants in Indiana			950
South branch of Catfish Creek, near Peosta, Iowa			500
Spring Branch, near Manchester, Iowa			500
Kinney Creek, near Vanceburg, Ky			1,000
Passaic River, near Providence, N. J			200
Stoney Brook, near Boonton, N. J			150
Troy Brook, near Boonton, N. J			150
North branch of Raritan River, near Boonton, N. J			100
Whipping River, near Boonton, N. J			100
Iron River, near Iron River Station, Mich			1,300
Spring Brook, near Columbiaville, Mich			500
Barker Creek, near Oscoda, Mich			500
Cold Brook, near Lawton, Mich			600
South Branch of Paw Paw River, near Paw Paw, Mich			500
Sisson Creek, near Paw Paw, Mich			275
Trowbridge Creek, near Vanderbilt, Mich			1,500
Stewart Creek, near Wolverine, Mich			1,000
Applicants in Michigan			750
Collins Lake, near Schenectady, N. Y			100
Applicants in Massachusetts			250
Rattlesnake Creek, near White Mills, Pa			250
Von Behr trout:			
Egypt Branch, near Brooklandville, Md			237
Vermont Fish Commission	10,000		
Wisconsin Fish Commission	20,000		
U. S. Fish Commission Station, Neosho, Mo	(20,000)		
Duluth, Minn	(8,000)		
West Aspetuck Creek, near New Haven, Conn			200
Pinchen Creek, near Dover, Del			200
North and South Branch of Bear Creek, near Decorah, Iowa			2,970
Baldwin Creek, near Cresco, Iowa			250
Barlois Creek, near Cresco, Iowa			250
Passaic River, near Providence, N. J			200
Lincoln Lake, near Reed City, Mich			497
Applicants in Michigan			1,275
Rattlesnake Creek, near White Mills, Pa			200
Delaware Fish Commission	8,000		
New Jersey Fish Commission	5,000		
P. C. Hewitt, Ringwood, N. J	8,000		
U. S. Fish Commission Station, Duluth, Minn	(35,000)		
Michigan Fish Commission	16,000		
New Hampshire Fish Commission	9,000		
U. S. Fish Commission Station, Craig Brook, Me	(9,000)		

A.—*Details of distribution, 1889-90*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Black-spotted trout:			
East Fork Gardiner River, Yellowstone National Park			1,000
Brook trout:			
Meadow Brook, near Orland, Me			250
Craig Brook, near Orland, Me			772
Pine Creek, near Felton, Pa		23,000	
Paris G. Engle, Hancock, Pa		5,000	
A. B. Hayward, Washington, D. C		2,500	
Clinch River, near Tazewell, Va			900
Egypt Branch, near Brooklandville, Md			184
E. F. Warner, St. Paul, Minn	40,000		
Bellevue Trout Club, Castalia, Ohio	20,000		
Henry E. Maynard, Northampton, Mass	25,000		
Dr. E. S. Bowen, Brattleboro, Vt	25,000		
Charles F. Orvis, Manchester, Vt	15,000		
Baptism River Club, St. Paul, Minn	30,000		
S. Holmes, Stroudsburg, Pa	2,500		
Deutsche Fischerei Verein, Germany	20,000		
U. S. F. C. Station, Neosho, Mo	(25,000)		
Leadville, Colo	(25,000)		
Central Station, Washington, D. C	*a*(37,500)		
Bloody Run, near Dubuque Iowa		10,000	
Spring Creek, near Decorah, Iowa			985
Vernon Springs, near Cresco, Iowa			500
Trout Stream on Island of Marthas Vineyard			200
Gardiner River, Yellowstone National Park			4,975
Spring Brook, near Oxford, Mich			100
Applicants in Michigan			500
New Jersey			500
Baptism River, tributary to Lake Superior in Minnesota		27,000	
Lester River, tributary to Lake Superior in Minnesota		1,000	
U. S. Fish Commission Station, Fort Gaston, Cal	50,000		
Northville, Mich	25,000		
Dr. John Law, Leadville, Colo		126,881	
Lake trout:			
Pleasant Lake, Sullivan County, N. Y		265,000	
Sackett Lake, Sullivan County, N. Y		105,000	
Otsego Lake, Otsego County, N. Y		50,000	
Lake in Westchester County, N. Y		50,000	
Wyoming Fish Commission	200,000		
New Hampshire Fish Commission	50,000		
Vermont Fish Commission	325,000		
Minnesota Fish Commission	250,000		
Nebraska Fish Commission	200,000		
E. Cházari, City of Mexico, for Republic of Mexico	50,000		
U. S. Fish Commission Station, Neosho, Mo	(25,000)		
Cold Spring Harbor, N. Y	*b*(500,000)		
Duluth, Minn	*c*(1,000,000)		
Pine Lake, near La Porte, Ind			500
Elder, Green, and Otter Lakes, near Fremont, Ind			390
Lake near Richmond, Ind			1,000
Lake Maxinkuckee, near Indianapolis, Ind			1,900
Applicants in Indiana			1,150
Zukey Lake, near Ann Arbor, Mich			2,500
Applicants in Michigan			1,993
Stoney Creek, near Hunter Land, N. Y			1,000
New York Fish Commission			1,082
Applicants in Connecticut			1,486
Lake Superior, off mouth of Lester River, Minn		935,000	
Saibling:			
New Hampshire Fish Commission	4,000		
New York Fish Commission	4,000		
U. S. Fish Commission Station, Craig Brook, Me	(4,000)		
Whitefish:			
Lake Ontario, near Sacketts Harbor, N. Y		1,800,000	
Black River Bay, near Sacketts Harbor, N. Y		1,000,000	
Chaumont Bay, near Chaumont, N. Y		1,000,000	
Detroit River, near Detroit, Mich		500,000	
Pennsylvania Fish Commission	10,000,000		
Wisconsin Fish Commission	6,000,000		
U. S. Fish Commission, Central Station, Washington, D. C	*a*(6,000,000)		
Lake Erie, near North, Middle Bass, and Put-in Bay Islands		27,984,000	
Lake Erie, near Monroe, Mich		2,544,000	
Indiana Fish Commission		100,000	
Delaware Fish Commission	1,000,000		
New York Fish Commission	1,000,000		
Indiana Fish Commission	10,000		
Midland Counties Fish Culture Establishment, Malvern Wells, England	200,000		
U. S. Fish Commission station, Duluth, Minn	*c*(26,250,000)		

a Distributed as fry from Central Station.
b Distributed as fry from Cold Spring Harbor Station.
c Distributed as fry from Duluth Station.

A.—*Details of distribution, 1889–90*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Whitefish—Continued.			
Lake Huron, near North Point, Mich		2,000,000	
South Point, Mich		2,000,000	
Sulphur Island, Mich		1,400,000	
Middle Island, Mich		2,000,000	
Thunder Bay Island, Mich		3,000,000	
East Tawas, Mich		2,000,000	
Miller Point, Mich		3,000,000	
Sturgeon Point, Mich		3,000,000	
Mackinac Island, Mich		3,000,000	
Lake Michigan, near Epoufette, Mich		1,500,000	
Scott Point, Mich		1,500,000	
Manistique, Mich		1,500,000	
Thompson, Mich		1,500,000	
Long Lake, near Alpena, Mich		2,000,000	
Turtle Lake, near Montmorency, Mich		1,000,000	
Grand Lake, Presque Isle County, Mich		200,000	
Detour Passage, near Hay Point, Mich		3,000,000	
Lake Superior, off mouth of Lester River, near Duluth, Minn		24,850,000	
Yellowstone River, Yellowstone National Park			1,000
Twin Lakes, Yellowstone National Park			2,000
Brook pike:			
Sangamon River, Decatur, Ill			70
Yellow perch:			
Potomac River, near Washington, D. C		704,000	
Applicants in Maryland		50,000	
Flat Rock River, Flat Rock, Ind			50
Blue Ridge, Ind			25
Big Blue River, Shelbyville, Ind			50
Little Blue River, Ray Crossing, Ind			50
Brandywine Creek, Fairland, Ind			100
Comus Creek, Waldron, Ind			100
Des Plaines River, Riverside, Ill			995
Chicago, Burlington and Quincy Railroad Company's ponds, Galesburg, Ill			500
Island Lake, Waterloo, Ill			500
Schoors Lake, Waterloo, Ill			500
Mill pond, Red Bud, Ill			100
Kipple Creek, Plymouth, Ill			150
Crooked Creek, Macomb, Ill			500
Bigger Head Lake, Bardolph, Ill			50
Little Wabash River, Louisville, Ill			480
City reservoir, Litchfield, Ill			400
Saylor Springs Lake, Saylor Springs, Ill			200
Illinois Central Railroad Company's ponds, Clinton, Ill			200
Private pond, Potomac, Ill			250
Kankakee River, Kankakee, Ill			300
Insane Asylum reservoir, Jacksonville, Ill			300
Deaf and Dumb Asylum reservoir, Jacksonville, Ill			150
Macoupin River, Macoupin, Ill			150
Beaver Dam Lake, Macoupin, Ill			200
Mill pond, Monmouth, Ill			50
Echo Lake, Kansas City, Mo			118
Pertle Springs, Warrensburg, Mo			760
Private pond, Little Blue, Mo			345
Private pond, Independence, Mo			350
Reed Creek, Liberty, Mo			200
James River, Nichols, Mo			350
City water-works pond, Moberly, Mo			200
Lake at Soldiers' Home, Leavenworth, Kans			119
Sibley Lake, Concordia, Kans			575
Lake Geneva, Lake Geneva, Wis			1,020
Cedar River, Waterloo, Iowa			200
Charles City, Iowa			200
Cedar Rapids, Iowa			300
Lake in city park, Keokuk, Iowa			100
Blue River, Milford, Nebr			240
Loup River, Ravenna, Nebr			250
North fork of Elkhorn River, Norfolk, Nebr			175
Headwaters of Elkhorn River, Stuart, Nebr			175
Nebraska State fish ponds, South Bend, Nebr			300
Sun River, Great Falls, Mont			910
Missouri River, Mid-Cañon, Mont			200
Private pond, Helena, Mont			50
Frost, Tex			500
Athens, Tex			400
Jones Fork River, Winslow, Ark			400
Barren River, Bowling Green, Ky			190
Shenandoah River, Riverton, Va			325

A.—*Details of distribution, 1889-90*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Pike perch:			
Pennsylvania Fish Commission	18,000,000		
New York Fish Commission	1,000,000		
White River, near Noblesville, Ind		2,000,000	
Tributaries of White River, near Shelbyville, Ind		2,000,000	
Flat Rock Creek, near St. Paul, Ind		2,000,000	
Turkey Lake, near Cedar Beach, Ind		9,980,000	
Flint Lake, near Valparaiso, Ind		3,500,000	
Long Lake, near Valparaiso, Ind		1,500,000	
Indiana Fish Commission		500,000	
Twin Lakes, near Earlville, Ohio		2,500,000	
Cuyahoga River, near Ravenna, Ohio		2,500,000	
Mahoning River, near Warren, Ohio		2,500,000	
Embarras River, near Charleston, Ill		1,500,000	
Sangamon River, near Virginia, Ill		1,000,000	
near Petersburg, Ill		300,000	
Spring Lake, near Pekin, Ill		500,000	
Mackinac River, near Pekin, Ill		500,000	
Kankakee River, near Kankakee, Ill		3,370,000	
Chicago, Burlington and Quincy Railroad Company's ponds			500
City reservoir, Belleville, Ill			500
Lester River, Duluth, Minn		580,000	
Sea bass:			
Buzzards Bay, off Massachusetts coast		3,893,500	
White bass:			
Indian Creek, New Albany, Ind			100
Silver Creek, New Albany, Ind			100
Flat Rock River, Flat Rock, Ind			100
Blue Ridge, Ind			50
Big Blue River, Shelbyville, Ind			100
Comus Creek, Waldron, Ind			200
Sangamon River, Riverton, Ill			1,500
Chicago, Burlington and Quincy R. R. Co. ponds, Galesburg, Ill			450
City reservoir, Belleville, Ill			400
Kipple Creek, Plymouth, Ill			150
Crooked Creek, Macomb, Ill			350
Bigger Head Lake, Bardolph, Ill			50
Little Wabash River, Louisville, Ill			990
City reservoir, Litchfield, Ill			400
Saylor Springs Lake, Saylor Springs, Ill			600
Wabash Railroad Company's ponds, Lanesville, Ill			1,490
James River, Nichols, Mo			300
City water-works pond, Moberly, Mo			400
Sibley Lake, Concordia, Kans			230
Lake Geneva, Lake Geneva, Wis			814
Cedar River, Waterloo, Iowa			200
Charles City, Iowa			190
Cedar Rapids, Iowa			40
Private pond, Frost, Tex			200
Private pond, Athens, Tex			100
Jones Fork River, Winslow, Ark			500
Fresh-water drum:			
Indian Creek, New Albany, Ind			100
Silver Creek, New Albany, Ind			100
Black bass:			
Small lakes in cemetery, Winton Place, Ohio			150
Indian Creek, New Albany, Ind			1,000
Silver Creek, New Albany, Ind			1,000
Flat Rock River, Flat Rock, Ind			300
Blue Ridge, Ind			250
Big Blue River, Shelbyville, Ind			500
Little Blue River, Ray Crossing, Ind			200
Brandywine Creek, Fairland, Ind			200
Comus Creek, Waldron, Ind			400
Sangamon River, Decatur, Ill			275
Des Plaines River, Riverside, Ill			1,990
Chicago, Burlington and Quincy R. R. Co. ponds, Galesburg, Ill			650
City reservoir, Belleville, Ill			1,200
Island Lake, Waterloo, Ill			500
Schoors Lake, Waterloo, Ill			500
Mill pond, Red Bud, Ill			350
Kipple Creek, Plymouth, Ill			100
Crooked Creek, Macomb, Ill			500
Bigger Head Lake, Bardolph, Ill			50
Little Wabash River, Louisville, Ill			300
City reservoir, Litchfield, Ill			200
Saylor Springs Lake, Saylor Springs, Ill			300
Illinois Central Railroad Company's ponds, Clinton, Ill			800
Private pond, Potomac, Ill			500
Kankakee River, Kankakee, Ill			1,800
Insane Asylum reservoir, Jacksonville, Ill			1,000
Deaf and Dumb Asylum reservoir, Jacksonville, Ill			300
Embarras River, Charleston, Ill			475

A.—*Details of distribution, 1889-90*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Black bass—Continued.			
Macoupin River, Macoupin, Ill			300
Beaver Dam Lake, Macoupin, Ill			850
Mill pond, Monmouth, Ill			100
Creve Cœur Lake, Creve Cœur, Mo			270
Echo Lake, Kansas City, Mo			1,865
Pertle Springs, Warrensburg, Mo			2,655
Private pond, Little Blue, Mo			2,995
Independence, Mo			2,998
Reed Creek, Liberty, Mo			300
James River, Nichols, Mo			150
U. S. Fish Commission ponds, Neosho, Mo			600
City water works pond, Moberly, Mo			900
Lake at Soldiers' Home, Leavenworth, Kans			1,865
Sibley Lake, Concordia, Kans			2,000
Private lake, Monroe, Wis			200
Lake Geneva, Lake Geneva, Wis			4,940
Mississippi River, Ferryville, Wis			1,498
Cedar River, Waterloo, Iowa			1,400
Charles City, Iowa			1,390
Cedar Rapids, Iowa			1,700
Spirit Lake, Spirit Lake, Iowa			900
Lake in city park, Keokuk, Iowa			200
Blue River, Milford, Nebr			1,962
Loup River, Ravenna, Nebr			1,963
North Fork Elkhorn River, Norfolk, Nebr			175
Headwaters Elkhorn River, Stuart, Nebr			165
Nebraska State fish ponds, South Bend, Nebr			1,200
Sun River, Great Falls, Mont			4,358
Missouri River, Mid-Cañon, Mont			1,000
Private pond, Helena, Mont			100
Frost, Tex			600
Athens, Tex			1,000
Jones Fork River, Winslow, Ark			790
Barren River, Bowling Green, Ky			1,800
Private pond, Gordonsville, Va			50
City reservoir, Charlottesville, Va			113
North River, Lexington, Va			640
Peony Falls, Marriottsville, Md			250
Delaware Fish Commission, Wilmington, Del			125
Crappie:			
Small lakes in cemetery, Winton Place, Ohio			150
Indian Creek, New Albany, Ind			200
Silver Creek, New Albany, Ind			200
Flat Rock River, Flat Rock, Ind			47
Blue Ridge, Ind			75
Big Blue River, Shelbyville, Ind			100
Little Blue River, Ray Crossing, Ind			300
Brandywine Creek, Fairland, Ind			100
Sangamon River, Decatur, Ill			350
Chicago, Burlington and Quincy Railroad Company's ponds, Galesburg, Ill			290
City reservoir, Belleville, Ill			800
Island Lake, Waterloo, Ill			150
Schoors Lake, Waterloo, Ill			150
Kipple Creek, Plymouth, Ill			50
Crooked Creek, Macomb, Ill			150
Little Wabash River, Louisville, Ill			95
Saylor Springs Lake, Saylor Springs, Ill			100
Insane asylum reservoir, Jacksonville, Ill			1,500
Deaf and dumb asylum reservoir, Jacksonville, Ill			500
Embarras River, Charleston, Ill			1,500
Macoupin River, Macoupin, Ill			1,000
Beaver Dam Lake, Macoupin, Ill			900
Mill Pond, Monmouth, Ill			96
Creve Cœur Lake, Creve Cœur, Mo			135
Pertle Springs, Warrensburg, Mo			180
Private pond, Independence, Mo			295
U. S. Fish Commission ponds, Neosho, Mo			13
Sibley Lake, Concordia, Kans			95
Private lake, Monroe, Wis			50
Lake Geneva, Lake Geneva, Wis			414
Mississippi River, Ferryville, Wis			2,490
Cedar River, Waterloo, Iowa			200
Charles City, Iowa			180
Lake in City Park, Keokuk, Iowa			100
North Fork of Elkhorn River, Norfolk, Nebr			175
Headwaters of Elkhorn River, Stuart, Nebr			165
Nebraska State fish ponds, South Bend, Nebr			2,000
Sun River, Great Falls, Mont			548
Missouri River, Mid-Cañon, Mont			200

A.—*Details of distribution, 1889–90*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Crappie—Continued:			
Private pond, Helena, Mont			25
Frost, Tex			200
Athens, Tex			150
Barren River, Bowling Green, Ky			900
Shenandoah River Riverton, Va			750
Rock bass:			
Applicants in Maryland			150
West Virginia			150
North Carolina			300
Virginia			411
Pennsylvania			375
Delaware			75
Georgia			50
Arizona			355
Texas			56
Republic of Mexico, City of Mexico			150
U. S. Fish Commission Station, Neosho, Mo			275
North Fork of Elkhorn River, Norfolk, Nebr			1,400
Headwaters of Elkhorn River, Stuart, Nebr			1,350
Sunfish:			
Flat Rock River, Blue Ridge, Ind			100
Big Blue River, Shelbyville, Ind			50
Little Blue River, Ray Crossing, Ind			50
Chicago, Burlington and Quincy Railroad Company's ponds, Galesburg, Ill			100
City reservoir, Belleville, Ill			100
Island Lake, Waterloo, Ill			300
Schoors Lake, Waterloo, Ill			300
Kipple Creek, Plymouth, Ill			50
Crooked Creek, Macomb, Ill			250
Biggar Head Lake, Bardolph, Ill			50
Little Wabash River, Louisville, Ill			50
City reservoir, Litchfield, Ill			100
Saylor Springs Lake, Saylor Springs, Ill			150
Private pond, Potomac, Ill			50
Kankakee River, Kankakee, Ill			65
Insane asylum reservoir, Jacksonville, Ill			200
Deaf and dumb asylum reservoir, Jacksonville, Ill			50
Embarras River, Charleston, Ill			2,500
Macoupin River, Macoupin, Ill			50
Beaver Dam Lake, Macoupin, Ill			43
Pertle Springs, Warrensburg, Mo			185
Private pond, Little Blue, Mo			340
Private pond, Independence, Mo			347
Cedar River, Cedar Rapids, Iowa			50
Blue River, Milford, Nebr			235
Loup River, Ravenna, Nebr			250
Sun River, Great Falls, Mont			100
Missouri River, Mid-Cañon, Mont			100
Private pond, Athens, Tex			200
Jones Fork River, Winslow, Ark			100
Barren River, Bowling Green, Ky			300
Scup:			
Buzzards Bay, off Massachusetts coast		396,000	
Squeteague:			
Buzzards Bay, off Massachusetts coast		227,500	
Mackerel:			
Buzzards Bay, off Massachusetts coast		688,500	
Tautog:			
Buzzards Bay, off Massachusetts coast		732,000	
Cod:			
Massachusetts Bay, off Massachusetts coast		14,957,500	
Vineyard Sound, off Massachusetts coast		6,826,000	
Pollock:			
Massachusetts Bay, off Massachusetts coast		14,899,000	
Haddock:			
Massachusetts Bay, off Massachusetts coast		5,192,000	
Vineyard Sound, off Massachusetts coast		528,000	
Flatfish:			
Buzzards Bay, off Massachusetts coast		4,086,500	
Lobsters:			
Galveston Bay, near Galveston, Texas	250,000		
Buzzards Bay, off Massachusetts coast		4,511,000	
Total*	44,280,000	261,706,606	383,942

* Figures inclosed in parentheses are not included in summations.

B.—*Details of distribution, 1890–91.*

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Carp:			
Applicants in Alabama			860
Tallapoosa River, Cowles Station, Ala			4,000
Applicants in Arizona			1,620
Arkansas			690
Washita River, Arkadelphia, Ark			5,000
Arkansas Fish Commission			3,000
Applicants in California			60
Colorado			255
Colorado Fish Commission			5,000
Applicants in Connecticut			210
Delaware			120
Delaware Fish Commission			4,000
Applicants in District of Columbia			65
Florida			250
Georgia			880
Chattahoochee River, West Point, Ga			2,000
Georgia Fish Commission			3,000
Applicants in Idaho			1,220
Illinois			750
Illinois Fish Commission			6,690
Applicants in Indiana			260
Indian Territory			510
Shawnee Lake, Shawnee, Indian Territory			1,500
Spring River, Quapaw Agency, Indian Territory			500
Applicants in Iowa			690
Kansas			6,170
Kansas Fish Commission			5,000
Applicants in Kentucky			340
Kinney River, Vanceburg, Ky			6,000
Cumberland River, Barboursville, Ky			5,957
Applicants in Louisiana			570
Maine			150
Maryland			660
Monocacy River, Frederick Junction, Md			4,980
Patuxent River, Laurel, Md			4,989
Patapsco River, Relay House			4,000
Gunpowder River, Cockeysville, Md			4,000
Elk River, Elkton, Md			4,490
North East River, North East, Md			4,490
Applicants in Massachusetts			800
Michigan			430
Zukey Lake, Hamburg Junction, Mich			5,000
Applicants in Minnesota			1,150
Mississippi River, St. Paul, Minn			6,000
Lake Superior, near Duluth, Minn			500
Minnesota Fish Commission, Minn			2,000
Applicants in Mississippi			270
Pearl River, Jackson, Miss			3,000
Applicants in Missouri			150
Hickory Creek, Neosho, Mo			450
Shoal Creek, Boyden, Mo			3.500
North Fork Spring River, Lamar, Mo			4,000
Missouri Fish Commission			45,000
Applicants in Montana			1,000
Nebraska			1,150
Nevada			110
New Jersey			150
New Hampshire			190
New Mexico			150
New York			1,270
Oquaga Lake, Deposit, N. Y			2,000
New York Fish Commission			5,200
Applicants in North Carolina			2,080
North Dakota			90
Ohio			810
Muzzy Lake, Ravenna, Ohio			2,000
Twin Lake, Earlville, Ohio			2,000
Punderson Pond, Burton, Ohio			2,050
Bass Lake, Chardon, Ohio			2,050
Applicants in Oklahoma			300
Pennsylvania			3,190
Brandywine River, Coatsville, Pa			3,000
East Branch Brandywine River, Downington, Pa			3,000
Perkiomen Creek, Perkiomen, Pa			2,943
Pennsylvania Fish Commission			5,000
Applicants in Rhode Island			30
South Carolina			150
Long Cane Creek, Abbeville, S. C			5,055
Applicants in South Dakota			870
Tennessee			2,110
Texas			2,120

B.—*Details of distribution, 1890-91*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Carp—Continued.			
Trinity River, Dallas, Tex			5,000
Brazos River, Waco, Tex			4,000
San Marcos, San Marcos, Tex			6,000
Texas Pacific R. R. Co. ponds, Wills Point, Tex			2,000
Mesquit, Tex			2,000
Arlington, Tex			2,000
Red River, Texarkana, Tex			5,000
Applicants in Utah			5,840
Utah Fish Commission			2,000
Vermont Fish Commission			500
Applicants in Virginia			5,350
Middle River, West View, Va			7,000
Bull Run, Manassas, Va			5,000
Rapidan River, Rapidan, Va			5,000
Little River, Taylorsville, Va			4,000
Mattaponi River, Milford, Va			4,000
Neabsco Creek, Freestone, Va			4,000
Stoney Creek, Stoney Creek, Va			4,000
Meherrin River, Belfield, Va			4,000
Cedar Run, Catletts, Va			4,000
Rockfish River, Rockfish, Va			4,000
Tye River, Tye River Station, Va			4,000
Reed Creek, Wytheville, Va			2,405
Applicants in Washington			330
West Virginia			570
West Virginia Fish Commission			1,000
Applicants in Wisconsin			300
Wisconsin Fish Commission			25,000
Applicants in Wyoming			270
Wyoming Fish Commission			5,000
Tench:			
Applicants in Colorado			60
Shawnee Lake, Shawnee, Indian Territory			1,000
Applicants in Indiana			15
Kansas			320
Monocacy River, Frederick Junction, Md			400
Patuxent River, Laurel, Md			1,000
Applicants in Michigan			30
Missouri			200
Hickory Creek, Neosho, Mo			860
Shoal Creek, Boyden, Mo			3,500
North Fork Spring River, Lamar, Mo			4,000
Goldfish:			
Applicants in Alabama			176
Arizona Territory			41
Arkansas			462
California			30
Colorado			103
Connecticut			24
Delaware			42
District of Columbia			11,721
Florida			42
Georgia			270
Idaho			6
Applicants and public waters in Illinois			1,796
Applicants in Indiana			814
Indian Territory			124
Iowa			99
Kansas			890
Kentucky			294
Louisiana			170
Maine			6
Maryland			790
Massachusetts			129
Michigan			48
Applicants and public waters in Minnesota			398
Applicants and public waters in Missouri			11,542
Applicants in Mississippi			48
Nebraska			73
New Jersey			252
New Mexico			6
New York			455
North Carolina			174
Ohio			283
Ontario			6
Pennsylvania			970
Rhode Island			18
South Carolina			176
South Dakota			6
Tennessee			400
Texas			503

B.—*Details of distribution, 1890-91*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Goldfish—Continued.			
Applicants in Utah Territory			226
Vermont			6
Virginia			2,676
West Virginia			170
Wisconsin			34
Wyoming			62
Shad:			
Hudson River, West Point, N. Y		388,000	
Albany, N. Y		332,000	
Chesapeake and Delaware Canal, Delaware City, Del		400,000	
Delaware River, Lackawaxen, Pa		824,000	
Delaware Water Gap, Pa		558,000	
Port Jervis, N. Y		841,000	
Callicoon, N. Y		859,000	
Gloucester City, N. J		25,000	
Big Timber Creek, Westville, N. J		1,200,000	
Cohansey River, Bridgeton, N. J		500,000	
Potomac River, Fort Washington, Md		170,000	
U. S. Fish Commission, Central Station, Washington, D. C	*a*(32,361,000)		
United States Fish Ponds, Washington, D. C		*b*(2,054,000)	
Cedar Run, Catletts, Va		360,000	
Occoquan Creek, Woodbridge, Va		638,000	
Chappawansic Creek, Quantico, Va		333,000	
Rappahannock River Fredericksburg, Va		385,000	
Mattaponi River, Milford, Va		375,000	
Rockfish River, Rockfish, Va		653,000	
Little River, Taylorsville, Va		360,000	
Potomac River, Wide Water, Va		360,000	
Rapidan River, Rapidan, Va		354,000	
Tye River, Tye River Station, Va		390,000	
Neabsco Creek, Freestone, Va		365,000	
Otter River, Evington, Va		363,000	
Patapsco River, Relay, Md		681,000	
Patuxent River, Laurel, Md		820,000	
Meherrin River, Belfield, Va		723,000	
Stoney Creek, Stoney Creek, Va		480,000	
Neuse River, Goldsboro, N. C		568,000	
Pasquotank River, Elizabeth City, N. C		351,000	
Lumber River, Lumberton, N. C		600,000	
Newport River, Newport, N. C		495,000	
Congaree River, Columbia, S. C		1,594,000	
Savannah River, Augusta, Ga		1,570,000	
Ocmulgee River, Macon, Ga		931,000	
White Water Creek, Butler, Ga		558,000	
Flint River, Reynolds, Ga		558,000	
Alabama River, Montgomery, Ala		947,000	
Chattahoochee River, West Point, Ga		947,000	
Chattahoochee River, Bolton, Ga		637,000	
Palmer River, Providence, R. I		1,030,000	
Taunton River, Dighton, Mass		3,890,000	
Connecticut River, Warehouse Point, Conn		1,959,000	
Hudson River, West Point, N. Y		1,900,000	
Albany, N. Y		2,559,000	
Newburg, N. Y		2,113,000	
Glen Falls, N. Y		2,056,000	
Brandywine Creek, Wilmington, Del		1,800,000	
Blackbird Creek, Middletown, Del		138,000	
Appoquinnack Creek, Middletown, Del		137,000	
Smyrna Creek, Clayton, Del		275,000	
Leipsic Creek, Creswold, Del		275,000	
Jones Creek, Dover, Del		413,000	
Murderkill Creek, Felton, Del		495,000	
Mispillion Creek, Milford, Del		275,000	
Broadkill Creek, Ellendale, Del		192,000	
Susquehanna River, Peach Bottom, Pa		1,350,000	
Columbia, Pa		1,900,000	
Fites Eddy, Pa		2,100,000	
near Battery Station		412,000	
Nanticoke River, Seaford, Del		960,000	
Gunpowder River, Gunpowder, Md		1,300,000	
Elk River, Elkton, Md		1,350,000	
North East River, North East, Md		1,660,000	
Bush River, Bush River, Md		1,670,000	
Tuckahoe River, Queen Anne, Md		1,350,000	
Chester River, Chestertown, Md		450,000	
Back River, Back River, Md		450,000	
Wicomico River, Salisbury, Md		1,165,000	

a Distributed as fry from Central Station.
b Deposited for rearing and distribution in fall of 1891.

B.—*Details of distribution, 1890–91*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Shad—Continued.			
Satilla River, Waycross, Ga		285, 000	
Ocmulgee River, Macon, Ga		240, 000	
Ocklocknee River, Ocklocknee, Ga		600, 000	
Alapaha River, Alapaha, Ga		540, 000	
Withlacoochee River, Quitman, Ga		513, 000	
Arkansas River, Fort Smith, Ark		400, 000	
Van Buren, Ark		1, 462, 000	
Weber River, Ogden, Utah		500, 000	
Bear River, Montpelier, Idaho		571, 000	
Bear Lake, Bear Lake, Idaho		1, 194, 000	
Delaware Fish Commission, Wilmington, Del	837, 000		
Savannah River, Augusta, Ga		300, 000	
Withlacoochee River, Quitman, Ga		513, 000	
Arkansas River, Ozark, Ark		800, 000	
Potomac River, Washington, D. C			*a* 800, 000
Quinnat salmon:			
California Fish Commission, Sisson, Cal	2, 837, 900		
E. Cházari, city of Mexico, Mexico	50, 000		
Société Nationale d'Acclimatation, Paris, France	90, 000		
McCloud River, near Baird, Cal		722, 000	
Trinity River, near Fort Gaston, Cal		30, 000	
Redwood River, Fort Gaston, Cal		25, 000	
Oregon Fish Commission, Warrendale, Oregon	700, 000		
Clackamas River, Clackamas, Oregon		4, 902, 000	
Atlantic salmon:			
Tributaries of Penobscot River, near Craig Brook, Maine			103, 506
Hudson River, near Troy, N. Y			10, 329
Landlocked salmon:			
Pennsylvania Fish Commission	40, 000		
New York Fish Commission	50, 000		
New Hampshire Fish Commission	50, 000		
Massachusetts Fish Commission	25, 000		
Vermont Fish Commission	25, 000		
Nevada Fish Commission	20, 000		
Minnesota Fish Commission	20, 000		
Wilmurt Fishing Club, Newton Corners, N. Y	25, 000		
Bisby Fishing Club, Prospect, N. Y	20, 000		
Blooming Grove Park Association, Glen Eyre, Pa	10, 000		
George A. Starkey, Troy, N. H. (for A. N. Cheney)	10, 000		
W. P. Greenough, Lachevroliene, Canada	10, 000		
Herr von Behr, Schmaldow, Germany	20. 000		
U. S. Fish Commission Station, Washington, D. C	*b* (30, 000)		
Northville, Mich	(30,000)		
Duluth, Minn	(50,000)		
Craig Brook, Me	*c* (21,900)		
Schoodic Lake, Schoodic, Me		113, 000	
Green Lake, in Hancock County, Me		3, 000	
Commodore Club, Hartford, Me		5, 289	
Craig Pond, near the station			48
Green Lake, in Hancock County, Me			7, 319
Twin Lake, near Como, Wayne County, Pa		25, 000	
Lake Superior, off the mouth of Lester River, Minnesota		20, 000	
Loch Leven trout:			
Mountainy Pond, near Green Lake, Me			11, 297
Long Island Sound, Glen Cove, N. Y		3, 000	
Bayville, N. Y		5, 000	
Great South Bay, Newton, N. Y		10, 000	
Nebraska Fish Commission	10, 000		
New Hampshire Fish Commission	10, 000		
Berkshire Trout Club, Great Barrington, Mass	10, 000		
W. P. Greenough, Portneuf, Quebec, Canada	10, 000		
U. S. Fish Commission Station, Cold Spring Harbor, N. Y	*d* (20, 000)		
U. S. Fish Commission, Craig Brook, Maine	(20, 000)		
Shoshone Lake, Yellowstone National Park			3, 350
Lewis Lake, Yellowstone National Park			3, 350
Catfish Creek, Dubuque, Iowa			300
Bloody Run, Dubuque, Iowa			300
Waskqukoto Creek, Dubuque, Iowa			300
Clear Creek, Lansing, Iowa			1, 800
Big and Little Blue River, Shelbyville, Ind			900
Tributaries of Eagle Lake, Warsaw, Ind			225
Private applicants in Michigan			450
Ohio Fish Commission at Toledo			400
Dayton			400
Garrettsville Anglers' Association, Garrettsville			450
Private applicants in Vermont			2, 250

a Estimated product of 2,144,000 fry deposited in May, 1890.
b Distributed as fry from Central Station.
c Distributed as fry from Craig Brook Station.
d Distributed as fry from Cold Spring Harbor Station.

B.—*Details of distribution, 1890–91*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Rainbow trout:			
Starrucca Creek, Starrucca, Pa		11,981	
Charles Run, Monkton, Md			200
Carroll Run, Monkton, Md			250
Bee Tree Run, Freeland, Md			219
Creeks near New Market, Md			950
Tributary of Gunpowder River, Long Green, Md			490
Tributary of Deer Creek, Belair, Md			550
Patapsco River, Glen Falls, Md			889
Western Run, branch of Jones Falls, Baltimore, Md			800
Big Hunting Creek, Mechanicstown, Md			700
Little Hunting Creek, Mechanicstown, Md			700
Applicants in Maryland			979
Burns Brook, Delaware, N. J			110
Jacksonburg Creek, Delaware, N. J			982
Yards Creek, Haynesburg, N. J			226
Blairstown, Haynesburg, N. J			875
Musconitcung Creek, Hackettstown, N. J			876
Trout brook, Hackettstown, N. J			500
New Hampshire Fish Commission	10,000		
Vermont Fish Commission	20,000		
John H. Gordon, South Bend, Wyo	5,000		
Hon. Otto Gramm, Laramie, Wyo	5,000		
W. C. Harris, American Angler, New York City	10,000		
E. Cházari, City of Mexico (for Mexican Government)	25,000		
Midland Counties Fish Culture Establishment, Malvern Wells, England	15,000		
Herr von Behr, Schmaldow, Germany	10,000		
E. Warner, Swiss consul, Havre, France, for the Government of Switzerland	40,000		
Frank H. Mason, Frankfort on the Main, Germany	10,000		
U. S. Fish Commission Station, Neosho, Mo	(20,000)		
Central Station, Washington, D. C	*a* (25,000)		
Reedy Creek, Concord, Va			493
Flat Creek, Lawyers, Va			500
Fowl Ground Creek, Redwood, Va			142
Tributaries of Clinch River, Tazewell, Va			50
Big Cedar Creek, Cleveland, Va			230
Tats Run, Wytheville, Va			75
Colvin Run, Herndon, Va			100
Elk Creek, Natural Bridge, Va			500
Applicants in Virginia			1,180
Trout and Meadow runs, Romney, W. Va			400
Big Sandy Creek, Bruceton Mills, W. Va			400
Mill Run, Fairchance, Pa			400
Alder Run, Kylertown, Pa			400
Carmul Run, Kennedy, Pa			90
Waste-House Run, Shenandoah, Pa			400
Trindle Run, Mechanicsburg, Pa			700
Cochlin Run, Mechanicsburg, Pa			1,500
Yellow Breeches Creek, Williams Grove, Pa			2,790
Applicants in Pennsylvania			450
North Fork, Swananoa River, Black Mountain Station, N. C			675
Sugar Fork, Swananoa River, Black Mountain Station, N. C			675
Stony Fork, Swananoa River, Black Mountain Station, N. C			450
Flat Creek, Black Mountain Station, N. C			675
Yadkin River, Salisbury, N. C			1,700
Elkin, N. C			630
Applicants in North Carolina			2,205
Dykes Creek, Rome, Ga			1,350
Applicants in Georgia			450
East Cohoba River, near Birmingham, Ala			450
Linsey Creek, Florence, Ala			200
Cypress Creek, Florence, Ala			200
Applicants in Alabama			180
Vermont			917
East Branch Cedar Creek, Meredith, Mich			467
North Branch Cedar Creek, Meredith, Mich			468
Tobacco Creek, Hatton, Mich			800
Chippewa Creek, Hatton, Mich			200
Stacy Creek, branch of Sturgeon River, Vanderbilt, Mich			535
Applicants in Michigan			380
Ohio			525
Trout Run, Avonia, Pa			113
Hickory Creek, Newton County, Mo			1,000
Baynham Branch, Newton County, Mo			500
Big Lost Creek, Racine, Mo			250
Five Mile Creek, Newton County, Mo			250

a Distributed as fry from Central Station.

B.—*Details of distribution, 1890-91*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Rainbow trout—Continued.			
North Branch Indian Creek, McDonald County, Mo			400
North Fork of Elkhorn Creek, McDonald County, Mo			400
Sugar Fork of Buffalo Creek, McDonald County, Mo			400
Big Sugar Fork of Elk River, McDonald County, Mo			400
Little Sugar Fork of Elk River, McDonald County, Mo			400
Jones Creek, Jasper County, Mo			400
Turkey Creek, Jasper County, Mo			400
Tributaries of Shoal Creek, Jasper County, Mo			400
Small Lake, near Joplin, Mo			200
Spring River, Jasper County, Mo			500
Crane River, Stone County, Mo			500
Sac River, Ash Grove, Mo			801
James River, Turner, Mo			800
Gasconade, Mansfield, Mo			800
Big Branch, Gasconade River, Cabool, Mo			846
Copper Mine Branch, Carter County, Mo			500
Applicants in Missouri			1,000
Marmaton River, Fort Scott, Kans			1,048
Marisdescygne River, Boiscourt, Kans			1,050
Big Sugar Creek, Boiscourt, Kans			1,077
Five Mile Creek, Leavenworth, Kans			200
Applicants in Kansas			2,300
War Eagle Creek, War Eagle Mills, Ark			970
Tributaries of White River, Fayetteville, Ark			1,847
Applicants in Arkansas			1,400
Von Behr trout:			
Great Brook, Green Lake, Maine			3,413
Heart Pond near Orland, Maine			167
U. S. Fish Commission Station, Leadville, Colo	(100,000)		
Starrucca Creek, Brandt, Pennsylvania		13,200	
Hemlock Creek, Stevens Point, Pennsylvania		3,200	
Lake Superior off mouth of Lester River		10,000	
Baptism River, in Minnesota		5,000	
Nebraska Fish Commission	10,000		
Wyoming Fish Commission	20,000		
Minnesota Fish Commission	20,000		
Otto Gramm, Laramie, Wyo	5,000		
A. N. Cheney, Manchester, Vt	10,000		
A. B. Smith, Bellevue, Ohio	25,000		
W. P. Greenough, Portneuf, Quebec, Canada	10,000		
E. Cházari, Mexico City (for Mexican government)	10,000		
U. S. F. C. Station, Wytheville, Va	(40,000)		
Central Station, Washington, D. C	*a* (28,000)		
Neosho, Mo	(28,000)		
Duluth, Minn	*b* (20,000)		
Nez Percé Creek, Yellowstone National Park			9,800
Thornington Pond, Romeo, Mich			250
Catfish Creek, Dubuque, Iowa			300
Bloody Run, Dubuque, Iowa			300
Wasqukoto Creek, Dubuque, Iowa			300
Clear Creek, Lansing, Iowa			1,800
White River, Noblesville, Indiana			450
Big and Little Blue River, Shelbyville, Indiana			900
Spearfish Creek, Spearfish, South Dakota			350
Tributaries of Menominee River, Marinette, Wis			450
Ohio Fish Commission, Toledo, Ohio			525
Dayton, Ohio			900
Garrettsville Anglers' Association, Garrettsville, Ohio			450
Applicants in Ohio			270
Hoosac River, North Adams, Mass			330
Otsego Creek, Oneonta, N. Y			425
Applicants in New York			455
North Branch of Indian Creek, Stella, Mo			400
Sugar Forks of Buffalo Creek, McDonald County, Mo			400
Big Sugar Fork of Elk River, Pineville, Mo			400
South Fork of Elkhorn River, Indiana Springs, Mo			400
Little Sugar Fork of Elk River, Pineville, Mo			400
Jones Creek, Fidelity, Mo			400
Turkey Creek, Scotland, Mo			400
Grand River, Harrisonville, Mo			835
Spring River, Jasper County, Mo			1,200
Crane Creek, Stone County, Mo			500
Piney River, Cabool County, Mo			1,750
Bull Creek, Paola, Kans			840
War Eagle Creek, War Eagle, Ark			1,000
West Fork, White River, Fayetteville, Ark			2,000

a Distributed as fry from Central Station. *b* Distributed as fry from Duluth Station.

B.—*Details of distribution, 1890–91*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Von Behr trout—Continued.			
Applicants in Arkansas			1,000
Delaware Fish Commission	8,500		
W. C. Harris, "American Angler," New York City	8,500		
New York Fish Commission	12,750		
U. S. Fish Commission Station, Northville, Mich	(31,750)		
Craig Brook, Me	(9,000)		
Brook trout:			
Moose Pond, Hartland, Me		4,251	
U. S. Fish Commission Station, Leadville, Colo	(20,000)		
Starrucca Creek, Brandt, Pa		16,660	
Hemlock Creek, Stevens Point, Pa		3,920	
Applicants in New Jersey			48
Gen. Geo. W. Hooker, Brattleboro, Vt	25,000		
Dana Pearson, Northampton, Mass	20,000		
U. S. Fish Commission Station, Wytheville, Va	(20,000)		
Central Station, Washington, D. C	*a* (25,000)		
Neosho, Mo	(20,000)		
West Fork of Gardiner River, Yellowstone National Park			7,875
Catfish Creek, Dubuque, Ia			400
Bloody Run, Dubuque, Ia			400
Wasqukoto Creek, Dubuque, Ia			550
Cooley Creek, Lansing, Ia			1,350
Greene River, Werley, Wis			900
Creeks tributary to Menominee River near Marinette, Wis			1,340
White River, Noblesville, Ind			450
Turtle Lake, Alpena, Mich			900
Sand Creek, Grand Rapids, Mich			360
Rush Creek, Grand Rapids, Mich			180
Spearfish Creek, Spearfish, S. Dak			450
Applicants in Indiana			450
Ohio Fish Commission, Dayton, Ohio			400
Ohio Fish Commission, Toledo, Ohio			100
Hoosac River, North Adams, Mass			100
Heywood Creek, Weston, Mass			100
West Pasture Brook, North Hatfield, Mass			100
Applicants in Massachusetts			100
Ten-Mile River, Dillon, Colo			5,000
Snake River, Dillon, Colo			5,000
Platte River, Estabrook, Colo			10,000
Willow Creek, Dillon, Colo			5,000
Grape Creek and tributaries, West Cliff, Colo			5,000
Applicants in Colorado			13,000
Wyoming State Fish Commission			5,000
Applicants for stocking public streams near Rapid City, S. D.			8,500
in South Dakota			1,000
Otto Gramm, Laramie, Wyo	5,000		
Lester River, near Duluth Station			100
Lake trout:			
Pleasant Lake, Fallsburg, N. Y		99,900	
White Lake, Liberty, N. Y		99,820	
Sheldrake Lake, Hurleyville, N. Y		99,790	
Round Lake, Rockland, N. Y		99,730	
Guilford Lake, Guilford, N. Y		82,460	
Comforts Pond, Susquehanna, Pa		24,500	
Lake Hopatcong, Lake Hopatcong, N. J		62,441	
Lake Erie, near Put-in Bay, Ohio		192,000	
Minnesota Fish Commission	150,000		
New Hampshire Fish Commission	500,000		
Rhode Island Fish Commission	20,000		
Wyoming Fish Commission	100,000		
Nebraska Fish Commission	50,000		
John H. Gordon, South Bend, Wyo	50,000		
C. F. Stoddard, Granville, N. Y	10,000		
Blooming Grove Park Association, Glen Eyre, Pa	55,000		
E. Cházari, City of Mexico (for Mexican Government)	50,000		
U. S. F. C. Station, Cold Spring Harbor, N. Y	*b* (500,000)		
Duluth, Minn	*c* (500,000)		
Put-in Bay, Ohio	*d* (200,000)		
Central Station, Washington, D. C	*a* (100,000)		
Whitefish Lake, Pierson, Mich		31,500	
Sand Lake, Sand Lake, Mich		40,500	
Crandall Lake, Cedar Springs, Mich		22,500	
South Lake, Cedar Springs, Mich		27,000	
Moore Lake, Cedar Springs, Mich		22,500	
Lincoln Lake, Spencer Mills, Mich		31,500	
Trufants, Mich		31,500	
Gowen, Mich		31,500	
Curley Lake, Harrard, Mich		31,500	

a Distributed as fry from Central Station.
b Distributed as fry from Cold Spring Harbor Station.
c Distributed as fry from Duluth Station.
d Distributed as fry from Put-in Bay Station.

B.—*Details of distribution, 1890-91*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Lake trout—Continued.			
Myers Lake, Rockford, Mich		45,000	
Zukey Lake, Hamburg Junction, Mich		225,000	
Walnut Lake, Oakland, Mich			20,000
Selkirk Lake, Shelbyville, Mich			3,400
Fatal Lake, Greenville, Mich			500
Baldwin Lake, Greenville, Mich			500
Burgess Lake, Greenville, Mich			600
Murray Lake, Ionia, Mich			2,050
Fern Lake, Grand Rapids, Mich			400
Reed Lake, Grand Rapids, Mich			400
Lake Odessa, Lake Odessa, Mich			400
Camp Lake, Sparta, Mich			1,100
Carp Lake, Provemont, Mich			1,970
Meberts Creek, Meberts, Mich			1,000
Mainstay Lake, Waterford, Mich			982
Orchard Lake, Orchard Lake, Mich			6,000
Union Lake, Oakland County, Mich			74,000
Cooley Lake, Oakland County, Mich			12,000
Applicants in Iowa			3,625
Michigan			500
South Dakota			400
Lake Kampeska, Watertown, S. Dak			1.000
Lake Maxinkuckee, Marmont, Ind			2,250
Applicants in Indiana			450
Ohio			505
Shenango River, Sharon, Pa			494
Hampton Lake, Yardley, Pa			500
Applicants in New York			250
Rhode Island			500
Vermont			2,300
Maryland			955
New Jersey			55
Shoshone Lake, Yellowstone National Park			30,012
Lewis Lake, Yellowstone National Park			12,013
Lake Superior, off the mouth of Lester River in Minnesota		303,000	
Lake Menozia, in St. Louis County, Minn		55,000	
Lake Superior, off the mouth of Lester River			235,000
Elk River, Rutledge, Mo			500
Whitefish:			
Lake Ontario, near Oswego, N. Y		1,000,000	
Lake Ontario, near Sacketts Harbor, N. Y		2,312,000	
Ohio Fish Commission	47,500,000		
Pennsylvania Fish Commission	14,000,000		
Wisconsin Fish Commission	10,000,000		
Carl G. Thompson, Warren, Ind	125,000		
Lake Erie, near Put-in Bay, Ohio		10,000,000	
New York Fish Commission	4,000,000		
Herr von Behr, Schmaldow, Germany	100,000		
Midland Counties Fish Culture Establishment, Malvern Wells, England	200,000		
U. S. F. C. Station, Duluth, Minn	*a*(12,000,000)		
Central Station, Washington, D. C	*b*(4,000,000)		
Put-in Bay, Ohio	*c*(200,000)		
Lake Huron, north of Thunder Bay Island		1,500,000	
near Middle Island		1,500,000	
East Tawaos		2,000,000	
Miller Point		2,000,000	
Sturgeon Point		2,000,000	
Lake Michigan, near Epoufette and Warehouse		2,000,000	
Naubinway and Scott Point		2,500,000	
Lake Superior, near Whitefish Point		2,500,000	
Straits of Mackinac, near St. Ignace		2,500,000	
Detour Passage, near Hay Point		2,000,000	
Thunder Bay, near South Point and Scarecrow Island		1,500,000	
Sulphur Island		1,000,000	
North Point		1,060,000	
Lake Superior, near mouth of Lester River		11,330,000	
Yellowstone River, above the falls, in Yellowstone National Park			10,000
Smelt:			
Potomac River, near Chain Bridge, D. C		400,000	
Yellow perch:			
Chicago, Burlington and Quincy Railroad reservoir, Rio, Ill			500
Sangamon River, Decatur, Ill			495
Lakes in vicinity of Greenville, Ill			200
Virginia, Ill			300
Big Flat Creek, St. Paul, Ind			440
Small private pond, Indianapolis, Ind			50

a Distributed as fry from Duluth Station. *b* Distributed as fry from Central Station.
c Distributed as fry from Put-in Bay Station.

B.—*Details of distribution, 1890-91*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Yellow perch—Continued.			
Big Indian, New Albany, Ind			257
Silver Creek, New Albany, Ind			200
Pine Lake, La Porte, Ind			50
Elkhart River, Elkhart, Ind			50
St. Joe River, Elkhart, Ind			50
Simmons Lake, Elkhart, Ind			50
Elk River, Goshen, Ind			100
Eagle Lake, Warsaw, Ind			50
Massinneawa, Marion, Ind			50
White River, Anderson, Ind			35
Iowa River, Iowa Falls, Iowa			385
Lone Tree Lake, Burlington, Iowa			510
Cedar River, Cedar Rapids, Iowa			280
Iowa River, Decorah, Iowa			400
Middle Creek, Maple Hill, Kans			96
Mill Creek, Poxico, Kans			96
Mill Creek, Alma, Kans			98
Spring Pond, Holliday, Kans			100
Creek near Burton, Kans			100
Wakerasa Creek, Topeka, Kans			100
Chiscaki River, Nashville, Kans			100
Calvary Creek, Coldwater, Kans			100
Elm Creek, Medicine Lodge, Kans			200
Falls of the Rough, Roughdale, Ky			390
Lake Cockerell, Independence, Mo			195
Big Hole River, Butte City, Mont			2,607
Weber River, Ogden, Utah			200
Utah Lake, Battle Creek, Utah			436
Lake Colville, Sprague, Wash			30
Loon Lake, Loon Lake, Wash			25
Washington Lake, Seattle, Wash			237
Applicants in Pennsylvania			6
Pike perch:			
Pennsylvania Fish Commission	58,000,000		
West Lake, Kalamazoo, Mich		500,000	
Gourdneck Lake, Kalamazoo, Mich		750,000	
Gum Lake, Plainville, Mich		1,250,000	
Wetmore Lake, Allegan County, Mich		375,000	
Dumont Lake, Allegan County, Mich		375,000	
Miner Lake, Allegan County, Mich		750,000	
Swan Lake, Allegan County, Mich		500,000	
Little John Lake, Allegan County, Mich		250,000	
Lake 16, Allegan County, Mich		250,000	
Turkey Lake, Cedar Beach, Ind		8,000,000	
Lake Maxinkuckee, Marshall County, Ind		800,000	
Clear Lake, Springfield, Ill		2,000,000	
Kankakee River, Kankakee, Ill		6,000,000	
Susquehanna River, Susquehanna, Pa		5,000,000	
Bass Lake, Chardon, Ohio		2,300,000	
Summit Lake, Akron, Ohio		3,250,000	
Brady Lake, Kent, Ohio		3,100,000	
Muskingum River, Zanesville, Ohio		10,000,000	
Ravenna Lake, Ravenna, Ohio		2,200,000	
Mahoning River, Newton Falls, Ohio		1,000,000	
Geauga Lake, Garrettsville, Ohio		850,000	
Lake Erie, near Bass Island, Ohio		1,800,000	
Cleveland, Ohio		1,000,000	
St. Louis River, Fond du Lac, Minn	12,000,000		
Minnesota River, near Mendota, Minn		5,000,000	
Mankato, Minn		5,000,000	
Lester River, near Duluth, Minn		100,000	
Black bass:			
Applicants in North Carolina			260
South Carolina			400
Tennessee			150
Chicago, Burlington and Quincy Railroad reservoir, Rio, Ill			1,585
Lake in vicinity of Columbia, Ill			1,530
Sangamon River, Decatur, Ill			500
Lakes in vicinity of Shirley, Ill			200
Lebanon, Ill			150
Waterloo, Ill			450
Greenville, Ill			300
Embarras River, Charleston, Ill			2,280
Lakes in vicinity of Virginia, Ill			1,200
Macomb, Ill			300
Spoon Lake, Seville, Ill			500
Fox River, McHenry, Ill			494
Taylor Lake, Grays Lake, Ill			200
Second Lake, Grays Lake, Ill			493
Du Page River Naperville, Ill			800
Kaskaskia River, Keysport, Ill			200

The steamer *Fish Hawk* also assisted in the work here during a part of June. The region between Cape Cod and the Bay of Fundy, including the coast waters of Massachusetts, New Hampshire, and Maine, and the Gulf of Maine, was assigned to Capt. A. C. Adams, formerly in command of the schooner *Grampus*, and having a long experience in connection with the mackerel fishery. His inquiries were started at Provincetown on Cape Cod, about the middle of May, and were thence extended along the shores of Massachusetts Bay, Cape Ann, and the coast farther north to Portland, where he was joined by the steamer *Fish Hawk* and Dr. Wolhaupter in the latter part of June. By the close of the year the examination had been carried as far east as Boothbay Harbor.

MENHADEN.

From the 1st of March to early in May, 1894, the steamer *Fish Hawk*, Lieut. Robert Platt, U. S. N., commanding, was stationed in the lower Chesapeake Bay investigating the spawning and other habits of the menhaden and making observations respecting the natural history of the other economic fishes of the region, and the fisheries to which they give rise. Mr. W. C. Kendall was on duty as naturalist during the first part of the season, being succeeded later by Dr. W. E. Wolhaupter. The collecting work was carried on by means of seines, fyke nets, gill nets, and the beam trawl, and specimens were obtained from the fishermen wherever possible. In this manner much important information was secured relative to the life-history, distribution, seasons, food, spawning characteristics, etc., of several species. Physical observations relating more especially to the temperature and density of the water were also conducted at frequent intervals during the entire cruise.

The fact seems to have been quite conclusively established, through recent observations, that the menhaden resort to shallow, protected coastal waters, such as bays, inlets, and the lower parts of rivers and creeks, for spawning purposes, and that the young remain for a considerable length of time in the same or similar situations, but persistent investigations have failed to discover the mature fish in the act of breeding. A few specimens have been secured from time to time containing ripe eggs or ripe milt, but ripe individuals of both sexes have never yet been taken together, thus precluding the fertilization and hatching of the spawn artificially, whereby the conditions necessary to that process could positively be ascertained. The *Fish Hawk* was again unsuccessful in regard to the matter this spring, but many interesting observations on the young of different stages and on the adult fish were obtained, and from the evidence supplied by the fishermen and by the condition of the fish it was concluded that the spawning period in the Chesapeake Bay region occurs probably in February or March, or during parts of both of those months.

Mr. Vinal N. Edwards, of the Woods Hole Station, also gave much time during the spring of 1894 to the study of the menhaden question in the region about Buzzards Bay, where that species is known to spawn abundantly, and where Mr. Edwards has conducted extensive inquiries on the subject during several years past.

TILEFISH.

During a part of July and August, 1893, the schooner *Grampus* was employed, under the immediate direction of the Commissioner, in making fishing trials along the margin of the Gulf Stream slope off the coast of southern New England, New York, and New Jersey, for the purpose of determining the present range and abundance of the tilefish, in continuance of the examinations conducted during the past few years, as described in previous reports. A number of specimens, weighing from 7 to 20 pounds apiece, were obtained, and the reestablishment of the species seems to be assured, although it does not appear as yet to have been restored to its old-time abundance.

TEMPERATURE OBSERVATIONS.

The Fish Commission has continued to receive, through the courtesy of the Light-House Board and the Southern Pacific Company, the daily records of water-temperature observations taken at many seacoast and inland stations, as follows:

Temperature stations on the Atlantic Coast.

Stations of the Light-House Board:
- Coast of Maine: Petit Manan Island, Mount Desert Rock, Matinicus Rock, Seguin Island, Boon Island.
- Coast of Massachusetts: Race Point, Pollock Rip light-ship, Great Round Shoal light-ship, Nantucket New South Shoal light-ship, Cross Rip light-ship, Vineyard Sound light-ship.
- Coast of Rhode Island: Brenton Reef light-ship, Block Island southeast light.
- Long Island Sound: Bartlett Reef light-ship, Stratford Shoal light-ship.
- Coast of New Jersey: Absecon Inlet, Five Fathom Bank light-ship.
- Delaware Bay: Fourteen Foot Bank light-ship.
- Coast of Virginia: Winter Quarter Shoal light-ship.
- Chesapeake Bay: Windmill Point, Stingray Point, York Spit.
- Coast of North Carolina: Cape Lookout, Frying Pan Shoal light-ship.
- Coast of South Carolina: Rattlesnake Shoal light-ship, Martins Industry Shoal light-ship.
- Coast of Florida: Fowey Rocks, Carysfort Reef, Dry Tortugas.

Temperature stations on the Pacific Slope.

Stations of the Southern Pacific Company:
- Sacramento River at Tehama and Yolo bridges and Kings Landing, California.
- Feather River at Feather River Bridge, California.
- American River at American River Bridge, California.
- Mokelumne River at Lodi, Cal.
- Tuolumne River at Modesto, Cal.
- San Joaquin River at the upper and lower railroad crossings.
- King River at Kingsburg, Cal.
- Colorado River at Yuma, Ariz.

B.—*Details of distribution, 1890-91*—Continued.

Species and disposition.	Eggs.	Fry.	Adults and yearlings.
Rock bass—Continued.			
Kaskaskia, Keysport, Ill			100
Big Muddy River, De Soto, Ill			100
Lakes in vicinity of Carbondale, Ill			100
Anna, Ill			100
Cache River, Ullin, Ill			100
Flat Rock River, Flat Rock, Ind			300
Big and Little Blue rivers, Shelbyville, Ind			300
Big Flat Creek, St. Paul, Ind			195
White River, Indianapolis, Ind			370
Cedar River, Cedar Rapids, Iowa			185
Iowa River, Decorah, Iowa			300
Des Moines River, Ottumwa, Iowa			134
Big Creek, Rome, Iowa			133
Skunk River, Mt. Pleasant, Iowa			133
East Nodaway River, Valisca, Iowa			100
Middle Nodaway River, Valisca, Iowa			100
Railroad reservoir, Moxon, Iowa			200
Des Moines River, Albia, Iowa			200
West Nishnabotna River, Hastings, Iowa			250
Des Moines River, Levey, Iowa			200
Nishnabotna River, Red Oak, Iowa			250
Lakes in vicinity of Pee Wee Valley, Kentucky			60
Little Kentucky River, La Grange, Ky			50
Falls of the Rough, Roughdale, Ky			470
Lake in vicinity of Versailles, Ky			84
Covington, Ky			100
Walton, Ky			100
Snow Island, St. Ignace, Mich			300
Lake Cockerell, Independence, Mo			195
Salt River, Hunnewell, Mo			100
Chariton River, Chariton, Mo			100
Oquaga Lake, Deposit, N. Y			490
Neahoning River, Leavittsburg, Ohio			395
Delaware River, Callicoon, N. Y			50
Lackawaxen, Pa			25
Port Jervis, N. Y			50
Susquehanna River, Easton, Pa			50
Pennsylvania Fish Commission, Allentown, Pa			50
Susquehanna River, Harrisburg, Pa			150
Lancaster, Pa			150
Lake Kampesta, Watertown, S. Dak			350
Williams Bay, Geneva, Wis			297
State hatchery, Laramie, Wyo			290
Potomac River, Washington, D. C			59
Flaghole, Spring River, Seneca, Mo			1,368
Sunfish:			
Chicago, Burlington and Quincy Railroad reservoir, Rio, Ill			500
Sangamon River, Decatur, Ill			495
Small lake near Fort Wayne, Ind			94
Big Indian, New Albany, Ind			250
Silver Creek, New Albany, Ind			238
Iowa River, Decorah, Iowa			290
Agent Railroad Company, Waverly, Pa			50
Lake Kampesta, Watertown, S. Dak			150
Lake Colville, Sprague, Wash			25
Loon Lake, Loon Lake, Wash			25
Applicant in Pennsylvania			15
Potomac River, Washington, D. C			130
Spanish mackerel:			
Off mouth of Chesapeake Bay, near Cape Charles, Va		776,000	
Cod:			
Massachusetts Bay, off Cape Ann, Massachusetts		18,968,000	
Vineyard Sound, off the Massachusetts coast		36,416,000	
Pollock:			
Massachusetts Bay, off Cape Ann, Massachusetts		14,827,500	
Haddock:			
Massachusetts Bay, off Cape Ann, Massachusetts		78,500	
Flatfish:			
Vineyard Sound, off the Massachusetts coast		3,350,500	
Lobsters:			
Vineyard Sound, off the Massachusetts coast		3,533,500	
Total*	152,129,650	264,076,667	2,016.152

* Figures inclosed in parentheses are not included in summations.

REPORT UPON THE INQUIRY RESPECTING FOOD-FISHES AND THE FISHING-GROUNDS.

By Richard Rathbun,
Assistant in charge.

INTRODUCTION.

During the two years covered by this report the field researches assigned to this division have extended over a large part of both the Atlantic and Pacific seacoasts, and have embraced a wide area of fresh-water drainage. Most noteworthy from the novelty and importance of their results have been the investigations by the steamer *Albatross* in Bering Sea and along the coasts of Washington, Oregon, and California.

A very thorough reconnaissance has been made of the eastern or shallow-water part of Bering Sea, including its fishing-grounds for cod, the shore lines as far north as the Kuskokwim River, and the general characteristics of the bottom to the western border of the continental platform, whose position also was determined. The principal fishing-bank in this region, which has been named after the late Prof. Baird, was discovered to have a very large area, exceeding even that of Georges Bank, off the New England coast. The distribution of the fish on this and on other grounds, as well as their abundance and average size in different places, has been ascertained for the summer season, and much further information of value to the fishermen has been placed on record. The importance of a more thorough knowledge of the physics and natural history of Bering Sea, in view of the grave questions connected withits seal and other fisheries, suggests, however, many additional problems, for the study of which the *Albatross* is well adapted, and which require early attention.

The preliminary examination of the continental slope off the States of Washington, Oregon, and California, from the Straits of Fuca to the Mexican boundary line, was completed in the fall of 1890. The location of all the fishing-grounds contained within these limits has now been determined, and sufficient material has been collected to illustrate the different varieties of food-fishes, and their distribution throughout the region, as well as the principal features of the bottom fauna. Very encouraging results have attended the observations made in San Francisco Bay with respect to the breeding of the Atlantic coast oyster, and an important scientific investigation has been conducted off the western coast of Mexico and Central America, under the direction of Prof. Alexander Agassiz.

The field operations on the Atlantic coast have been directed chiefly to the study of the oyster-grounds of Long Island Sound, of Tangier Sound in Maryland and Virginia, and of the coast of South Carolina. Extensive surveys were made in Long Island Sound with respect, mainly, to the conditions of the bottom, the natural enemies of the oyster, and the varying distribution of the set of spat. The absence of any pollution in the oyster-ground waters was also fully demonstrated by careful physical and chemical observations. The extent and causes of the deterioration of the oyster beds in Chesapeake Bay has been made the subject of a special investigation, which is still in progress, Tangier and Pocomoke sounds having been selected for the first examinations. The inquiries in South Carolina were conducted for the purpose of ascertaining the character and distribution of the natural oyster-cultural resources and of determining the proper measures for their development. The work was completed in the course of a single winter, and has afforded very satisfactory results. Arrangements have also been made for the preparation of a series of reports descriptive of the methods of oyster-culture practiced in European countries, which will, it is hoped, be at least suggestive to American oyster-growers.

The study of the physical characteristics of the coast waters off the Northern Atlantic States, especially in the region traversed by the mackerel during their seasonal migrations, has been taken up for the first time in a thoroughly comprehensive manner, and has now been actively prosecuted during two summers. While the principal part of this work has been limited to the southern New England coast, a series of observations has also been carried southward to Virginia. These inquiries will have an equal bearing upon the habits of all other migratory fishes which resort to this region during a greater or less part of each year, and nearly all of the important economic species which enter into the fisheries there are of this character.

Among the investigations relating to the fresh waters the one of most direct importance has probably been the study of the salmon rivers of Alaska with respect to the natural history of the salmon, the threatened depletion of the schools by the destructive methods of capture now in use, and the measures necessary to preserve this extensive food supply. The observations were made on Kadiak and Afognak islands, and on Wood River at the head of Bristol Bay. The fresh-water systems have also been examined in eleven different States and Territories, as follows: The Yellowstone National Park, Colorado, Utah, Missouri, Arkansas, Iowa, Wisconsin, Indiana, Ohio, Kentucky, and

Florida. The majority of these surveys have been very thorough, affording much desired information regarding the natural features of a large number of lakes and rivers, in respect to which fish-cultural operations have been undertaken or proposed.

The Woods Holl laboratory has been open continuously during the entire period, a competent scientific expert having been employed to study the biological questions which are constantly arising in connection with the hatching work conducted at this station. During both summers the facilities of the laboratory have also been extended, as in former years, to a large number of naturalists, some of whom have given their attention exclusively to the Fish Commission work. Many special observations have been made on the life history of the seacoast fishes, and interesting experiments have been conducted relative to their artificial propagation. One result of these inquiries has been to demonstrate conclusively that the attempts recently made to increase the supply of cod on some parts of the New England coast have met with complete success. Not only has the number of fish augmented from year to year, but schools of this species are making their appearance in many places where they had never been seen before. Twelve other species of fishes have also been studied to a greater or less extent, the greatest amount of progress having been made with respect to the sea bass and Spanish mackerel. A thorough investigation into the life history of the lobster is likewise now being made.

PACIFIC COAST.

The steamer *Albatross* was at work on the coasts of Washington and Oregon at the close of the fiscal year ending June 30, 1889, and on July 8 following left Tacoma, Wash., with several members of the U. S. Senate Committee on Indian Affairs to visit the principal Indian settlements in southeastern Alaska. The trip was made by way of the inland passages and extended as far as Sitka and Juneau. It terminated July 28, and the *Albatross* then started for Bering Sea, but when only a few days out the port engine became disabled, and she was obliged to return to Seattle for repairs. When these had been completed the season was too far advanced to warrant making the long passage to Alaska, and the steamer again took up the investigations off Washington, carrying them southward along the coasts of Oregon and California as far as Cape Mendocino. During the following winter repairs were made at the Mare Island navy-yard, and during March and April, 1890, the region between Point Arena and Point Conception was examined, thereby nearly completing the preliminary survey of the California coast.

On May 5, 1890, the *Albatross* left San Francisco and proceeded to Alaska, where several months were spent in defining the fishing-grounds and in determining the physical and natural-history features of the eastern part of Bering Sea. Subsequently some additional observations were made in regard to the fishing region south of the Alaska Peninsula, which had been surveyed in 1888; a short stop was made on the coast of Washington, and the examination of the continental platform was finished between Cape Mendocino and Point Arena, California. The last of January, 1891, the *Albatross* was dispatched on a special expedition off the west coast of Mexico and Central America, and to the region about the Galapagos Islands, under the scientific direction of Prof. Alexander Agassiz. This occupied about three months, and by the end of June, 1891, the steamer had been refitted for a third cruise to Alaska.

The conduct of these investigations was in charge of Lieut. Commander Z. L. Tanner, U. S. Navy, commanding the *Albatross*, assisted by an efficient staff of naval officers in the management of the ship and in connection with the physical observations. The civilian staff has consisted of Mr. Charles H. Townsend, naturalist; Mr. A. B. Alexander, fishery expert, and Mr. N. B. Miller, assistant naturalist. Prof. Charles H. Gilbert, of Indiana University, was also attached to the steamer as ichthyologist and chief naturalist from January to August, 1889, and during the Bering Sea cruise of 1890.

ALASKA.

During the summer of 1890 the *Albatross* was in Bering Sea, where an examination was made of all the principal cod-fishing banks as well as of the general features of the shallow-water area which composes the entire eastern part of this important region. The *Albatross* entered Bering Sea by way of Unimak Pass, in May, and carried a line of soundings in a northerly and easterly direction a distance of about 80 miles, when stormy weather made it necessary to proceed to Unalaska, the dredgings and soundings being continued, however, in that direction. Leaving the latter place on May 28, the vessel began a reconnaissance of the shore line of Bristol Bay, which was conducted first along the north side of the Alaska Peninsula as far as the Kvichak River, and thence to the Kuskokwim River. During this cruise the contour and topography of the coast were sufficiently well defined to serve as a basis for the subsequent hydrographic observations. From Cape Newenham a line of stations was run in the direction of the Northwest Cape of Unimak, and the latter part of June investigations were commenced on Slime Bank, being carried thence over Baird Bank to the head of Bristol Bay and the Kulukak Ground. Two visits were paid to Port Möller and Herendeen Bay, where a coal mine had recently been opened, and partial surveys were made of each of these inlets, which define their entrance and the channel leading to the coal landing.

During the first part of August a line of soundings was made from off Cape Cheerful, Unalaska, to Bogoslof Island and volcano, from the latter locality in a westerly and northerly direction and subsequently in a southerly direction, for the purpose of determining the western boundary of the elevated platform characterizing the eastern part of Bering Sea. The remainder of the season was employed in the vicinity of Unalaska, mainly in ascertaining the positions and value of the cod banks lying off the northern side of that island, but on leaving Bering Sea a few stops were made upon the fishing-grounds south of the Alaska Peninsula.

Slime Bank.—This is the first of the large fishing-banks which is reached after entering Bering Sea through Unimak Pass. As defined by the surveys of the *Albatross*, it begins directly off the Northwest Cape of Unimak Island, is elongate in shape and follows approximately the trend of the adjacent coast to within a few miles of Amak Island. It measures about 85 miles in length by about 17 miles in average width, and thus has a total area of about 1,445 square miles. The inner margin of the bank lies only a short distance off the land and the depths range from 20 to 50 fathoms, although some cod were taken in deeper water. The bottom consists chiefly of sand, gravel, and pebbles, changing to mud on the offshore limits.

The bank derives its name from the occurrence of immense numbers of a large jelly-fish, brownish or rusty in color, and provided with long slender tentacles, having great stinging powers. These jelly-fishes, it is said, have never been observed at the surface, but seem to occupy an intermediate zone toward the bottom, where they occasion much annoyance to the fishermen by becoming entangled about their fishing gear, and in this way are often brought on board the vessels. It is also reported that sometimes they even interfere with the hooks reaching bottom, and, by covering the bait and lines with a prickly slime, render the former unattractive to the fish and the latter very uncomfortable to handle. In the early part of the season not much trouble is experienced from this cause, but by July 1 the jelly-fishes become so thick that it is almost useless to remain longer upon the bank, and other localities farther north are then resorted to. Except for this unusual phenomenon, however, the advantages for fishing on Slime Bank are excellent. The largest and most thrifty looking cod were taken by the *Albatross* some 6 or 8 miles from shore, but fish of fair size and good quality were plentiful over nearly the entire bank. Small specimens of halibut were also secured occasionally, and the beam trawl disclosed a rich bottom fauna. Attempts have been made to use cod trawls upon this bank, but without success, owing to the obstacles which the jelly-fishes interpose. The depths of water, however, are everywhere so moderate that hand lines can be employed conveniently, and that is the only method of fishing now followed.

There are, unfortunately, no available harbors for fishing vessels along the coast adjacent to Slime Bank, although Shaw Bay offers some protection from southeast to southwest winds. Winter fishing would, therefore, be attended with much danger from the heavy storms which prevail during that season, and operations are chiefly limited to the summer months. According to Capt. Tanner, a well-found schooner could anchor anywhere on the bank between May and September, with an even chance of being able to ride out any gale she might encounter.

Baird Bank, so named by Capt. Tanner in honor of the late Prof. Spencer F. Baird, is the largest and most important fishing-ground yet discovered in Bering Sea. Having a total area of about 9,200 square miles, it exceeds in size Portlock Bank, the largest bank south of the Alaska Peninsula, by 2,400 miles, and Georges Bank, the second largest fishing-ground in the North Atlantic, by 800 miles. Commencing a few miles east of Amak Island, it extends eastward, just off the northern coast of the Alaska Peninsula, to the vicinity of Cape Chigagof, at the mouth of the Ugaguk River, a distance of about 230 miles, and has an average width of about 40 miles. The depth of water ranges from 15 to 50 fathoms, and the bottom corresponds both in character and in the richness of its fauna with that of Slime Bank. The adjacent mainland affords a weather shore during southeast winds, and Amak Island offers fairly good protection on its southeast and southwest sides. Port Möller and Herendeen Bay, which were partly charted by the *Albatross*, will be ports of call when they are better known, and Port Haiden may also become available for shelter after it has been surveyed.

The examination was begun at the western end of the bank, and was carried thence northeastward, the conditions improving with each line of stations until off Port Möller, where the best fishing was obtained. Cod were taken at nearly every trial, but their abundance and quality varied with the locality, the largest and finest specimens having been secured from 15 to 20 miles from shore, in depths of 25 to 40 fathoms. Beyond the Port Möller region they continued abundant and of good size to near the northern end of the bank. The extreme head of Bristol Bay has no value as a cod-fishing ground, and only a few specimens in poor condition were captured here and there. The water is not only too fresh for this species, but owing to the strong currents produced by the immense discharge from several rivers and by the tides an unusual amount of sand and mud is constantly held in suspension.

Kulukak Ground.—Kulukak Bay occupies a large part of the region included between Cape Constantine and Cape Newenham, and contains Hagemeister Island and the Walrus group. Within this area codfish are found in various isolated spots, scarcely entitled to the name of banks, but for convenience sake the name of Kulukak Ground has been used to designate them. Extensive shoals occur off Hagemeister and the Walrus Islands, a depth of 6 fathoms being found about 18 miles to the southward of the latter. The principal fishing-spots are outside of these shoals, as well as to the eastward and westward of them, and have depths of 12 to 15 fathoms. The bottom in this region consists generally of sand, with some mud and gravel, and the fauna is essentially the same as on Slime and Baird banks. Cod are plentiful at times, but they are smaller than on the more southern grounds. An exception in this particular, however, has been reported with respect to a small spot called Gravel Bank, situated about 16 miles SSW. from the southern end of Hagemeister Island, in depths of 16 to 20 fathoms, but its extent is inconsiderable. Small fish predominate among the islands of the Walrus group, but larger ones may be taken in some of the indentations and on some of the rocky patches. The Kulukak grounds were formerly resorted to by a few vessels, but they are not visited at present.

Cod were found to be abundant in the vicinity of Cape Peirce, but, owing to the number of diseased fish among them, this ground has been named Hospital Bank by the fishermen. Off Cape Newenham no cod were taken, and it is supposed that their absence may be due to the great volume of fresh water issuing from the Kuskokwim River.

Port Möller and Herendeen Bay.—The recent opening of a coal mine near the head of Herendeen Bay has called particular attention to this locality, and it was visited twice by the steamer *Albatross* during the summer of 1890. Although the first purpose in going there was to obtain a supply of coal, partial surveys were made which now render these inlets accessible to fishing vessels during stormy weather. Port Möller and Herendeen Bay are closely adjacent to one another, and open on the north side of the peninsula, the principal passage into the latter being by way of Port Möller entrance. They are located, as before explained, in the vicinity of the best fishing-grounds on Baird Bank, and their availability for shelter is an important consideration for the fishermen. Should this locality, moreover, become a coaling center, it will increase the number of vessels resorting to the region, and tend greatly to develop its resources.

The entrance to the mine which has just been opened, and from which the *Albatross* received the first output of coal, is about 1¼ miles from the water front, on the east side of the head of Herendeen Bay, the coal being transported to the landing over a tramway operated by a small steam motor.. A small bight at this place has been called Mine Harbor. The survey made by the *Albatross* has defined the entrance to Port Möller and the channel thence through Herendeen Bay to its extreme upper part, where there are good places for beaching and repairing small vessels, the rise and fall of the tide amounting to 15 feet, and where fresh water and fuel can readily be procured in any quantity.

The Herendeen Bay coal was used on board the *Albatross* with satisfactory results, but, owing to the lack of proper screening facilities, much fine material and dirt was delivered with it, and it was found necessary to burn from 20 to 25 per cent more of it to obtain the same results as with a fair quality of Wellington coal. Capt. Tanner states, however, that considering that it was taken from a vein near the surface, the extra amount required to furnish the same quantity of steam will not seem excessive. It was shown that the coal possesses merit, and it will doubtless improve with the development of the deeper veins.

South of the Alaska Peninsula.—While on the way south from Bering Sea in September, 1890, a line of dredgings and soundings was carried along the line of islands lying off the Pacific coast of this peninsula. From off the Trinity Islands the soundings were continued in deep water as far south as the Queen Charlotte Islands. The deep ocean trough described in former reports as lying south of the Aleutian Islands and the peninsula, and trending in the same general direction, was traced as far west as latitude 56° 02′ N., longitude 151° 12′ W., which is to the southeastward of Kadiak Island.

Southeastern Alaska.—Practically nothing has yet been done toward investigating the fishery resources of southeastern Alaska, all of the time suitable and available for work in northern latitudes since the *Albatross* arrived in the North Pacific having been spent off the southern coast of the Alaska Peninsula and in Bering Sea. During July, 1889, however, a trip was made through the inland passages of the southeastern part of the Territory as far as Juneau, with several members of the Senate Committee on Indian Affairs, who were desirous of inspecting the principal Indian settlements. The steamer left Tacoma on July 8, and returned on the 28th of the same month. Stops were made at Fort Tongass, Port Chester, Karta Bay, Port Wrangall, Sitka, Pavloff Harbor, Hoonyah Bay, Portage Bay, Chilkat, and Juneau. Several important fishing stations and canneries were visited, and some investigations were made by means of the beam trawl, and other kinds of fishing apparatus. Good photographic views were also obtained of Patterson, Muir, and Davidson glaciers.

WASHINGTON, OREGON, AND CALIFORNIA.

Puget Sound to Cape Mendocino, California.—The investigations begun in this region in 1888 were continued as far south as Cape Mendocino during the latter part of the summer and the fall of 1889, and again for a short time in the fall of 1890. This completed the preliminary examination regarding the general features of the continental platform within these limits, and the location and principal resources of the fishing-grounds. Very few soundings had been made on this coast previous to the surveys of the steamer *Albatross*, in 1888, and none outside of the 50-fathom curve. The hydrographic work thus far accomplished by the *Albatross* affords the necessary information to define the contour of the bottom into depths of at least 200 fathoms, and as the fisheries for a considerable time to come will not be carried beyond the 100-fathom curve, the characteristics of the bottom observed within those limits are sufficient for all immediate considerations in connection with fishery matters. The distance of the 100-fathom curve from shore varies in different places from 7 to 40 miles, averaging broadest at the north, and becoming reduced to from 7 to 9 miles off Cape Orford, Trinidad Head, and Cape Mendocino. The superficial area of the submerged platform within this depth is computed at 3,700 square miles for the outer coast of Washington, 4,750 square miles for the coast of Oregon, and 1,160 square miles for the coast of California north of Cape Mendocino, a total of 9,610 square miles.

The soundings off Cape Flattery are irregular and suggest the existence of submarine ridges trending parallel with the coast. A semicircular depression, with depths of 100 to nearly 200 fathoms, was found between Cape Flattery and Flattery Rocks, at a distance of about 10 miles from shore. From the latter place to Yaquina Head the depths increased regularly toward the sea, except upon the rocky bank off Grays Harbor and Willapa Bay, where elevations of a few fathoms occur. A triangular platform having depths under 100 fathoms lies between Yaquina Head and Umpqua River, Heceta Bank being located upon its southwestern extremity. Thence to Cape Mendocino the soundings are regular.

Distinct fishing-grounds in this region are few in number and of small extent, the principal ones being the following: Flattery Bank has an area of about 1,100 square miles, with a least depth of 27 fathoms. Halibut and other fishes have been taken upon it in considerable numbers for some years past. The former species occurs in greatest abundance on a very rough, rocky bottom, having an extent of about 35 square miles near the southeastern end of the main bank. A small bank covering about 110 square miles and with a least depth of 42 fathoms lies 23 miles W. by S. (magnetic) from Toke Point light-house, Willapa Bay. The bottom consists of sand and mud with rocky patches. Another bank having an area of only about 40 square miles, with the same minimum depth as the preceding, and with a bottom of clay, mud, and rock, is located 19 miles SSW. ¼ W. from Yaquina light-house. Heceta Bank, the largest fishing-ground south of Cape Flattery on this part of the coast, is situated 35 miles SW. ½ W. from Heceta Head, Oregon, and has an area of about 600 square miles. The least depth, 41 fathoms, has been found near its southern end, where the bottom is rocky and rough.

Only occasional specimens of halibut were taken off Flattery Rocks and Tillamook Rock and on Heceta Bank. Several species of rock-cod were generally distributed along the coast, as well as on the banks, and flounders were found everywhere, being especially abundant in depths of 50 to 100 fathoms. The flat surface of the plateau is particularly rich in the latter group of fishes, and is destined to become a favorite ground for the beam trawl when that method of fishing is introduced. Cultus-cod occur on all the banks and on Orford Reef, while the black-cod inhabits the deeper waters, half-grown individuals also being found in moderate depths, together with the ling or Pacific whiting. Large red prawns of excellent quality are likewise very abundant and widely distributed, having been captured frequently in considerable numbers in the beam trawl.

Although gales are of rare occurrence in this region during the summer months, yet the coast winds blow constantly from the northward and maintain a boisterous sea and strong currents. During the fall and winter southeasterly storms are frequent. Owing to the scarcity of good harbors, the fishermen have, therefore, many hardships to contend with, and the lack of sufficient markets to handle a large catch interferes at present with the rapid development of the fishery.

Cape Mendocino to Point Conception, California.—During March and April, 1890, the coast waters between Point Arena and the Santa Barbara Channel, including the important fishing-grounds off San Francisco, were surveyed by the *Albatross*, and in September of the same year the region from Cape Mendocino to Point Arena was examined, thereby completing the preliminary investigations on the California coast. Capt. Tanner reports that he found the slope very abrupt near Cape Mendocino, but it gradually widens toward the south, the 200-fathom curve off Point Arena being distant about 12 miles from shore. There are no fishing-banks properly so called within these limits, but the same fishes which are commonly met with farther north are distributed also through this district, and the beam trawl may be used off Point Arena, although some rocky patches occur in places.

Between Point Arena and Point Conception the width of the continental platform into depths of 200 fathoms varies considerably, the extreme range being from less than 1½ to 26 miles. Within these boundaries the most active fisheries on the California coast are now being conducted. The character of the bottom is generally very uniform, the area between the Golden Gate, Point Pillar, the Farallones, and Point Reyes being sandy and free from rocks, except in the immediate vicinity of the islands or of the shore. South from Pillar Point rocky patches frequently occur near the shore, with fine gray sand farther off, finally merging into green mud at varying distances from the land. Rocky spots also exist in depths of 30 to 70 fathoms on sand and mud bottoms.

One hundred and eleven trawling and fishing stations were made in this region, and a very large variety of fishes was obtained, many being of excellent food quality. Flounders, including several choice edible species, composed the principal features of every haul. The beam trawl and other corresponding forms of drag nets are the only appliances by which these forms can readily be secured. Several species of rockfish were also common.

Oyster investigations, San Francisco Bay.—Investigations having for their object to determine if the waters of San Francisco Bay are suitable for the breeding of the Atlantic coast oyster (*Ostrea virginica*) have been conducted by Mr. Charles H. Townsend, naturalist of the steamer *Albatross*, during such periods as that steamer has been detained at San Francisco or Mare Island. These inquiries have been carried to all parts of the main bay and to San Pablo Bay, and have had reference to the temperature and density of the water, the character of the bottom, and the actual attachment and growth of spat derived from the planted beds. The results are very gratifying, and, while not conclusive on all points, they seem to indicate that the conditions existing in some portions of the bay are not unfavorable to the establishment of self-sustaining colonies of the eastern oyster.

The oyster industry of the Pacific coast, exclusive of the trade in the small indigenous species, has never extended beyond San Francisco Bay, where it is restricted to the growing or fattening of seed or yearling oysters, brought annually in large quantities from the Atlantic coast. This method of transplanting oysters has been practiced ever since the completion of the first overland railroad, and a supply of the eastern species has thereby been constantly maintained in the waters of San Francisco Bay, yet it has generally been understood that no natural increase has taken place in this region. To account for this supposed failure to propagate, it has been assumed that the temperature of the water during the breeding season is lower than it should be, but the subject has never been investigated and practically nothing has been known regarding it.

While the observations of Mr. Townsend were limited to a few months in each year, temperature data covering all seasons have been obtained from other sources, and these lead to the conclusion, based upon a comparison with the eastern coast, that the water temperature in at least the southern part of San Francisco Bay is sufficiently high to fulfill all the necessary requirements of reproduction. Any failure to produce spat would therefore have to be traced to other causes; but, as a matter of fact, Mr. Townsend finds that the *Ostrea virginica* does breed in this region and that the young attaches itself under suitable conditions. To what extent this prevails, however, can only be determined after a more complete study of the bottom. The largest and most important tract of oyster propagation, according to Mr. Townsend, is the region of the natural shell banks of native oysters along the east side of the bay, beginning at Bay Farm Island and extending well southward and offshore into the deeper water. Here wild oysters of the Atlantic coast type may be found during the low tides which expose the outer portions of the shell banks. They are numerous, and when the tide is sufficiently low it is possible to gather them by hand, ranging in size from yearlings to specimens several years old. Considerable quantities are obtained annually in this region, and also on other smaller tracts farther south, for transplanting to the cultivated beds. Oysters of the same species were likewise found at greater distances from the planted beds, in San Leandro Bay and at Sheep Island and Point San Pedro, attached to rocks and to piles driven in the bottom, leaving no room for doubt that they had originated through the spawning of oysters in the bay.

OFF MEXICO, CENTRAL AMERICA, AND THE GALAPAGOS ISLANDS.

On January 30, 1890, the steamer *Albatross* left San Francisco for Panama to engage in a special scientific inquiry, authorized by the President of the United States. The expedition was under the direction of Prof. Alexander Agassiz, director of the Museum of Comparative Zoölogy at Harvard College, who also paid a large proportion of the expenses incidental to the cruise. The area marked out for investigation lay off the western coast of Mexico and of Central and South America, from Cape San Francisco in the south to Guaymas in the north, and extended seaward to and including the Galapagos Islands. The biological and physical features of this region, as well as the contour and character of the bottom, except in the vicinity of the coast, were then almost entirely unknown, the *Albatross* having made only a few observations there during the voyage from Washington to San Francisco, while H. M. S. *Challenger*, during her famous expedition around the world, sailed directly from the Sandwich Islands to Chile, and thence into the Atlantic Ocean.

The present inquiry had reference mainly to the natural history and temperature of the deeper waters off the coast, at the bottom and surface, and also at intermediate depths. The ordinary outfit of the *Albatross*, frequently described in previous reports, was well adapted to the greater part of the observations, but for collecting organic forms at intermediate depths a new form of net was improvised by Capt. Tanner, and gave entire satisfaction. It is so arranged that after being lowered and dragged for any desired distance through the water it may be tightly closed by the falling of a messenger, thus preventing any objects from entering it while it is being hauled on board. It is, therefore, well suited for determining the character and amount of animal life at any depth below the surface, without the danger of its contents being added to at other levels. An appliance of this sort would have been of material assistance in the researches hitherto made respecting the mackerel-grounds on the Atlantic coast of the United States, and it is proposed to utilize the new invention during the future investigations in that region.

Beginning off Cape Mala, near Panama, a line of stations was carried to Cocos Island, and thence, with some deviation toward the south, to Malpelo Island and back to Panama, where several short lines were run immediately outside of the 100-fathom curve. On the second cruise the steamer proceeded first to the vicinity of Cape San Francisco, thence to the Galapagos Islands, and from there to Acapulco. Subsequently, dredgings were made from off Cape Corrientes to Guaymas, in the Gulf of California. The greatest depth of water explored was 2,232 fathoms. Short stops were also made at the different islands lying in the course of the expedition, for the purpose of studying the land and shallow-water animals and plants. While it was observed that the marine fauna of this region is not so rich as that occupying the corresponding waters off the east side of the continent, very large collections were secured, and the general results obtained are of great importance. Soon after this material was received in Washington the different groups were carefully sorted out, and the greater number have already been assigned to specialists for study under the direction of Professor Agassiz.

One of the most important outcomes of the expedition has been the determination by Prof. Agassiz, through the instrumentality of the intermediate towing net, of the vertical distribution of the surface pelagic fauna, which he considers to descend only to a depth of about 200 fathoms. Some forms among the bottom animals may work up a distance of several fathoms, but between these levels in the open sea he finds no evidences of life. Regarding this subject there are still some differences of opinion among explorers, and further investigations will be awaited with much interest. As a solution of the problem may have some bearing upon the study of the habits of the Atlantic coast mackerel during its migrations in the deeper water, the practical importance of continuing the experiments can readily be appreciated.

Detailed accounts of this investigation will be found in the report of Capt. Tanner, contained in the appendix to this volume, and in the publications of the Museum of Comparative Zoölogy, Cambridge, Mass.*

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*Three letters from Alexander Agassiz to the Hon. Marshall McDonald, U. S. Commissioner of Fish and Fisheries, on the dredging operations off the west coast of Central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California, in charge of Alexander Agassiz, carried on by the U. S. Fish Commission steamer *Albatross*, Lieut. Commander Z. L. Tanner, U. S. N., commanding. Bull. Mus. Comp. Zoöl., XXI, No. 4, pp. 185-200, 1891.

General sketch of the expedition of the *Albatross*, from February to May, 1891. By Alexander Agassiz. Bull. Mus. Comp. Zoöl., XXIII, No. 1, pp. 1-89, plates 1-22, including a detailed chart of the explorations, 1892.

Calamocrinus diomedæ, a new stalked crinoid. By Alexander Agassiz. Mem. Mus. Comp. Zoöl., XVII, No. 2, 96 pp., 32 plates, 1892.

ATLANTIC COAST.

OYSTER INVESTIGATIONS.

LONG ISLAND SOUND.

The steamer *Fish Hawk*, Lieut. Robert Platt, U. S. N., commanding, was at work upon the oyster-grounds of Long Island Sound during a part of both 1889 and 1890. In the former year the investigations were begun on August 18 and terminated on October 8; in the latter year they continued from June 11 until October 16.

During the season of 1889, Dr. C. F. Hodge, of Clark University, served as naturalist, and the operations were restricted chiefly to dredging on and about the oyster beds, and to experimenting with traps and other devices intended for the capture of starfishes. Certain statements having gained currency, to the effect that the waters of Long Island Sound do not interchange freely with the waters of the open ocean, and are thereby rendered more or less stagnant and impure from the accumulation of town sewage and the effects of the dumping-grounds, to the serious detriment of the oyster beds, the greater part of the season of 1890 was occupied in making physical and chemical investigations to determine the actual sanitary condition of the region, but after their completion the dredging and natural-history work was again taken up. Mr. E. E. Haskell was detailed by the Superintendent of the U. S. Coast and Geodetic Survey to conduct the physical inquiries, while Mr. Fred Neher, of Princeton College, was employed to make the chemical observations. The natural-history work was attended to by Mr. James E. Benedict, of the U. S. National Museum, and Mr. W. C. Kendall, of the Fish Commission.

The natural oyster beds of Connecticut are restricted to the bays and inlets and to the shallow waters near the shore, extending sometimes, however, into depths of 3 to 5 fathoms. The artificial or planted beds are for the most part outside of the natural ones, and they have been carried in some instances as far as the middle of the sound, and into depths occasionally of 13 to 14 fathoms. Both the natural and planted beds are mostly limited to the western half of the sound, comparatively few areas occurring to the eastward of New Haven Harbor. The Fish Commission obtained for its use, through the courtesy of the State Fish Commission, a complete set of the engineer's charts showing the exact position of all the grounds sold for planting purposes. The same data has since been published by the Connecticut Bureau of Labor Statistics on a smaller scale, and in a very convenient form for reference. An examination of these charts shows that the area of bottom which has been sold for oyster purposes is relatively very large, covering up to 1889 a total extent of over 78,000 acres. It must be borne in mind, however, that not all of this bottom has been planted with oysters; in some parts of the region the proportion under cultivation is relatively small, and a part of the designated area is unsuited to oyster-planting in its present condition. Just what extent of bottom is now in actual use it has been impossible to ascertain.

The waters of Long Island Sound within the territory of Connecticut (the State line being midway of the sound) are divided into a number of districts by straight lines extending due north and south, each district being named after the adjacent township. In nearly all of the western districts a certain area has been set aside as a dumping-ground for the materials dredged up in the course of the improvements in the neighboring harbors and river mouths. While these dumping-grounds have well-defined boundaries, and it is intended that no refuse shall be deposited elsewhere, they have come to have a rather unenviable reputation among the oystermen, who consider them the source of many of their troubles.

While the attention of the Fish Commission was first requested toward the depredations of starfishes upon the oyster beds, so many other questions have since been raised respecting the conditions of the latter that it has become necessary to greatly increase the scope of the inquiry and to give it rather the character of a general investigation.

In 1889 the work was begun in the Norwalk district and was carried thence eastward through the Westport, Fairfield, Bridgeport, Stratford, and Milford districts, into Orange district. Dredgings were made at frequent intervals, and sometimes under guidance of the owners of oyster territory, who were able to indicate particular localities where starfishes were then abundant. The oyster traps were also set under many different conditions, but always with practically negative results, as explained below. In 1890 the physical and chemical examinations occupied nearly all the time from the beginning of the season until the middle of September. Self-registering tide gauges were first established at New London and New Haven, Conn., and at Willets Point, N. Y., after which observations upon the direction and velocity of the currents were made at regular intervals between the mouth of the Connecticut River and East River, by means of the Ritchie-Haskell electrical meter. The chemical analyses of the water were conducted in the same connection, and covered samples taken from every variety of location, from the harbors and river mouths to the outer and deeper portions of the sound. The subsequent dredging operations were chiefly restricted to Bridgeport and Stratford districts, and were carried on with greater detail and precision than in 1889, stations being made at regular intervals of half a mile in both directions. In this manner it was expected to obtain a continuous record showing the character and condition of the bottom.

Both the physical and chemical investigations were conclusive in demonstrating that, so far as regards the general conditions of the waters in Long Island Sound, the oyster-growers have nothing to fear for the safety of their beds, no great amount of pollution having been found at any place examined, and the interchange of waters with the open sea being sufficient also to insure their purity far above the standard required for oyster-raising. Much has been learned with respect to the present condition of the oyster beds and of the adjacent bottom, and as to the natural-history features of the region, including the habits of starfishes; but no new methods have been discovered for the destruction of this enemy, although suggestions have been offered which may prove of some value.

During the course of the investigation it was not observed that any of the oyster beds were being harmed to any appreciable extent by the growth of sponges or worm tubes, the latter, however, having occasioned some loss in 1882 in the vicinity of New Haven. The large winkles (*Fulgur* and *Sycotypus*) are said to do a greater or less amount of damage, but no instance of their destructiveness came directly to the attention of the party, and, owing to their size, they may readily be detected and removed. The oyster-growers claim, moreover, that when they have once been cleaned from the beds they give them no further trouble during the same year, and they also state that they are rapidly decreasing in abundance, due no doubt to the numbers which are destroyed annually, together with their conspicuous egg capsules. The drills and starfishes dispute the title of being the most destructive of the oyster pests, the former operating chiefly in the more brackish and shallow waters, and the latter invading all other territory, although not entirely absent from the former. The drill, however, feeds generally on smaller oysters than the starfish, and the extent of its damage is less appreciated by the oystermen. The starfish, therefore, is usually most dreaded, and very justly so, in the more open waters of the Sound, where the great majority of the beds are situated.

It is unnecessary in this connection to enumerate the mass of facts that has been obtained to show the amount of damage caused annually by these two enemies of the oyster. In fact, it is very difficult to estimate the money value of the losses, which may include only the outlay in the planting and tending of the beds, or extend to the prospective profit on the crop after it has matured. An invasion by starfishes may be detected early enough to insure their being dredged up before they have accomplished much injury. Otherwise they may succeed in destroying a portion of a bed, or even an entire bed of large area, and they generally appear suddenly, without any warning.

Opinions differ as to the months during which starfishes are most destructive. The evidence collected, however, tends to prove that they are feeding on or about the beds during the entire year, and when the food in one locality is exhausted they move elsewhere, the places where they congregate and do the most damage changing more or less from year to year. The breeding season appears to extend over nearly, if not quite, three months—from June to August. It is the popular belief that during a part of this period the starfish bunch up in large clusters, the supposition being that this habit may have some relation to the spawning functions. Both this occurrence and the reasons assigned for it may be true, and it seems very probable that the starfish do sometimes collect together in large masses, but this can also be explained, in a measure, as an incident of their feeding. It has been noticed, in connection with the large invasions, that these animals clean the beds up very thoroughly as they go. It can well be imagined that, on reaching a new ground, the first arrivals begin to feed at once, while those in the rear, pressing forward, pile up over them, forming for the time a sort of windrow, but these conditions would probably not continue long.

The rate of movement attained by a body of starfishes when invading an oyster-ground has been variously estimated, but the observations in respect to this matter must, for the most part, be very unreliable. One planter, however, has informed us on good authority that a dense line of starfishes advanced about 2,000 feet over one of his beds in the course of four days, while his steamers were engaged in dredging them. In connection with some experiments made by Dr. Hodge, specimens of medium size were seen to move at the rate of 6¾ to 11½ inches per minute, and if this rate were to be maintained without intermission they might cover, on an average, a mile in a little over five days.

Unfortunately records are seldom kept of the quantity of starfishes removed from any of the beds, but a large planter in the Bridgeport and Stratford districts has furnished a detailed statement which shows that from 1884 to 1889, inclusive, about 36,000 bushels were dredged up by his steamers, the average catch per month, computed for the six years, being as follows: January, 460; February, 250; March, 180; April, 90; May, 400; June, 490; July, 620; August, 560; September, 560; October, 480; November, 350; December, 440. It should be borne in mind, however, that these figures relate to only a comparatively limited area, and might not apply to other districts. It is also possible that his steamers were less watchful at some times than at others, and that the averages for the catch of starfishes would not indicate with exactness their relative abundance during the several months. The principal utility of this statement consists in its showing that starfishes are always present on the oyster-grounds, and may be regarded as plentiful in every month of the year, but whether they are always feeding or not still remains to be determined. They are said to begin to feed on oysters when very young, selecting individuals, of course, which are in proportion to their own size, and several have frequently been found attached to the same oyster. They also live on other bivalves, such as mussels and clams, and even on small gastropods, barnacles, etc.

As to the distribution of the attacks of starfishes, it seems probable that, the conditions being equal, all the beds are subject to their in-roads in about the same proportion. If kept cleared from any given area, those owning beds around the margin have the most to do in fighting them, and in so doing they shield their neighbors. Mutual and persistent efforts in this direction furnish the only means by which all the beds can at present be protected, and by coöperation not only may the destructiveness of starfishes be greatly lessened, and the security of the beds be more or less insured, but the cost of removing starfish or of guarding against their attacks will fall less heavily on the planters who are now most active in their watchfulness. It is these men whose grounds are kept in the best condition and who are securing the most benefits, while those who are careless or indifferent in their attentions are subject at any time to heavy or entire losses.

It is generally considered that the beds or parts of beds in close proximity to a reef or other obstruction on the bottom are among the most liable to be invaded at frequent intervals, as the starfishes can not be completely eradicated from such places. The natural beds may also be cited as a fruitful source of danger, in that the stars may breed and grow upon them practically undisturbed, and may at any time pass to the neighboring cultivated areas. Steam dredging is not allowed upon these public grounds; no one is responsible for their condition, and no one has the power, even if he had means and interest, to keep them free from pests. As matters stand at present they are a constant menace to valuable private interests—a condition of affairs never tolerated in respect to agricultural pursuits.

Despite the amount of damage caused by natural enemies, the oyster industry of Connecticut is exceedingly prosperous, yet no one doubts that this prosperity might be increased by a removal of this source of injury. While this can, probably, not be done effectually, a great measure of protection might be afforded through the intervention of the State, as well as by a reduction in the relative extent of the planted area to such a limit that all the grounds could be under constant supervision. The greater losses have resulted from a lack of vigilance, and unfortunately the diligent cultivator is too often made to suffer from his neighbor's carelessness. In the Norwalk district they do not, as a rule, attempt to cultivate more ground than they can properly attend to, and a reduction in the abundance of starfishes has been noted there, but the same was not found to be the case in some of the other districts examined.

During 1888 and 1889 only a small set of spat was secured throughout the sound, and a great amount of damage by starfishes was recorded. In 1890, however, a heavy set was obtained, although it was not evenly distributed. It was fairly good from the Thimble Islands to the Milford district, being very abundant in the latter region, and especially so on the natural bed off Stratford and on some of the planted grounds in the same vicinity. The region farther west was less favored in this respect, except in some places of limited extent.

In ridding their beds of starfishes the oystermen generally make use of the common oyster-dredge, which also brings up everything from the bottom, and the living oysters may then be transplanted to other grounds if desirable. This method is necessarily laborious and expensive, as well as destructive, as many oysters are often damaged by the dredge, especially if they are young and thin-shelled. A special dredge, invented by Mr. Landcraft, of New Haven, and designed to remove only the starfishes, has been employed with some success, but its use does not seem to have become very general. Other devices having the same object in view have recently been patented, but nothing has been learned regarding their effectiveness. The tangles, suggested some years ago for this purpose by the Fish Commission, have been tried occasionally, but they are said not to work the ground clean, and it is difficult to extricate the starfishes after the apparatus has been landed on the deck. The first of these troubles also manifested itself in the trials made by the *Fish Hawk* with the beam trawl, but it was partly overcome by attaching a drag chain between the runners slightly in advance of the net. This appliance would not, however, present any advantage over the oyster dredge, and, as a whole, might be regarded as very inferior to it, its expense and the difficulty of working it from a small steamer also operating to its disfavor.

Baited traps were experimented with in 1889 under the direction of Dr. Hodge, but only with negative results. They were made of iron rings, 2 feet in diameter, filled in with a shallow bag of netting, and when in use were suitably weighted, and their positions marked with a small wooden buoy. Many different kinds of bait were employed, and they were as thoroughly tested as was possible at the time in the Norwalk district, but no starfishes were secured on any trial. This experiment is not, however, to be regarded as conclusive, because traps have been and are still being used for this purpose with some success in Providence River. They are there made box-shaped, of laths, something after the pattern of the rectangular lobster pots. It is not expected that any devices of this sort will prove effectual where starfishes are very abundant, but under some circumstances they might serve a good purpose, and further tests should be made whenever the opportunity occurs.

Physical inquiry.—The following preliminary report by Mr. E. E. Haskell, upon the results of his current observations in Long Island Sound, has been transmitted by the Superintendent of the U. S. Coast and Geodetic Survey.

PRELIMINARY REPORT UPON THE CURRENT OBSERVATIONS IN LONG ISLAND SOUND.

BY E. E. HASKELL.

The observations for this discussion were made during the summer of 1890, from the U. S. Steamer *Fish Hawk*, during a joint investigation by the U. S. Commission of Fish and Fisheries and the U. S. Coast and Geodetic Survey, for the purpose of studying the condition of and the circulation of the sea through Long Island Sound.

For a knowledge of the tides that traverse the Sound we placed at New London, New Haven, and Willets Point—practically at each end and the middle—a self-registering tide gauge. With the tide gauges in operation, we made from the steamer *Fish Hawk* a series of current observations, occupying therefor current stations which in location give a cross section near each end of the Sound; a current station about every 10 miles in the longitudinal axis of the Sound; and a current station on each of the dumping-grounds of the towns of New Haven, Milford, Bridgeport, Norwalk, and Stamford.

In illustration of the tides of the Sound, the mean establishment of Block Island and that of Sandy Hook are about the same, namely 7^h 31^m and 7^h 35^m, respectively. There being but about ten minutes difference in time, due to difference in longitude, it is practically high water at both places at the same time. From these places the tide wave that causes high water travels by two different channels, the Block Island branch through Long Island Sound from its eastern entrance, and the Sandy Hook branch passing through New York Harbor and East River into the Sound from its western entrance, and give to this inland channel a compound tide.

From our observations, which confine us to the reach from New London to Willets Point, we find it is high water at New London (the mouth of the Thames) 9^h 47^m, at New Haven (Light-House Point) 11^h 17^m, and at Willets Point 11^h 24^m after the moon's transit. The opposite phase of the tide takes place at New London 3^h 31^m, at New Haven 5^h 03^m, and at Willets Point 5^h 45^m after the moon's transit. These figures give for the duration of rise 6^h 16^m, 6^h 14^m, and 5^h 39^m for New London, New Haven, and Willets Point, respectively; and, for the corresponding duration of fall, 6^h 08^m, 6^h 10^m, and 6^h 45^m.

The distance from New London to New Haven, measured on a central line through the Sound, is 36 nautical miles, and the distance from New Haven to Willets Point, measured on the same course, is 48 nautical miles. From the mean establishment of these points, given above, and the corresponding distances between them, it appears that the tide wave travels from New London to New Haven in 1^h 33^m, or at the rate of 23 nautical miles per hour, while it travels from New Haven to Willets Point in 10^m, or at the rate of 288 nautical miles per hour. This remarkable difference in speed of the wave in these two reaches is undoubtedly caused by the interference of the two waves that have arrived on the scene by the two different routes. It is the meeting-ground; or, to be more explicit, the reach from Hell Gate to Stratford Shoal is where the energy of these waves, traveling in opposite directions, is spent.

An interesting feature in the tide of the Sound is the vertical motion of the water that takes place. Mean sea level at all points throughout this water course is at the same elevation, and might be represented by a straight line so far as the present discussion is concerned. At New London the average rise of the tide is 2.6 feet, or it has a semi-amplitude in its oscillations above and below the straight line representing mean sea level of 1.3 feet. At New Haven the average rise of the tide is 6 feet, or its semi-amplitude is 3 feet. At Willets Point the average rise of the tide is 7.3 feet, or its semi-amplitude in reference to the line is 3.65 feet. These figures show that with every tide the water surface of the western portion of the Sound is alternately made a hill and a hollow when compared to the water surface in the eastern portion, or perhaps a better reference would be to the open sea either at Block Island or Sandy Hook, where the amplitude of the tide is 1.5 feet and 2.3 feet, respectively.

Having indicated briefly the tides of the Sound, we will now consider the other and far more important component in the circulation, viz, the horizontal movement of the water, or the tidal current.

Beginning at the eastern cross section at the mouth of the Connecticut River, the station located near the axial line of the Sound gave for the mean velocity of the maximum flood vertical curve of velocities 3.2 feet per second, and for the mean velocity of the maximum ebb vertical curve of velocities 2.8 feet per second.

The current station located similarly on the western cross-section at Matinicock Point, Long Island, gave for the mean velocity of the maximum flood vertical curve of velocities 0.86 of a foot per second, and for the mean velocity of the maximum ebb vertical curve of velocities 0.77 of a foot per second.

The striking contrast in the difference in the strength of the flood or ebb currents of the eastern and western ends of the Sound indicated by the figures given above shows clearly what was to be expected from the tidal data, namely, that as we approached the meeting-point of the two waves from opposite directions the horizontal motion of the water should decrease. The series of current stations, located at intervals of about 10 miles on the axial line of the Sound, when considered in connection with the two mentioned above, illustrate very well this decrease and furnish a knowledge of the horizontal movement throughout the Sound. Taking any station in the series, its flood and ebb velocities will be greater or less than those given above for the stations on the eastern or western cross-sections in almost direct proportion to its distance from those cross-sections.

By comparing the maximum flood and ebb velocities for the central stations on each of the cross-sections, we find that the flood velocity is to the ebb velocity as 1.15 is to 1.0 for the eastern cross-section; and that for the western cross-section the flood velocity is to the ebb velocity as 1.12 to 1.0. These indicate clearly a resultant movement to the westward, for in the diagram of current velocities, which can not well be reproduced here, the duration of flood and ebb stream are seen to be about equal. The maximum in the former takes place at the VIII lunar hour and the maximum in the latter at the II lunar hour, and at these times the stream is a continuous maximum stream throughout the Sound.

This excess of westerly over the easterly flow was to have been expected, for in Prof. Mitchell's report, "The circulation of the sea through New York Harbor," Appendix No. 13 of the Report of the Coast and Geodetic Survey for 1886, are given the results of a series of gaugings of East River at Nineteenth street, and in round numbers there is as a mean value 448,000,000 cubic feet more water transferred to the southward on every ebb tide of New York Harbor than is brought northward by the flood tide.* This surplus of water must come through the eastern entrance of the Sound, hence from the open sea, where it must be pure; and although small in quantity in comparison with the volume in the Sound, it is a constant force to crowd out at the western end stagnant or polluted water.

Another interesting phenomenon brought out by our observations, and one which plays a prominent part in the circulation of the Sound, is the "underrun." Beginning at the eastern entrance, the change from ebb to flood current takes place by the denser sea water of the outside forcing its way in along the bed of the Sound while the surface is still running ebb. The beginning of this "underrun" was found to be about one and a half hours previous to the surface reversal of the stream. The neutral plane between the two currents running in opposite directions would gradually rise (the "underrun" or flood current increasing while the ebb current was decreasing), reaching the surface finally when the ebb current disappeared altogether. The

* It must be here noticed that the flood tide of Long Island Sound corresponds in direction to the ebb tide of New York Harbor and *vice versa*.

effect of this movement is a raising to the surface and a crowding gradually seaward of the water that had in previous tides performed the part of a purifying agent.

The strong winds of the winter season are also a factor in the circulation, as they take part in the annual cleansing of the Sound by either drawing in an extra supply of water over that brought by the tide, or forcing out water in excess of that taken out by the ebb flow.

The question of fresh water brought down by the rivers and creeks has been ignored, because, in my judgment, it plays no essential part in the circulation of the Sound. Fresh water on reaching the sea simply slides off on the surface of the much denser sea water, to be carried ebb or flood with the current prevailing at the time.

In regard to the current stations located on the dumping-grounds, the current shown, with the possible exception of those in the towns of New Haven and Milford, is not strong enough to transport the dredgings dumped on them, so that little fear of the distribution of this material in the Sound need arise.

In conclusion, the circulation of the sea in Long Island Sound seems to me to be sufficient to allay all fears of its waters becoming polluted. It is time, however, to raise in general a warning voice against what is now a common practice, and that is converting our rivers, harbors, lakes, and sounds into receptacles for the sewage and refuse of the cities and factories that line their banks. In the long run it can only work an injury, which as population becomes more dense will of necessity have to be considered and a remedy applied.

Chemical inquiry.—Mr. Neher joined the *Fish Hawk* on June 9, 1890, and the remainder of that month was mostly occupied in perfecting the arrangements for the chemical analyses, in preparing the reagents, and in making the preliminary tests. For the convenience of this work a small, temporary laboratory was constructed on the hatching deck of the steamer, where observations were conducted in comparative security.

The object of the investigation being simply to ascertain the relative purity of the water in the Sound, the tests applied were chiefly those used to detect sewage contamination by volumetric, colorometric, and gasometric methods. The Wanklyn test was resorted to for determining the amount of free and albuminoid ammonia contained in the water, for which purpose it is unsurpassed by any other. Ammonia being one of the products of decomposition of organic substances, the determination of its quantity in any given sample of water offers a means of measuring relatively the organic pollution of the same. A few tests were made by the aluminium method for ascertaining the amount of nitrogen as nitrates and nitrites, and the ratio of the dissolved oxygen was also determined in some instances. The samples of water analyzed were taken both from the surface and from the bottom in all depths down to 28 fathoms, and under many different conditions, as in the open sound over clean bottom, on and about the dumping-grounds, and in some of the harbors.

Owing to the fact that no standard of purity of sea water with reference to oysters or to the general health of adjacent land has been established, Mr. Neher found it difficult to interpret his results in that respect. The standards followed with regard to potable water may be used for comparison, but it is not to be expected that such low organisms as oysters would be as readily affected by these impurities as the human system, and a very liberal margin may be allowed in favor of the former. In fact, it is probable that a very large percentage of what might ordinarily be regarded as impurity in potable water is more beneficial than harmful to oysters. When the amount of free ammonia in potable water exceeds 0.01 it is generally considered to be due to recent sewage contamination, and the amount of albuminoid ammonia in a safe drinking-water should not much exceed 0.015 parts per 100,000 parts of the water. The figures furnished by Mr. Neher's tests may be summarized as follows: At the mouth of the Connecticut River, .005 of free ammonia and .013 of albuminoid ammonia; on a line across the Sound opposite the mouth of this river, .002 and .015, respectively; a second line somewhat further west, .005 and .01; a line opposite Matinicock Point, .01 and .016; at Throgs Neck, .023 and .018. The last two undoubtedly show the influence of the East River. On and near the dumping-grounds off New Haven, Bridgeport, Norwalk, and Stamford the amount of free ammonia ranged from .006 to .013 and the albuminoid ammonia from .014 to .019. These dumping-places have always been regarded as the most serious menaces to the oyster-grounds in Long Island Sound, but the chemical observations fail to support that claim. In New Haven Harbor the free ammonia amounted to .013 and the albuminoid to .018, while in Bridgeport Harbor they were .02 and .018, respectively.

The results of analyses made in three other bodies of water may be noted here for the sake of comparison, the first figures given in each case being those for the free and the last for the albuminoid ammonia, as above. Lake Ontario, 0.002 to 0.004 and 0.013 to 0.020; Oneida Lake, 0.004 to 0.008 and 0.015 to 0.024; Thames River, England, 0.004 to 0.176 and 0.028 to 0.035.

It may, therefore, safely be concluded that so far as regards organic impurities, the oyster beds in Long Island Sound are in no immediate danger from that cause. The results of the dredging work also support this conclusion, the animals taken of all kinds being generally in a good and healthy condition.

Life history of the starfish.—In connection with the investigation of starfish depredations, a special study of the embryology and life history of this species was begun at Woods Holl Station during the summer of 1889 by Prof. W. K. Brooks, of Johns Hopkins University, and was again taken up during the season of 1890, by one of his assistants, Mr. George W. Field. Both of these biologists have published brief notices of their preliminary results in the Johns Hopkins University circulars, vol. x, No. 88, 1891.* This inquiry will be continued in subsequent years, and it is expected that some conclusions may be reached which will be of considerable practical importance.

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* On the early stages of Echinoderms; by W. K. Brooks. Contributions to the embryology of *Asterias vulgaris* (*Forbesii*); by George W. Field.

SOUTH CAROLINA.

During the winter of 1890–91, the steamer *Fish Hawk*, Lieut. Robert Platt, U. S. Navy, commanding, was detailed to investigate the coast waters of South Carolina in the interest of the development of their oyster resources. This inquiry necessitated the determination of the position, extent, and characteristics of the natural oyster beds, and of the bottom areas not now producing oysters but suitable for their cultivation, as well as the study of the natural history of the oyster, as displayed in this region. Surveys of a similar character, previously made by the U. S. Coast and Geodetic Survey on the coasts of North Carolina and Georgia had greatly stimulated the oyster industry in those States, and had demonstrated the practical utility of such an investigation. In arranging for the work in South Carolina, however, it was deemed expedient to increase the scope of the observations, so as to provide for a careful study of the biological features of the region, with special reference to the feeding of the oyster, chemical analyses of the water, and a more detailed inquiry than had been customary respecting the physical characteristics of the latter.

The hydrographic work, including the delineation of the natural oyster beds, the determination of suitable bottoms for oyster-planting, and the specific-gravity observations, was placed in charge of Mr. John D. Battle, formerly associated with Lieut. Francis Winslow, U. S. Navy, in the oyster survey of North Carolina, and with Ensign J. C. Drake, U. S. Navy, in that of Georgia. The services of Dr. Bashford Dean, of Columbia College, New York, were secured for the more special biological researches respecting the oyster and its food and the chemical and physical considerations, subjects to which he had previously given much attention in connection with the investigations of the oyster-grounds of New York State. The general natural history of the waters was studied by Mr. James E. Benedict, of the U. S. National Museum, and Mr. W. C. Kendall. The officers of the *Fish Hawk* participated in all the branches of the work, and their hearty coöperation, especially in regard to the hydrographic part of the survey, was essential to its success.

Operations were begun December 23, 1890, in the neighborhood of Winyah Bay, in the northeastern part of the State. The creeks in that vicinity had already been examined by Mr. Battle, in the interest of an oyster company, and the privilege of using his results being obtained, but little time was spent there. The steamer then proceeded to the Savannah River and worked thence northward to the northern part of Bull Bay, near Cape Romain, completing the survey March 30, 1891.

The coast region of South Carolina consists chiefly of very low land, marshy to a great extent, which in many places extends inland a considerable distance. It is indented or cut through by a number of sounds, bays, and river mouths, which are connected by an intricate system of winding creeks and rivers, separating the sea islands from one another and from the mainland. Oysters are found in most of the creeks and rivers which are suited to their growth, but they occur mainly as fringing ledges along the borders between the levels of high and low tide. In only a few localities do they grow naturally in the stream bed, and their cultivation or improvement by transplanting has not hitherto been attempted, except upon a very limited scale.

The water that circulates through these oyster-bearing channels is derived from several sources, the sea on one side, the rivers from the interior, neighboring springs, and land seepage on the other. That coming from the sea has the high salinity or density of the ocean, while the rest is fresh. As is naturally to be expected from the positions and relations of these numerous bodies, their contents, resulting from the mixture of different waters, present a great diversity as regards saltness, and the density in each is subject to great and frequent variations through the tides and seasonal changes. Moreover, the larger rivers bring down an immense quantity of sediment, which, becoming widely disseminated, fills many of the channels with highly discolored water, especially during times of freshets. From this source, and probably from others also, the channels have derived, over a large part of their extent, a very soft, muddy bottom, not capable of supporting heavy objects of any character.

The reason for the peculiar distribution of the oysters, above referred to, which obtains also in Georgia, in some parts of North Carolina, and on the outer coast of Virginia, has not positively been determined, but it may possibly be due to the high specific gravity of the water. The heavy sediment and soft character of the bottom may also have some influence in that respect. The solution of this question is of great practical importance, as the result will have much weight in determining the methods of oyster-culture best suited to the State, and it is proposed to give further attention to the matter at the first convenient opportunity. The problem involved is as to whether the spat derived from mature oysters planted on the bottom will attach themselves in similar situations; in fact, as to whether such beds would be self-sustaining, as they are, to a greater or less extent, in all the principal oyster regions farther north. The present indications are that in the South Carolina waters whose salinity is above a certain standard the spat or embryos, which are free-swimming during the earlier part of their existence, float only at the surface, and therefore have the means of attaching themselves only between the levels of high and low tide. In any case, however, a very simple and effective means of cultivation is presented in the transplanting of the raccoon oysters from the tide ledges to suitable bottoms in deeper water, where they rapidly attain a better shape and quality. The raccoon ledges are a source of seed, which, if properly protected, can be made the basis of an extensive industry, and one probably of great profit.

The total water area surveyed amounts to about 81,280 acres, or 127 square miles, of which it is estimated that about one-fourth, in its present condition, is suitable for oyster-planting. The extent of the natural oyster beds in the same area is placed at about 775 acres. Other territory, which was not examined, from the lack of time, would greatly increase these figures, and much of the bottom not now regarded as favorable might be rendered so by proper treatment. Furthermore, it is believed that the marshes and flats along the coast channels are well adapted for the establishment of tidal ponds, which could readily be constructed by excavating the soft material to a slight depth or, in some places, by building dikes. In this manner the oyster-producing territory could be greatly extended, and the plan suggested would give the oysterman complete control over his stock.

Two reports respecting this investigation have been published. One, by Mr. John D. Battle,* contains a detailed account of the hydrographic survey, including the density observations at all the localities visited. It is accompanied by seven charts, showing the topography of the coast region, the location and extent of all the natural oyster-beds discovered, and the specific gravity of the water in each stream. The base charts used for this purpose were furnished by the U. S. Coast and Geodetic Survey. A second report, by Dr. Bashford Dean,† treats especially of the character and conditions of the natural oyster-beds and their environment; the food of the oyster, its character, distribution, and abundance in the region examined, and the chemical composition and physical characteristics of the water upon the oyster-grounds. The account of the general natural history of the region has not yet been completed.

MARYLAND AND VIRGINIA.

The oyster inquiries were extended to the waters of Chesapeake Bay, adjacent to the States of Maryland and Virginia, during the spring of 1891. Tangier and Pocomoke sounds, located on the east side of Chesapeake Bay, were first selected for examination, both because they have been for many years the seat of very extensive and important fishing operations, and because their oyster-beds had previously been subjected to careful investigations, which furnished a suitable basis for comparison. The *Fish Hawk* began its work in this region on May 15, 1891. The middle of June, however, this vessel was temporarily withdrawn to engage in the hatching of Spanish mackerel, and her place was taken by the launch *Petrel*. The survey was still in progress at the close of the fiscal year, and was continued until late in the fall.

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*An investigation of the coast waters of South Carolina with reference to oyster-culture. By John D. Battle. Bull. U. S. Fish Com., vol. x, 1890, pp. 303-330, 7 charts.

†The physical and biological characteristics of the natural oyster-grounds of South Carolina. By Bashford Dean. Bull. U. S. Fish Com., vol. x, 1890, pp. 335-361, pls. LXII-LXVII.

During the years 1878 and 1879, Lieut. Francis Winslow, U. S. Navy, then attached to the U. S. Coast and Geodetic Survey, made a very detailed study of the oyster bottom in Tangier and Pocomoke sounds, in the course of which he determined accurately the positions and outlines of all the oyster beds and calculated the number of living oysters upon them to the square yard. The small proportion of live oysters to the quantity of dead shells and other débris, which he discovered to exist, occasioned much surprise, and also furnished tangible proof of the gradual depletion of the beds through overfishing. A few years later Prof. W. K. Brooks, of Johns Hopkins University, made a second but less exhaustive examination of the same ground.

The plans for the present survey and the methods to be pursued in executing them were based upon those of Lieut. Winslow, but with some changes and additions. Besides the customary hydrographic and physical observations, the outlines of all the natural oyster-beds or "rocks" and of the areas of scattered oysters are to be accurately determined, and also the characteristics of the entire bottom not occupied by oysters. The following are among the principal facts to be ascertained regarding the condition of the beds and of the oyster crop: The number of oysters of different sizes and the relative quantity of débris to the square yard, and also the composition of the latter; the abundance and distribution of the set of spat with reference to the physical conditions of the water; the size at which oysters begin to spawn, the limits of the spawning season, and the proportion of ripe spawners on the beds at any time; the character and abundance of natural enemies, and the general natural history of the grounds. The inquiry differs entirely in character from that previously made in South Carolina, in that it has to deal with grounds which have long been drawn upon, instead of with crude and undeveloped resources. The region is a natural and typical producing district, and the information which it is expected to obtain from the work now in progress will be suggestive in regard to future surveys on any part of the coast. The States directly interested in the investigation, Maryland and Virginia, are chiefly concerned to know the conditions of their grounds and the manner in which they may be extended and enriched, and also to obtain the necessary data on which to base a standard of production for defining the natural or public beds in case the present movement to permit the lease of oyster bottom to private parties shall be carried out.

Mr. John D. Battle has acted as chief assistant in connection with the hydrographic work, and has also been in charge of the observations upon the material obtained by dredging, while special biological subjects have been attended to by Mr. J. Percy Moore, of the University of Pennsylvania. Much delay was occasioned in the beginning from the fact that nearly all of the original triangulation points established in this region by the Coast Survey had disappeared, and the shore lines had also been greatly modified by the action of the currents since the last survey was made. It was, therefore, necessary to place new signal stations before commencing upon the regular observations, but by July 1 the hydrography in Tangier Sound had been nearly completed, and the dredging was soon to be taken up. The former consisted chiefly of cross lines of soundings with appropriate instruments, which were run at close intervals and with sufficient care and accuracy to permit of the construction of a chart showing the precise outlines of all the oyster-beds, of the bottom occupied by scattered oysters, and of the barren ground.

Tangier Sound is about 36 miles long, from Watts Island to the head of Fishing Bay. Along both sides of the channel the oyster-ground is practically continuous, except in the vicinity of Jane Island light-house. Covering more or less of this bottom are large natural oyster-beds, generally elongate in shape, many of them bordering close upon the channel. It was found that the persistent dredging which has been kept up in this region for so many years has tended to extend the area of oysters and oyster shells, and to consolidate the beds by filling up the intermediate areas. Without having complete returns from the investigation, however, it is only possible to say that the total area covered by oysters seems to be considerably greater now than it was in 1878, but the comparative richness of the bottom can not be determined until the information obtained by dredging has been compiled. Comparatively little variation was found in the density of the water, which, during May and June, averaged 1.011 in the northern part of the sound, 1.012 in the central part, and 1.0124 in the southern part.

PROPOSED STUDY OF EUROPEAN OYSTER-CULTURE.

In some parts of Europe, where the market supply of oysters is largely maintained by resorting to artificial methods of propagation, oyster-culture has been carried to a high state of perfection, quite in advance of any system that has been practiced in this country. Where the natural beds of oysters along our own coasts are still sufficiently productive, or where the seed for forming new beds can be obtained abundantly under natural conditions, no further efforts are demanded for the conduct of the oyster industry than to follow the simple methods now in use. Unfortunately, in many of the older and more extensive oyster districts, it is complained that the natural supply of seed is not equal to the requirements, and much concern is felt lest the beds become impoverished on that account. Genuine oyster-culture is unknown in the United States, and none of the experiments hitherto tried in that line have served to develop a thoroughly practical American system. The Fish Commission report for 1880 contains translations of the principal French and German publications on this subject which had appeared previous to that date, but many changes have taken place since then, and in France especially the industry has made great advancement. It has, therefore, seemed advisable to undertake a careful study of the modern European methods for the information of the oystermen of this country, and to guide them in any efforts they may desire to make for the improvement of this fishery. In providing for this investigation it has been deemed important to secure the services of some one who is thoroughly conversant with the American oyster and oyster-grounds, in order that his observations shall be conducted with due regard to the requirements of our own coast.

Dr. Bashford Dean, of Columbia College, New York, who was intending to visit Europe for the purpose of scientific study, offered to coöperate in this matter, and his services have been accepted. Dr. Dean was an assistant of Mr. E. G. Blackford in the oyster surveys of New York State during several years, and was also naturalist and physicist on the steamer *Fish Hawk* during the oyster investigations on the coast of South Carolina in 1890. He is, therefore, well qualified to undertake the proposed inquiry, and has been given explicit instructions regarding the matters deemed of most importance. Dr. Dean left New York in June, 1891, and will be absent over a year. He will visit the oyster-fishery centers of France, Spain, Portugal, Italy, Germany, Holland, and Great Britain.

PHYSICAL INQUIRIES.

Off the Southern New England coast.—The physical investigation of the waters in the mackerel region off the southern coast of New England, the preparations for which were described in the last annual report, was taken up by the schooner *Grampus* in the latter part of July, 1889, and was continued actively until early in September, when stormy weather put a stop to further operations for the season. Prof. William Libbey, jr., of Princeton College, was in charge of the inquiry, assisted by Prof. Wm. F. Magie and Prof. C. G. Rockwood, jr., of Princeton College, and Prof. M. McNeill, of Lake Forest University. The *Grampus*, commanded by Capt. A. C. Adams, was furnished with a small boiler, engine, and reeling apparatus for working the wire cable used in taking the serial water temperatures, and with a complete outfit of physical appliances suitable for the examinations which it was proposed to make. The principal instruments supplied for the water observations were a large series of Negretti and Zambra reversible thermometers for the intermediate and bottom temperatures, Wilder protected thermometers for the surface temperatures, Hilgard salinometers and water bottles for obtaining samples from any depth; and for the observations regarding the conditions of the atmosphere, standard air, dew point, minimum and maximum, and solar radiation thermometers, marine barometers, air meters, rain gauge and ozonometer.

The area selected for examination lay south of Massachusetts and Rhode Island, extending coastwise from the eastern end of Nantucket to Block Island, and seaward a distance of about 130 miles. Through this region the *Grampus* proceeded to make continuous series of observations along lines of longitude 10′ apart, with stations on each of these lines 10 miles apart. Nine lines were run and four of these were duplicated. Twelve to thirteen stations were made on each line, and at each station the entire series of observations was repeated, thereby resulting in the most thorough and comprehensive inquiry respecting such a body of water that had ever been undertaken up to that time. The serial water temperatures were taken at the surface and at depths of 5, 10, 15, 20, 25, 30, 40, 50, 75, 100, 150, 200, 250, 300, 400, and 500 fathoms, where the water was sufficiently deep, the lower thermometers being successively omitted as the water shoaled toward the coast, but the distance between those that were used remaining always the same. The density of the water was also ascertained at the surface and bottom, and at one intermediate position in deep water. It will be observed that, by this means, the physical conditions of the waters of this region were determined along parallel sections running off from the coast into the warm water bordering the inner edge of the Gulf Stream, and the results can, therefore, be graphically represented by means of profiles, on which the distribution of the belts of equal temperature may readily be shown.

During the summer of 1890 the Fish Commission had the coöperation of the U. S. Coast Survey in continuing this inquiry, the superintendent, Dr. T. C. Mendenhall, detailing for this purpose the steamer *Blake*, commanded by Lieut. Charles E. Vreeland, U. S. Navy, which remained in actual service from July 9 to August 4. The schooner *Grampus* was at work upon the same ground from July 3 until August 25, and a party of observers was also stationed on board the Nantucket New South Shoal light-ship during the entire period of the investigation. Prof. Libbey was again in charge of the observations, and was assisted by Prof. C. G. Rockwood, jr., Prof. M. McNeill, Mr. S. T. Dodd, Mr. L. S. Mudge, Dr. R. P. Bigelow, Mr. J. Zimmerman, Mr. W. H. Dodd, and Mr. A. Harris. It was arranged to have three observers each on the *Grampus* and the light-ship at all times, while only two were necessary on the *Blake*, as Lieut. Vreeland and his officers relieved the civilians of many duties which would otherwise have devolved upon them. The Fish Commission is under many obligations both to the Light-House Board and to the Superintendent of the Coast Survey for their liberal action in respect to this undertaking, and the assistance rendered by them has permitted a much more thorough and extensive study of the problem than was possible in 1889. In acknowledging the coöperation of these Bureaus it is also well to note that these physical studies will probably be as significant in regard to questions of navigation as to those which bear upon the fisheries, and the Fish Commission is, therefore, not alone concerned in the practical results to be derived from their successful prosecution.

The steamer *Blake*, not being dependent upon favorable winds for carrying on the share of work allotted to it, was able to make much more rapid progress than the *Grampus* and to occupy a larger number of stations. The area covered was the same as in 1889, except that the lines run by the *Blake* were carried out to sea a distance of 150 miles, those of the *Grampus* being restricted to 130 miles as before. The vessels were kept as far apart in an east and west direction as was feasible in conformity with the plans, in order that, so far as possible, parallel lines of observations might be made more or less conjointly in different parts of the field. The *Blake* was on the western side of the ground during the early part of July, and the *Grampus* on the eastern side, these relative positions being subsequently changed. Ten north and south lines, 10′ of longitude apart, were marked out as the courses to be followed by the vessels, but each of these was gone over two or more times, and the actual number of lines run was 27, with 382 stops or stations for observation. The total number of observations was, for serial temperatures, 4,000; for specific gravity, 850, and for meteorology, 14,000. The temperature of the water was not taken this year at greater depths than 200 fathoms, but a complete meteorological record was made every hour while the vessels were at sea.

On the light-ship meteorological observations were taken continuously, amounting to 18,000 separate entries for the season, the temperature of the water was noted regularly at the surface and at depths of 5, 10, and 15 fathoms, and the changes in the surface specific gravity were recorded hourly. The direction and velocity of the tidal currents were also determined by means of a Ritchie-Haskell meter.

An account of the investigations made in 1889 has been published in the Fish Commission Bulletin for the same year,* but Prof. Libbey has not yet completed his report for 1890, and any discussion of his conclusions must be left for a future time. In connection with the data obtained by the two expeditions, Prof. Libbey has also utilized the meteorological records for Boston and New York City, which have been kindly furnished by the Signal Office. Information of this character has, therefore, been supplied from three stationary positions, two upon the land and one upon the sea, the latter being distant some 20 miles from shore. It affords an excellent opportunity for comparing the relations of atmospheric variations with those observed in connection with the waters, and by continuing the study of the same for a term of years it will be possible to determine whether there is any coordination of conditions between the two elements, and if a change in one produces any effect upon the other. Some such relationship has been shown to exist, but its full extent can not yet be established.

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*Report upon a physical investigation of the waters off the southern coast of New England, made during the summer of 1889 by the U. S. Fish Commission schooner *Grampus*. By William Libbey, Jr. Bull. U. S. Fish Comm., vol. IX, 1889, pp. 391–459, pls. CXXIV–CLVIII.

In Prof. Libbey's report for 1889 the vertical water temperature curves are represented by nine profiles, and twenty-seven sectional diagrams have been prepared for the report of 1890, as well as several plates showing the surface isotherms from time to time. The hourly changes of air and surface water temperatures for each day while the survey was in progress are also illustrated in the same graphic manner, being based upon the records made at the three stations and on board the vessels. Prof. Libbey has likewise summarized the results of observations upon the direction and force of the winds, as given on the Hydrographic Office pilot charts of the North Atlantic Ocean, in order to afford an insight, if possible, into the relations between the winds and the positions taken by the northern boundary of the warm waters coming from the Gulf Stream.

By means of the observations so far made it has been possible to indicate very clearly, for the region and periods covered by the examination, the distribution of the bands of equal water temperature both vertically and superficially, and the relations of the cold and warm water bodies to one another. The charts of surface isotherms are especially interesting as furnishing a possible key, in connection with meteorological conditions, to the physical changes at greater or less depths, which relate to the movements of fishes.

Aside from the more general subdivision into Gulf Stream and Labrador current, Prof. Libbey states that two different sets of currents have to be dealt with in the study of this region. First are the deep currents which flow in two, and generally opposite, directions alongside of one another, their courses being controlled more by the mechanical influence of the impact of one current upon the other, their relative velocities, etc., than by changes in temperature and density. Second come the surface currents, which flow in the same general directions as the deep ones and are, of course, subject to the same mechanical laws, but their courses are additionally affected to a considerable degree by the frictional influence of the winds. Moreover, they present a peculiarity not detected in connection with the deep currents, in that certain branches are apparently reversed. The outlying bands of warmer and denser water, which pass off from the shore side of the Gulf Stream, seem to be drifted toward the shore or away from it to an extent dependent upon the direction, velocity, and duration of the winds. When they are forced toward the shore, thus bridging over the colder currents, as they proceed farther and farther from the original source of their velocity, they become overpowered. Although retaining much of their temperature and density, even to a considerable depth, their direction is then sometimes at right angles and finally opposite to their first course.

In connection with this investigation, the surface-towing nets were constantly employed, and a large and valuable collection of pelagic organisms was thus obtained. Those collected in 1889 have been reported upon by Prof. W. K. Brooks, in the paper of Prof. Libbey above cited, and the material subsequently taken has been referred to Prof. Brooks and others for examination. During the first summer Prof. Magie took advantage of the opportunity afforded to secure a set of observations on the electric conditions of the atmosphere, which have also been published in Prof. Libbey's report.

Southern mackerel-grounds.—From May 5 to June 8, 1891, the schooner *Grampus* was engaged in making a series of observations over the mackerel-grounds, from Delaware northward to Massachusetts. This was in continuation of similar inquiries made in previous years to determine so far as possible the temperature and other physical phenomena connected directly with the northerly movement of the advance schools of mackerel along the coast. As is well known, these fish first make their appearance inside of the warm waters of the Gulf Stream at a variable distance north of Cape Hatteras, and work thence northward or approach the shores at successively more northern latitudes. The first schools have generally been seen the very last of March or early in April, and previous to the enactment of the law prohibiting the use of purse seines before June 1, the fishing vessels were accustomed to anticipate their coming with much eagerness, making diligent search for them, and subsequently following the fish during their migrations. In her former cruises over these grounds the *Grampus* was greatly aided by the presence of these vessels, which, scattered over a rather wide area, made it difficult for any schools of fish to pass unnoticed. During the last season, however, her work was necessarily carried on without this very material assistance.

The principal object of the cruise was to locate the early schools of mackerel, to follow their movements northward or in whatever direction they might take, and to learn everything possible regarding the conditions of the air and water in connection with their habits. As it was somewhat late in the season before the trip began it was expected that the schools were already upon the grounds, and that it would not be necessary to proceed very far south before meeting them. Such was found to be the case, but the observations were carried southward from Woods Holl until the fish were encountered, and thence over a part of the area through which they had passed, in order to obtain the necessary data for comparing the conditions in advance of the first schools with those existing in their rear. Subsequently the *Grampus* followed the schools as far as Marthas Vineyard, taking ripe males the last of May and ripe females the first of June, in that vicinity. The physical observations have not yet been reduced and compared.

Permanent temperature stations.—The permanent stations at which temperature observations of the air and water have been taken daily for a greater or less period during the past two years, through the courtesy mainly of the Light-House Board, the Signal Service, and the Southern Pacific Company, are as follows:

Temperature stations on the Atlantic Coast.

Stations of the Light-House Service:
- Coast of Maine: Petit Manan Island, Mount Desert Rock, Matinicus Rock, Seguin Island, Boon Island.
- Coast of Massachusetts: Race Point, Pollock Rip light-ship, Nantucket New South Shoal light-ship, Cross Rip light-ship, Vineyard Sound light-ship.
- Coast of Rhode Island: Brenton Reef light-ship, Block Island southeast light.
- Long Island Sound: Bartlett Reef light-ship, Stratford Shoals light-ship.
- Coast of New York: Sandy Hook light-ship.
- Coast of New Jersey: Absecon Inlet, Five-Fathom Bank light-ship.
- Delaware Bay: Fourteen-Foot Bank light-ship.
- Coast of Virginia: Winter Quarter Shoal light-ship.
- Chesapeake Bay: Point Lookout, Windmill Point, Stingray Point, Wolf Trap Bar, York Spit.
- Coast of North Carolina: Bodys Island, Cape Lookout, Frying Pan Shoal light-ship.
- Coast of South Carolina: Rattlesnake Shoal light-ship, Martin's Industry Shoal light-ship.
- Coast of Florida: Fowey Rocks, Carysfort Reef, Dry Tortugas.

Stations of the Signal Service:
- Eastport, Me.
- Boston and Nantucket, Mass.
- New York City, N. Y.
- Charleston, S. C.
- Key West, Cedar Keys, and Pensacola, Fla.

Stations of the Fish Commission:
- Gloucester and Woods Holl, Mass.
- Fort Washington, Potomac River, Maryland.
- Washington, D. C.

Temperature stations on the Pacific coast and slope.

Station of the Signal Service:
- Portland, Oregon.

Stations of the Southern Pacific Company:
- Sacramento River, at Tehama and Yolo Bridges and King's Landing, California.
- Feather River, at railroad crossing, California.
- American River, at railroad crossing, California.
- Mokelumne River, at Lodi, Cal.
- Tuolumne River, at Modesto, Cal.
- San Joaquin River, at the upper and lower railroad crossings, California.
- King River, at Kingsbury, Cal.
- Colorado River, at Yuma, Ariz.

No serious breaks have occurred in the records of any of the light-house stations above enumerated, and the Southern Pacific Company has added several new stations to those reported upon in 1889, but, unfortunately, through the lack of sufficient means the Signal Service was obliged, in the latter part of 1890, to discontinue its coöperation in regard to this important subject.

During October, 1889, Prof. Libbey, with the steamer *Fish Hawk*, visited nearly all of the temperature light-stations located between Cape Cod and Chesapeake Bay, and inspected the thermometers used in making the observations, also instructing the attendants as to the proper way of reading and caring for them. All instruments were compared with a standard, and those showing any appreciable variation were replaced by new ones. Prof. Libbey suggests several changes in respect to this branch of work, which it is intended shall be introduced at an early date. The stations visited were as follows: Pollock Rip, Nantucket New South Shoal, Vineyard Sound, Brenton Reef, Block Island, Sandy Hook, Five Fathom Bank, and Winter Quarter Shoal.

Changes in density observations.—The hydrometers which have been used by the Fish Commission, as well as by the U. S. Coast and Geodetic Survey, for determining the density of sea water are the so-called Hilgard salinometers, consisting of an elongate glass float and stem, the scale being marked upon the latter. They are described and figured in Appendix 16 of the Coast Survey Report for 1874. Up to the present time the graduation of the scale has been referred to pure water at 60° F., and the observations have been reduced by means of the Hubbard table to a uniform temperature of 60° F. for the purposes of comparison. For certain reasons, however, it now seems advisable to change the former standard by making it conform to the temperature at which pure water attains its maximum density, and 4° C., the nearest integer to that temperature, has, for convenience sake, been adopted as the future standard. Upon this basis the observations will conform more closely with modern European methods. This change was agreed upon by the Superintendent of the Coast Survey and the Commissioner of Fisheries during the winter of 1889–90, but some delay must ensue in the preparation and the introduction of the new instruments, which will be constructed upon the same patterns as the old ones, the only difference being in their graduation.

In the future, moreover, the observations will be reduced to 15° C., instead of 60° F., both of these temperatures, however, being approximately identical, and a convenient table for this purpose, prepared by Mr. O. H. Tittmann has been published in Bulletin No. 18 of the Coast Survey for 1890. This table also gives a constant by which the reductions of observations obtained with the old instruments may be made to conform to the new standards.

Other physical inquiries are discussed in connection with the operations of the steamer *Albatross* in the north Pacific Ocean and of the steamer *Fish Hawk* on the oyster-grounds of the Atlantic coast.

INVESTIGATION OF INTERIOR WATERS.

ALASKA.

In the last report reference was made to the organization of an exploring party in charge of Dr. Tarleton H. Bean, for the investigation of certain Alaskan salmon rivers, in pursuance of an act of Congress approved March 2, 1889. This act was based upon the representations of persons interested in the preservation of the important industries which have been developed on the Pacific coast, and made provisions both for the protection of the salmon and for the study of the natural-history and industrial features relating to the fisheries. The party consisted of Dr. Bean, ichthyologist of the Commission; Mr. Livingston Stone, superintendent of the Fish Commission salmon station in California; Mr. Franklin Booth, topographical engineer, of the University of California, and Mr. Robert E. Lewis, rodman and general assistant. The instructions called for observations respecting the habits, distribution, abundance, etc., of the salmon and associated species; the physical characteristics of their environment; the methods, statistics, and conditions of the fishery, and the necessities and advantages of Alaskan waters for the artificial propagation of the salmon.

The first steamer by which the party could reach Kadiak did not leave Port Townsend until July 19, arriving at the former place on the 28th of the same month. The season suitable for fieldwork was thereby greatly shortened, and it became necessary to restrict their operations to the islands of Kadiak and Afognak, where, however, the principal salmon fishery in Alaska was then being conducted, the catch on Karluk River comprising about one-half the entire yield of the territory. No examination has been made of Cook Inlet, but in 1890 the steamer *Albatross* visited the fishery at the head of Bristol Bay and obtained some important information respecting the methods there employed, as explained below. Kadiak Island, however, afforded the means for making a very satisfactory study of the problem, and the results obtained, combined with previous observations, especially on the habits of the salmon, have enabled Dr. Bean to report in full upon the questions proposed by Congress.*

Examinations were made of Karluk River and Lake, including the open bay into which the former empties; of Uyak Bay adjacent to Karluk, on the northern side of the island; of Alitak and Olga bays at the southeastern end of the island, and of Afognak Bay on the island of the same name, including in the case of each bay the small salmon rivers which empty into them.

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* Report on the salmon and salmon rivers of Alaska, with notes on the conditions, methods, and needs of the salmon fisheries. By Tarleton H. Bean. Bull. U. S. Fish Comm., IX, 1889, pp. 165–208, pls. XLV–LXXIX.

The red salmon, according to Dr. Bean, is now the most important species for canning and salting in Alaska, and its flesh is so red as to win for it a reputation not warranted by its edible qualities. The largest and finest species is the king or quinnat salmon, which, while it enters some of the smaller streams like the Karluk, occurs more abundantly in the larger rivers, such as the Yukon and the Nushagak. The humpback is the smallest, most abundant, and most widely distributed of the Alaskan salmon. It is not taken for canning purposes, but being one of the most palatable species in the fresh-run condition it is destined to become of great importance in that connection. The silver salmon is used to some extent for canning, but far less than the red salmon, while the dog salmon is regarded by the whites as one of the least important of the group. The steelhead or hardhead is used only to a limited extent, while the dolly varden trout or malma is not canned.

It was impossible to determine if a decrease had occurred among any of these species in the region examined, owing to the lack of positive information regarding their previous abundance. In fact, it is to be doubted if more than one species—the red salmon—is in imminent danger in that regard, as it is the only species which is fished for to excess. However, any injudicious methods which might be established to increase the catch of this species would have its effect upon all the others entering the streams at the same time, or while the practices in question were continued. An illustration is furnished by Dr. Bean with respect to the dolly varden trout, of which, he says, great numbers are taken in connection with the red salmon and left to die on the beaches.

Dr. Bean states:

> The catch of red salmon has been increasing, owing to the increase in the number of persons engaged in the fishery and in the effectiveness of the implements used in its capture. The size of seines has been greatly enlarged, and the number of boats, seines, and men largely augmented. That there will be a falling off in the supply very soon there can be no doubt. The number of spawning fish in Karluk Lake and its tributaries last year was unexpectedly small. There was, early in the season of 1889 and in previous seasons, injudicious obstruction of the ascent of spawning fish in the Karluk River. At one time an impassable weir, similar to the *Zapor* of the Russians, was placed in this river. At the time of our visit we saw the remains of pound nets, made of wire netting, which interfered so seriously with the ascent of the fish that they were dismantled by unknown parties and were reëstablished.

The report of Dr. Bean was submitted to Congress by the Commissioner on June 6, 1890, with recommendations as to additional steps necessary to insure the protection of the Alaskan salmon-fisheries.

While engaged in the surveys of Bering Sea, during the summer of 1890, the steamer *Albatross* was dispatched, at the request of the Secretary of the Treasury, to investigate the methods of salmon-fishing practiced in connection with the canneries on the Nushagak River at the head of Bristol Bay, as it had been reported that a barrier was in course of construction across the Wood River, a tributary of the Nushagak. Lieut. Commander Tanner, U. S. Navy, who made the inspection, found that a double trap was being built upon the Wood River, about 20 miles above its mouth and 40 miles from the Nushagak cannery. The Wood River at this point is a swift-running stream of clear, cold water, between 700 and 800 feet wide and 10 to 14 feet deep. Operations had not progressed sufficiently to indicate the character and extent of the work, but the plans contemplated an opening in mid-stream 100 feet wide, flanked on each side by a trap 40 feet square, with wings extending from the latter to the shores. The report of Lieut. Commander Tanner was submitted to the Secretary of the Treasury, who decided that the proposed traps were obstructions to the ascent of salmon within the meaning of the law, and that their erection was therefore illegal.

Although the salmon-canning industry of Alaska is of very recent origin, the amount of capital invested in it is nearly $4,000,000, while the output in 1889 was valued at about $3,000,000, which is greatly in excess of the value of the yield of seal skins on the Pribilof Islands before the reduction was made in the number of seals that are allowed to be killed annually. That the salmon industry in that region is capable of very much greater development is unquestionable, as the resources have been tapped at only a comparatively few places, but, unless the fishery is carefully guarded, sooner or later there will be repeated in Alaska the same unfortunate condition of affairs which has obtained in every country where salmon have been abundant. The salmon spend most of their time at sea. The spawning instinct leads them into fresh waters, which furnish the necessary conditions for the hatching of the eggs and the development of the young during a portion of their existence. The different species vary more or less in the date and duration of the spawning season and in their spawning habits. Some enter by preference the smaller streams, and others the larger rivers. Some never return to the sea, dying soon after having accomplished their reproductive functions, while others may survive to return again in a subsequent season. This habit of running up the rivers makes them fall an easy prey to the fishermen, especially if the river be small or shallow, or be restricted near its mouth. It is evident that if a river channel be closed against their ascent no spawning can be accomplished in it, and from what is known of their habits it is also probable that the fish will not seek another river the same season. They remain below the obstruction, unable to make progress, but still guided by the common impulse to arrive at the spawning-grounds. Smaller barriers and large nets, of one character or another, accomplish the same result, although on a lesser scale, as they are generally arranged to retard whatever fish are not captured.

The fishing season is, to be sure, restricted in its duration, and in this fact the fishermen find an excuse for resorting to their wholesale methods of capture; but, whatever may be the circumstances, there is no warrant for destroying any product which is the common property of a country. It would, therefore, seem advisable to institute a system of inspection, by scientific experts, which could determine periodically such facts as might be considered necessary as a basis for regulations, the expenses to be met, if need be, by a slight tax upon the fishery. By paying proper attention to the habits of a species, by prescribing the methods of capture or by limiting the amount of catch, the source of the industry can readily be maintained and its permanency insured. The justice of such provisions are undeniable, and those who are directly interested in the fishery and must profit by its permanence should be the first to recognize its necessity. An inflexible system of police supervision is not adequate to accomplish this purpose. There is a natural fluctuation in the fish supply, and the conditions which surround it vary more or less from time to time.

Considering the present abundant stock of salmon in Alaska, and the possibility of preserving it from destruction, it seems unnecessary to bring up the subject of artificial propagation as a means of maintaining or increasing the supply. Should a resort to such measures become necessary at any time, however, it would not be difficult to find proper sites for hatching-stations, or to obtain the eggs in sufficient quantities from the fish captured for canning or salting purposes; but at present a system of protection seems most judicious and expedient.

WYOMING.

The Yellowstone National Park.—Two investigations have been made in the Yellowstone National Park within the past two years, the first by Dr. David S. Jordan and Prof. Charles H. Gilbert, during September and October, 1889, the second by Prof. S. A. Forbes and Prof. Edwin Linton, during July and August, 1890. These inquiries were instituted chiefly for the purpose of obtaining information to be used in connection with the stocking of certain of the streams and lakes with fishes, a measure which had previously been determined upon by the Fish Commissioner. A peculiarity of the park is the small variety of fishes which inhabit it and the entire absence of fish life over a very large area. The park is drained by tributaries of both the Mississippi and the Columbia rivers, being traversed toward the southwest by the continental divide, which extends in a general northwest and southeast direction. The streams which are devoid of fishes form several small, distinct basins, in each of which it is proposed to plant only one or two species, and at the time of writing this report considerable progress had been made in this direction. Under the conditions which there exist not only may all suitable waters become replete with fishes, but it is expected that the results will afford an interesting study in acclimation, owing to the isolation of the different forms.

The following brief account of the principal characteristics of the park from an ichthyological standpoint is from the report of Dr. Jordan:*

The Yellowstone Park is a high plateau, having a general elevation of 7,000 to 8,000 feet above the sea. Its entire surface, with the exception of the Gallatin Range of mountains in the northwest and some granitic summits in the northeast, is covered with lava, with its varieties of obsidian, rhyolite, etc. This mass of lava covers to a great depth what was previously a basin in the mountains. According to Mr. Hague, the date of the lava flow is probably Pliocene. Its existence was of course fatal to all fish life in this region. Since its surface has become cold, the streams flowing over it, most of them now wholly unaffected by the heat within, have become well stocked with vegetable, insect, and crustacean life, but are for the most part destitute of fishes. The cause of this absence of fishes is to be found in the fact that nearly all the streams of the park, on leaving the lava beds, do so by means of vertical falls situated in deep cañons. Except in the Yellowstone and its tributaries, in Gibbon River and in Lava Creek, no fishes have been found above these falls, and the presence of fishes in the Upper Yellowstone and Lava Creek is doubtless due to the imperfect character of the watersheds separating these streams from others. Outside of the park, the falls in Clark Fork of the Yellowstone exclude fish from that river, and perhaps the Great Shoshone and American Falls in Snake River exclude from the upper part of the stream the fauna of the Lower Columbia. Another supposed obstacle to the spread of fish life in the Yellowstone Park is the presence of the innumerable hot springs, solfataras, and geysers, for which the region is famous.

Dr. Jordan's trip was made somewhat late in the season, and on that account was considerably hurried, but he was, nevertheless, enabled to study the leading points in the problem which had been suggested to him. Yellowstone River and Lake, including all their western tributaries, were examined at many places, and also all the principal streams and lakes of the Madison and Snake River basins. The total number of fishes discovered was 10, of which 2 belong to the *Salmonidæ* (the Rocky Mountain trout and the whitefish), 1 is the miller's thumb or blob, 1 the grayling, 4 are minnows and chubs, and 2 suckers. Nowhere above the falls, except in the Yellowstone and its tributaries, in Gibbon River, and in Lava Creek, were any fishes found. The miller's thumb or blob was very abundant above the falls in Gibbon River, and its presence there is unexplained; but the occurrence of trout in Lava Creek, where they are common, is supposed to be due to the imperfect character in some places of the watershed which surrounds it. The grayling is restricted to the extreme northwestern part of the park. Dr. Jordan describes with much care the peculiarities and distribution of the different species, and the characteristics of all the principal lakes, rivers, and creeks in the park, making his report invaluable as a guide in the stocking of those waters. His conclusions regarding the suitability of certain areas for that purpose are also very important.

*A reconnaissance of the streams and lakes of the Yellowstone National Park, Wyoming, in the interest of the U. S. Fish Commission. By David Starr Jordan. Bull. U. S. Fish Com., IX, for 1889, pp. 41-63, pls. VII-XXII, and one map.

Speaking of the hot springs, solfataras, and geysers, he states:

Although these springs exist in almost every lake basin, cañon, or other depression in the park, we do not think that, in their present condition at least, they would stand in the way of the stocking of the streams and lakes with fishes. The waters of the geysers and other calcareous and silicious springs do not appear to be objectionable to fishes. In Yellowstone Lake trout are especially abundant about the hot overflow from the Lake Geyser Basin. The hot water flows for a time on the surface, and trout may be taken immediately under these currents. Trout have also been known to rise to a fly through a scalding hot surface current. They also linger in the neighborhood of hot springs in the bottom of the lakes. This is probably owing to the abundance of food in these warm waters, but the fact is evident that geyser water does not kill trout. * * * There are, however, numerous springs in the park which discharge sulphurous liquids, very offensive in odor and doubtless fatal to fishes. Most of these springs have but a very slight discharge, and so exert no appreciable influence on the streams. The upper part of Obsidian Creek, between Twin Lakes and Beaver Lake, is the only running stream noticed by us as likely to prove uninhabitable by fishes. An obstacle of equal importance in the lower course of the same creek is the series of three beaver dams, to which the existence of Beaver Lake is due. These, with their covering of brush, must be wholly impassable.

During 1889 and 1890 the following plants of fishes were made in the Yellowstone Park: The eastern brook trout in the Gardiner River and its west fork; the mountain trout in the east fork of the Gardiner River; the California or rainbow trout in Gibbon River; the Loch Leven trout in Firehole River and Lewis and Shoshone lakes; the Von Behr trout in Nez Percé Creek; the lake trout in Lewis and Shoshone lakes; the native whitefish in the Twin lakes and Yellowstone River. None of these waters, except the Yellowstone and Gibbon rivers, and possibly the East Fork of the Gardiner River, were previously inhabited by fishes, and the only species known from the Gibbon River was the little blob or miller's thumb. With the exception of Lewis and Shoshone lakes, in both of which two species were planted, each basin was supplied with only a single species.

The observations of Dr. Jordan proved conclusively that the absence of fishes in certain parts of the park was not due to the unsuitable condition of the waters, although within a few limited areas they may be unfitted for them. However, it was deemed expedient to obtain more positive information relative to the character, abundance, and distribution of the lower forms of life, on which the introduced species would be dependent for their food, as a deficiency in respect to such organisms might necessitate their being supplied by artificial means. Arrangements were made with Prof. S. A. Forbes, director of the State laboratory of natural history of Illinois, and Prof. Edwin Linton, of Washington and Jefferson College, Pennsylvania, to conduct this investigation during the summer of 1890. Prof. Linton, in addition to assisting Prof. Forbes in the general inquiry, was charged with the special study of the parasitic worm which infests so large a proportion of the trout in certain portions of the park, penetrating into the flesh and rendering it unsightly. Specimens collected by Dr. Jordan the previous year had been examined by him, but observations were desired on fresh material and in relation to the life history of the species.

The party reached the park about the middle of July, and, provided with a very complete outfit, began at once their examinations, which were continued until August 30. The ground gone over was practically the same that had been traversed by Dr. Jordan in 1889, including the Gardiner, Madison, and Yellowstone river systems on the Atlantic slope of the continental divide, and that of the Snake River on the Pacific slope. Collections were made in 43 localities. The principal fishless waters visited were Shoshone and Lewis lakes, the upper Gibbon and its tributaries, the Firehole and its branches, Goose Lake, Twin Lakes, Swan Lake, and Tower Creek. The effects of geyser and hot-spring overflow were studied especially on the Firehole and on Alum Creek, and of the intervention of falls on the Gibbon River and some of its tributaries. The highest waters examined were Mary Lake, having an altitude of 8,200 feet, and a small lake, near Norris Pass, at about the same level. Dredging was carried on in Yellowstone Lake to a depth of 195 feet. The general collection of specimens obtained is very large, and has been sent to the State Laboratory of Natural History, at Champaign, Ill., where it is being carefully studied under the direction of Prof. Forbes. It is considered to be sufficiently complete to explain the biological conditions existing in those lakes, ponds, rivers, and creeks which are devoid of fishes, in such as have only a single species of fish, and again in others supporting from 3 to 8 species each. Awaiting the preparation of Prof. Forbes's report, we are able, in this connection, to present only a few of his preliminary conclusions, which are as follows:

The waters of the park, wherever they were examined, were found to provide a fair amount, and often an abundance, of animal life suitable as food for the ordinary carnivorous fishes, the fishless areas being no less well supplied in this respect than those already containing trout. These observations, therefore, support those of the ichthyologists, that the peculiar distribution of the fishes in this region can be explained alone from its topographical features, which have had no noticeable effect upon the distribution of invertebrates. Collections made both above and below the falls in certain rivers show that these obstructions to fish migrations have in no way interfered with the dissemination of the lower forms. The scarcity of fresh-water mussels and crayfishes is probably due to the chemical condition of the waters, especially in the absence of lime. The former were found only in Cañon Creek, where the living specimens were greatly eroded and the dead shells rapidly decalcified. Crayfishes have also been recorded from only a single stream. No isopod crustaceans were discovered, and amphipods were very irregularly distributed, being very abundant in some places and entirely wanting in others. No phyllopod crustaceans were collected, but they may abound earlier in the season, in temporary pools. Entomostraca were abundant in every situation where they might naturally be expected to occur, copepods largely predominating, except in the smaller ponds. These indispensable elements to the preservation of young fishes were as plentiful in the waters of the park as they are in Lake Michigan and in the deeper lakes of the Wisconsin series.

The greater proportion of animal life found in the streams consisted of insect larvæ, chiefly neuropterous. Caseworms, ephemerid larvæ, and the larvæ of stone flies and *Sialidæ*, which are everywhere excessively abundant, are the main dependence of the trout in waters containing no other fishes. The larvæ of *Chironomus* are very common, and those of *Simulium* are exceedingly numerous in suitable localities. The smaller mollusks, especially species of *Physa*, were also plentiful occasionally. In the deepest waters examined the bottom fauna consisted mainly of a few slender annelids, an abundance of red *Chironomus* larvæ, some small mollusks, mostly *Pisidium*, and occasional specimens of *Gammarus*. By far the most important elements of fish food, however, were the entomostraca for the young and the neuropterous larvæ for the adult fishes.

Prof. Linton was entirely successful in his study of the wormy trout, the history of which he has been able to complete. This instance of excessive parasitism was noticed during the early explorations of the park, and has ever since attracted much attention from tourists and scientific men. The parasite is a species of tapeworm, named *Dibothrium cordiceps* by Prof. Joseph Leidy, and occurs among the viscera, beneath the peritoneal lining of the abdominal cavity, or burrowing in the muscular tissue of the body wall. The only fish which it is known to infest is the native trout of the Yellowstone Park, and it has been found almost exclusively in Yellowstone Lake, in Yellowstone River above the falls, and in Heart Lake. It does not, however, finish its development in the trout, which contain only the larval stages, but requires a second host to complete its life history. The latter is, in part at least, the white pelican, which spends the summer in this region, and breeds on an island in the southeast arm of Yellowstone Lake. All of the birds examined had been feeding on the trout, the only fish occurring in the lake.

The cause of the unusual multiplication of parasites in this locality may be traced to the peculiar combination of circumstances there prevailing. Probably not less than 1,000 pelicans resort to the lake during the summer, and of this number 50 per cent or more are infested with the adult *Dibothrium*, the eggs of which become disseminated through the water, where, after a short development, they are swallowed by the trout. The eggs hatch more readily in warm than cold water, and the former conditions, according to Prof. Linton, are—

Supplied in such places as the shore system of geysers and hot springs on the west arm of the lake, where for a distance of nearly 3 miles the shore is skirted by a hot spring and geyser formation, with numerous streams of hot water emptying into the lake, and large springs of hot water opening in the floor of the lake near shore. Trout abound in the vicinity of these warm waters, presumably on account of the abundance of food there. They do not love the warm water, but carefully avoid it. Several persons with whom I talked on the subject while in the park assert that diseased fish—that is to say, those which are thin and affected with fleshworms—are more commonly found near the warm water; that they take the bait readily, but are lazy. I frequently saw pelicans swimming near shore in the vicinity of the warm springs on the west arm of the lake. It would appear that the badly infested or diseased fish, being less active and gamy than the healthy fish, would be more easily taken by their natural enemies, who would learn to look for them in places where they most abound. But any circumstances which cause the pelican and trout to occupy the same neighborhood will multiply the chances of the parasites developing in both the intermediate and final host. The causes that make for the abundance of the trout parasite conspire to increase the number of adults. The two hosts react on each other, and the parasite profits by the reaction.

An effective remedy might be found in the extermination of the pelicans, providing they are the only final hosts of this parasitic worm. The relief which might thereby be afforded, however, is not of sufficient importance to justify the destruction of so interesting a feature of the park. The trout in that region is not important as a food supply; the diseased fishes are in most convenient places for capture, and with the increase in fishing will be drawn upon more largely than the healthy ones. The introduction of other species into the lake would, moreover, tend to improve conditions by adding new varieties of food for the trout, thereby probably diverting them more or less from the warm waters and imparting to them a more vigorous constitution. The pelicans would also profit by this new source of food, the trout would suffer less from their attacks, and parasitism would be decreased in proportion.

Other fish parasites were obtained in the Yellowstone Park by Prof. Linton, who has presented three reports treating of these interesting forms.*

COLORADO AND UTAH.

Investigations were conducted in Colorado and Utah during July and August, 1889, by Dr. David S. Jordan, assisted by Prof. B. W. Evermann, Mr. Bert Fesler, and Mr. Bradley M. Davis. The special object of this inquiry was to determine the character of the streams and lakes of the Rocky Mountains and the Great Basin as represented in this State and Territory, the variety and distribution of the food-fishes now inhabiting these waters, and their suitability for the intro-

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* On two species of larval Dibothria from the Yellowstone National Park. Bull. U. S. Fish Comm., IX, for 1889, pp. 65–79, pls. XXV–XXVII.

A contribution to the life-history of *Dibothrium cordiceps*, a parasite infesting the trout of Yellowstone Lake. *Idem*, pp. 337–358, pls. CXVII–CXIX.

On fish entozoa from the Yellowstone National Park. (Appendix 5 to this volume.)

duction of species not native to them. The importance of these studies was much increased by the fact that a new hatching station for the *Salmonidæ* was about to be established in the vicinity of Leadville, Colo., a site for the same having already been selected. In Colorado the examinations had reference to four river basins, and were naturally confined for the most part to their upper courses, although on three of the rivers the work was extended beyond the limits of the State. These river basins were as follows: The Platte and Arkansas, tributaries of the Mississippi; the Rio Grande, flowing directly into the Gulf of Mexico; and the Colorado, flowing into the Gulf of California. In Utah, in addition to the Colorado River, the Great Salt Lake and Sevier Lake basins were examined.

According to Dr. Jordan's report* of this expedition, most of the streams of Colorado rise in springs in or above the mountain meadows, while many have their origin in banks of snow, their waters being very clear and cold. In their descent from the snow banks they are brawling and turbulent, often so much so as to be unfitted for fish life. In their course through the mountain meadows the streams have usually a gentle current, and lower down most of them pass to the valleys through deep cañons, which generally, however, present no obstacles to the presence of trout, especially as vertical falls are very rare in Colorado. In the valleys the water grows warmer, fine silt renders it more or less turbid, and at last it becomes unfit for trout, and at the same time suitable for suckers and chubs. During the colder temperature of winter the trout extend their range somewhat down the valleys, but during the summer and fall they are more or less confined to the mountains or the cañons. After reaching the base of the mountains the streams flow with little current over the ill-defined beds across the plains. In some cases placer mining and stamp mills have filled the waters of otherwise clear streams with yellow or red clay, rendering them almost uninhabitable for trout. Parts of the Upper Arkansas and Grand Rivers have been almost ruined as trout streams by mining operations. Dr. Jordan says:

In the progress of settlement of the valleys of the Colorado the streams have become more and more largely used for irrigation. Below the mouth of the cañons dam after dam and ditch after ditch turn off the water. In summer the beds of even large rivers (as the Rio Grande) are left wholly dry, all of the water being turned into these ditches. Much of this water is consumed by the arid land and its vegetation; the rest seeps back, turbid and yellow, into the bed of the stream, to be again intercepted as soon as enough has accumulated to be worth taking. In some valleys, as in the San Luis, in the dry season there is scarcely a drop of water in the river bed that has not from one to ten times flowed over some field, while the beds of many considerable streams (Rio la Jara, Rio Alamosa, etc.) are filled with dry clay and dust. Great numbers of trout, in many cases thousands of them, pass into these

* Report of explorations in Colorado and Utah during the summer of 1889, with an account of the fishes found in each of the river basins examined. By David Starr Jordan. Bull. U. S. Fish Comm., IX, for 1889, pp. 1–40, pl. I–V.

irrigating ditches and are left to perish in the fields. The destruction of trout by this agency is far greater than that due to all others combined, and it is going on in almost every irrigating ditch in Colorado.

The fishes of Colorado comprise very few species, only 32 indigenous species being enumerated by Dr. Jordan, of which 2 were new to science.

The Rocky Mountain trout, *Salmo mykiss*, is found in all the mountain lakes and streams tributary to the four main rivers, extending down to a point where the summer temperature reaches 60° to 65° F., where it gradually disappears. The mountain minnows, *Rhinichthys dulcis* on the eastern slope and *Agosia yarrowi* in the Colorado basin, accompany the trout in the mountain meadows, not, however, ascending so near to the sources of the streams, but, on the other hand, much farther down their courses. They are eaten by the trout. The blob or miller's thumb is very abundant in the clear and cold waters of the Colorado basin, and is very destructive to the eggs of trout. The suckers extend up the rivers more or less to the point where the trout disappear, and, for the most part, the species are different in the different basins. The species of *Catostomus* and *Xyrauchen* reach a considerable size, but are of poor quality for food. The suckers and the chubs, especially the latter, are very destructive to the trout eggs. The *Ptychocheilus lucius* of the Colorado attains a great size, and in default of better fish assumes economic importance. The bulk of the rich fauna of the Mississippi, as well as most of the Texan fishes, are excluded from Colorado on account of the intervening turbid waters through which they can not ascend.

Three species of the *Salmonidæ* have been introduced into some of the streams and lakes of Colorado, the Eastern brook trout most extensively, the rainbow trout of California, and the landlocked salmon of Maine. Carp ponds have also been established in the State, and Dr. Jordan strongly recommends the introduction of the larger catfishes into the tributaries of the lower Colorado, the entire basin of that river having, besides the trout, only fishes of very inferior quality for food.

Tributary to the Arkansas River are the Evergreen Lakes, a series of trout ponds, wholly or partly artificial, fed by cold streams from the flanks of Mount Massive. One of these streams, having its rise in the largest permanent snow field in Colorado, has been chosen as the site of the new U. S. Fish Commission hatchery. Dr. Jordan states that no better location for that purpose could be desired.

In Utah no permanent streams of any importance, except the Colorado River, occur to the east of the Wahsatch Mountains. West of the divide of those mountains lies the Great Basin, in which the Salt Lake Basin and the Sevier River were examined. In the former 14 species of fish, including the trout, *Salmo mykiss*, were taken, and in the latter 7 species. The trout of Utah Lake are of excellent quality and reach a weight of 3 to 10 pounds. The same trout also occurs in Panquitch

Lake and the upper part of the Sevier River. In all streams like the latter occurring in this basin Dr. Jordan considered that catfishes might be planted to good advantage.

In connection with his description of the many mountain trout observed, Dr. Jordan defines carefully the several varieties or subspecies which he now recognizes, numbering 10 in all. One of these, a new and large variety from the Twin Lakes, has been named *Salmo mykiss macdonaldi*, in honor of the U. S. Fish Commissioner. Five of the varieties mentioned were collected in Colorado and Utah, and nine have been figured in his report.

MISSOURI AND ARKANSAS.

The investigations in these two States, which had been planned for 1888, were taken up in the summer of 1889 by Prof. S. E. Meek, of Coe College, Iowa, assisted by Mr. Louis Rettger and Mr. Frank M. Drew, of the Indiana University. The operations of this party were chiefly limited to the Ozark region of southern Missouri and northern and western Arkansas, in the midst of which, at Neosho, Mo., a hatching station was in course of building by the U. S. Fish Commission. The surface of the country in this region is much broken, although none of the hills reach a very great height. Springs abound and the streams are clear and cold even during midsummer. The bottoms of the latter are rocky, gravelly, or sandy, with little mud, and aquatic vegetation is not abundant. Fishes were plentiful in nearly all of the rivers in Missouri that were visited, but they were scarce in the Mazarn, and especially so in the Caddo and the forks of the Saline. It was reported that large numbers of fishes had been killed in the latter streams by the use of dynamite, and also in the neighborhood of Newburg, Neosho, and Cabool, Mo. Were this pernicious practice of destroying the native fishes to be continued, fish-cultural operations could not have much effect in replenishing the supply, but it is hoped that measures may be taken to prevent it in the future. In the Missouri River basin the Meramec, Gasconade, and Osage rivers were examined; in the Arkansas basin, Neosho River and Spadra Creek; in the White basin, White River, the tributaries about Mammoth Spring, and Little Red River; and in the Washita basin, Washita, Caddo, and Saline rivers and Mazarn Creek.

Mammoth Spring, Arkansas, is one of the largest springs in the United States, flowing about 50,000 cubic feet of water per minute; the temperature of the water ranges from 59° to 62° F., throughout the year. A fish farm has recently been established at this place, and in 1889 they began the rearing of trout which are said to grow rapidly, the conditions being exceedingly favorable for that purpose. The U. S. Fish Commission hatchery at Neosho is situated on a branch of the Neosho River and is fed from a fine spring. The station, however, had not been completed, and was, therefore, not in operation at the time of Prof. Meek's visit.*

IOWA.

Prof. S. E. Meek, of Coe College, Iowa, began in the summer of 1889 a careful study of the fishes of Iowa, which was continued, with some intermissions, until into June, 1891. During this period he examined all the rivers in the State tributary to both the Mississippi and the Missouri, and also many of the smaller streams which empty into the former, as well as the principal lakes. Large collections of fishes were made, and upon them and his field observations Prof. Meek has based a very important report,† in which the fishes are classified in accordance with each river basin.

Iowa is situated between the Mississippi and the Missouri rivers. Its surface is comparatively level, rising gradually toward the north and west. Many streams traverse it, the greater number and the larger ones flowing southeasterly into the Mississippi, the remainder southwesterly into the Missouri, the affluents of the former draining more than two-thirds of the entire area of the State. The vast agricultural industry for which the State is so conspicuous has apparently had much to do with changing the character of many of these streams, causing their deterioration and at the same time a decrease in the abundance of the better food-fishes. This is said to have been caused in large part by the breaking up of the original stiff sod of the prairies, which tended to prevent the rapid flowing of the waters after heavy rains toward the river channels, but ditching and underdraining have also been instrumental in this respect. Rivers which formerly had well defined, deep, and narrow channels have widened out and become more shallow, overflowing their banks in the rainy season and losing most of their water during the succeeding months. The soil, loosened constantly for farming purposes, is also readily transported by the rain to fill the streams with sediment, which has caused the rapid disappearance of the trout.

The streams of southwestern Iowa have mostly muddy bottoms, and comparatively few fishes, but elsewhere the currents are generally stronger, the bottom consists chiefly of sand, gravel, and rocks, and fishes are relatively abundant both as to species and individuals. There are very many dams throughout the State, few, if any, of which are provided with fishways, thus greatly interfering with the spawning instincts of many species. There are a number of large and fine springs

*Report of explorations made in Missouri and Arkansas during 1889, with an account of the fishes observed in each of the river basins examined. By Seth Eugene Meek. Bull. U. S. Fish Comm., IX, for 1889, pp. 113–141, plate XLII.

†A report upon the fishes of Iowa, based upon observations and collections made during the years 1889, 1890, and 1891. By Seth Eugene Meek. Bull. U. S. Fish Comm., X, 1890, pp, 217–248.

in some places, which feed small but clear and cool brooks, in which trout have been abundant and in some of which they still exist. Numerous bayous are found along some of the larger rivers, to which the young bass, pickerel, and sunfishes resort, but owing to the greater or less drying up of such places during the summer a great mortality occurs among these species. The practice of seining out these young fishes and planting them in the open streams, which has proved so efficacious in Illinois and other States, was at one time resorted to in Iowa, but it has since been abandoned. If it were again renewed upon a proper scale, it would add greatly to the fishery wealth of the State.

The total number of rivers, smaller streams, and lakes examined by Prof. Meek was 41, and as many of these were visited at several places, and at several different times, it is safe to conclude that the principal ichthyological features of the State have been brought out in his report. The greatest number of species of fishes recorded from a single stream was 85 from Cedar River: the smallest, 4 from Boyer River.

WISCONSIN.

During 1890 Prof. S. A. Forbes presented to the Fish Commission an interesting report* upon investigations made in lakes Geneva and Mendota, partly at the instance of Prof. Baird. The work was performed between 1881 and 1887, but the completion of the report had been deferred in the hope of obtaining more material that might throw additional light upon the principal subject of direct practical importance to which the paper relates—the fish mortality in Lake Mendota in 1884. Although no opportunity has yet occurred to add to Prof. Forbes's original inquiries in regard to this matter, it has been deemed advisable not to delay further the publication of his observations.

Lake Geneva, situated in the extreme southeastern part of the State, lies in a trough-like valley of the drift, the southern side of which formed part of the terminal moraine of the great Lake Michigan glacier. It is 7 miles long by 1½ miles in greatest width, and has an extreme depth of about 132 feet. It drains by a small outlet into Fox River, and thence into the Illinois. In his examination of the lake conducted in 1881 and 1887, Prof. Forbes made a very comprehensive study of all its characteristics, running lines of soundings to determine the contour of the bottom, and collecting its animals and plants by dredging and by the use of surface and other nets. While the investigation is not considered as complete, it is one of the most comprehensive and instructive examinations of such a body of water that has yet been made in this country, and may well serve as a model for future studies of the same character. Its usefulness consists in demonstrating very

* Preliminary report upon the invertebrate animals inhabiting lakes Geneva and Mendota, Wisconsin, with an account of the fish epidemic in Lake Mendota in 1884. By S. A. Forbes. Bull. U. S. Fish Comm., VIII, for 1888, pp. 473–487. Three maps and diagrams.

fully the natural conditions of the lake in all its main features, a knowledge of which shows its capacity for fish life, its suitability for the introduction of new species, and the measures necessary for the protection of its fisheries. Most attention in the line of biology was paid to the smaller forms of life, such as the larval and adult insects, crustaceans, mollusks, and worms, which serve as food for fishes, both adults and young.

In his conclusions, Prof. Forbes remarks:

> It is evident that even in a lake of so moderate size as this the smaller inhabitants are quite clearly divided into pelagic and littoral groups, the latter containing the greater number of species, but the former not less numerous in individuals; and a comparison of the results of dredging shows that this difference applies to the animals of the bottom as well as to those swimming freely above it. * * * It is also apparent, from the product of the towing net in deep water under varying conditions, that the pelagic entomostraca avoid the surface by day, whether it be rough or calm, or the weather cloudy or clear; but they do not necessarily withdraw to any great depth, hauls 10 feet below yielding "good" or "large" collections when the sun was shining. By night, on the other hand, the yield at the surface was large, even in a high wind.

The examination of Lake Mendota was made for the purpose of studying a most remarkable mortality among the common perch (*Perca flavescens*) in August, 1884, and was repeated in August of the following year. A study of the lake similar to that of Lake Geneva was also instituted, but upon a less comprehensive scale. The fish mortality began early in July of the former year and continued until about the middle of August, the quantity of fish dying during that period being estimated at above 300 tons. About 90 per cent of the fish which perished were the common perch, after which in numbers came the lake herring, followed by a few other species. Prof. Forbes's studies of the subject were thorough and covered all the questions that could be suggested, including an examination of all the conditions of the lake, both physical and biological, and of the morphological and histological conditions of both the dead and living fishes. It was impossible, however, to arrive at satisfactory deductions respecting the cause of the mortality, Prof. Forbes not having been apprised of its occurrence until it was practically over, and no subsequent opportunity having arisen to study similar phenomena. However, all the facts have been carefully recorded and discussed, and are available for future consideration. The more significant facts connected with the mortality are stated in considerable detail, but they are too long to make more than a brief reference to them in this connection.

A diseased condition of some parts of the viscera was noticed, especially in the herring, but externally the dying fishes seemed to be in good condition. The herring are subject to some mortality of the same character every year, but to a much less extent than in 1884. It is probable that the causes affecting the two species were the same, and it is also possible that the disease is contagious and was taken directly from the herring. The majority of the dead perch were full grown, no young individuals having been observed. Moreover, the dead and diseased fishes had been feeding almost exclusively on a red insect larva peculiar to the mud of the deep water, while all the healthy fishes observed had been feeding on shallow-water forms.

The mortality, thus, seems to have been limited to the perch that were ranging in the deeper parts of the lake in company with the diseased herring, and observations indicate that such a deep range for the perch is unusual in midsummer. There also seems to be a deficiency in Lake Mendota of the kinds of animals usually selected by the perch as food, according to observations made elsewhere. A heavy flooding rain which occurred not long before the outbreak of the disease may have washed into the lake unusual quantities of organic matter from the swamp beyond Catfish Bay and from the surrounding country. Quite similar cases of destruction of the native fishes are of rather common occurrence in the rivers of Illinois in the hottest weather of the year. They usually, if not always, follow upon flooding rains, and thus occur when the streams are full or overflowing with turbid water loaded with the products of decay.

During the summer of 1890, Prof. C. Dwight Marsh, of Ripon College, began a physical and biological examination of Green Lake, situated in Green Lake County, Wis., for which the Fish Commission supplied one of its deep-sea thermometers for taking bottom temperatures. His investigations will be continued during the summer of 1891, when he expects to publish an account of his results.

INDIANA.

The investigations begun in Indiana by Prof. B. W. Evermann in 1888 were continued by him during the summer of 1890 in the northern and western parts of the State. Considerable work was done at intervals in the vicinity of Terre Haute, both in the Wabash River and in the numerous ponds which occur along its course in this region. During the regular spring rise in the river these ponds fill with water and numerous fishes enter at the same time, but in the summer and early autumn many of the ponds become dry, and great numbers of fishes perish there in consequence. Among the species which are thus destroyed are the black bass and crappie, and other valuable food-fishes. Several hundred specimens in good condition were transplanted to Lake Maxinkuckee by Prof. Evermann. Observations and collections were also made at Bonebank and Mackey Ferry on the lower Wabash River and at several places in the St. Joseph River basin, as follows: Pigeon River, Twin Lakes and Cedar Lakes near Ontario and Lima; Oliver Lake at Valentine, and Elkhart River at Goshen. Material was likewise obtained at Plymouth from the Yellow River, a tributary of the Kankakee, from Lake Maxinkuckee, and from the Tippecanoe River, a few miles south of the lake. Prof. Evermann was assisted in his work by a number of his students at the State Normal School, Terre

Haute, among whom may be mentioned Mr. D. C. Ridgley, Mr. C. S. Hoover, and Mr. C. H. Copeland. A report upon these inquiries is now in course of preparation.

OHIO.

Dr. James A. Henshall, secretary of the Cincinnati Society of Natural History, continued, during the summers of 1889 and 1890, his researches respecting the fishes of Ohio, referred to in the last annual report A complete account of these inquiries is deferred until further observations can be made, but the following brief notice of the work accomplished during the past two years has been furnished by Dr. Henshall:

The watershed of the State of Ohio extends from Ashtabula County, in the northeast corner of the State, to Mercer County, on its western border. The streams north of this ridge flow into Lake Erie, while those south of it empty into the Ohio River. The waters explored in the latter basin were the Ohio, Muskingum, Scioto, and Little Miami rivers and a number of smaller streams. Of the Great Lake Basin, the Maumee and Sandusky rivers and Lake Erie in the vicinity of Put-in Bay were examined. From these various sources 130 species of fishes were obtained out of about 150 known species supposed to inhabit Ohio waters. The only previous efforts in this direction were made by Rafinesque in 1818 to 1820, and by Dr. J. P. Kirtland from 1836 to 1846. The former explored the Ohio River and its tributaries from Pittsburg to Louisville, and described 120 species, of which the existence of about 70 valid species have since been verified. Dr. Kirtland described, from the waters of both basins, even a less number.

The most important food-fishes collected in the Ohio and its tributaries were the black bass, pike perch, sunfish, crappie, fresh-water drum, and several species of suckers and catfish. Those from the Lake Erie basin were the whitefish, lake herring, black bass, pike perch, sauger, and sturgeon, the first-named being the most important commercial food-fish of the State. From this it will be seen that were the fishes of Ohio afforded proper protection during their breeding season, and the pollution of the streams by the refuse and offal of various mills and factories prevented by wise and efficient legislation, a bountiful supply of good food-fishes would be assured to the people of the State that would go far toward supplying the demand for fish food.

KENTUCKY.

During the autumn of 1889 and the spring of 1890, Prof. Philip H. Kirsch, superintendent of public schools at Columbia City, Ind., made an investigation of the streams of Clinton County, Ky., and obtained a very complete collection of their fishes. In his report upon the subject,* Prof. Kirsch explains that this is one of the smallest counties in

* Notes on the streams and fishes of Clinton County, Ky., with a description of a new darter. By Philip H. Kirsch. Bull. U. S. Fish Comm., x, 1890, pp. 289–292.

the State, having an area of only about 206 square miles. It lies between the Cumberland River and the Tennessee State line, its surface being hilly and broken by the deeply-cut valleys of the water courses. The central Poplar Mountain range and other elevations form a watershed, dividing the county into two districts of nearly equal extent; the northern of these drains directly into the Cumberland River, while the other drains into the same river in Tennessee, through Obeys River. The total number of species obtained from all the streams was 33.

In the summer of 1890, Mr. Albert J. Woolman, assisted by Mr. H. W. Monical and Mr. C. O. Chambers, all students in Indiana University, made a very extensive and thorough investigation with regard to the fishery resources of Kentucky, their fieldwork beginning in July and continuing until near the middle of September. All of the principal river systems were visited, and very careful observations were made upon their physical characteristics, as well as upon the variety, abundance, and distribution of their fishes. The observations embraced not only the main stream in each basin but also a greater or less number of its tributaries. In his report* Mr. Woolman gives a detailed description of all of these features, and also has taken pains to incorporate the results of several previous collecting trips to this State by assistants of Indiana University. The collection of fishes obtained was especially large and interesting, and was noteworthy as containing nearly all the known species of darters.

Work was begun near the center of the State, in the Rolling Fork of Salt River, and was carried thence westward to the Green River, Tradewater River, the lower Cumberland and Tennessee rivers, Mayfield Creek, Obion River and the Bayou de Chien, in the extreme southwestern part of the State. Subsequently the party proceeded to the upper Cumberland and Tennessee rivers in eastern Kentucky, the upper Kentucky, Big and Little Sandy and Licking rivers. More work was done in the mountainous regions than elsewhere, leaving some of the lower streams to be investigated at a future time. The greatest number of species of fishes taken in any one basin was 64, in the Upper Green River and its tributaries.

FLORIDA.

During December, 1890, and January, 1891, Mr. A. J. Woolman, accompanied by Prof. Louis Rettger, made an examination of the fresh-water streams occupying the western slope of Florida between Charlotte Harbor and the Suwanee River. Beginning operations in the vicinity of Punta Gorda and proceeding northward, the following rivers, together with their tributaries, were visited in succession, namely: Alligator, Peace, Hillsboro, Withlacoochee, and Santa Fe, the last mentioned

* Report of an examination of the rivers of Kentucky, with lists of the fishes obtained. By Albert J. Woolman. Bull. U. S. Fish Comm., x, 1890, pp. 249–288, pl. LI.

being one of the largest affluents of the Suwanee. As comparatively little information has hitherto been obtained regarding the ichthyological features of this region, Mr. Woolman's efforts were well rewarded, notwithstanding that the rainy season had commenced before the party reached the field. The relatively small number of species which inhabit these waters is especially noteworthy, only 12 species having been taken in the Alligator River, 20 in the Peace River, 14 in the Hillsboro River, 16 in the Withlacoochee River, and 17 in the Santa Fe River. Mr. Woolman's report* gives descriptions of the principal characteristics of the rivers, with annotated lists of their fishes.

NEW YORK.

In July, 1889, an examination was made of Lake Ronkonkoma and Great Pond, Long Island, by Mr. Fred. Mather and Dr. Bashford Dean, a part of the collecting outfit and the thermometers having been supplied by the U. S. Fish Commission. An account of this inquiry has been published in the Eighteenth Report of the Commissioners of Fisheries of New York, 1890, pp. 205–217.

Lake Ronkonkoma is situated in the center of Long Island on the top of an extended gravelly ridge of land. It is one of the largest bodies of fresh water on the island, having an area of a trifle over a square mile, and occupies a depression in the drift formation. Many myths are associated with the place, and the lake has been supposed by residents of the vicinity to have a very great depth. The soundings made during the summer developed, however, a nearly uniform depth of only 15 feet, a maximum of 65 feet having been discovered in one place. There are no inlet or outlet streams, the source of its water being underlying springs. The temperature was found to be high, ranging from 75° F. in the deep hole to 77° F. in depths of 3 to 4 feet, and 80° F. at the surface. It was concluded from the observations made that "the balance of fish life in this lake is nearly if not quite complete." Black bass of both species, which were planted some years ago, are now plentiful and have attained a large size. Notes are given on all the species of fishes found, and the commoner forms of invertebrates and plants are enumerated.

Great Pond is at Riverhead, near the eastern part of the island, and although also situated in the drift, differs considerably in character from Lake Ronkonkoma. It drains the surrounding hills and has an outlet flowing into Great Peconic Bay. Its average depth is something over 24 feet, the temperature at the bottom ranging from 65° to 75° F. The pickerel (*Esox reticulatus*) and common sunfish (*Lepomis gibbosus*), absent from Lake Ronkonkoma, are abundant here, but the black bass has never been introduced.

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*Report upon the rivers of central Florida tributary to the Gulf of Mexico, with lists of fishes inhabiting them. By Albert J. Woolman. Bull. U. S. Fish Commission, x, 1890, pp. 293–302, pls. LII, LIII.

WOODS HOLL LABORATORY.

Nearly all of the important food-fishes occurring in the Vineyard Sound region spawn during the spring or winter months, and as the Woods Holl Station has not generally been occupied for scientific purposes until about July 1 of each year, the study of their breeding habits and of the development of the young has, for the most part, been neglected. The pressing demands of fish-culture have been met from time to time by the temporary employment of specialists in the proper seasons for such investigations, but nothing in the way of a thorough and continuous series of observations relative to these subjects has hitherto been attempted. Among the forms respecting which information is most urgently desired at present are the cod, sea bass, scup, tautog, mackerel, menhaden, lobster, and oyster, but there is not a food species common to this coast an account of whose life history and spawning habits would not contribute something to the welfare of the fisheries by suggesting either methods of propagation or suitable measures of protection.

In order that scientific studies bearing upon these subjects might be continued at all seasons, Dr. H. V. Wilson, a graduate of Johns Hopkins University, was appointed in May, 1888, resident naturalist at the Woods Holl Station, in charge of the biological laboratory. Within the past two years Dr. Wilson has completed a very important monograph on the embryology of the sea bass, and has also collected much material illustrating the development of the egg and larval stages of the cod, scup, tautog, and other species of fishes as well as of some crustaceans. He has also made some progress in the study of the development of sponges, preliminary to a proposed visit to the coast of Florida, where it is intended to investigate the life history of the commercial forms. A complete series of the eggs and embryos of the Atlantic salmon, obtained at the Maine station of the Fish Commission, has likewise been prepared by Dr. Wilson for future examination. The surface nets have been in constant use in the vicinity of Woods Holl, under his direction, and Mr. H. G. White, a draftsman, has been employed during a portion of each year to make drawings of the larval fishes secured by this means. A more complete account of the results of Dr. Wilson's inquiries is given under the heading of "Special Investigations."

Mr. V. N. Edwards has continued his field observations respecting the different fishes which inhabit the Vineyard Sound region, keeping a careful record of the time of approach and disappearance of the migratory species, of the breeding and feeding habits of all forms, and of the growth of the young from day to day. He has also experimented successfully with the hatching of several common fishes, and has demonstrated practically the best methods by which their artificial propagation may be accomplished.

The steamer *Fish Hawk* was at Woods Holl during a part of the summer of 1889, and made several collecting trips for the purpose of securing material desired for examination. This station was also the headquarters of the schooner *Grampus* during both summers, while engaged upon the physical inquiries respecting the mackerel-grounds off the adjacent coast, as described elsewhere, and Prof. Libbey and the members of his party were given the necessary accommodations in the laboratory for working upon the materials and observations obtained on each cruise.

Many important additions have been made to the laboratory equipment, and the facilities for research are now much better than they have been at any previous time. The aquaria have also been maintained upon a proper basis, and while supplying the requirements of the investigators for the preservation of living specimens, they are equally appreciated by the public, which is given free access to the building at all hours. The greatest desideratum at the station is the lack of a good collection of scientific books, but this has been met in part by the courteous action of the Marine Biological Laboratory in placing its fine working library at the service of the Fish Commission. Books are also obtained when needed from the Boston Society of Natural History, and from Washington, and the principal technical journals treating of biological subjects have been subscribed to.

During the summer months of each year the laboratory has been occupied by a relatively large number of scientific men, some of whom have been employed by the Fish Commission in making special investigations, while others were given such facilities as they required for conducting whatever researches they desired to make. The Commissioner was also present during a part of both seasons. Seventeen investigators were in attendance during 1889, and 14 during 1890. Below is given a brief summary of the work performed by each, the principal topics pertaining to the operations of the Fish Commission being again referred to under special headings.

SUMMER OF 1889.

During this season Prof. W. K. Brooks, of Johns Hopkins University, was occupied chiefly with a study of the life history of the common starfish, the most dreaded enemy of the oyster beds on the New England coast, whose breeding habits it is very desirable should be carefully determined. He also paid some attention to the natural history of physalia and salpa, surface organisms which are sometimes very abundant in the vicinity of Woods Holl.

Prof. F. H. Herrick, of Adelbert College, best known for his joint memoir with Prof. Brooks on the Embryology and Metamorphosis of the Macrura, soon to be published by the National Academy of Sciences, began for the Fish Commission an exhaustive inquiry into the development and spawning habits of the lobster, one of the most interesting marine forms now being propagated artificially at the Woods Holl Station. He also collected material bearing upon the embryology of other crustaceans inhabiting this region.

Prof. Edwin Linton, of Washington and Jefferson College, who has been engaged for several years in a study of the entozoan and other worm parasites of fishes, was employed to continue his field researches and to make additional observations in respect to this subject. Fish diseases, so far as they have been investigated, appear to be almost entirely the result of parasitism in one form or another, and it is, therefore, very important that the relations of these low organisms to their respective hosts should be made out with as much care as possible.

Dr. C. F. Hodge, of Clark University, was at Woods Holl during the first part of the summer, and afterwards joined the steamer *Fish Hawk* as naturalist in connection with the oyster investigation. While at the station he was occupied in making observations upon the feeding habits of larval lobsters, and in attempting to rear them through their free-swimming stages, during which period they are subject to great mortality.

Mr. James I. Peck, of Johns Hopkins University, was engaged to investigate the habits and distribution of the young of the scup and sea bass, two of the principal food-fishes of the Vineyard Sound region. His observations were made both in the field and with the aid of the aquaria.

Johns Hopkins University was represented at the station by four independent workers, Dr. E. A. Andrews, Mr. T. H. Morgan, Mr. S. Watase, and Mr. R. P. Bigelow. Dr. Andrews investigated the anatomy and development of certain annelid worms, and Mr. Bigelow the comparative histology of the discophore medusæ, and the habits and the physiology of physalia. The researches of Mr. Morgan were mainly in the direction of the phylogenetic life history of jelly-fishes, of which he examined specimens of *Cyanea artica*, *Aurelia flavidula*, and *Pelagia*, but also paid some attention to the development of pycnogonids, of which three species are found in this region. Mr. S. Watase continued his studies, begun in 1888, on the structure and relationship of the eyes of crustaceans and echinoderms. Preliminary reports on this subject had previously been published by him.

Mr. W. McM. Woodworth, Mr. C. B. Davenport, and Mr. E. R. Boyer were present as representatives of Harvard University. Mr. Woodworth was chiefly interested in tracing the development of a small parasitic planarian which infests the gill lamellæ of the king crab; Mr. Davenport, in studying the structure and development of marine and fresh-water polyzoa, and of *Bopyrus palæmonites*, the latter being an isopod parasite living on the common prawn (*Palæmonites vulgaris*);

and Mr. Boyer in investigating the embryology of a common minnow (*Fundulus heteroclitus*).

Mr. B. H. Waters and Mr. C. W. Stevens, of Princeton College, gave their attention to inquiries of a general character, while Prof. A. A. Wright and Mr. M. J. Greenman, who were in attendance for only a short time, were occupied in securing miscellaneous collections of marine animals for Oberlin College and the University of Pennsylvania, respectively.

SUMMER OF 1890.

During the summer of 1890 Prof. F. H. Herrick continued his investigations, begun the previous year, respecting the life history of the lobster. Prof. H. C. Bumpus, of Brown University, was also present during the spring months and gave attention to the same species, his studies having special reference to the length of time the eggs are carried by the parent lobster before hatching. Mr. R. G. Harrison and Mr. J. L. Kellogg, of Johns Hopkins University, worked conjointly on several problems relative to the habits and fixation of oyster spat, and the latter also took up the study of the anatomy and life history of several bivalve mollusks, including the more common edible species, such as the quahog, soft clam, scallop, and mussel. Mr. George H. Field, also of Johns Hopkins University, continued the inquiries commenced by Prof. Brooks in 1889 on the development of starfishes, and extended his observations to other species of echinoderms. Mr. E. G. Conklin, of the same institution, studied the embryology of *Urosalpinx* and *Crepidula*, two gastropod mollusks, of which the former is the so-called oyster drill, second only to the starfish as to the amount of damage which it inflicts upon the oyster-beds of southern New England.

Dr. E. A. Andrews investigated the structure and development of the eyes of annelid worms, and the growth of a small nemertean (*Meckelia*). Dr. R. P. Bigelow, who was attached to the schooner *Grampus*, in addition to the physical observations assigned him, made large collections of surface animals in the region of the Gulf Steam, which occupied his attention while the vessel was in port. Prof. William Patten, of the University of North Dakota, was interested in the study of the sense organs of crustaceans and of the horseshoe crab, and Mr. W. McM. Woodworth continued his observations upon the parasitic planarian which lives on the gills of the latter species. The development of teleostean fishes was studied by Dr. Thomas G. Lee, of Yale University, and general inquiries were carried on by Mr. W. C. Prime, of Princeton College.

SPECIAL OBSERVATIONS AND EXPERIMENTS.

The Cod (*Gadus morrhua*).

In the last annual report an account was given of the efforts that had been made to increase the supply of cod on the southern New England coast and of the success with which this experiment had been attended. The evidence since obtained in regard to this matter is even more gratifying, and the expediency of continuing the propagation of this species upon as large a scale as possible can no longer be denied. In fact, the observations which are being made from year to year upon the habits of marine fishes tend to prove that they are nearly all much more susceptible to human influences than has generally been supposed, and we feel justified in predicting for this branch of fish-culture a more brilliant future than has usually been accorded to it.

The number of cod fry planted in the Vineyard Sound region prior to July 1, 1889, was about 38,000,000, to which may now be added 5,800,000 for the season of 1889–90, and 36,200,000 for the season of 1890–91, making a total of over 80,000,000 down to the close of the last fiscal year. For the details of the hatching work reference should be made to the fish-cultural report of the Woods Holl Station, but it is interesting to note in this connection that the 36,200,000 embryos deposited in 1890–91 were obtained from the eggs of 587 fish, caught chiefly on Nantucket Shoals, although a few were taken off Marthas Vineyard and No Mans Land. The season during which ripe eggs were secured lasted from November 17, 1890, to February 7, 1891, each fish yielding from 11,000 to 238,000 eggs at a stripping, but some of the fish were handled more than once. The period of incubation ranged from 216 to 762 hours, according to the temperature of the water, which varied from 32° to 49° F.

The observations of Mr. V. N. Edwards during the past two years have shown not only that the young cod have continued to be abundant at the proper seasons, but also that the larger fish enter the inner waters in considerable numbers. In the autumn of 1889 cod of two sizes were plentiful; the smaller, measuring 12 to 13½ inches long, were considered to be yearlings, while the others, from 18 to 22 inches long, were supposed to be 2-year-olds. Fish 1½ years old, captured in the spring, measured 15 inches. The 2-year-old cod were abundant all along the Massachusetts coast south of Cape Cod, and off Block Island, during the fall of 1889, and over 1,000 individuals of this age were secured by the schooner *Grace* during one day's fishing. They were also taken by the tautog fishermen in Vineyard Sound and Buzzards Bay, and 16 were captured in a fyke net which had been set in the Great Harbor of Woods Holl for twenty years, the first time that any of this size have been known to occur in these waters.

During April, 1890, young cod measuring from 1¼ to 2 inches long, were very plentiful all along the shores, and were taken by Mr. Edwards in his small collecting seine. The latter part of the month they had entered Woods Holl harbor and had become common around the wharves. In May large fish, weighing from 5 to 15 pounds apiece, made their appearance in these waters in very large numbers, and were abundant in Buzzards Bay from Cuttyhunk to Quisset, and in Vineyard Sound from Robinson Holl to Falmouth Heights. The fishermen caught them in their fish traps, and they also entered the lobster pots, something previously unheard of. A small funnel-shaped bass trap set on the shore off Nonamessett Island caught 23 of these large cod on May 3, 15 on the 5th, and 8 on the 6th of the same month. They were the first cod ever taken in that locality. From the latter part of October until the end of November, 1890, fish of good size were abundant throughout Vineyard Sound and Buzzards Bay and in the neighboring regions. October 31, Mr. Edwards reported that since the 20th of the month all the tautog fishermen in the sound and bay had been catching codfish every day, measuring from 15 to 20 inches long. On November 18, he stated that individuals weighing from 5 to 10 pounds each were very plentiful in Vineyard Sound, and also occurred in Buzzards Bay. They were also said to be abundant at the same time on Nantucket Shoals and off Cape Cod. During the latter part of the month the boats were obtaining from 75 to 90 good-sized cod at each tide off the mouth of Edgartown Harbor, and sometimes as many as 100 off Nantucket Bar. There is no record of this species having been captured previously in either of these localities. On April 30, 1891, Mr. Edwards reported that codfish were more abundant in the Vineyard Sound region than they had been for thirty-five or forty years, and some of them were of large size.

On November 24, 1890, Mr. Willard Nye, of New Bedford, Mass., reported that during the same fall codfish had been more numerous than for many years in the shoal waters at the mouth of Buzzards Bay and to the westward. They have been caught, he states, in the traps from Salter Point off Narragansett River, Buzzards Bay, as far to the west as Seaconnet Point, and at many places inside of Buzzards Bay, which is something new even to the oldest inhabitant. The fish taken in shoal water are of two sizes, one averaging about 4, the other about 6 pounds, each. They are both school cod and do not have the red color of the so-called rock-cod, stragglers of which are caught every year in shallow water. Cod fishing in Buzzards Bay has been a rarity for a great many years.

On December 3, 1890, Mr. George A. Griffin, wrote from Wakefield, R. I., to the effect that codfish had been very plentiful during the fall off Narragansett Pier and Point Judith. They had formerly been abundant there, but have been very scarce during the past 20 years.

Granting that the increase of codfish, indicated by the above and previous announcements, has resulted from the hatching work of the U. S. Fish Commission, and that fact seems now to have been settled beyond any question, it is interesting to note the extent of sea coast which can be covered from a single station without the need of making a wide distribution of the fry, as nearly all of the plantings have been made in the immediate vicinity of Woods Holl. As to the increase recorded on Nantucket Shoals and off the outer coast of Cape Cod, it is impossible to say at present whether this was brought about by the operations at Woods Holl or at Gloucester, but it is probable that the plantings made from the former station were instrumental in this respect, to some extent at least. As the Fish Commission has not had the means of obtaining careful observations regarding the presence and abundance of young fish north of Cape Cod, there is less positive information at hand to show the outcome of the hatching work at Gloucester, but there is every reason to believe that it has been entirely successful. One instance of the survival and growth of the young planted from that station has been reported as follows: Writing from Kingston, Mass., July 26, 1889, Mr. H. M. Jones stated that he had had forty years' experience in fishing in the waters adjoining Plymouth Harbor, but certain schools of fish, which he describes as having white bellies and dark spots on the back, had appeared during the summer, and were entirely new to him. They averaged 4 pounds in weight, and had been plentiful all summer. Although he considered them to be cod, they differed from those ordinarily found in that vicinity. A specimen forwarded to Washington was found to represent the variety of cod propagated at the Gloucester Station, and there seemed to be no doubt that these schools had originated in the plantings made from that place.

During the winter of 1890–91, Dr. H. V. Wilson began the study of the embryology of the cod, in connection with the hatching operations at the Woods Holl Station, and before the end of the year he had made considerable progress in this work.

The Sea Bass (*Serranus atrarius*).

The experiments with respect to the spawning of the sea bass made at Woods Holl in 1888 and 1889 were continued by Mr. Edwards during 1890. From 4,270,000 eggs obtained during May and June of the latter year, 3,890,000 embryos were secured, an exceedingly large percentage, showing that the propagation of this species could be carried on without difficulty. Ripe fish were first taken on the spawning-grounds off Hyannis on May 10, and eggs were obtained as late as June 23, in the vicinity of Woods Holl. Ripe milters, according to Mr. Edwards, are found two weeks in advance of ripe females, and he reports the same also with respect to the scup, mackerel, and squeteague. If sea bass are held in the traps over thirty-six hours their eggs are always found to be dead when the fish are examined.

That the planting of embryo sea bass, as well as scup, in the shallow waters south of Cape Cod would undoubtedly be attended with good results, is well illustrated by an experiment made by Mr. Edwards in 1890. In June of that year he liberated about 50,000 fry of each of these species in the so-called Eel Pond at Woods Holl, a shallow tidal basin having an area of only a few acres. On November 7, while seining in the pond, he caught thousands of both species, the smallest measuring 2 inches long and the largest 4½ inches. During most of the same month they were observed passing out in large schools through the narrow outlet from the pond, becoming very common in the harbor at Woods Holl, but occurring nowhere else. Sea bass young placed in Eel Pond during the spring of 1889 apparently remained there continuously until the fall of 1890, when they had attained a length of 10 to 11 inches.

The embryology of the sea bass has been worked out in a very complete and satisfactory manner by Dr. H. V. Wilson, assistant in charge of the Woods Holl laboratory. A preliminary notice of his researches was published in the Johns Hopkins University Circular, vol. IX, No. 80, 1890, and the final report in the Bulletin of the Fish Commission for 1889.* Very instructive and important results were obtained by Dr. Wilson, and his observations throw much additional light on the origin and structure of many organs, the developmental history of which has been only imperfectly understood. His explanation of the derivation and function of the lateral line is especially interesting.

The Spanish Mackerel (*Scomberomorus maculatus*).

On June 14, 1891, the steamer *Fish Hawk* was temporarily detached from the oyster survey in Tangier Sound and was detailed to carry on investigations respecting the hatching of Spanish mackerel in the vicinity of Cape Charles City, Virginia. Similar inquiries and experiments had been made in the lower Chesapeake Bay during several previous years ending with 1885, but the work had never been conducted on a large scale, and only a comparatively small number of fry had ever been obtained at any one time. The rapid diminution in the abundance of this valuable food species, reported from year to year, had again called attention to this subject, and rendered it of considerable importance that additional and more positive information should be obtained. Lieut. Robert Platt, U. S. Navy, was charged with the fish-cultural operations, and the services of Mr. J. Percy Moore, an assistant in the University of Pennsylvania, were secured to conduct the scientific observations, with the view of supplementing the studies previously made by Prof. John A. Ryder, and published in the Fish Commission Bulletin for 1881. The principal work mapped out was to de-

* The Embryology of the Sea Bass (*Serranus atrarius*). By Henry V. Wilson, Ph. D., assistant U. S. Fish Commission, Bull. U. S. Fish Commission, vol. IX, 1889, pp. 209–277, pls. 88–107.

termine suitable places for obtaining the spawning fish, the means necessary for securing them in good condition, and the apparatus best adapted to the hatching of the eggs. The scientific inquiries were to be directed chiefly towards ascertaining those facts respecting the natural history of the parent fish and of the embryos which could be turned to practical advantage in the artificial propagation of the species. The work continued until the end of July, 1891, and, therefore, only the progress made during the last half of June belongs appropriately to this report.

The vicinity of Cape Charles City was found to offer good facilities for the work, but breeding fish in suitable condition were very difficult to obtain. By the ordinary methods of capture in the pound nets, the fish are held in captivity over night, and those which do not spawn before morning (they are supposed to be mainly nocturnal spawners) are subjected to so much pressure and rough handling when the nets are emptied on the next day that, as a rule, they lose not only what ripe eggs they contain, but also many immature ones. An attempt was made to secure them by means of gill nets, but only a few were so taken, and the nets were almost invariably torn by sharks and gars. It is suggested that several pound nets might be run exclusively for the benefit of the hatching work, in which case they could be hauled at night, and in such a manner as to retain the spawning fish in good condition.

It was ascertained that the ovaries of this species mature slowly and not at the same rate in all parts. Consequently, ova in very different stages of development were found in the same fish. The largest number of ripe eggs taken from a single fish at one time was 60,000. The movements of the schools were much influenced by the physical conditions of the water and atmosphere, but precisely to what extent was not determined. The fry were planted soon after hatching, and it was found impossible to keep them alive in the small compass of an aquarium for more than a week at the most. As young fish, especially alewives, are very abundant at the surface at this season, it is considered that the embryo mackerel stand a poor chance of escaping such enemies while in their earliest and most helpless stages, and it is suggested that some means of confining them along the shore might prove advantageous in case the hatching work should be undertaken upon a large scale.

The tidal or cod jars were employed successfully for this species. The eggs were found to be buoyant in the bay water of ordinary density, but sank and afforded poor results if the water became too brackish. Up to July 1, 1,090,000 fertilized eggs had been taken from 30 female fish, producing 366,000 embryos, which were planted in the vicinity of Cape Charles City. The length of time required for hatching after the eggs had been impregnated was about twenty-four hours.

The Mackerel (*Scomber scombrus*).

Mr. Edwards continued at Woods Holl, in 1890, his experiments with regard to the hatching of this species which had been conducted during 1886, 1888, and 1889. From 768,000 eggs, 688,000 embryos were obtained. About 2,000,000 eggs taken from fish which had been dead a short time proved worthless. During November, 1890, small mackerel, measuring from 8 to 11 inches long, were unusually abundant in Woods Holl harbor, and about 5,000 were caught with hook and line from the Fish Commission wharf. Some adult specimens were also captured at the same place and others in a fyke net set by Mr. Edwards, the first time they had been so taken.

The Scup (*Stenotomus chrysops*).

About 396,000 fry were obtained from 443,000 eggs of this species at the Woods Holl station during June, 1890. The eggs are buoyant and hatch in from three to five days. Ninety-five per cent of all the scup taken at this period were milters. After remaining in the traps over twenty-four hours, the females are never found to contain any ripe spawn. An account of an experiment on the planting of young scup in Eel Pond during the summer of 1890 is given in connection with the sea bass.

The Squeteague (*Cynoscion regale.*)

The artificial propagation of this species was first attempted at Woods Holl by Mr. Edwards in June, 1890, when 237,000 eggs were hatched in 3 to 4 days with a loss of only about 10,000. The eggs are buoyant. Nineteen out of twenty of all the squeteague taken were milters, and ripe males occurred as late as June 30, but nearly all the females had spawned before that time.

The Tautog (*Tautoga onitis*).

From 808,000 eggs of the tautog, secured by Mr. Edwards at Woods Holl during June, 1890, 732,000 embryos were obtained. The eggs are buoyant and hatched in from 3 to 5 days. On June 29, 1890, about 50,000 fry were planted in Eel Pond, where young fish were abundant in the following November. They did not attempt to escape from the pond, but stowed themselves away in the eelgrass. This species is said to be growing less abundant every year on the southern coast of New England.

The Cunner (*Ctenolabrus adspersus*).

The eggs of the cunner are buoyant and very transparent; about 26 are contained in a linear inch. About 50,000 eggs of this species obtained May 22, 1890, were hatched at Woods Holl on the 5th day, with a loss of only 5,000. The tidal cod jar was used, the temperature of the water being 56° F.

The Atlantic Salmon (*Salmo salar*).

In the fall of 1890, after completing his monograph on the sea bass, Dr. H. V. Wilson paid a short visit to the Fish Commission station at East Orland, Maine, where he made carefui preparations of a series of embryos of the Atlantic salmon, illustrating different stages in their growth. This material will serve as the basis for the study of the development of the species.

The Flounders (*Paralichthys dentatus* and *Pseudopleuronectes americanus.*)

The two most important flounders which occur on the southern coast of New England are the common flounder, *Paralichthys dentatus*, and the flatfish or winter flounder, *Pseudopleuronectes americanus.* Both of these species, which have a very extended range, are now regarded as valuable food products, and both are sent to market from the Woods Holl region. Nothing is positively known regarding the breeding habits of the former, except that it does not spawn in the shallow water near the shore, but the ripe eggs of the latter may readily be obtained there in large quantities. Experiments regarding the hatching of this species were taken up by Mr. V. N. Edwards in the spring of 1888, and were continued by him during 1890 and 1891. The spawning season begins early in February and lasts until late in April. During the spring of 1890 Mr. Edwards obtained 5,800,000 eggs from 87 fish, the same yielding over 4,000,000 fry; in 1891 71 fish produced 4,680,000 eggs and 3,350,000 fry, the proportion of eggs hatched in each case being about 70 per cent. The length of the period of incubation varied from 400 to 600 hours, the temperature of the water ranging from 32° to 46° Fahrenheit. The fry were liberated in from 1 to 5 days after hatching. The eggs are adhesive and sink. Several different methods of handling them were tried, but the best success was obtained by spreading them thinly on panes of glass and placing them in a current of water in the hatching boxes. If allowed to accumulate together they adhere in masses, and under such conditions a very large percentage, if not the entire lot, soon dies. In some cases, Mr. Edwards found that the eggs had hardened up in the fish, and when pressure was applied they came out in one solid body. Under such circumstances the eggs do not ripen and the fish itself generally dies.

This species can be caught in large numbers in the harbor of Woods Holl and in the neighboring waters during the spawning season. During the more severe winter weather, however, they retreat to the deeper parts of Vineyard Sound and Buzzards Bay. The earliest spawners have been obtained in the upper parts of Waquoit Bay, in the town of Falmouth, where they are said to appear every season at the first thaw in February. Later in the spring they can be taken in the vicinity of Woods Holl. Dr. Wilson found it difficult to keep the young flounders alive for any length of time in the aquaria, but early in May, 1890, they were abundant at the surface and were captured in the tow net.

The Sand Dab (*Pleuronectes maculatus*).

On May 12, 1890, Mr. Edwards secured about 100,000 eggs of this species, which, in a temperature of 51° to 54° F., hatched on the fifth day, with a loss of only 10 per cent. The tidal cod jar was used for this purpose. The eggs are buoyant, and about 24 are contained in a linear inch.

The Four-Spotted Flounder (*Paralichthys oblongus*).

Of this species, 50,000 eggs were obtained on May 15, 1890. They are of the same size as the eggs of the sand dab, are also buoyant, and hatched in the same length of time, but with a loss of 50 per cent. The tidal cod jar was employed.

The Lobster (*Homarus americanus*).

In previous reports accounts have been given of the successful attempts made to hatch lobster eggs which had previously been removed from the swimmerets of the parent, but at the same time attention was called to the difficulty of rearing the embryos in captivity, owing to their propensity to devour one another, notwithstanding great care was exercised in supplying them with proper food. On this account the embryos have generally been planted when only a few days old, but it is considered that much better results could be accomplished by confining them in tanks until they had reached an age of 4 or 5 weeks, when they are better able to protect themselves against their enemies.

During 1890 and 1891 the hatching work was continued at Woods Holl on a moderate scale, and at the same time careful experiments were made to discover some way of keeping the larvæ in the aquaria without the great mortality which has hitherto occurred. Mr. V. N. Edwards also made some interesting observations regarding the eggs and the size at which the adult first becomes mature, and important studies respecting the breeding habits and life history of the species were undertaken by Prof. F. H. Herrick, of Adelbert College, and Prof. H. C. Bumpus, of Brown University. Prof. Herrick first turned his attention to this matter during the summer of 1889, and in the following year arrangements were made with him to prepare a comprehensive monograph covering the entire subject, which will probably require several years for its completion. Prof. Bumpus was at the station in the spring of 1890. Preliminary reports have been published by Prof. Herrick in the Johns Hopkins University Circular No. 80, 1890, and No. 87, 1891, the latter containing the two following papers by him, namely: "Notes on the habits and larval stages of the American lobster," and "The reproductive organs and early stages of development of the American lobster."

From the inquiries made up to this date some very valuable deductions have been reached. The fact that the eggs laid during the summer are carried by the parent until the following spring or summer before hatching, a conclusion reached by the writer from his experiments in 1885, has been proved conclusively. During 1889, eggs were laid from June 20 to July 15, and probably later; and in 1890, from July 1 until about August 20, according to the observations made. Lobsters do not breed readily when confined in close quarters. One female kept in a small aquarium for about eight weeks extruded eggs which were somewhat abnormal in their condition, and in the course of a few days they were scratched off by her from the swimmerets. The hatching period at Woods Holl occupies about eight weeks, beginning about the middle of May and continuing until near the middle of July, but it varies somewhat. In 1890 the last lobster with light-colored spawn (about ready to hatch) was taken July 7, and on the same day the Gay Head fishermen obtained the first lobster of the season with dark-colored or newly laid eggs.

Prof. Herrick considers that the lobster does not breed annually, judging from the immature condition of the ovaries at the time of hatching of the eggs attached to the swimmerets, and by the large percentage of non-egg-bearing females taken in the winter and spring. In April, 1889, 21 per cent of all the lobsters caught at Woods Holl by Mr. Edwards were females with eggs; in May, 19 per cent, and in June only about one-half of 1 per cent, the larger proportion of the eggs having hatched previous to, or during the early part of, the last-mentioned month. In the course of these observations it was also noticed that the females somewhat exceeded the males in numbers.

Freshly laid eggs are very dark green in color, but toward the next spring they become much lighter, owing to the partial consumption of the yolk. The adult lobster may molt soon after its eggs are hatched (most commonly in the early summer) or not until fall, and possibly at any other time when not carrying eggs. The frequency of the fall molting has been referred to elsewhere. Prof. Herrick is inclined to think that, after becoming sexually mature, lobsters do not, as a rule, molt annually. From six to eight weeks are probably required to produce a fairly hard new shell. At the time of hatching the larval lobster also molts for the first time, the delicate skin being cast off with the shell. This is a critical period in its history, and in connection with the work at Woods Holl large numbers die at this stage through inability to pass the first molt. The young swim at the surface for six or eight weeks, when they attain a stage which bears a general resemblance to the adult, although differing from it in many details. The larva at this age both walks on the bottom and swims at the surface, but when it reaches the next stage, it leaves the surface entirely.

During the early spring of 1890, Prof. Bumpus succeeded in hatching lobster eggs prematurely by placing them in running water, of which the temperature had been elevated artificially to that of the sea water in June. The young made their appearance in a very few days. Other eggs from the same lobster retained in water of normal temperature did not develop appreciably during the same period. The young produced in this way seemed strong and hardy and no fatal results attended their transfer to water of ordinary temperature. In fact, they were kept for twenty-four hours in a temperature as low as 32° F. without injury. The expediency of resorting to this method is, however, questionable, on account of the extra trouble and expense of manipulation where the work is carried on upon a large scale. Experience has taught that in nearly all fish-cultural operations it is best to conduct them under natural conditions as far as possible.

The observations made by Dr. C. F. Hodge, during the summer of 1889, respecting the feeding of young lobsters in confinement, while not successful from a practical standpoint, furnished some interesting facts regarding the larval habits of this species. The stomachs of specimens, about one month old, taken at the surface in Woods Holl harbor, contained fragments of copepods and of the larval stages of crabs, showing, so far as these examinations go, that their normal food at this age consists of active crustacean forms having the same pelagic habits as themselves. In the aquaria they were supplied with all sorts of food, both animal and vegetable, which it was conjectured might be suited to their tastes and needs, including surface towings brought in from the harbor. They did not appear to touch anything of a vegetable nature or any preparations made from flour. They will eat almost any character of animal food if suitably prepared, but while some kinds seem to be beneficial to them, others are more or less harmful, the yolks of hard-boiled eggs and freshly coagulated milk belonging to the former category. When well supplied with nutriment they rapidly gorge themselves, and it was found necessary to take much pains in dividing the solid particles, which should be neither too fine nor too coarse, to insure their proper feeding and prevent their becoming entangled in the loose tissues. In none of the trials, however, did more than a small percentage of the larvæ survive for any considerable length of time. They appeared to rest mainly upon the bottom of the aquarium at night, but rose toward the surface whenever a light was brought near them. In the daytime, also, they feed chiefly on the bottom, and are apt to spend much of their time there even when not so occupied.

Dr. Hodge is inclined to believe that the difficulties in the way of raising young lobsters in the aquaria do not arise entirely from their feeding habits, but are due in part to other causes, not at present understood. He experimented upon the effects of light, of temperature, of the conditions of the water, etc., but without producing any modifications in his results. Larvæ confined in floating cars off the wharf, moreover, fared no better than those kept in the laboratory. It has been suggested that a minute protozoan, which constantly swarmed about the living young, and completely infested their dead bodies, may to some extent have been instrumental in their destruction, a matter that could readily be determined by a sterilization of the water, but it is improbable that such a widespread mortality could result from such a cause.

Between April 16 and June 13, 1890, 723 lobsters furnished 8,317,000 eggs yielding 4,511,000 embryos. Between April 28 and June 30, 1891, 4,353,000 eggs were obtained from 482 lobsters, and from these 3,533,000 embryos were secured. The proportion of eggs hatched in 1889 was about 51 per cent; in 1890, 54 per cent; and in 1891, 81 per cent. The greatly increased percentage in the last-mentioned year was due to greater skill in the handling of the eggs, and to the exclusive use of the automatic shad jar, which is better adapted to the treatment of lobster eggs than any other apparatus yet employed for that purpose. Observations made in 1890 tended to show that the lobster eggs did not hatch in the apparatus until the temperature of the water had risen to between 54° and 59° F. This fact, however, needs to be corroborated.

During the seasons of 1890 and 1891, Mr. V. N. Edwards kept a careful record respecting the sizes of all breeding lobsters which he handled, and the number of eggs furnished by each. The results obtained are exceedingly interesting, and indicate that a larger proportion of the lobsters begin to spawn at an early age than has generally been supposed. These facts are shown in the following table:

Table showing the number of eggs to lobsters of each size, seasons of 1890 and 1891.

Size.	No. of lobsters.	No. of eggs.	Average No. of eggs to each size.
8 to 8¾ inches	23	149, 226	6, 480
9 to 10 inches	344	2, 642, 291	7, 600
10 to 11 inches	553	5, 763, 542	10, 400
11 to 12 inches	226	3, 095, 037	13, 600
12 to 13 inches	50	907, 330	18, 000
13 to 14 inches	9	208, 590	23, 100
Totals	1, 205	12, 766, 016	10, 594

The averages given in this table do not represent the total numbers actually extruded by the females, as in a large percentage of the specimens many of the eggs had been removed by one cause or another before the lobsters were captured. Eels, cunners, and other small rapacious fishes are undoubtedly responsible for much of this destruction. The extreme range in the number of eggs recorded for each size was as follows: In specimens measuring from 8 to 8¾ inches, 3,000 to 12,000 eggs; 9 to 10 inches, 3,000 to 16,500 eggs; 10 to 11 inches, 3,000 to 21,000 eggs; 11 to 12 inches, 3,000 to 24,000 eggs; 12 to 13 inches, 6,000 to 30,000 eggs; 13 to 14 inches, 15,000 to 36,000 eggs.

Over one-fourth of the breeding lobsters were between 9 and 10 inches long, and nearly one-half between 10 and 11 inches long. Only 59 were taken whose size was above 12 inches, and none exceeded 14 inches. It may, therefore, be concluded with respect to the Vineyard Sound region that the average size of the breeding lobsters is much less than it was ten and twenty years ago, and that much more than half are now under the legal limit of $10\frac{1}{2}$ inches prescribed by the Massachusetts fishery regulations. The search for egg lobsters has also disclosed the fact that the abundance of lobsters is still rapidly decreasing on this coast. During the season of 1890, 59 lobsters with dead eggs were taken, and among the females above 10 inches long caught in this vicinity there was an average of only about 1 with spawn to 12 without spawn. In November, 1890, with 175 traps set, the catch averaged 2 lobsters, measuring $10\frac{1}{2}$ inches and over to each trap per day. There was also an average of 1 egg lobster to every 7 lobsters taken. In February, 1891, 5 traps averaged 1 $10\frac{1}{2}$-inch lobster and 10 small lobsters per day. In April, 1891, 400 traps set in the bay and sound averaged about 100 lobsters per day, measuring $10\frac{1}{2}$ inches and over, and about 10 egg lobsters. In May the average per day was 1 large lobster to every 2 traps. Small lobsters were also less abundant than in previous years. At Monomoy, where lobsters were formerly very common within a mile of the point, the fishermen are now required to go nearly to the Nantucket shore to set their traps. The catch in 1890 was only about half that of the previous year.

During October and November, 1890, Mr. Edwards made some interesting observations on the fall molting of lobsters which indicate that the habit of shedding at this season is more common than has generally been supposed. Eight specimens were measured, and the increase in size in each instance, ranging from one-half to $1\frac{1}{2}$ inches, was found to be as follows: From 5 to 6 inches, from $5\frac{1}{2}$ to $6\frac{1}{2}$ inches, from $7\frac{1}{2}$ to 8 inches, from $7\frac{3}{4}$ to $8\frac{1}{2}$ inches, from 8 to 9 inches, from $8\frac{1}{2}$ to $9\frac{1}{4}$ inches, from 9 to $10\frac{1}{2}$ inches, and from 11 to 12 inches. The rate of growth seems, therefore, to vary considerably, even among individuals of approximately the same size.

In the fall of 1890 Mr. F. N. Barrett, editor of the American Grocer, New York, called the attention of the Commissioner to the fact that in the canned-lobster trade cans were often found in which the contents had turned black and were unfit for eating. This circumstance had created considerable prejudice against this product, especially in the foreign markets. Many causes had been assigned for the phenomenon, none of which, however, were based upon an investigation of the actual condition of the spoiled goods. Several cans containing the blackened lobsters were sent to Washington, and were placed by the Commissioner in the hands of Dr. William Gray, microscopist of the Army Medical Museum, for analysis. Dr. Gray's studies upon the subject have not yet been completed, but in the discolored patches of muscular tissue he has found a species of bacillus apparently undescribed, which is probably responsible for the changes observed in the color and condition of this product.

Edible Mollusks.

Mr. R. G. Harrison and Mr. J. L. Kellogg, of Johns Hopkins University, were employed at the Woods Holl laboratory during the summer of 1890, under the direction of Prof. W. K. Brooks, to investigate certain natural-history problems relative to the oyster and other edible mollusks, and bearing upon their artificial cultivation. They worked conjointly on the embryology of the oyster, and made experiments respecting the effects of density, temperature, sunshine, etc., on the oyster larva during its free-swimming and fixative stages. They also collected material for a study of the trematode parasites of the oyster and other bivalves, Dr. Brooks having been led to believe that these organisms may have been instrumental in causing the deterioration of oyster beds in some cases. The general investigation of the anatomy, histology, and embryology of lamellibranchs was taken up by Mr. Kellogg and was conducted by him in accordance with modern methods of biological research. It is expected that these inquiries will furnish many important facts regarding the morphology of the common edible bivalves which will be of service to the fish-culturist. They will be continued during the summer of 1891. Dr. Wilson has also, during his investigations at Woods Holl, recorded many valuable observations respecting the breeding habits and organs of the long clam, quahog, mussel, and scallop.

Sponges.

Preliminary to a study of the life history of the Florida commercial sponges, which it is intended shall soon be taken up, Dr. H. V. Wilson began at Woods Holl, in the summer of 1890, an investigation of the breeding habits of certain species occurring in that vicinity. His observations were continued during the following winter and spring, most attention being paid to a silicious form which is common on the wharf at the Fish Commission station. Dr. Wilson found that during the summer and early fall this species, instead of reproducing by means of eggs, does so asexually through the formation of internal buds or gemmules, solid oval bodies which swim about by means of cilia. Similar means of reproduction have been detected in the fresh-water sponges and in the genus *Chalinula*. The formation of these gemmules in the silicious species referred to, the character of the swimming larvæ, and its metamorphosis into the adult sponge, were carefully studied by Dr. Wilson, who, judging also from observations made at the Bahama Islands, is led to believe that this method of propagation is common among marine sponges. Should this hold true with the commercial species, three possible methods of accomplishing their artificial cultivation would thereby be presented, namely, by means of the eggs, by means of the gemmules, and by cuttings. All the practical experiments made in this direction up to the present time have dealt only with the cuttings, and while that method may still prove to be the more satisfactory one, the others might present certain advantages in any attempt to improve the grade of sponges or to distribute them over new grounds.

DISEASES AND PARASITES OF FISHES.

Fishes are subject to a variety of diseases, some of which are local and unimportant, having little or no effect upon the general condition of the fish, while others assume a very serious character, becoming even epidemic in their course and causing the mortality of immense numbers of individuals. But little attention has been paid to the nature or pathology of such diseases or to their treatment, and an important field is, therefore, open for investigations in this direction. It is well known that a large percentage of the disorders which have been observed among fishes is due to parasitism of one sort or another, and as biologists have long been interested in the natural history of the parasites so concerned, much information has been secured regarding the structure and the development of these organisms. This branch of research must, in fact, precede the more special consideration of the relations of the parasites to their hosts and their effects upon the latter; but the time has come when not only the amount of material collected seems ample to begin upon a full investigation of this more practical phase of the subject, but also when the demands for accurate information regarding it have become sufficiently urgent to necessitate its being taken up without delay. Dr. Revere R. Gurley has recently been assigned to the study of these problems.

The parasites which infest fishes belong to both the animal and vegetable kingdoms, and some fishes even are parasitic on others. The groups of crustaceans and worms furnish the greatest variety of known parasitic forms, the former occurring generally on the exterior of the body or in the mouth cavity, the latter in or among the viscera and in the tissues. A majority of these, however, seem to be entirely harmless, but many produce a diseased condition of greater or less extent, and some at least must eventually prove fatal. The protozoan parasites, called psorosperms, give rise to large excrescences on the exterior of the fish, making it very unpresentable in appearance, and undoubtedly soon causing death. Among fresh-water fishes most harm is probably effected by low forms of plants, which often result in a very widespread mortality, as in some of the large northern lakes. Their attacks are not confined to the adults, but extend also to the younger stages and the embryos as well as to the eggs, and in the artificial hatching apparatus they often cause much destruction. A great mortality also occurs among fishes, which has not been traced to parasitism, and of the true nature of which we are still ignorant. One instance of this character is noticed elsewhere in this report, in the account of Prof. S. A. Forbes's observations at Lake Mendota, Wisconsin.

The long-continued investigations by the Fish Commission on the Atlantic coast of the United States, especially in the vicinity of Woods Holl, Mass., have afforded the means of collecting and studying the crustacean and worm parasites of marine fishes under exceptionally favorable conditions. A few papers bearing upon the former group have appeared in the publications of the Fish Commission and U. S. National Museum from time to time. In 1884 Prof. Edwin Linton, of Washington and Jefferson College, began an exhaustive inquiry respecting the entozoan worm parasites of fishes, which has been continued down to date. Three general papers on this subject have been printed in the annual reports of the Commission for 1886, 1887, and 1888, and a special account of a parasite of the tiger shark in the last-mentioned report. The protozoan parasites occurring on *Cyprinodon* in the Vineyard Sound region, and on cyprinoid fishes in Ohio, have also been discussed by Prof. Linton in the Fish Commission Bulletin for 1889. The entozoan parasites of the trout collected by Dr. Jordan in the Yellowstone Park, in 1890, were referred to Prof. Linton for investigation, and the following year he accompanied Prof. S. A. Forbes on an expedition to the same region, where he was able to study the same forms in a fresh condition and to trace their development through the pelican. An account of his researches in respect to this subject will be found under the heading of the Yellowstone National Park.

The attention of the Commission has been called to several instances where young trout kept in confinement have become blind. Specimens in this condition were carefully examined by Prof. Linton, but no trace of parasitism was discovered. The eyes were congested and there appeared to be an unusual amount of pigment in the choroid coat and in the vicinity of the crystalline lens. It seems probable, therefore, that the trouble arose from some external conditions surrounding the fish, and which affected only the eyes, as the specimens were otherwise in good condition.

COLLECTIONS, PREPARATION OF REPORTS, ETC.

The laboratory established at the Central Station in Washington at the close of the fiscal year 1889 has, up to the present time, met the principal requirements of the work of this division, but it is rapidly becoming overcrowded and furnishes insufficient accommodations for taking proper care of specimens obtained in the investigations now in progress. Very large collections have been received during the past two years, resulting mainly from the explorations of the steamer *Albatross* in the North Pacific Ocean and in Bering Sea, from the oyster surveys along the Atlantic coast, and from the inquiries respecting the lakes and rivers. While it is not proposed to retain permanently in the Fish Commission building more than a type or working series of the specimens thus obtained, yet a considerable time must elapse before any extensive collection can be fully studied and the reports bearing upon it prepared for printing, and ample storage and working space is therefore required for the accommodation of this branch of research.

The study of the fishes has progressed rapidly under the care of Dr. Tarleton H. Bean, the ichthyologist of the Commission, and through the coöperation of Dr. David S. Jordan and Prof. Charles H. Gilbert, of Indiana University. As elsewhere explained, the fresh-water fishes have been mostly worked up at the last-mentioned institution, and the marine species recently collected by the *Albatross* on the Pacific coast have been sent there to be classified and described by Prof. Gilbert.*

Considering the invaluable assistance received from this source during the past four years, the acceptance by Dr. Jordan of the presidency of the Leland Stanford Junior University is to be regretted in the immediate interests of the Fish Commission, and yet, through his assurance of continued coöperation, the opportunity will now be afforded to make a thorough investigation of the fishery resources of California, a region which has been much neglected in that respect.

Arrangements are now in progress for the study by specialists of high standing of many of the groups of oceanic animals which are richly represented in recent collections from the Pacific coast. This will be done without expense to the Government, and will insure the preparation of a very valuable series of reports upon the more important biological features of the fishing-grounds now in course of examination by the *Albatross*. The higher crustaceans from this region, such as the crabs and shrimps, are now being studied by Mr. James E. Benedict and Miss M. J. Rathbun, of the U. S. National Museum.

Very large collections of fishes and marine invertebrates have been transferred to the custody of the National Museum, and many sets of duplicate natural-history specimens have been distributed for educational purposes, either directly by the Fish Commission or through the medium of the National Museum. The following institutions have been thus supplied: Ohio State University, Columbus, Ohio; Museum of Comparative Zoölogy of Harvard University; Indiana University, Bloomington, Ind.; State Normal School, Terre Haute, Ind.; Purdue University, Indiana; Syrian College, Beirut, Syria; Clark University, Worcester, Mass.; University of South Carolina; Ottawa University, Ottawa, Kans.; Lawrence University, Appleton, Wis.; Muhlenberg College, Allentown, Pa.; University of Wisconsin, Madison, Wis.; High School, Council Bluffs, Iowa; New Orleans University, New Orleans, La.; Woman's College of Baltimore, Baltimore, Md.; Superintendent of schools, Olean, N. Y.; State Agricultural College, Corvallis, Oregon; South Jersey Institute, Bridgeton, N. J.; Dakota Univer-

* A preliminary report on the fishes collected by the steamer *Albatross* on the Pacific coast of North America during the year 1889, with descriptions of twelve new genera and ninety-two new species. By Charles H. Gilbert. Proc. U. S. Nat. Mus., XIII, pp. 49–126, 1890.

A supplementary list of fishes collected at the Galapagos Islands and Panama, with descriptions of one new genus and three new species. By Charles H. Gilbert. Proc. U. S. Nat. Mus., XIII, pp. 449–455, 1891.

Descriptions of thirty-four new species of fishes collected in 1888 and 1889, principally among the Santa Barbara Islands and in the Gulf of California. By Charles H. Gilbert. Proc. U. S. Nat. Mus., XIII, pp. 539–566, 1891.

sity, Mitchell, S. Dak.; Massachusetts Agricultural College, Amherst, Mass.; Nebraska Institute for the Deaf and Dumb, Omaha, Nebr.; St. John's College, Annapolis, Md.; Pennsylvania State College, Centre County, Pa.; Brooklyn Training School, Brooklyn, N. Y.; Mount Vernon Seminary, Washington, D. C.; High School, Bridgton, Me.; Missouri Valley College, Marshall, Mo.; Columbia College, New York, N. Y.; Louisiana State University and Agricultural and Mechanical College, Baton Rouge, La.; State Normal School, Milwaukee, Wis.; High School, Springfield, Mass.; K. K. Naturhistorisches Hof-Museum, Vienna, Austria; British Museum, London, England.

A scheme of exhibits to illustrate the objects and work of this division at the World's Columbian Exposition at Chicago has been prepared in accordance with the directions of the Commissioner. It is proposed to use in this connection actual specimens and appliances where they will serve appropriately, and also models, relief maps, charts, and drawings. The principal subjects to be represented are the following: The economic features of the fauna and flora of the seacoasts and of the lakes and rivers, including the embryology and life history of the more important food-fishes; the general hydrography of the Atlantic and Pacific coasts, and the location, configuration, and principal characteristics of the oceanic fishing-grounds; the lake and river basins, and the distribution, past and present, of fresh-water fishes; the vessels and apparatus used in the investigation of fishing-grounds; laboratories for the study of aquatic life and of fishery problems; temperature, and other physical conditions and variations affecting the distribution of fishery products, and publications bearing upon these different topics.

REPORT ON THE INQUIRY REGARDING THE METHODS AND STATISTICS OF THE FISHERIES.

By Hugh M. Smith, M. D.,
Acting Assistant in charge.

INTRODUCTORY NOTE.

The report on the work of this division for the fiscal years 1890 and 1891 is herewith respectfully submitted. Owing to the fact that during this time the affairs of the office were under the immediate direction of Capt. J. W. Collins, the writer labors under some disadvantage in preparing a full and satisfactory account of the operations of the division. The special reports on the fisheries now in course of preparation based on the researches of this division will clearly disclose the functions of the office, and indicate the scope of the work and the nature of the inquiries carried on during the period specified. It is, therefore, unnecessary in this place to do more than give an outline of the results accomplished and to mention certain other matters that are not covered by the regular reports. In considering the operations of the division the various topics that come up for notice may be discussed under the following general heads: Abstract of the field investigations conducted by the office; summary of the miscellaneous affairs of the division; analysis of the reports printed during the two years, and record of certain prominent matters affecting the commercial fisheries.

FIELD INVESTIGATIONS.

During the years covered by this report the entire available force of the division was placed in the field and more extensive investigations were carried on than had previously been undertaken by the office. Complete studies were made covering the commercial fisheries of fifteen coast States, and special inquiries were conducted in some of the principal fishing centers and regions of the Atlantic seaboard. The field work may be referred to under the following heads: Pacific coast, New England coast, South Atlantic coast, Gulf coast, Potomac River, Lower Chesapeake Bay, and minor regions.

PACIFIC COAST.

The investigation of the fisheries of the Pacific coast of the United States, which was begun November 15, 1888, and has been referred to in a previous report of the division, was brought to a close on September 23, 1889, and Mr. W. A. Wilcox, who had been conducting the canvass, was ordered to other duty. In December, 1889, Mr. A. B. Alexander, fishery expert on the Fish Commission steamer *Albatross*, which was then at San Francisco, was assigned to temporary duty in this division and detailed to make additional inquiries on certain fisheries for the calendar year 1889 at times when his services on the vessel were not required. As a result of Mr. Alexander's work, the office came into possession of valuable statistical and descriptive information on the whale, cod, fur-seal, market, and other vessel fisheries of the west coast; the salmon-canning industry of California, Oregon, Washington, and Alaska, and the wholesale fish trade of San Francisco, for a later year than could be obtained by Mr. Wilcox.

The present importance of the fisheries of this region, and the augmented prominence they are destined to attain as a result of the industrial growth of the western States in other lines of business, warranted the very detailed investigation undertaken by the division in connection with the careful scientific and other researches carried on by the *Albatross* in the offshore waters. While the fisheries of the Pacific coast are, as a whole, less extensive than those prosecuted on the Atlantic seaboard, certain branches have precedence over all similar fisheries. The fur-seal and salmon fisheries and the canning industry, for instance, are unsurpassed in other regions, and San Francisco has recently become the leading center of the whaling industry, owing to the transfer of vessels from the Atlantic to the Pacific, occasioned by the relative scarcity of whales in the former ocean. Taken in the aggregate, the fisheries were probably as successful as during any previous period. The number of persons ascertained to be engaged in the industry in the three coast States was 13,850; the vessels, boats, apparatus, etc., employed were valued at $6,498,239; and the first value of the products taken was $6,387,803. Of salmon, the most important product, 48,806,913 pounds were secured, for which the fishermen received $2,082,809. The salmon-canning industry, exclusive of Alaska, utilized 41,632,223 pounds, which were made into 622,037 cases of canned fish, having a market value of $3,703,838.

The inquiry disclosed a very marked advance in the fisheries as compared with 1880, when Prof. D. S. Jordan and Mr. Charles H. Gilbert canvassed the fisheries of the Pacific States in behalf of the Tenth Census. Mr. Wilcox's investigation showed that the value of the ocean, shore, and river fisheries of the region, viz, $6,387,803, exceeded by $2,111,300 the results of the fisheries in 1880. Especially worthy of mention is the increase in the whale and oyster fisheries.

Up to the time of this investigation definite information was lacking as to the results which had attended the attempted acclimatization of shad and striped bass in the waters of the Pacific States, although it had been known for some years that the plants had been successful and that more or less mature fish had been taken at various places on the coast. It was found that the shad have become distributed along the entire coast north of Monterey Bay, California, and occur in special abundance in the Sacramento River. Notwithstanding the fact that the fishermen have provided themselves with no apparatus especially adapted to the capture of shad, 101,071 pounds were taken in 1888 and 170,500 pounds in 1889. The quantity caught affords no idea of the abundance of the fish, and it is thought that the use of suitable apparatus will demonstrate the existence of large bodies of these fish in all the coast waters between southern California and Puget Sound. The striped bass, although introduced some years before the shad, are apparently less abundant and less widely distributed than the latter. They are chiefly found in San Francisco Bay, where examples weighing as much as 40 pounds have been taken, although the average weight is only 8 or 10 pounds. In 1888 only about 1,000 pounds reached the San Francisco market, but in 1889 Mr. Alexander reported that at one period they became so plentiful that the price, which had been $1 a pound in 1888, fell to 18 cents. There is every reason to believe that in a short time this species will take a prominent place among the commercial fishes of the west coast.

NEW ENGLAND COAST.

Early in the fiscal year 1890 the entire field force was placed in the New England States and a very comprehensive canvass of that region was inaugurated. The field inquiries in Maine were made by Messrs. H. M. Smith, W. H. Abbott, Ansley Hall, and C. H. Stevenson; in New Hampshire by Mr. Stevenson; in Massachusetts by Messrs. W. A. Wilcox, W. H. Abbott, E. E. Race, C. H. Stevenson, and Ansley Hall; in Rhode Island by Mr. Hall, and in Connecticut by Mr. Stevenson. At Boston and Gloucester, respectively, the local agents of the office, Mr. F. F. Dimick and Capt. S. J. Martin, aided in the work, and in the vicinity of Gloucester Mr. E. F. Locke, of the Division of Fish-Culture, rendered efficient service at times when his regular duties did not require his attention. No investigation of the entire fishing industry of this region had been undertaken since 1879–80. It was well known that marked changes had occurred in the methods, extent, and character of certain fisheries in the various States; and in view of the general prominence of the New England fisheries and the important international questions arising in connection therewith, it was deemed advisable to have full and accurate data thereon.

The inquiry placed the office in possession of complete statistical and other information concerning the ocean, shore, and river fisheries for the years 1887, 1888, and 1889. Special studies were also made of such important branches as the sardine industry, the smoked-herring industry, the lobster-canning industry, the canning of clams and other products, the menhaden industry, the oyster-packing industry, the preparation of clam bait, and the frozen-herring trade. In connection with this investigation a careful study was conducted in Boston and Gloucester, with a view to ascertain the extent of the wholesale trades in fresh fish, salt fish, smoked fish, lobsters, oysters, and other fishery products, which constitute such a prominent feature of the industrial life of those cities. The manufacture of glue, isinglass, and fish fertilizer, the trade in ice and salt consumed in the fisheries, the making of boxes for the packing of fish, the preparation of boneless fish, and various other phases of the fishing industry were also considered. Several special papers based on these inquiries, now in course of preparation, and a detailed report on the entire subject which will soon be issued, preclude the necessity for more than a general reference at this time to the results of the canvass.

The following summary gives the extent and condition of the fisheries in 1889 as determined by the inquiry: The number of persons engaged in the fisheries of the region was 36,536, of whom 15,122 were vessel fishermen, 12,295 shore fishermen, and 9,119 shoresmen. Of the 1,542 vessels employed, 1,440 were actually used in fishing, and 102 were engaged in the transportation of fishery products; the tonnage of the fleet was 79,738.49, and the value of the vessels and their outfits was $6,382,006. The fleet consisted of 1,206 schooners, 171 sloops, 88 steamers, 38 barks, 30 cat-rigged vessels, 5 ships, and 4 brigs. The boats used in the shore fisheries numbered 11,561, and had a value of $657,010. The apparatus fished consisted of 1,178 pound nets, trap nets, and weirs, 540 seines, 9,591 gill nets, 280 bag nets, 965 fyke nets, and 175,458 pots, which, together with other miscellaneous apparatus, had a value of $1,681,575. The shore and accessory property devoted to the fisheries was valued at $5,850,979, and the cash capital required to maintain the industry was $5,523,224. The aggregate investment was $20,094,794. The products taken weighed 653,170,040 pounds, for which the fishermen received $10,550,641. The gross return on the investment was, therefore, about 50 per cent. The most important single species is the cod, of which 97,145,645 pounds, valued at $2,549,757, were marketed. The fish taken in largest quantities is the menhaden, the catch of which was 173,632,210 pounds, equivalent to about 300,000,000 fish, but the value of this enormous yield was only $428,228. After the cod, in point of value, come oysters, worth $1,393,284; lobsters, worth $833,736; whale products, worth $828,463; haddock, worth $738,732; mackerel worth $731,424; and halibut, worth $725,756.

The New England fisheries have always been more important than those of any other section of the United States, and the inquiry shows that this precedence is still maintained, notwithstanding a very serious decline in some of the most extensive fisheries and the diversion of many large fishing vessels to the Pacific States. Compared with 1880, in 1889 there were 507 less persons engaged in the fisheries; there were 445 fewer vessels and 3,226 fewer boats employed, and a corresponding decrease in the value of vessels, boats, and apparatus, but owing to a large increase in the amount of shore, accessory, and cash property the total investment was $191,837 more than in 1880. The value of the general food-fish fisheries was about $1,850,000 less in 1889; the oyster, clam, and scallop fisheries were $965,000 greater; the lobster fishery was $310,000 more valuable; the menhaden fishery exceeded by $30,000 the results in 1880; and the whale fishery declined in value $1,400,000. A net decrease in the value of the fishing industry amounting to $1,950,000 is disclosed, a sum that would be easily overcome by the return of mackerel to our shores in their former abundance.

SOUTH ATLANTIC COAST.

The field work in this region occupied parts of two years. On January 14, 1890, Mr. W. de C. Ravenel, field superintendent in the Division of Fish-Culture, who had been assigned to temporary duty in the Division of Fisheries, was detailed to make a study of the methods and statistics of the fisheries of the South Atlantic States. Mr. Ravenel had conducted a similar inquiry in this section during the previous year, and his familiarity with the fisheries made his services of special value to the office. The canvass was begun in Florida and had extended to a point on Albemarle Sound, North Carolina, when, on April 1, 1890, it became necessary to detach Mr. Ravenel from this work in order to resume his regular duties.

Owing to various exigencies, the canvass which was brought almost to a close by Mr. Ravenel could not be completed at that time, and it was not until the following year that it became feasible to do additional work in the South Atlantic region. Immediately after the completion of the inquiry in the Gulf States, to which reference will be made, the force there engaged was transferred to this section and disposed at proper intervals along the coast. Mr. Ravenel had again been assigned to this duty, and, while the investigation in the Gulf was in progress, had begun his canvass and had gotten the work well advanced by the time the regular agents were available to assist in the inquiry. He visited the fisheries of eastern Florida, Georgia, and the greater part of South Carolina before being obliged to suspend on account of other duties. Mr. Stevenson took up Mr. Ravenel's inquiry at Georgetown, S. C., finished that State and visited a part of North Carolina, Messrs. Hall and Race covering the remaining part of the State. The work was brought to a close about the middle of June, 1891.

This inquiry was addressed to every phase of the fishing industry and may be regarded as a complete canvass of all the commercial fishing interests, including those of the rivers draining into the Atlantic Ocean.

The only exception to this statement was the hunting of alligators in the interior waters of Florida, the small force available and the time required personally to visit these regions, remote and difficult of access, precluding the possibility of undertaking the work at this time. Considerable valuable information on the alligator industry of the St. Johns River and the coast sections was, however, obtained in connection with the regular fishery canvass, and, together with data relating to the western part of the State, will enable the office to possess a satisfactory knowledge of the present condition of the business.

The fisheries of this region are less valuable than those of any other coast section; the natural advantages, however, are extensive, and the possibilities for development are considerable, especially in the oyster and offshore line fisheries. Up to a comparatively recent date the South Atlantic States took precedence over the Gulf States, but the marked advances in the latter easily overcame the comparatively slight difference between the two regions in the absence of a correspondingly large increase in the South Atlantic States. Special fisheries of this section are nevertheless of great extent, and the industry as a whole has undergone a very important increase since 1880.

In 1890, 16,001 persons were engaged in the South Atlantic fisheries, $1,688,286 was invested in the industry, and $1,573,704 accrued from the sale of products, of which sum $482,403 represented shad, $254,141 oysters, $166,106 alewives, and $133,635 mullet. During the years covered by the field inquiries the fisheries of this region were, as a whole, more successful and extensive than at any previous time. Especially worthy of mention was the flourishing condition of the shad, alewife, striped bass, black bass, and other fresh-water fisheries, and of the oyster, squeteague, mullet, and other salt-water fisheries. The only important branches which have declined are the shrimp and sturgeon fisheries. More than half the proceeds of the fisheries represents fresh-water products. The fresh-water fisheries of North Carolina and Florida are more important than those prosecuted in salt water. The relative extent of the river and other fresh-water fisheries of the region is probably greater than in any other coast section, and constitutes one of the principal features of the industry; in 1890 the salt-water products had a value of $740,539, and the fresh-water were worth $833,165.

The oyster fishery and the question of oyster cultivation have of late years received more attention in these States than at any previous time. Careful surveys of the coast waters with reference to oyster-culture have been made in the three northern States of the tier, and the legislatures have shown their appreciation of the importance of the subject by enacting modern laws intended to promote and protect the oyster industry. Large areas of oyster land have been taken up for private planting purposes, new capital has been brought into the States, and a very decided impetus has been given to the oyster fishery.

Factories designed for the canning and packing of oysters have been established in every State, and have always resulted in an increased output, owing to the convenient market and ready sale afforded the fishermen.

The following table will convey a clear idea of the large advance that has taken place in the oyster fishery of each State since 1880:

Statement of the yield of oysters in the South Atlantic States in 1880, 1887, 1888, 1889, and 1890.

Year.	North Carolina.		South Carolina.		Georgia.		Florida.		Total.	
	Bushels.	Value.	Bushels.	Value.	Bushels.	Value.	Bushels.	Value.	Bushels.	Value.
1880.....	170,000	$60,000	50,000	$20,000	70,000	$35,000	20,000	$5,000	310,000	$120,000
1887.....	212,980	48,353	37,725	18,581	110,086	26,950	48,250	9,950	409,041	103,834
1888.....	204,703	46,129	40,242	19,146	120,600	29,370	57,750	12,950	423,295	107,595
1889.....	1,001,620	194,272	43,620	19,890	163,200	26,684	62,356	11,123	1,270,796	251,969
1890.....	807,260	175,567	63,150	23,204	224,357	40,520	97,350	14,850	1,192,117	254,141

GULF COAST.

For a number of years the investigation of the fisheries of the States bordering on the Gulf of Mexico had been contemplated, but the inquiry was deferred from time to time owing to the small force available and the more urgent need of studies in other coast regions. By the 1st of January, 1891, however, the opportunity for inaugurating this work seemed favorable, and accordingly four agents, Messrs. W. H. Abbott, Ansley Hall, E. E. Race, and C. H. Stevenson, were detailed to examine and report on the fisheries and related industries of this region. The fisheries of no other section of the United States had received less attention and very little information was at hand bearing on their present condition, extent, and resources. The results of the inquiry were therefore awaited with interest. Three months were consumed in work, during which time the agents canvassed the entire coastal region from Key West to the Rio Grande.

The reports of the agents show that in 1890, the last year covered by the investigation, 11,752 persons were employed in the fisheries of the Gulf States; the capital invested amounted to $2,978,292, and the value of the catch was $2,438,675. Comparing these figures with the returns from the New England, Middle Atlantic, and Pacific States, the fisheries of this region are much less extensive. It is not in their present condition, however, that their importance chiefly consists, but rather in their recent phenomenal growth and the possibilities for still greater development. The fishery resources of the Gulf States are very extensive. Few sections of the country are better supplied with desirable marine food and economic products, including fish, reptiles, mollusks, crustaceans, and sponges. The utilization of these has as yet been incomplete, but the past growth of the industry and the present attention it is receiving will doubtless greatly advance the fishing interests in the near future.

The prominent features of the fisheries, as disclosed by the inquiry, may be chiefly mentioned, as follows: The large foreign element engaged in the industry, amounting to about 25 per cent, the aliens being most numerous in Louisiana, where they constitute one-third of the fishing population; the predominance of seines as a means of capture, gill nets and lines being important only in Florida, and pound nets, trap nets, and fyke nets, which are so extensively used in some other regions, not being used; the presence of a large fleet of lug-rigged vessels in Louisiana, a type which is peculiar to the Gulf region; the recent establishment of numerous factories for utilizing raw products of the fisheries, especially oysters, turtles, and shrimps; the extent of the oyster fishery (which is the most important and yielded $796,062), the sponge fishery (the output of which had a value of $438,692), the mullet fishery (valued at $238,528), the snapper fishery (which brought the fishermen $134,716), the squeteague fishery (which yielded $122,570), and the shrimp fishery (worth $108,811).

The only previous examination of the fisheries of these States addressed to complete statistical information was undertaken in 1880 by Mr. Silas Stearns in connection with the work of the U. S. Fish Commission in behalf of the Tenth Census. Although other inquiries have since been made by this Commission covering various phases of the fisheries, the report of Mr. Stearns is the only one that essays to be complete or affords an opportunity for comparing the past and present conditions of the industry. Since 1880, the fisheries of the Gulf States have undergone an important advance in nearly every feature. The increase in the number of fishermen amounted to 6,621, or 129 per cent; the increase in investment was $2,432,708, or 446 per cent, and the increase in the value of the catch was $1,211,131, or 99 per cent. The fisheries of Mississippi have grown at an unprecedentedly rapid rate, the proportional increase in the three foregoing particulars being 825 per cent, 4,840 per cent, and 990 per cent, respectively. The importance of the oyster in this region is made manifest by the statement that nearly half of the aggregate increase during the past decade, viz, $564,862, represented that mollusk, and that in every State the output of this product has been conspicuously augmented, a condition due in no small degree to the establishment of canning and packing houses.

POTOMAC RIVER.

In May and June, 1891, a canvass of the fisheries of the Potomac River and its tributaries was made by Mr. W. A. Wilcox. At the time of the inquiry the most important fish were being caught and a favorable opportunity was thus afforded to meet the fishermen and inspect the means and methods employed. The investigation had special reference to the condition of the shad fishery, but also related to all other branches. Mr. Wilcox began work at the mouth of the river and continued his inquiries as far as the Little Falls, 3 miles above Washington. He was assisted by Mr. Charles E. Ingersoll, of this division. The fishermen of the river evinced a deep interest in the work, and extended to the agents all possible assistance. The investigation was also further facilitated by Mr. S. G. Worth, in charge of the shad-hatching station of the Commission at Fort Washington, Md., who greatly aided Mr. Wilcox in that part of the river.

The Potomac is one of the most important rivers of the country viewed from the standpoint of the commercial fisheries, and in the extent and value of its shad fisheries it is surpassed only by the St. Johns, Hudson, and Delaware rivers. The shad fisheries of the river have a special interest to this office because of their early importance, their serious decline and threatened extermination in recent years, and their restoration as a result of the artificial propagation carried on by the U. S. Fish Commission. Through the courtesy of the health department of the District of Columbia, this Commission has, for many years, obtained a statement of the number of shad landed at Washington and other places from the Potomac fisheries, which, with other information on the subject received from the same and other sources, has furnished from year to year a fairly satisfactory knowledge of the abundance of shad; but no systematic canvass of the fisheries had been made since 1880 and there was but little authentic information available regarding the lower course of the river. The actual extent of the other fisheries was unknown for a later year than 1880.

The canvass showed that in 1890 3,576 persons were directly engaged in the fisheries of this region, of whom 295 were employed in the vessel fisheries and 3,281 in the shore and boat fisheries.

Thirty-two vessels engaged in dredging oysters during the season of 1889–90, and 33 other vessels found employment in running to market the oysters and fish caught in the shore fisheries; the aggregate tonnage of the vessels was 1,118.78, and the value of these and their outfit was $58,652. Besides those carried by the vessels, 1,472 boats were used in the river, having a value of $75,526. The apparatus of capture consisted of 261 gill nets, 376 pound nets, 32 seines, 903 fyke and other minor nets, 122 dredges, 1,289 tongs and rakes, the whole having a value of $112,053. The total investment in the fisheries of the river, including shore property worth $48,560, was $294,091.

The most important single product of the fisheries of this river is the oyster, which represents about half the proceeds from the fisheries. During the season terminating in the spring of 1890, 594,629 bushels of oysters were taken by fishermen living on the river, and large additional quantities of which no separate record could be obtained were secured by vessels belonging in various ports on Chesapeake Bay. In the following season 498,641 bushels were marketed. The value of the oyster yield was $256,782 the first season and $273,039 the next. Notwithstanding the diminished output in the latter year, amounting to 95,988 bushels, the market value of the catch was $16,257 more, owing chiefly to a higher average price per bushel and a comparative scarcity of oysters in Baltimore, to which place a large part of the output goes. The decreased yield in 1890–91 was principally due to the destruction of beds in the upper part of the oyster region by the extension of the fresh water consequent upon freshets.

Next to the oyster in value is the shad, of which 2,571,002 pounds, equivalent to 731,453 fish, were taken in 1890, for which the fishermen received $75,935. The following year the aggregate catch was 2,356,759 pounds, or 621,977 fish, the value of which to the fishermen was $69,160. In 1891 there was a considerable diminution in the abundance of the fish in the upper part of the Potomac, although the fishing at the mouth of the river was regarded as very good. In both these years, however, the catch was much less than in 1889, which was one of the best seasons during the past decade, 868,900 fish, valued at $85,378, being taken. This presents a striking contrast with the condition of the shad fishery before the effects of artificial propagation began to be manifested. The present Commissioner of Fisheries, writing in 1880 concerning this river, stated: *

> The fisheries of this river annually decreased in value and production up to the time of the war. The intermission which then ensued in the fishing operations on account of those of a martial character allowed the fisheries to recuperate, so that in the years immediately succeeding the war it was found that they had in a measure recovered from their former depletion. In 1878 the minimum of production was attained, during which less than 200,000 [about 186,000] shad were taken in the entire river. In 1879 the results of previous artificial propagation first manifested themselves, and there was a considerable increase in the run of shad, from which time the shad fisheries steadily increased until, in the season of 1880, nearly 600,000 [582,872] were taken.

The alewives rank next to shad in importance, and during some seasons, 1891 for instance, they have had a greater value than shad. The output is now considerably larger than in 1880, the bulk of the catch being taken with pound nets. In 1890, 7,508,416 pounds, worth $67,481, were obtained, and, in 1891, 7,330,635 pounds were secured, which yielded the fishermen $71,402.

The decrease in the run of sturgeon is a noteworthy feature of the fisheries; 288,000 pounds were taken in 1880, since which time the catch has gradually dwindled until only 60,920 pounds were caught in 1890, and 45,710 pounds in 1891, notwithstanding the greater demand in recent years as shown by the higher prices received. The striped bass is an important fish in the Potomac, ranking next to alewives in total value and commanding a better price than any other species; 333,304 pounds were secured in 1890, the market value of which was $26,487. Among the other fishes taken in the river the following are the most important, and in 1890 yielded the amounts stated: Bluefish, $4,843; catfish, $7,555;

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* The River Fisheries of the Atlantic States. By Marshall McDonald. <The Fisheries and Fishery Industries of the United States, sec. V, vol. I.

perch, $6,512; and squeteague, $6,722. Terrapin and frogs, of the value of $2,999; crabs, worth $14,760, and crayfish, valued at $637, complete the list of products.

The aggregate value of the Potomac fisheries in 1890 was $485,523, of which sum the fresh-water and anadromous fishes represented $202,082, and the salt-water products, $283,441. No separate figures for the salt-water fisheries are available for comparison, but in 1880 the fresh-water fisheries had a value of $165,503.

Perhaps the most important feature of the present condition of the fisheries is the large number of pound nets employed. In early times haul seines were the only kinds of apparatus used in the shad and alewife fishery. About fifty-five years ago gill nets were introduced and gradually displaced the seines. Pound nets were first set in the river about 1875, and have in turn supplanted the gill nets to a considerable extent, and are now exerting an important influence on the fisheries; 330 of these nets were operated in 1889, 376 in 1890, and 411 in 1891. They are particularly numerous near the mouth of the river, and it is thought that the diminished catch of shad in the upper Potomac which has been observed in recent years has been partly due to the multiplication of these nets in the lower waters. The ultimate effect of the taking of larger and larger quantities of shad and other fish before they have reached the spawning-grounds can not fail to be harmful, and if the fisheries are to be maintained some restrictions will probably soon have to be placed on the number, nature, and location of the nets used, or artificial propagation will have to be conducted on an increasingly extensive scale. The greater prominence which the pound net is attaining in the shad and alewife fisheries is shown in the following table; notwithstanding that the aggregate catch of both of these gradually declined from 1889 to 1891, the yield in the pound nets advanced each year, and the percentage of increase was marked, while the output of both the seines and gill nets decreased actually and relatively.

Statement of the aggregate and proportional catch of shad and alewives in each form of apparatus in the Potomac River in 1889, 1890, and 1891.

Species and year.	Pound nets.		Gill nets.		Seines.		Total.	
	Number of fish.	Per cent.	Number of fish.	Per cent.	Number of fish.	Per cent.	Number of fish.	Per cent.
Shad:								
1889	219,679	25.28	462,675	53.25	186,546	21.47	868,900	100.00
1890	233,794	31.96	348,843	47.69	148,816	20.35	731,453	100.00
1891	251,760	40.48	267,164	42.95	103,053	16.57	621,977	100.00
Total	705,233	31.73	1,078,682	48.54	438,415	19.73	2,222,330	100.00
Alewives:								
1889	10,371,620	59.62	1,012,500	5.82	6,011,048	34.56	17,395,168	100.00
1890	11,200,878	59.67	1,287,500	6.86	6,282,663	33.47	18,771,041	100.00
1891	12,809,362	69.89	900,250	4.91	4,616,978	25.20	18,326,590	100.00
Total	34,381,860	63.09	3,200,250	5.87	16,910,689	31.04	54,492,799	100.00

LOWER CHESAPEAKE BAY.

The fisheries of the Lower Chesapeake, especially those tributary to Norfolk, Old Point Comfort, and Cape Charles, were the subject of an inquiry conducted by the writer in December, 1890, and January, 1891. Special attention was given to the condition and methods of the oyster fishery, the oyster shucking and canning trades, and the oyster-planting industry in Norfolk and vicinity, and to the pound-net fishery and oyster trade at Cape Charles. This region, viewed from a fishery standpoint, is one of the most important in the United States; it maintains the most extensive oyster and seine fisheries and the largest fish and oyster trades in Virginia, and the gill-net, pound-net, and other fisheries are of considerable value. The oyster vessel fishery centering at Norfolk and the oyster-packing industry of the place rank next to those of Baltimore in importance. As it is not intended to publish a special report embodying the results of this inquiry, a somewhat detailed reference to the more important features of the fishing industry may appropriately be made in this place.

Next to Baltimore, Norfolk receives more oysters than any other southern city. It is the headquarters of a large part of the extensive fleets belonging in Norfolk, Yorktown, Cherrystone, and other customs districts, and in the course of a season probably between 600 and 800 vessels land more or less of their catch there. The boat fisheries carried on from the city are also important. The large area of oyster-ground included in Hampton Roads and the James, Nansemond, Elizabeth, Lynn Haven, and other rivers, is in great part tributary to Norfolk. Numerous other sections on the western shore of the Chesapeake also contribute their quota to the oyster trade of the city, notably the Back, York, Piankatank, and Rappahannock rivers; and even parts of the bay and ocean shores of the eastern peninsula depend on Norfolk for a market.

The James River is perhaps the most important oyster-ground in the lower Chesapeake. For about 20 miles above its mouth there are large natural beds or "rocks," which have been seriously depleted in recent years. It is said that the beds would have been productive for a much longer period had the oystermen been obliged to return to the water the small unmarketable oysters taken with the large stock. Instead of culling the catch on the grounds, as should be required by law, this was, and is, deferred until the shore is reached, and hundreds of thousands of bushels of young oysters have thus been sacrificed, although of late the practice of making private beds with the smaller oysters has been gaining favor, and is to be commended. At the present time it is said that in every 25 bushels of oysters taken from the natural beds, 20 bushels are unmarketable. Fortunately the grounds in this river replenish from the spat with phenomenal rapidity, otherwise they must long ago have become practically barren of oysters. Owing to favorable conditions, the supply in 1890 was very abundant, some oystermen affirming that not since the war had there been a more plentiful natural growth of oysters, although it was generally acknowledged that the quality was much poorer than usual.

One of the most noted natural oyster-grounds in this region was Hampton Bar, located on the left side of the James River at its mouth, extending parallel with the course of the stream and covering an area of about 3,000 acres. According to Col. W. N. Armstrong, who is now extensively engaged in oyster-planting on the bar, as early as 1883 the natural beds had been so exhausted that the entire yield of the tongers from Old Point Comfort to Newport News did not amount to 10 barrels a day, and the tongers who reside in Hampton were in the habit of resorting to other natural beds in the James River 20 or 30 miles distant. Since that time laws have been enacted securing the rights of planters, and extensive planting has been done on the bar; about 700 or 800 acres are now under cultivation, on which the plantings are about 600 bushels per acre, and as many as 800 barrels of oysters have been shipped from these grounds to the general markets in a single day.

With the exhaustion of the natural beds, more attention is being bestowed on artificial methods of maintaining the supply than ever before, and it is being generally recognized that the oyster industry in the near future must depend for its maintenance on planted beds.

A number of fishermen in this section were met with who use the so-called deep-water oyster tongs, a report concerning which has been prepared by this office. The depth of water in which it is commonly used is from 30 to 50 feet; oysters in this depth are far beyond the reach of ordinary tongs, and as the employment of dredges is restricted in this region the new apparatus is being advantageously operated. On the planted beds and in shoal-water fishing the old type of tongs will continue to be used. The only objection made to the new pattern is that on rough bottom it fails to work well, and even when oysters are abundant only small hauls can be made. In the Back River and a few other localities the deep-water tongs are successfully employed in taking clams (*Venus mercenaria*) in water 5 or 6 fathoms in depth.

A large percentage of the oysters landed in Norfolk goes through the packing and canning houses before reaching the consumer. This business is of large proportions and constitutes one of the principal industrial enterprises of the city. The fall and winter of 1890 was regarded by the packers as the best season in at least five years. All of them handled larger quantities of oysters than for some years, and the prices received for the prepared oysters were very satisfactory. Larger shipments to the western States and the interior formed a noticeable feature of the season's trade. It is generally held that the chief factor in bringing about this condition of affairs was the comparative scarcity and high price of oysters in the Baltimore market. Numbers of the Maryland dredging vessels transferred their operations to North Carolina waters, and some of the Baltimore packers established houses in that State. The new Maryland "cull law," requiring the return to the water of all oysters less than 2½ inches in length, materially reduced the output and was the principal cause of the scarcity of oysters for shucking purposes.

The oyster-packing industry of Norfolk and the adjacent city of Portsmouth had the following extent in the calendar year 1890. The season of 1890–91 was not over at the time of the inquiry, and no statistics for that time could be obtained; it is known, however that the business was considerably larger than is shown by the figures.

Number of firms	24
Number of employés	1,605
Value of buildings, machinery, tools, etc	$308,125
Cash capital	$94,800
Bushels of oysters bought	1,897,871
Cost of same	$1,043,829
Cost of opening and packing	$317,060
Gallons of shucked oysters sold	1,385,307
Value received	$1,454,572
Gross profits of the trade	$93,683

During the year 1890 the average price paid by the packers for the oysters utilized was between 50 and 60 cents a bushel. The shucked oysters had an average value of $1.05 a gallon, the latter measure representing about 1⅗ bushels.

While at Norfolk, the methods of oyster-culture pursued in Lynn Haven River were studied, and a knowledge was acquired of the conditions to which the celebrated oysters there reared are subject. Lynn Haven River empties into the Chesapeake Bay about 5 miles from Cape Henry and 12 miles in an air line from Norfolk. The river has two main arms and extends inland for about 5 miles. On the east it is connected by an exceedingly long and narrow thoroughfare with Broad Bay, which, in turn, joins Linkhorn Bay. Owing to the very slight rise of tide which occurs in these bays, they can not be utilized for planting purposes, as the oysters will not fatten and thrive under such conditions, and they simply serve as natural seed beds. The river has long been the scene of oyster-raising, and of late has come into prominent notice on account of the fine grade of oysters that have been shipped from this place, known to the trade as "Lynn Haven Bays," or "Lynn Havens," which deservedly rank among the finest stock now placed on the market. As early as seventy-five years ago oysters were planted in the river, and the business may be considered to have been permanently established fifty years ago, since which time it has gradually increased in extent and importance.

The fresh-water streams emptying into the Lynn Haven River are of small size and do not carry a sufficient volume of water to affect, except in a minor degree, the salinity of the river, which is said to be almost as pronounced as that of the adjoining waters of the Chesapeake Bay. Conditions exist apparently favorable to the development of minute vegetable organisms—desmids and diatoms—upon which oysters are now known chiefly to subsist, and the abundance of such food no doubt accounts for the rapid growth and characteristic flavor which distinguish these particular mollusks. There have been years when an apparent excess of vegetable food has imparted a green coloration to the gills of the oysters, a feature which from time to time has attracted much attention in oyster circles throughout the country, and which has been shown to be due to the absorption of the coloring matter of ingested algæ. The winter of 1888–89 was one of the seasons in which the Lynn Haven oysters became thus affected.

The oyster beds or "coves" in this river are in part leased from the State and in part owned by private individuals. The holdings vary in extent from 2 to 40 acres or more. Semi-professional fishermen usually have from 2 to 5 acres, while the regular planters lease or own 30, 40, or more acres. It is interesting to observe that much of the oyster land in the vicinity of Church Point, one of the most favorable locations, has been only comparatively recently submerged. Some of the ground is the part of an old graveyard, and even now by wading a man may feel the submerged tombstones. Nearly all persons living on the shores of the river and its multitudinous coves are more or less interested in oyster-culture. In round numbers there are 100 regular planters and as many more irregular or semi-professional, not including the persons employed in tonging, packing, carting, etc.

The entire output of the river consists of oysters that have been artificially reared, there being no natural beds. Originally most of the seed oysters in Lynn Haven River were brought from Broad and Linkhorn bays, and even at the present time a part of the yearly supply, amounting to 4,000 or 5,000 bushels, comes from those sources, but a considerable quantity is also obtained from the James River and the Chesapeake. To a small extent the planters depend on spat obtained from their own grounds, some "coves" being apparently better adapted than others for producing native seed. The practicability of sowing shells for the attachment of the spat is fully understood by those planters who depend for their supply to some extent on spawning oysters on their own beds, and this method is followed whenever it is desired to collect spat. The seed oysters placed in the river are usually one year old, and are allowed to remain down about three years. Oysters raised from the spat are taken up for market when four years old. Some oysters, destined for special trade, are left down five or six years, and reach the exceptionally large size for which the "Lynn Havens" are noted.

In recent years the ruling price for Lynn Haven oysters at first hands has been about $2.50 per bushel, regardless of size. Small quantities of specially large oysters often bring $3 or $3.50 per bushel. In 1887 26,000 bushels of oysters were reported to be on the beds in the Lynn Haven River, of which 9,500 bushels were taken up and sold, yielding $23,750. The following year there were 42,000 bushels on the grounds, and of these 7,800 bushels were marketed for $19,500. In 1890 the output was larger than for some years, amounting to 11,153 bushels, valued at $26,100.

The principal fishing in the vicinity of Cape Charles City is with pound nets. Owing to the ample facilities for shipment by both rail and water, to the favorable character of the shore, to the proximity of the ocean, and to the general abundance of fish, this is perhaps the finest region for pound-net fishing in the Chesapeake Bay as regards marine species, the run of Spanish mackerel, bluefish, and squeteague being particularly large; but on account of the absence of fresh-water streams of any volume the catch of shad, alewives, and other anadromous fishes is very small as compared with localities on the opposite side of the bay. In 1889 17 pound nets were operated along this shore between Hunger Creek and the mouth of the bay, and in 1890 16 nets were set. The fishery in 1889 yielded 934,835 pounds of fish, for which the fishermen received $16,155, and in 1890 1,169,033 pounds, with a first value of $15,988. Some interesting notes (based on the results of the fishery) were obtained on the abundance and movements of certain species in those years. Among other commercial fishes occurring on this shore, and taken in the pound nets, the following may be briefly referred to; the common names in use in the region are given in quotation:

Scomberomorus maculatus. *"Spanish mackerel"; "Bay mackerel."*

This is the most important fish taken, and the average catch per net is probably larger than at any other locality on the Atlantic coast. The fish reach this shore late in May or early in June, and are usually in a spawning condition when they arrive. The first run consists of larger fish than those which come in July and are most abundant through the summer. In fall there appears to be another run of large fish. The average weight of the fish caught is 1¼ pounds, but examples weighing as much as 6 pounds are not rare, and, on the other hand, large quantities of very small fish are often secured. The run in 1889 and 1890 was considered quite large, although less than 10 years ago. The most noticeable feature of the fishery in 1890 was the occurrence in the fall of enormous quantities of very small fish; they weighed a quarter of a pound or less and 200 were required to fill a bushel measure. Old fishermen reported that never in their experience had there been so many "tinkers" as in August and September, 1890. Two pound nets of Mr. C. F. Wilkins, near Hunger Creek, are said to take more Spanish mackerel than any others in the bay; they have been set from the same shore for many years, and are of special interest because the first experiments in the artificial hatching of Spanish mackerel were made with eggs obtained from fish caught in these nets.

The following table, showing the daily catch of these pounds in 1889 and 1890 will be of interest as indicating the times of arrival and departure of the fish in this locality and the fluctuations in abundance; the figures do not include the small mackerel referred to, of which no account was taken. As such detailed and accurate information is not often obtainable, it probably warrants the full presentation given it.

Daily pound-net catch of Spanish mackerel near Hunger Creek, Northampton County, Va.

Month and day.	Number caught.		Month and day.	Number caught.		Month and day.	Number caught.	
	1889.	1890.		1889.	1890.		1889.	1890.
May 24	....	2	July 1	916	42	Aug. 9	79	69
26	....	2	2	1,154	238	10	274	....
27	....	2	3	1,336	1,012	12	877	310
29	....	7	4	899	623	13	67	....
30	....	1	5	1,800	314	14	198	57
31	....	2	6	475	....	15	1,038	187
			7	....	506	16	164	2
Total	....	16	8	535	55	17	301	....
			9	241	682	18	....	1,050
			10	84	....	19	166	100
June 2	....	10	11	37	275	20	146	220
4	4	3	12	284	75	21	96	169
5	15	11	13	76	....	22	121	(*)
6	13	179	14	....	318	23	146	(*)
7	....	135	15	42	500	24	227	(*)
8	8	....	16	1,080	1,300	25	....	62
9	....	6	17	344	505	26	143	....
10	111	21	18	190	1,979	28	22	....
11	59	15	19	2,400	250	29	....	13
12	93	13	20	1,474	....	30	12	9
13	53	....	21	....	119	31	30	....
14	15	3	22	925	5	Total	6,428	4,633
15	122	....	23	257	....			
16	....	30	24	815	1	Sept. 1	646	12
17	281	1	25	137	45	2	....	1
18	221	6	26	1,380	163	3	69	....
19	85	170	27	225	....	4	56	....
20	11	381	28	....	107	5	50	9
21	2	91	29	2,135	1,684	6	96	14
23	....	746	30	621	369	7	95	....
24	191	50	31	186	2,715	8	....	18
25	195	66				9	....	49
26	316	115	Total	20,048	13,882	10	....	3
27	541	124				11	....	2
28	635	98	Aug. 1	254	286	13	....	8
29	358	....	2	895	192	15	....	5
30	....	18	3	544	....	16	....	1
			5	262	575	17	....	9
Total	3,329	2,292	6	72	1,120	Total	1,012	131
			7	137	132	Grand total	30,817	20,954
			8	157	80			

* On these days a storm was raging and no fish were caught.

Another lot of pounds, consisting of 4 nets in 1889 and 3 nets in 1890, situated nearer the ocean than the foregoing, took the following number of mackerel:

Monthly pound-net catch of Spanish mackerel near Cape Charles City, Va.

Month.	Number of fish caught.	
	1889.	1890.
May	....	58
June	3,378	3,132
July	15,304	3,223
August	3,655	3,459
September	250	10,723
Total	22,587	20,595

The aggregate yield of Spanish mackerel on this shore was 151,934 pounds in 1889 and 124,640 pounds in 1890, valued at $10,783 and $6,799, respectively. The fish are sold by the piece, at the uniform price of 8½ cents each. The fishermen explain that the somewhat smaller yield in 1890 was not due to a scarcity of fish, but to conditions of weather and temperature which kept the fish offshore or beyond the reach of the nets.

Pomatomus saltatrix. *"Bluefish."*

Next to the Spanish mackerel the bluefish is the most valuable species taken in the pound nets. July and August are the months during which the largest runs occur; the catch then is always greater than in May, June, September, and October. The fish was as abundant at Cape Charles in 1890 as it was ever known to be, but as the schools kept well offshore for the most part, the catch was not commensurate with the abundance. The following statement, based on the catch in nets for which detailed figures are available, shows the monthly variations in the abundance of the fish in the inshore waters:

Monthly pound-net catch of bluefish in the vicinity of Cape Charles, Virginia.

Month.	1889 (6 nets).	1890 (5 nets).
	Pounds.	*Pounds.*
May	35	2,214
June	6,680	6,772
July	19,073	13,567
August	13,436	14,420
September	1,773	8,190
October	....	490
Total	40,997	45,653

The total catch of bluefish in pound nets was 71,420 pounds, valued at $2,193, in 1889, and 112,703 pounds, worth $3,161, in 1890. The yield of most of the nets is sold on the grounds at the uniform rate of $2 a bushel.

Cynoscion nebulosum. *Spotted squeteague; "Trout"; "Salmon trout"; "White trout."*

The spotted squeteague ranks next to the preceding species in commercial value. It occurs from April to October, inclusive, although it is taken in small quantities early and late in the season, as only a few and often no pound nets are then in operation. The fish is most common in July and August, during which months more than half of the catch is made. The fish was four times more abundant in 1890 than in the previous year, although it is usually not subject to variations so marked as this. The aggregate catch in the pound nets of this section was 62,610 pounds in 1889 and 262,110 pounds in 1890, for which the fishermen received $672 and $2,251, respectively. Nearly all the fish are sold locally by the bushel, at prices ranging from 50 cents to $1, according to the demand. The average weight of the fish is one-half pound. The monthly fluctuations in abundance are shown in the following table, representing the catch of a part of the nets:

Monthly pound-net catch of spotted squeteague in the vicinity of Cape Charles, Virginia.

Month.	1889 (6 nets).	1890 (5 nets).
	Pounds.	*Pounds.*
April	....	70
May	....	8,138
June	5,010	10,406
July	7,636	29,540
August	7,438	25,078
September	3,343	8,488
October	280	4,690
Total	23,707	86,410

Cynoscion regale. *Weakfish; "Gray trout."*

Unlike its congener, the spotted squeteague, the weakfish is found on this shore only early in the season, being very rarely taken after July. It would seem that coincident with the beginning of the largest catch of bluefish, there is a cessation in the run of weakfish. The fish have an average weight of 1½ pounds, and, like bluefish, are mostly sold at $2 a bushel, which is equivalent to about 3 cents a pound. In 1889 12,720 pounds were caught, and in 1890 19,800 pounds. The monthly yield of the nets for which detailed figures are available was as follows:

Monthly pound-net catch of weakfish in Northampton County, Va.

Month.	1889 (6 nets).	1890 (5 nets).
	Pounds.	*Pounds.*
May	1,313	1,626
June	4,128	5,482
July	1,738	2,022
Total	7,179	9,130

Elacate canada. *Cobia; "Bonito"; "Coalfish."*

Most common in June, and probably more numerous on the eastern shore of Virginia than elsewhere in the Chesapeake. The fish taken weigh about 20 pounds on an average and sell for 25 cents each. Next to the sturgeon this is the largest food-fish occurring regularly in the bay; it reaches a weight of 150 pounds.

Trachynotus carolinus. *"Pompano"; "Sunfish."*

Weighs about 1¼ pounds and sells at 12½ cents each. Occurs sparingly between May and September. During some seasons it becomes very abundant. The fish doubtless spawns in the Chesapeake, as ripe fish have been found in June.

Caranx hippos. *Crevallé; "Trevallé."*

Occurs abundantly in the lower Chesapeake, but is generally so small that when taken it is not utilized; it weighs less than half a pound. It seems to enter the bay for the purpose of spawning, which takes place in midsummer.

Roccus lineatus. *Striped bass; "Rock."*

This valuable food-fish occurs regularly on this shore in March, April, and May, but is much less numerous than formerly. In 1890 the entire pound-net catch was only 15,512 pounds, valued at $566. Dr. John T. Wilkins states that this species was formerly very abundant in the lower bay, where it was taken by seine fishermen of the eastern shore and sent to Norfolk by the vessel load, selling for 25 to 50 cents a bushel. The yield was enormous; hauls of 200 to 400 bushels were often made, and an average catch for a 100-fathom seine was 40 bushels to each haul, from the last of March to the middle of May. About 1855 the fish began to decrease, and have continued more or less scarce to the present time. Three sizes of fish are taken on this coast, to which the fishermen have applied different names. The smallest ones, called little rock, weigh 1 or 2 pounds; the next size, called chub rock, average 10 pounds in weight; the largest, or bass rock, range from 20 to 60 pounds, averaging about 35 pounds. The run of the little rock precedes that of the others; it begins in March, and is soon joined by that of the chub rock, the two sizes being found till about May 15. About May 10 the bass rock appear and continue running until June 1. Another short run occurs in September and October, but few fish are then taken.

Chætodipterus faber. *"Porgy"; "Moonfish."*

Weighs 3½ to 4 pounds, and is a food-fish of some value. It sells at 10 cents each. Arrives in schools late in May, and is most numerous in June and July, when most of the fish are caught. It usually remains in the bay until the latter part of September. In 1889 six nets took 1,164 of these fish, 1 being caught in May, 891 in June, and 272 in July. The following year the fish were comparatively scarce, and only 111 were taken in the same nets. It is more abundant on the eastern side of this part of the bay than on the western shore, where the salinity of the water is reduced by a large volume of fresh water brought down by the rivers. The following interesting account of the spawning conditions, eggs, etc., of this fish in this part of the Chesapeake Bay is from an unpublished article by Mr. R. Edward Earll:

Porgies seem to visit Chesapeake Bay for the purpose of spawning. When they first arrive the ovaries and spermaries are well advanced, and soon individuals may be found with the eggs and milt running freely from them. On June 3 several females were seen at New Point, Va., with eggs nearly ripe, while ripe males were very abundant. June 28 ripe fish of both sexes were found at Crisfield, Md., and eggs were taken from several females and impregnated, after which they were confined in floating boxes having wire-cloth bottoms, which had been placed in the water of the harbor. They hatched out in eighteen hours, with the water at a temperature of 84° F. Other lots were also taken and successfully hatched, the time varying with the temperature; with the water at 78° F. it required twenty-four hours.

The eggs are one twenty-sixth of an inch in diameter, and have a specific gravity almost exactly the same as that of salt water; when there is no motion most of them remain at or near the surface, but with the least current they become generally distributed through the mass. Each egg has a very prominent oil globule, which keeps it in a proper position in the water.

The porgy is a very prolific species, a good-sized individual probably containing about a million of eggs. These ripen irregularly, some being quite green and immature after the first have been deposited. As the eggs ripen they burst the membrane that holds them and pass down the channel that leads to the vent; they are thus thrown out gradually, or at intervals of a few days at most, the time required by the individual for spawning being not less than six weeks, while the spawning season for the species must extend into September. The species evidently matures when young or are of slow growth, for an individual weighing only half a pound was seen with the spermaries fully developed and the milt running freely.

Archosargus probatocephalus. *Sheepshead.*

Arrives in small schools early in May and remains until November. Most common in the pound nets in June. Weighs about 4 pounds and sells for 35 cents each. Much less numerous than it was a few years ago, when a single net took more than the aggregate yield in 1890. When pound nets were first introduced it is said that large catches were often made, and it is reported that during one day in September, 1877, a single net on this shore took 1,700 sheepshead, which were sold in Norfolk for $600.

Clupea sapidissima. *Shad.*

Arrive in March and are taken until June. The entire catch in all the pound nets is usually less than that in a single net on the opposite side of the bay, being 12,700 pounds in 1889. In 1890, however, there was a larger run, and 44,872 pounds were obtained.

Brevoortia tyrannus. *Menhaden; "Alewife"; "Oldwife."*

A small pound net set near Cape Charles City in December, 1890, caught small numbers of menhaden. The fish were of medium size, and, while not abundant, were quite constant in their occurrence at that time. Similar evidence has recently been adduced going to show that the fish is a regular, but perhaps not abundant, winter inhabitant of the Chesapeake.

Other economic fish taken in the pound nets are alewives (*Clupea æstivalis* and *C. pseudoharengus*), called "herring"; sturgeon (*Acipenser oxyrhynchus sturio*); redfish (*Sciæna ocellata*), called "drum" and "red drum;" sea bass (*Centropristis striatus*), locally known as "black will" and "black bass"; harvest fish (*Stromateus paru*), the "butter-fish" of the fishermen; spot (*Leiostomus xanthurus*); flounders (*Paralichthys dentatus* and other species); kingfish (*Menticirrhus saxatilis*); albacore (*Albacora thynnus*), called "horse-mackerel," and numerous other salt-water fishes taken irregularly or in small numbers.

In September, 1890, Mr. William P. Seal, superintendent of aquaria of the U. S. Fish Commission, visited this region for the purpose of obtaining a collection of living fishes. Mr. Barton A. Bean, assistant curator of the department of fishes in the U. S. National Museum, accompanied the party and has published a list* of the fishes there observed, which is an important contribution to the knowledge of the fish fauna of the lower Chesapeake. Sixty-nine species were detected during a visit of two weeks and an inquiry made earlier in the season would doubtless demonstrate the occurrence of a great many additional species.

At Cape Charles an inspection of the works of the International Oyster Company was made, and an opportunity was there afforded to witness the method of "wiring" oysters for distant shipment in the shell, on which process this company holds letters patent. The method originated with Mr. A. A. Freeman, the present manager of the company, and was first employed on a small scale in Philadelphia. In 1888 a stock company was formed to utilize the principle and the plant was located where it now is. The "wiring" is a simple process, consisting of the application of a rather stout wire tightly around the valves of the oyster. At first all the work was done with pliers and was necessarily slow, but in November, 1890, special machines were introduced, by means of which one man has been known to wire 48 oysters in a minute, but the average is much less. The advantage claimed for this process is that the natural juices are retained and the deterioration in quality which ensues upon their evaporation is prevented. In the prospectus which the company issues, Prof. John A. Ryder is quoted as indorsing the value of the method as follows:

> I have examined and had in my possession a number of wired oysters, and I am satisfied that the oyster can be preserved when the shells are thus wired for a considerable length of time. I have carefully examined oysters which I am satisfied have been wired for sixty days and I find that their vitality is fully preserved and the oyster in no way deteriorated in quality or flavor. I think the process of preserving oysters by placing a wire around them is a practically useful process, and in my opinion would lead to the transportation of oysters to distant points as an article of commerce, when it would be otherwise impossible to transport them alive in the shell.

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* Proceedings of U. S. National Museum, vol. XIV, p. 83.

MINOR FIELD WORK.

A number of other investigations, some of a more or less local nature, were undertaken by the division, among which the following may be mentioned:

The canvass of the fisheries of the State of New York, referred to in a previous report, which began in May, 1889, occupied the next fiscal year until August 24, when Mr. Charles H. Stevenson, the field agent who had been conducting it, was transferred to work in the New England States. This inquiry related to the calendar years 1887 and 1888, and the information was in part utilized in a statistical abstract of the coast fisheries.

In March, 1891, Mr. W. A. Wilcox made an examination of the wholesale fish and oyster trades of Philadelphia. Part of the information obtained was utilized in a report on the statistics of the fishery industries, and part will be available for incorporation in a later report on the fisheries of the Middle Atlantic States, the investigation of which is contemplated.

Independently of the extensive investigation of the entire fishing industry of the New England States, to which reference has been made, Mr. F. F. Dimick, the local agent of the office at Boston, Mass., has boarded each vessel landing fish at that port and obtained an account of the quantities and values of each kind of fish taken and the grounds on which the fishing was done, together with other information relating to the number and nationality of the crew, value of vessel, value of outfit and apparatus, etc. As Boston is the center of the fresh-fish fishery of New England, and as a large fleet of market and other vessels belonging not only at Boston but at many other fishing ports on the New England coast makes its headquarters at that place, the returns thus made by Mr. Dimick convey a very good idea of the extent and condition of the vessel fisheries of that region and are especially valuable in that they definitely indicate the actual and relative importance of the various fishing-grounds resorted to by the different vessels engaging in the different fisheries. Work essentially similar to that in Boston is done by Capt. S. J. Martin, a local agent, at Gloucester, Mass., and taken in conjunction with the inquiry made by Mr. Dimick in whole or in part covers the operations of nearly seven-eighths of the offshore fishing vessels of New England.

In June, 1891, Mr. Stevenson visited Wilmington, Del., and Newark, N. J., to obtain certain statistical and other information concerning the porpoise fisheries on the North Carolina coast south of Cape Hatteras. These are controlled by oil and leather companies located in the cities named, and the data desired by the office could not be secured at the time the agent visited the region in the course of the regular investigation of the fisheries of North Carolina already alluded to.

MISCELLANEOUS AFFAIRS OF THE DIVISION.

Relations with the Census Office.—With a view to secure the coöperation of the Fish Commission with the Census Office in taking a census of the fisheries and the subsequent preparation of reports thereon, as was done in the census of 1880, the Superintendent of Census, Hon. Robert P. Porter, in July, 1889, entered into communication with the Commissioner of Fish and Fisheries, and on August 26, 1889, appointed Capt. J. W. Collins, assistant in charge of the Division of Fisheries, a special agent in charge of the fishery census. On December 18, 1889, Capt. Collins resigned this position, other official duties demanding his entire time. Close relations between the two bureaus were still maintained, however; and, in response to requests from the Superintendent of Census, such data as the Fish Commission had collected were placed at the disposal of the Census Office.

Treasury Circular, "Statistics of the Fisheries."—The purposes and provisions of this circular have been fully discussed in previous reports of the Commissioner and the division. Its operation began in December, 1885, and continued in active force until October, 1890. During the five and a half years ending June 30, 1891, the number of circulars received was 23,177, of which 4,649 were received in 1889–90 and 2,266 in 1890–91; during the last six months of the fiscal year 1891 only 614 circulars were forwarded to the office. The circumstances which led to the discontinuance of the circular are embraced in the following correspondence between the Fish Commission and the Treasury Department:

[The Commissioner of Fish and Fisheries to the Secretary of the Treasury.]

WASHINGTON, D. C., *August 18, 1890.*

SIR: Permit me to call the attention of your Department to the fact that in certain customs districts the requirements of Treasury Circular, Statistics of the Fisheries (No. 45, Bureau of Navigation, series of 1887), are apparently being overlooked or disregarded, to the detriment of the work of this office.

I have the honor to transmit a list giving the names of the customs districts that are derelict, together with such brief annotations as are thought necessary to show your Department the special conditions prevailing in each case.

It should be stated that at one time all the districts in question were complying with the circular; but, for reasons unknown to this office, they have, for a greater or less length of time, ceased regarding it.

I have to request that you will kindly have this matter brought to the attention of the collectors of the districts named, to the end that reports omitted in the past may be forwarded, and that in the future the requirements of the circular may be promptly and completely carried out.

I desire to improve this opportunity to convey to you an expression of the obligation felt by the Fish Commission for the assistance given by your Department in the matter of collecting fishery statistics. I have pleasure in expressing my hearty appreciation of the faithful manner in which the work has generally been performed by customs officials, and it only needs the addition of the few links in the chain, which

I have indicated, to make the work complete, which is not only an important auxiliary in our statistical inquiry, but has the additional merit of being inexpensive.

Yours, very respectfully,

M. McDONALD,
Commissioner.

[The Secretary of the Treasury to the Commissioner of Fish and Fisheries.]

WASHINGTON, D. C., *October 6, 1890.*

SIR: Your letter of the 18th of August last, relating to the statistics of the fisheries, was brought to my attention on my return recently to the Department.

It appears that collectors of customs in certain customs districts are disinclined to obtain the statistics you desire. The Department understands that when the subject of obtaining statistics through the offices of collectors of customs was first considered there was an intention of obtaining Congressional action in regard to the matter, and that the work to be performed by the customs officers in ascertaining and forwarding the information was to be temporary only. This was in the year 1886. It now appears from your communication that the statistics obtained are defective, owing to neglect on the part of the customs officers, and it has been stated to the Department that statistics somewhat similar are being gathered by the Census Bureau.

In the absence of any special appropriation for the purpose, or authority of law, it seems to me inexpedient to attempt further to collect the statistics through the officers of the customs.

The supply of blanks prepared by this Department is exhausted.

Respectfully, yours,

W. WINDOM,
Secretary.

Special information and statistics furnished.—The division is called upon to furnish to private parties, State officials, Congress, and the Executive Departments descriptive and tabular matter on various special subjects connected with the fisheries, which in the course of a year often constitutes a prominent feature of the work. While much of the information requested is already available and is readily furnished, some of the inquiries occasion protracted research, and may occupy the attention of the office force for a considerable time. An idea of the nature of the calls made on the division may be gained from the following partial list of data prepared for Government and State officials in the years 1890 and 1891:

An opinion relative to the effect on the abundance of fish in this country of the unrestricted use of pound nets, traps, purse seines, and gill nets.

Statistical and descriptive data covering the sponge fishery of Florida.

Statistics and observations regarding the salt-clam bait used by British provincial fishermen.

Summary statement of persons employed in the fisheries of Barnstable County, Mass., in 1889.

Detailed table giving the capital invested in vessels, boats, apparatus, etc., in Barnstable County, Mass., in 1889.

Statement of the quantities and values of each fishery product taken in the fisheries of Barnstable County, Mass., in 1889.

Comparative table showing the extent of the fisheries of Barnstable County, Mass., in 1880 and 1889.

A series of twelve tables showing the extent of the fisheries of Florida.

Comparative statistics of the oyster fishery of Connecticut, Maryland, and Virginia, in 1880 and 1890, with a synopsis of the laws in force and a discussion of the influence of the States' policy on the increase or decrease in the industry.

The whale fleet of the United States in 1889 classified by rigs of vessels and fishing-grounds.

The whale fleet of the United States in 1889 classified by hailing ports and fishing-grounds.

Table showing by hailing ports of vessels the products of the whale fishery of the United States in 1889.

Detailed statements for the year 1889 giving the operations of the San Francisco whale fleet in 1889, of the New Bedford fleet rendezvousing at San Francisco, of the New Bedford fleet having headquarters at that place, and of the Boston, Edgartown, Provincetown, Stonington, and New London fleets.

Summary of the receipts of whale products at Boston, from 1880 to 1889, inclusive.

Summary of the receipts of whale products at Provincetown, from 1883 to 1889, inclusive.

Summary from 1880 to 1889, inclusive, of the whaling vessels arriving at Edgartown, and the products landed by them.

Summary from 1880 to 1889, inclusive, of the whaling vessels arriving at New Bedford, and the products landed by them.

The San Francisco fur-seal, sea-otter, and walrus fleets in 1888.

The porpoise industry of North Carolina in 1889-90.

Three tables covering the fisheries of the Chesapeake Bay.

A series of six tables exhibiting the condition of the oyster fishery and oyster-packing trade of Virginia.

Three tables giving the extent of the coast and river fisheries of Maine in 1887 and 1888.

A detailed table showing by townships the condition of the lobster fishery of Maine in 1887, 1888, and 1889.

A statement by counties of the extent of the lobster-canning industry of Maine in 1887, 1888, and 1889.

When requests for information of the foregoing nature come from private individuals, an effort is always made to comply therewith, provided the desired data can be prepared without serious detriment to the regular work of the division. Demands have occasionally been refused, because, in order to fill them, days of research by many clerks would be necessary.

International Maritime Exhibition, Boston, Mass.—This exhibition was held for the purpose of presenting a history of the development of naval architecture and the shipping trades. It opened on November 4, 1889. The United States Fish Commission sent models of the steamers *Albatross* and *Fish Hawk*, and a number of photographic enlargements and crayon sketches of fishing vessels, boats, and methods, as well as swinging screens containing views illustrating the same subjects. Mr. W. H. Abbott, a field agent of this division, was detailed to superintend the installation of the articles.

ANALYSIS OF REPORTS ISSUED.

While the number of reports prepared by the division and printed during the years covered by this report was not large, several of them were very extensive and were important contributions to the subjects considered. Several other papers dealing with the commercial fisheries were prepared and submitted for printing in this period, but they were not issued until after the close of the period under consideration. The reports printed were as follows:

1. The beam-trawl fishery of Great Britain, with notes on beam-trawling in other European countries. (Bulletin U. S. Fish Commission, VII, pp. 289–407, 23 plates, 34 text figures.)

This report deals with the most important vessel fishery of Great Britain. Special chapters treat of the history and importance of the fishery, the fishing-grounds, the fishermen, the vessels, the apparatus, the methods of fishing, marketing of the catch, the effects of the fishery on the abundance of fish, beam trawling on the continent of Europe, attempts to use the trawl in the United States, and the possibility of its successful employment in this country. Some idea may be gained of the extent of this fishery when it is stated that about 20,000 persons find exclusive employment therein, and that the annual production is about 450,000,000 pounds, having a value of over $13,000,000, a sum that represents more than one-third the value of the entire coast and inland fisheries of the United States.

2. Suggestions for the employment of improved types of vessels in the market fisheries, with notes on British fishing steamers. (Bulletin U. S. Fish Commission, VIII, pp. 175–192, 10 plates.)

The recent improvements in the methods of preserving fish in a fresh condition, and in shipping them to distant points, have demonstrated the necessity for securing the more rapid landing of the fish after being caught, in order that they may reach the consumer in the best possible state of preservation. The greatest amount of deterioration ensues between the taking and the landing of the fish, and it is the reduction to a minimum of this impairment in quality which is demanded by the present conditions of the fresh-fish trade. To secure this result, an improvement in the form of the fishing vessels is the principal consideration, and in this report the special types of vessels adapted to different fisheries and to particular regions are indicated, described, and figured. Speed and seaworthiness are the main lines along which advances may be made in the building of fishing vessels; the possession of these factors will not only secure the landing of an improved quality of fish and the economy of time, but will also permit vessels to visit the more distant and less frequented grounds and thus perhaps add to the amount of the catch. The specially important subjects considered in the paper are the desirability of employing steamers in the market fishery of New England; the urgent need of steam vessels in the market fisheries of the Pacific coast, especially those of San Francisco; the advantages that would accrue as the result of the adoption of steam carriers in certain Chesapeake Bay fisheries; and the necessity for welled vessels and boats in the shore fisheries of southern California.

3. Review of the fisheries of the Great Lakes. (Report U. S. Fish Commission, XV, pp. 3-333, 44 plates.)

This report is a geographical review of the entire fishing industry of the Great Lake system. The history, methods, condition, and statistics of the fisheries are considered by minor civil divisions; the fishermen, apparatus, vessels, boats, and fishing-grounds are described; notes on the natural history, abundance, movements, etc., of the commercial fishes are given; the methods of preserving and shipping the catch are discussed; the extent of the wholesale trade in fishery products in the principal cities is shown; the changes in the methods of the fisheries since 1880 are indicated; detailed comparisons are made with 1880; the effects of artificial propagation on the maintenance of the supply is considered; illustrations are presented of the types of boats, vessels, principal forms of apparatus, methods, and most of the important food-fishes, and a series of large charts indicates the position and number of pound nets operated. The fisheries of the Great Lakes, which are the most extensive lake fisheries in the world, are shown by the report to have given employment to 10,355 persons; the capital invested was $4,520,081; the quantity of fish taken was 99,842,076 pounds, and the value of the catch to the fishermen was $2,691,866. An edition of 1,250 copies of this report was distributed among the fishing interests of the Great Lakes.

4. Notes on the crab fishery of Crisfield, Maryland. (Bulletin U. S. Fish Commission, IX, pp. 103-112, 6 plates.)

The business of catching crabs, impounding them until after the shedding process, and of shipping them to market as soft-shell crabs, has in recent years attained considerable importance in Chesapeake Bay. A special study of the industry was made at Crisfield in 1888, which formed the basis for the remarks in this paper. Crisfield has the distinction of being the center of the most extensive crab-fishery in the United States, and the industry has of late years increased with wonderful rapidity. In 1888, 785 fishermen engaged in taking crabs in Crisfield and vicinity; 4,437,823 crabs were obtained, for which the fishermen received $72,129. The dealers in Crisfield, to whom the entire catch is sold, shipped 3,782,057 crabs, the market value of which was $111,731. The difference between the number of crabs caught and the number sent to market, amounting to 655,766, represents the mortality among the crabs as a result of the molting process and injuries received when caught.

5. Notes on an improved form of oyster tongs. (Bulletin U. S. Fish Commission, IX, pp. 161-163, 1 plate.)

The tongs described are adapted to deep-water fishing and may be successfully operated in 200 feet of water. The apparatus consists of two curved iron bars riveted together, terminating in a series of teeth, and is manipulated by means of a rope. By its use large areas of natural oyster beds have been brought within reach of the boat fishermen, whose earnings have been considerably augmented. In places on the Chesapeake Bay individual fishermen have, during some seasons, taken five times as many oysters with the new tongs as they could with the old form. The principle involved in this apparatus is of wide application in the fisheries, and will in time no doubt be extensively utilized in the clam, scallop, sponge, and other fisheries.

REMARKS ON THE FISHERIES.

Certain special matters having an important bearing on the commercial fisheries which have been brought to the notice of the office by its general and local agents and correspondents may be properly mentioned in this report. It is not the intention, however, to enter into an extended review of the condition of the fishing industry, a subject which will be fully treated of in the separate papers published by the office.

The modus vivendi.—An important provision of the proposed fishery treaty between Great Britain and the United States was the so-called *modus vivendi*, which accorded to United States fishing vessels certain privileges in Canadian ports pending the ratification of the treaty. Although the latter was rejected by the United States Senate in August, 1888, the Canadian Government extended the operation of this part of the treaty, and numbers of American vessels have taken advantage of it. In 1888, 36 vessels from New England ports paid $3,831 for licenses obtained in Canada; the following year 78 vessels paid $9,589.50; and in 1890, 119 American fishing schooners took out licenses for which $14,461.50 was expended. The license fee is $1.50 per net ton, and the privileges thereby secured are the right (1) to enter Canadian ports to buy bait, apparatus, and supplies, (2) to transship the catch, and (3) to ship crews. The vessels engaging in the bank cod and halibut fisheries are those which have the greatest occasion to avail themselves of this regulation.

Effects of abrogation of Washington treaty on the herring fisheries and the bait supply.—A report on the fisheries of the New England States now being prepared will contain the following reference to the influence which the expiration in 1885 of the fishery treaty with Great Britain has had on the herring fishery of Maine and on the development in certain places of an important bait fishery to supply the needs of American vessels:

Since 1885 the herring fishery of Maine has undergone a noticeable increase, which has been chiefly due to the abrogation of the Washington treaty. The manufacturing enterprises connected with the canning of lobsters, the canning and smoking of herring, etc., have steadily increased, and new life and new capital have been put into the industry to meet the demand for larger supplies of raw materials, among which herring rank first in quantity and importance. The increase in the number of weirs and other appliances of capture has been more marked each year, and the growth and extension westward of the fishery and the dependent shore industries has been one of the most noteworthy features of the fisheries of this State during the past decade.

An increase in the herring weir fisheries has in most localities been attended with a corresponding increase in the smoked-herring business, but in the region of Mount Desert Island a most interesting and important exception to this rule is to be observed, due to its favorable location as a baiting rendezvous for the bank cod fishermen of both Maine and Massachusetts. In this vicinity the increase in the number of herring weirs has had no appreciable effect on the smoking of herring, the smokehouses being more neglected than ever before. This condition is due to the circumstance that herring can be sold fresh for bait at better prices than would result from smoking them. The demand for bait in this section is now so constant and so great that the weir fishermen have not been able to meet it, and an extensive herring fishery with gill nets has been inaugurated within the past three years to supplement the weir fishery. At the Cranberry Isles and also in the vicinity of Southwest Harbor and Bar Harbor large numbers of bank and shore vessels are baited each year, and the practice of taking bait in this vicinity is annually becoming more popular and of increasing importance to the deep-sea fisheries. Prior to the building of weirs there was little or no baiting done here, and vessels were obliged to resort to more distant places and often had to go to the provinces at great loss of time.

The marked effect which the expiration of the reciprocity treaty with Canada has had on the development ot the fisheries and fishery industries of the entire eastern coast of Maine has been nowhere more noticeable than in the increased facilities afforded American vessels to procure an abundant supply of bait in home ports through the building of brush weirs.

Eastward movement of menhaden.—One of the most prominent and interesting features of the New England fisheries during the decade terminating in 1888 was the practically complete absence of menhaden from the Gulf of Maine, where they had previously resorted in enormous bodies and supported an industry of great importance. This failure of the menhaden to appear within such a large area was one of the most remarkable variations in the movements of our Atlantic coast fishes that has been recorded, and was much more noteworthy, although less important, than the present scarcity of mackerel. In 1888 large schools of menhaden were found east of Cape Cod, considerable numbers being taken as far east as Frenchman Bay, Maine. The next season there was a return of the fish to the Maine coast in schools fully as large and numerous as had ever before been observed. The fishery, which was begun on a limited scale in 1888, was greatly augmented, and many vessels from Rhode Island and other States found it more profitable to fish in Maine waters during a part of the season, which was one of the most successful since the establishment of the fishery. The Maine fishermen took over 10,000,000 pounds of menhaden in 1889, for which they received more than $28,000, and the factories located in the State utilized over 26,000,000 fish in the preparation of oil and guano, having a value of $87,144.

New England vessels fishing for Spanish mackerel in Florida.—The winter and spring of 1889–90 was quite noteworthy in the annals of the New England and Florida fisheries because of the experimental visits of two mackerel vessels belonging at Gloucester, Mass., to the west coast of Florida for the purpose of engaging in the capture of Spanish mackerel, which abound in these waters at that season. The vessels made their headquarters at Key West, and shipped their catch in ice to Tampa, Punta Gorda, and New York. One of the vessels, the schooner *Hattie S. Clark*, fished from December 1, 1889, to April 1, 1890, and caught during that time 100,000 pounds of Spanish mackerel, for which $8,000 was received, the crew of 12 men sharing $225 each. The other schooner, the *Schuyler Colfax*, made only two trips, between February 1 and April 1, 1890, and landed 30,000 pounds, the value of which was $2,400. The owner of the schooner reports that the vessels averaged 8,000 or 10,000 pounds of fish each trip and that this catch was made in half a day's actual fishing, although, because of the delay in getting ice, it usually took about two weeks to complete a trip. This trial opens up a new field for winter operations on the part of mackerel vessels, and the continued scarcity of regular mackerel on the New England coast may lead to the establishment of an important winter fishery off the coast of Florida.

Voyage to Africa for mackerel.—The scarcity of mackerel on the Atlantic coast of the United States, which has been marked since 1885 and has been more prolonged than during any previous similar period in the history of the fishery, prompted the owner of the schooner *Alice*, of Provincetown, Mass., to undertake the prosecution of the fishery on the southern coast of Africa, where whalers and merchantmen had reported that mackerel occurred in abundance. The vessel sailed for Cape of Good Hope in October, 1889, and made the longest cruise ever accomplished by a mackerel vessel, the distance being about 7,000 miles. On arriving at the grounds, fish were found in considerable numbers, and during the first nine months about 900 barrels of mackerel were packed, and some were shipped to the United States, where they arrived about December 1, 1890. Some of the fish were of large size, being 2 feet in length and weighing over 3 pounds when salted, and the consignment sold at $14 to $18 per barrel. Examples were sent to this office for examination, and the fish were found to be the bull's-eye, chub, or thimble-eye mackerel (*Scomber colias*), and not the common mackerel of our coast (*S. scombrus*). During the second season of the vessel's sojourn on the African coast only a few fish were taken, and the vessel returned home in June, 1891, after a cruise that was not on the whole successful, although important.

Increase of shore cod as a result of artificial propagation.—Few subjects that have recently come up in connection with the New England fisheries possess greater interest and importance than the results which have been achieved by the planting by the U. S. Fish Commission of cod in the inshore waters of the southern New England coast during the past few years. Very few of the fishermen of the region had much confidence in the feasibility of this attempt to increase the supply of codfish, and they were much surprised, as well as pecuniarily benefited, by the appearance of young cod in great abundance on grounds on which the fish have been scarce or absent for years. The fishery began in 1889, when a few small vessels made good fares, one schooner landing 300,000 pounds of small fish. The inquiries conducted by the office showed that in 1890, by the last of July, about 4,000,000 pounds of small and medium sized cod were taken in the inshore waters of southern New England, which even the most skeptical fishermen were willing to acknowledge were fish that had been artificially propagated at the government hatcheries at Woods Holl and Gloucester. As a result of this single fishery over $100,000 was added to the income of the fishermen, and there is reason to believe that a permanent summer fishery has been inaugurated that promises good returns.

Other fishery matters.—Various other events of importance to the economic fisheries during the period covered by this report attracted more or less attention, which need only be mentioned and not discussed. Among these were the Bering Sea dispute and the seizures of American and Canadian sealing vessels for violating the regulations of the United States regarding the capture of fur seals in that region, the fish paragraphs in the new tariff law and in the reciprocity treaties made with countries of Central and South America, the agitation of the oyster question in Maryland and Virginia, the seizures of Rhode Island menhaden vessels for fishing in Massachusetts waters in Buzzards Bay, etc.

APPENDICES.

1.—REPORT UPON THE INVESTIGATIONS OF THE U. S. FISH COMMISSION STEAMER ALBATROSS FROM JULY 1, 1889, TO JUNE 30, 1891.

By Lieut. Commander Z. L. Tanner, U. S. Navy, Commanding.

THE FISCAL YEAR 1889-90.

SOUTHEASTERN ALASKA, JULY, 1889.

The *Albatross* was at Departure Bay, B. C., July 1, 1889, coaling ship, preparatory to a trip to southeastern Alaska with several members of the Committee on Indian Affairs of the United States Senate. On July 3 she proceeded to Victoria for supplies, and on the 4th to Port Townsend, Wash., where Capt. J. W. Keen, an Alaskan pilot, was engaged for the cruise. We were joined at Tacoma, on the 8th, by Senators H. L. Dawes, F. B. Stockbridge, C. F. Manderson, and J. K. Jones, together with several officers of the Senate and their attendants. The steamer left Tacoma the same day, and after touching at Port Townsend for mail proceeded northward through the inland passage. Night anchorages were made at Carter Bay and Cardena Bay on account of fog and tides, but no other stops were made until Fort Tongas was reached on the morning of the 11th. The senatorial committee landed, but, finding the place abandoned, soon returned on board, and we left for Port Chester, where we arrived the same evening. This beautiful bay lies on the west side of Annette Island and affords a secure harbor for all classes of vessels. The region has attracted much attention recently from having been selected as the site of the New Metlahcatlah, the home of Rev. Mr. Duncan's colony of Indians.

Mr. Duncan's labors among the Indians of British Columbia commenced about thirty years ago, and through his efforts a flourishing community had grown up at what is now called Old Metlahcatlah, near Port Simpson, B. C. The people were housed in comfortable cottages; churches and schools were in a flourishing condition; various industries were successfully prosecuted; and it was, in fact, considered the

Note.—All bearings are magnetic unless otherwise stated, and depths are expressed in fathoms.

ideal Indian community of the Pacific coast. Vexed questions of church discipline finally arose between the colonists and the bishop of the diocese, culminating about two years since in the abandonment of the settlement by the majority of the people, and removal to their present location. The site selected for the settlement was a densely wooded plain bordering on the bay, where many acres have been cleared and partially drained, and houses erected for the people. A steam sawmill and salmon cannery, and a large building for a general store have been built. The schoolhouse is the most imposing structure in the place, and compares favorably with many similar buildings in older communities. Boarding houses for boys and girls were in process of construction in connection with the school, all of this work being done by the Indians, under the general supervision of Mr. Duncan. The sawmill was burned shortly before our arrival. Mr. Duncan was absent, but the committee had several conferences with the leading men, obtaining from them the general condition of the settlement and their needs.

A dense fog prevailed until noon of the 12th, when we got under way for Karta Bay, via Clarence Straits. Arriving at 5:54 p. m., the committee visited the Indian village and cannery (the old Baronovitch fishery), which, in its day, was one of the most important in Alaska. Leaving Karta Bay at 7:55, we proceeded to Port Wrangell, where we arrived at 7:25 the following morning. The committee landed and visited the school and Indian village, returning at noon, when we went on our way. We entered Chatham Strait at 1 a. m., and at 5:30 came to with the stream anchor in 40 fathoms, near a rocky point off Kootznahoo Roads, for the double purpose of waiting for slack water at Peril Straits and to afford an opportunity for fishing. Many halibut and cultus-cod were caught with hand lines, and several salmon were captured by trolling. Leaving our fishing-ground at 7:50, we arrived in the harbor of Sitka at 4:20 p. m.

The next day, July 15, the committee were early on shore, visiting the Indian school, and other places of interest, while the vessel went to the Government wharf for coal. The wharf is a rickety affair, and the Government buildings, with few exceptions, are rapidly falling into decay. The Indian settlement occupies most of the water front, and, owing to strict sanitary measures and general supervision during the U. S. Naval regime, presents a very respectable appearance. Most of the men were away at the salmon fisheries, and the women and old men were busy in the manufacture of baskets and Indian curios, that being about the only industry prosecuted in the place. It was rainy and misty on the morning of the 16th, but partially cleared about noon. Through the courtesy of the governor, Mr. George Kastrometinoff joined us as interpreter for the northern trip, to facilitate communication with the native tribes.

We left Sitka at 4:35 p. m. for Peril Straits, through which we passed at slack water, and came to at 9:45 in Favorite Anchorage. A strong southeasterly wind sprang up during the night, with rain and mist, and on entering Chatham Strait the following morning, and finding that it would be impossible to land at Kootznahoo as intended, we turned to the northward, and ran into Pavloff Harbor, Freshwater Bay, for protection until the weather improved.

We found it a snug little anchorage, entirely protected from southerly winds. A salmon cannery was in operation on the western side of the bay, with the usual adjacent Indian village. Quite a large stream enters the head of the bay, over a fall of several feet, at the foot of which many trout were taken. Several salmon and a single halibut were caught by trolling. The senatorial party and others landed soon after our arrival, and visited the cannery, Indian village, and other points of interest. The following morning we went to Muir Inlet, reaching the great glacier at 2:40 p. m. The photographers and several of the senatorial party landed to get a nearer view of the glacier.

Leaving the glacier at 4 p. m., we worked our way down the bay through heavy masses of ice, which made navigation slow and intricate, until we reached the vicinity of Bartlett Bay. Soundings taken in Glacier Bay gave us 45 fathoms abreast of Willoughby Island, 48 at the entrance to Muir Inlet, and 57 about half a mile from the face of the glacier.

Steaming across Icy Straits, we anchored in the snug harbor of Hoonyah Bay, at 10:45 p. m., off a large village which the committee wished to visit; but it was found entirely abandoned by the Indians, who had gone on their summer hunting and fishing expeditions. The next day we went to the Indian village in Portage Bay. This village was also abandoned, but as the committee were anxious to meet the people, they went in the steam launch to the mouth of the river, up which they were rowed a mile or two in a skiff, and then walked a mile farther to the rapids, where the Indians were taking salmon. The senators were much pleased with their general appearance, and considered them superior to any native Alaskans they had previously met. Our anchorage at Portage Bay was in latitude 59° 09′ N., the highest point reached by the vessel during the season.

The committee having returned, we left at 7:36 p. m. for Chilkat, anchoring at 10:35 p. m., in Pyramid Harbor, in 21 fathoms. The committee visited the cannery and Indian village next morning. At 11 a. m. we proceeded to Juneau, where we arrived at 10:25 p. m., calling at Auk Village on the way, which was found abandoned.

The Senate committee held a conference with citizens and Indians of Juneau on the 22d, at which matters of interest to the Territory, and Juneau in particular, were discussed. We got under way at 3:30 p. m., and ran down the harbor to the great Treadwell Mine, the committee and others visiting the works. Leaving the mine at 5:30, we steamed to the southward. On the 23d, at 3:55 p. m., cast the trawl in 322 fathoms, black sand and gravel bottom, Lemesurier Point bearing NE. ¾ E. (mag.), distant $2\frac{2}{10}$ miles. After dragging a short distance, the trawl entered a soft mud bottom, with which the net became filled, and it required several hours careful work to land it on board. Hundreds of sea-urchins were brought up, besides starfish, ophiurans, annelids, shells, etc. One hagfish and another small fish, species unknown, were taken. The absence of fish was notable, and would seem to indicate unusually barren ground. A line of dredgings through the channels would be exceedingly interesting, as the only means of determining the species and general distribution of fish, occupying the inland waters of southeastern Alaska in summer time. Continuing our course to the southward, Victoria was reached at 8:40 p. m., without stop or incident, on the 26th.

The senatorial committee visited the principal places of interest in the city the following morning, including the dockyard and new dry dock at Esquimalt. We were under way at 3:40 p. m., and with steam and sail ran across the straits to Port Townsend, arriving at 7:35 p. m. Seattle was reached at 3 p. m. the next day, and Tacoma at 7:30. The members of the Senate committee were landed immediately, and, with many expressions of gratification at the results of the trip and regrets at its termination, took their departure. Prof. C. H. Gilbert left also, with instructions to return to Washington.

WASHINGTON, OREGON, AND CALIFORNIA, AUGUST-OCTOBER, 1889.

Preparations for cruise to Bering Sea.—We started for Port Townsend at 8:57, arriving at 11:50 a. m. on the 29th, having been detained about eight hours by fog. Supplies were obtained at this place, and, after completing our preparations for sea, we left at 2:30 p. m., August 1, for Departure Bay, British Columbia, arriving at 5:10 the following morning. Coaling was finished on the morning of the 4th, and we left the harbor at 2 p. m. for Bering Sea via Unalaska, under one boiler, the coal consumption being limited to 10 tons per day. The sky was clear, but the smoke, which had the effect of fog, obscured everything at a distance. This was caused by forest fires which prevail throughout Oregon, Washington, and British Columbia during the dry season, when the smoke becomes so dense at times that it is more dreaded by mariners than fog, rendering navigation exceedingly difficult and dangerous. It is prevalent until dissipated by the autumn rains.

We passed Seymour Narrows at 4:15 a. m. on the 5th, an hour before low water, and, although the swirls were somewhat heavy, the tide had slackened sufficiently to enable us to keep control of the helm without undue strain. It was discovered soon after leaving Departure Bay that the coal on board was of an inferior quality, and the allowance was increased to 12 tons per day, but even then we could not make our usual speed. At 8:05 p. m. we emerged from Goleta's Channel, steamed out into the Pacific, encountering light westerly winds and smooth sea. The weather was clear overhead, but misty about the horizon, obscuring the land.

Everything worked smoothly during the night and following day, and a gentle breeze from SW. enabled us to carry fore and aft sail. At 4:20 p. m., August 7, the port high-pressure piston broke, disabling that engine. The starboard one was uninjured and would drive the vessel between 4 and 5 knots per hour, dragging the port propeller; but it would be difficult to maneuver under favorable conditions, and in heavy weather the vessel would be nearly helpless. In view of the fact that there were no machine shops at Unalaska or any facilities for making repairs, the ship was immediately headed for Port Townsend, the nearest place affording the necessary appliances. The cylinder head was taken off as soon as practicable, and the broken piston was found lying in fragments at the bottom of the cylinder. The piston rod was bent, and there was a small scratch on the internal surface of the cylinder, but not of sufficient depth to do any damage. The low-pressure cylinder was uninjured, so the high-pressure engine was disconnected, and about three hours after the accident both propellers were working and, with the assistance of sail, the vessel was making nearly her usual speed. The accident happened in latitude 52° 45′ N. and longitude 136° 56′ W., 649 miles from Port Townsend. We encountered fog as soon as we approached the coast, but the sea remained comparatively smooth and we carried our fair wind into the Straits of Fuca, arriving at Port Townsend at 11:17 a. m., August 11.

Fog signal at Cape Flattery.—An incident in connection with the Cape Flattery fog signal is worthy of mention. A dense fog prevailed as we approached the Cape, and an anxious watch was kept for the sound of the whistle, which was finally heard distinctly at a distance of 5 or 6 miles. Our course led us in the direction of the sound, but it continued to grow fainter, until at Duncan Rock, 1 mile away, it ceased to be heard, except at long and irregular intervals, and then so faintly that it would hardly have been noticed. There can be no possible question as to our distance from the whistle, as we made Duncan Rock ahead not more than a quarter of a mile away. Going on up the straits, the sound increased in volume and regularity, and at a distance of 6 miles was still distinctly audible. We have observed this phenomenon on two previous occasions, but failing to sight Duncan Rock were not absolutely certain of our distance from it. Other vessels have met with the same experience, usually attributing it to a temporary lack of steam. There are two or three small rocky islets lying between the whistle and Duncan Rock, all less than a quarter of a mile from the former, and, although low and insignificant in appearance they may have something to do with the deflection of the sound of the whistle from the direction of the latter.

The erratic action of sound signals has been a fruitful theme of investigation for many years, and while we have learned in a general way that sounds may ricochet over the surface of land and sea by successive contacts with uneven surfaces, or air strata of different densities, we have not been able to lay down any rule by which the mariner can determine the existence of abnormal atmospheric conditions: hence his lack of confidence in sound signals in general and the necessity for great caution when approaching them. The peculiarity in this case is that the phenomenon has been observed only on, or near, the bearing of Duncan Rock, the critical point in entering the Straits of Fuca.

Port Townsend to coast of Oregon.—Work on the disabled engine commenced on the 12th. A new piston was made, the rod straightened, and other minor matters attended to. The job was completed on the morning of the 22d, and at noon we left for Departure Bay, where we arrived at 10:15 a. m. the following day. We commenced coaling at 1 p. m. and finished at 10:15 a. m. on the 24th, having taken on board 94¼ tons. Leaving the harbor an hour later, we anchored for the night in Otter Bay, where we found a safe and convenient harbor. Large numbers of surf ducks and a few puffins were swimming leisurely about the bay when we entered, but soon disappeared. Fishing lines were put over the side, resulting in the capture of one flounder and a dogfish.

We were under way at 6 the following morning and anchored off Victoria at 10:15 a. m., where we called for supplies. We left there at 11:20 on the morning of the 27th, and, steaming out of the Straits of Fuca, passed Cape Flattery at 9 p. m. A course was then made for Tillamook Rock, which brought the vessel into the trough of a westerly swell, causing her to roll heavily. We were steaming with one boiler, as usual, the consumption of fuel being limited to 10 tons per day. The coal turned out even worse than the previous lot, reducing the speed nearly a knot and a half an hour.

Coast of Oregon.—At 11:47 a. m., August 28, we commenced sounding off Tillamook Rock, running lines from shore to a depth of 200 fathoms, occupying stations at intervals of about 5 miles and working to the southward. It is not an easy matter under the most favorable conditions to keep an accurate account of a vessel's position when using the beam trawl or hand lines, and it was particularly difficult to do so with the strong and irregular currents, smoky atmosphere, and boisterous weather prevailing on the coast of Oregon. Knowing that our soundings would be used for hydrographic purposes, the necessity for as great a degree of accuracy as practicable was so apparent that we decided to give our undivided attention to the determination of depths, character of bottom, and temperatures, to be followed later by the usual investigations with beam trawl, hand lines, and the various methods of biological research. The weather being exceptionally clear, we continued work night and day until, at midnight of the 31st, we were in the vicinity of Cape Gregory.

September 1 was an unusually clear day, and the sea was comparatively smooth. The time was spent on Heceta Bank and vicinity, many soundings being taken to determine the extent of the 40-fathom patch. The beam trawl was used successfully, although the bottom was rough, and when it was too rocky for the trawl the tangles were brought into requisition. Boats were lowered and hand lines used on different parts of the bank. The result of the day's operations may be stated as follows: The area of the 40-fathom patch on Heceta Bank is very small. Beam trawl and trawl-line fishing are impracticable on the rougher portions of the bank. Hand lines from boats will meet with the best results. Fishes and invertebrates were almost identical with those taken last season, but dogfish had not reached the bank in great numbers. The list of food-fishes will be found in the table of fishing stations.

An interesting haul of the beam trawl was made after dark in 93 fathoms, green mud, a few miles inshore of the bank. One hundred flounders were taken, representing four species; and also large numbers of rock-cod, one black-cod, one cultus cod, and several species of small fish. Holothurians and other invertebrates were found in large numbers. In a subsequent haul in 61 fathoms, green mud and sand, made between 8 and 9 p. m., 200 flounders were taken, besides other species. Considering the size of the trawl (11 feet beam) and the duration of the haul, which did not exceed 20 minutes, it must be conceded that the region is rich in the various species of flatfishes and rock-cod.

September 2 and 3 were spent in the examination of the region over which we had recently sounded. The beam trawl and hand lines were used, the different species of flatfish, rock-cod, etc., being found generally distributed along the coast. There was a uniform bottom of fine gray sand to a depth of about 40 fathoms, when green mud began to show, increasing in proportion until at 60 fathoms there was but little sand. One exception to the uniform character of bottom was a small bank or rocky patch lying SSW. ¼ W. magnetic, 19 miles from Yaquina light-house. The least water found was 42 fathoms, clay and mud bottom, with frequent rocky or stony patches, covering an area of about 40 square miles. Several specimens of the rocks were brought up in the beam trawl—water-worn bowlders of blue limestone, weighing from 50 to 200 pounds, bearing evidence of drift deposit. The entire surface of the stones was honeycombed by borers and covered with a mass of life, including small cup corals, sponges, trachiopods, annelids, mollusks, ophiurans, etc. The weather was very boisterous during our exploration of the bank, which prevented a satisfactory examination regarding its fish life, but the various species of rock-cod will doubtless be found there in large numbers.

Wind and sea increased during the 3d, until it became too rough to continue work, and as our coal was getting short we decided to go to Astoria for a supply. Slow progress was made during the night, steaming head to wind and sea, but it moderated next morning, and we crossed the Columbia River Bar at 2 p. m., anchoring off Astoria an hour later. We received 50½ tons of coal on the 6th, and at 10:40 next morning got under way, crossed the bar at Meridian, and at 3:46 put the hand lines over in 40 fathoms, off Falcon Rocks. A fine salmon was taken on one of the lines.

The beam trawl and hand lines were used at various stations, working to the southward over ground previously sounded. The various species of rock-cod, flounders, etc., were found quite plentifully. A thick fog set in at 8 p. m., obliging us to lay to till daylight the following morning, when it partially lifted and we continued our investigations, working to the southward as before. Beam trawl and hand lines were used with good success, and Mr. Alexander made an examination of the shore line in the dory. There are many outlying rocks along this part of the coast, around which we expected to find rock-cod and other species, but we were disappointed. The presence of sea lions on nearly every rock may account for this scarcity of fish. Having reached Cape Lookout we anchored under its lee at 5:10 p. m., where we found smooth water and excellent protection from northerly winds.

Our attention having been called to a recently discovered bank off Nestuggah, Oregon, reported by Capt. Bell, of the steamer *A. B. Field*, we decided to give the region a careful examination. The report stated that 12 fathoms was found 10 miles from land. We sounded at intervals of 3 miles, extending the examination several miles north and south of Nestuggah, and found 15 fathoms about 1 mile from shore, the depth increasing regularly to 70 fathoms, 8 to 10 miles off, where the reported bank was said to be. The bottom was of fine gray sand, and the usual varieties of coast fishes were found, but no codfish. The report referred to is more circumstantial than usual, names being given, yet we found that a depth of 12 fathoms anywhere in the vicinity of Nestuggah would be but a fraction of a mile from shore and well within sound of the surf.

Having completed the examination of the reported bank we continued work along the coast, and although the weather was boisterous, it was usually clear, with bright moonlight nights, which enabled us to carry on the work continuously. Reaching the vicinity of Orford Reef on the afternoon of the 12th, Mr. Alexander went in with the dory and examined that locality, while the *Albatross* worked farther off shore. He reported sea lions on nearly every rock, and the total absence of fish in their immediate vicinity; but "spots" were found, a few hundred yards to the southward, where cultus-cod and the various species of rock-cod were taken in large numbers. We were equally successful with the hand lines on board ship at stations south and west of the reef.

Wind and sea increased during the afternoon, making boat work and line fishing from the ship so difficult that we sought shelter for the night off Port Orford, where we found good anchorage in 7 fathoms, protected from the prevailing coast winds. A destructive forest fire was observed to the northward of Cape Orford, steadily working its way south and approaching the coast. It was just back of the first range of hills when we anchored, and soon after reached the sawmill, lumber yard, and buildings adjoining, quickly sweeping them away.

A dense fog and smoke prevailed until 7:35 the following morning, when it began to clear, and, getting under way, we carried the soundings to the vicinity of Cape Sebastian during the day, the last one being taken at 7:13 p. m. Owing to high winds and sea we laid a course to the northward, and, under moderate speed, faced the swell during the night. Reaching the vicinity of Koos Bay at 8:30 the following morning, we ran a line of soundings off shore, to fill in a space left on the former examination, then started for Astoria, arriving at 2 p. m., September 15.

Orders were received on the 16th to proceed to Portland, Oregon, and place the *Albatross* on exhibition for about ten days, in connection with the Northern Pacific Industrial Exposition. We coaled on the 19th, taking 94½ tons; cleaned and painted ship, and early on the morning of the 26th got under way for Portland, anchoring below the city at 6:20 p. m. There was a dense fog next morning, and while waiting for it to clear, the *Bonita*, a river steamer, collided with this vessel and received considerable damage. Our injury was slight and was repaired by the crew. The *Albatross* was opened to visitors at 10 a. m., September 28, and every day thereafter, between 10 a. m. and 4 p. m., until the evening of October 9. The decks and laboratories were literally packed with people, anxious to see the various specimens of marine life. Many of them showed great interest in the apparatus and methods of investigation. The navigator prepared a chart of the coasts of Washington and Oregon on a large scale, showing in graphic form the results of the *Albatross* explorations. It was placed under glass on one of the bulkheads in the laboratory, and proved of great interest generally, and a veritable revelation to fishermen and the seafaring community. Details of officers and men were constantly on duty explaining matters of interest. Between 25,000 and 30,000 people visited the ship during the twelve days she was open for inspection.

We left Portland at 6 a. m., October 10, arrived at Astoria at 3.50 p. m., where we remained until 9 a. m. the following day, when we got under way and proceeded to sea. Crossing the bar at 10:20 we steamed to the southward, and at meridian on the 12th took up our work off Cape Sebastian.

Coast of northern California.—We developed the 200-fathom line to the southward, until at 1:47 a. m., on the 14th, we had reached Cape Mendocino, where we were compelled to cease work on account of boisterous weather. As the indications were unfavorable we started for San Francisco, under steam and sail, arriving at the quarantine station at 11:35 p. m. We came to for the night, moving up off Washington street the following morning. We remained at anchor until October 25, when, at 11:40 a. m., we left for the Mare Island navy-yard, arriving at 3 p. m. A general overhauling was commenced immediately, the work being done, as far as practicable, by our own crew.

Results of operations on the coasts of Washington, Oregon, and California.—Active operations for the season having been brought to a close with the practical completion of the examination of the coasts of Washington and Oregon, and a good beginning in northern California, it may not be out of place to give here a brief synopsis of the general results. A large part of our work has necessarily been hydrographic, as there were but few soundings on the charts and none outside of the 50-fathom curve. Lines of soundings were run off shore at intervals of 5 to 10 miles, defining the 200-fathom curve from Cape Flattery to the vicinity of Cape Mendocino. More detailed examinations were made in several localities hereafter mentioned. The fisheries will be prosecuted inside of 100 fathoms on the Pacific coast for years to come, and while for obvious reasons our investigations extended to the 200-fathom line, we will limit the discussion to areas within the former depth.

The soundings off Cape Flattery were irregular, and suggested the existence of submarine ridges lying parallel with the coast; and between the cape and Flattery Rocks, lying about 10 miles from shore, a semicircular depression was found having depths from 100 to nearly 200 fathoms; thence to Yaquina Head the depths increase regularly, with the exception of the rocky patch or bank off Grays Harbor and Shoalwater Bay, where elevations of a few fathoms were found. Between Yaquina Head and Umpquah River lies a submarine plateau, triangular in form, with depths less than 100 fathoms, Heceta Bank marking its southwestern extremity. Thence to Cape Mendocino the soundings were quite regular.

The 100-fathom curve forms an irregular line, at varying distances from shore, as shown by the following table:

Distance of the 100-fathom curve from shore.

Locality.	Miles.	Locality.	Miles.
Cape Flattery	40	Siuslaw River	40
Cape Johnson	18	Cape Gregory	12
Grays Harbor	30	Cape Orford	7
Shoalwater Bay	20	Cape Sebastian	10
Columbia River	18	Crescent City	10
Tillamook Rock	27	Klamath River	20
Cape Lookout	11	Trinidad Head	9
Yaquina Head	20	Cape Mendocino, about	9

These cover an area in round numbers of 3,700 square miles on the coast of Washington, 4,750 square miles on the Oregon coast, and 1,160 square miles in northern California, a total of 9,610 square miles.

Fishery investigations have been carried on from the vicinity of Cape Flattery to Cape Orford. The various species of fish were found generally distributed along the coast, occurring in greater numbers on the banks hereafter mentioned. There was a notable absence of fish in the immediate vicinity of rocks inhabited by sea lions and lying near the coast where the line fishermen would naturally expect to find employment. There were, however, exceptions to this rule, as good fishing was found on Orford Reef in close proximity to numbers of these animals. A table of fishing stations is appended, showing the species taken at each station, and for convenience of reference the work of last season is included.

The fishing-banks in the region under discussion are few and of small extent. Commencing with the most northern, Flattery Bank has an area of about 1,100 square miles, the least water, 27 fathoms, being found at its southeastern extremity, 11 miles W. by N. (magnetic) from Cape Flattery light-house. Halibut and other species of fish have been taken from this bank in large numbers for many years. The area over which they are found in greatest abundance is about 35 square miles, on an exceedingly rough, rocky bottom, near the southeast end. A small bank lies W. by S. (magnetic), 23 miles from Toke Point light-house, covering an area of 110 square miles, with a least depth of 42 fathoms, sand, mud, and rocky patches, over which the depths vary to the extent of a few fathoms. Another small bank or rocky patch lies SSW. ¼ W. (magnetic), 19 miles from Yaquina light-house. It covers an area of about 40 square miles, the least water found being 42 fathoms, clay and mud, with rough, rocky patches. Heceta Bank lies SW. ½ W. (magnetic), 35 miles from Heceta Head, and covers an area of about 600 square miles. The least water, 41 fathoms, is found near its southern end, over a rough, rocky bottom.

The following appliances were used by the *Albatross* for taking fish, viz: Seines, gill nets, beam trawls, trawl lines, and hand lines from the vessel and from small boats. The grains and harpoon were used also, and the submarine electric light was utilized in collecting minute forms. This was effective in attracting mackerel off the Revillagigedo Islands and in the Gulf of California.

Halibut were plentiful on Flattery Bank, and scattering specimens were taken off Flattery Rocks, Tillamook Rock, and on Heceta Bank. The various species of rock-cod were found generally along the coast, as well as on the banks. Flounders were found everywhere; most plentifully, however, between 50 and 100 fathoms. The plateau before mentioned is particularly rich in flatfish, and will be the favorite ground for the beam trawl when that method is introduced. Eight species of edible flounders, including the delicious deep-sea sole, were taken on this plateau. Cultus-cod were on all the banks and on Orford Reef; black-cod were in the deeper waters, and half-grown specimens, with ling, or Pacific whiting, were found in moderate depths. Large red prawns of excellent quality were taken frequently in the beam trawl, and do not seem to be confined to any particular depth.

The sea fishermen have much to contend with on the coasts of Oregon and Washington. Gales are of rare occurrence during the summer months, yet the coast winds, blowing constantly from the northward, keep up a boisterous sea and strong currents. During the fall and winter, southeasterly gales are frequent, and there being none but bar harbors on the coast, they can not be entered in bad weather; hence the unfortunate fisherman is obliged to go to sea and lay it out. The distance from a market and the excessively high price of ice are other obstacles to be contended with by the fishermen.

Surface life was quite abundant, particularly during fair weather. Whales were seen nearly every day, and occasional schools of porpoises; while close in shore, sharks were of frequent occurrence. Gulls, gonies, and petrels were flying about, and huge flocks of black fulmars were observed on several occasions.

Mare Island Navy-Yard.—The work of overhauling and refitting proceeded without incident worthy of mention until the evening of December 23, when an accident occurred, resulting in the drowning of three members of our crew and a civilian. The night was exceedingly dark and stormy. At 7 p. m. a small boat containing 9 men left the side for Vallejo, and 5 minutes later swamped in midstream. Boats from the U. S. S. *Thetis* rescued 5 men, but nothing was seen of the others, although boats from the various ships were on the spot within a few minutes and the search continued well into the night. The names of the drowned were R. S. Padgett, machinist; J. Enright, seaman; W. W. Lee (colored), seaman; Walter Philippi, civilian. The latter was a cripple who was in the habit of visiting the ship to sell newspapers to the crew. The remains of John Enright and Walter Philippi were subsequently recovered. The former was buried in the naval cemetery at Mare Island and the grave marked by a neat headstone furnished by the Coast Seaman's Union, of which organization he was a member. Philippi was buried by his parents in San Rafael.

Ensign H. E. Parmenter was detached January 8, 1890, and ordered to the *Charleston*. Lieut. C. G. Calkins, U. S. Navy, reported for duty on the 9th, relieving Ensign Marbury Johnston as executive officer and navigator, the latter having performed those duties since the detachment of Lieut. Waring a year ago.

We coaled ship March 3 and 4, and at 9:40 the following morning left the yard and steamed out into San Pablo Bay to try the engines and dredging apparatus. Two hauls of the trawl were made near the Brothers, and at 2:40 p. m. we reached the navy-yard and moored to a buoy in the stream. Everything worked fairly well during the trial trip, a few minor matters only requiring adjustment.

COAST OF CALIFORNIA, MARCH AND APRIL, 1890.

We left the navy-yard at 9:40 a. m., March 10, and proceeded to sea. Crossing the bar at 2 p. m., we lowered the trawl ten minutes later in 20 fathoms, and notwithstanding a heavy westerly swell succeeded in running a line of dredgings to the South Farallones. There we hove to for the night, rolling and tumbling about in the heavy swell, to the great discomfort of all hands.

Resuming work at daylight the following morning, we extended our explorations to the southward in depths ranging between 391 fathoms, 16 miles S. ¼ E. from South Farallon light, and 20 fathoms, 3 miles NW. ⅞ W. from Pigeon Point. After the last haul was completed we ran off shore a few miles and lay to until 5:46 the following morning, when operations were resumed by casting the trawl in 296 fathoms, fine gray sand, Pigeon Point light bearing NE. by E. ¾ E., 18.8 miles. Working to the southward as before, twelve stations were occupied during the day, the last one being 6.8 miles WNW. ½ W. from Santa Cruz light-house. The weather moderated until at sunset the sea was quite smooth. We anchored at 5:55 p. m. off Santa Cruz, where good protection is afforded from the coast winds.

Mr. Alexander was landed at daylight on the 13th to continue his fisheries investigations. At 6 a. m. we got under way and made a line of soundings and dredgings across the outer extremity of Monterey Bay, finally anchoring off the old town of that name. The naturalists were employed in shore collecting until noon on the 14th, when we left the anchorage and made a series of dredgings across the bay in from 9 to 48 fathoms, following the general direction of the coast line, finally anchoring off Santa Cruz at 6:23 p. m.

Getting under way at 6:20 next morning, we examined a rocky area off Santa Cruz on which a number of fishing boats were employed. The Coast Survey chart gave no indications of rocky bottom, and our attention was called to it by the presence of fishermen. The center of the bank is 2 miles SSW. from the light-house and the bank has an area of about 14 square miles, the depths ranging from 8 to 20 fathoms. Having completed the examination of the bank, we ran a line of dredgings to the northward in moderate depths as far as Pigeon Point, the last haul being finished at 5:43 p. m., when we started for port, anchoring off Saucelito at 11:25 p. m. We were under way again at daylight on the 16th, and reached the navy-yard, Mare Island, at 8:20 a. m.

Thick rainy weather prevailed until the 19th, when we ran down to San Francisco, took on board 92 tons of coal on the 20th, and at 9:40 the following morning got under way and proceeded to sea. At 12:50 p. m. we cast the trawl in 21 fathoms, fine gray sand, Point Bonita bearing NE. by E. ⅝ E., distant 9.8 miles, and ran a line of dredgings to the westward until 3:50 p. m., when we swung ship under steam for compass errors. The dredgings were then continued in the direction of Point Reyes, and at 6:15 we anchored in Drake Bay for the night. Getting under way at 6:15 the following morning, a line of dredgings was run to Noonday Rock, and the region examined with dredge, tangles, and hand lines. The beam trawl was used westward of the bank to depths exceeding 500 fathoms. Work continued until 8 p. m., when we steamed slowly inshore and lay to within the range of Point Reyes light. The weather was unsettled, with frequent showers, and the wind increased during the night. Work was resumed at daybreak next morning, however, and a line of dredgings run to the vicinity of Point Reyes. Wind and sea having increased until it was too boisterous to continue work, we came to in Drake Bay at 9:30 a. m. Seining and fishing parties went out, but the swell outside and the surf on the beach rendered operations exceedingly difficult.

The wind and sea moderated during the night, and at 6:10 on the morning of the 24th we got under way and steamed to Cordell Bank. A trawl line was set and a boat anchored, having mast and flag to serve as a central point from which soundings were taken at intervals of one mile, over a rough rocky bottom, and the tangles were hauled occasionally. Hand lines were used from time to time, but the swell and strong current made it difficult to keep them on the bottom. Rock-cod were taken at most of the stations, but not in great numbers. Our examination showed rocky patches extending somewhat farther than indicated by the chart, except in a westerly direction, where the depths increased rapidly with a bottom of green mud. The trawl lines brought up 45 rock-cod, averaging 6½ pounds, and 2 cultus-cod, weighing 25 pounds each.

Starting about 4 p. m., we ran a line of soundings to Point Arena, where we commenced to develop the 200-fathom line. Work was continued until 9:46 a. m. on the 25th, when bad weather forced us to cease operations; and, rather than lay out a gale, we ran for port, anchoring off Saucelito at 9:35 p. m., crossing over to San Francisco the following morning.

The weather clearing on the 27th, we left port at 6:20 p. m. and, steaming to the northward, took up our work off Wallalla Point, at 5:40 on the morning of the 28th, developing the 200-fathom line to the southward as far as Russian River, where a series of dredgings was made over smooth sand or mud bottom, quite rich in the various species of flatfish. The last haul was finished at 10 p. m., when we lay to for the night, the weather being overcast and rainy. Resuming work at daylight next morning, March 29, a line of dredgings was run to Point Reyes, and thence to the vicinity of Point Bonita. We then entered the Golden Gate, and, at 2:30 p. m., anchored in the harbor of San Francisco, where the ship was coaled.

At 4:10 p. m. on April 2, we got under way and proceeded to sea. Standing to the southward under steam and sail, we passed Pigeon Point light at 9:49, and at 11:40 cast the lead in 208 fathoms, the light above mentioned bearing N. ¾ W., distant 14.5 miles. This was the first of a series of soundings extending across Monterey Bay to the vicinity of Cypress Point. The maximum depth was 958 fathoms. We cast the trawl at 7:40 a. m., April 3, off Point Carmel, and the work of sounding and dredging continued until 11:45 p. m., when, the weather becoming misty, we lay to till daylight, within sight of Piedras Blancas light.

Work was resumed at 5:10 on the morning of the 4th, and carried to the vicinity of San Simeon Bay, where we anchored at 12:35 p. m., the weather having become very boisterous. Seining and fishing parties were out during the afternoon, meeting with fair success. The wind was light from the northwest next morning, increasing to a stiff breeze in the afternoon, with a heavy swell. We were under way at 5:30, and, with the lead and beam trawl, extended our examination southward, defining the 100 and 200 fathom lines across the open bay of Esteros to Point Buchon, and thence to Point San Luis. Soundings were continued throughout the night, a full moon making it practicable to locate stations. A succession of heavy tide rips was encountered while at work off Esteros Bay, which were noticeable from the fact that there was but little wind or sea.

We were off Point Arguello at midnight with a fresh breeze and heavy swell, making it difficult to carry on our work, but soundings were continued to the southward to the vicinity of Point Conception, and a series of dredgings made during the day in the deep waters of Santa Barbara Channel. The subsidence of wind and sea after passing Point Conception and entering the channel was quite noticeable. Having finished work, we ran into Santa Barbara, and anchored at 5:07 p. m. The naturalists were engaged in shore collecting until noon the next day, the 7th, when we got under way for Santa Rosa Island. The wind was light when we left the anchorage, but a fresh breeze was encountered in midchannel, which soon increased to a moderate gale with a heavy head sea, until we got under the lee of the land. We anchored in Becher Bay at 4:05 p. m., and the vessel and rigging were soon covered with fine sand, blown from the island. The wind was too high to admit of landing, but having moderated during the night the collectors were out at daylight, returning at 9:30, when we left our anchorage and steamed to the northward against fresh coast winds and a heavy swell, which reduced the speed about 2 knots an hour. We passed Point Conception at 3:15, and made Piedras Blancas light at 1 a. m. on the 9th. The region between Point Sur and Lopez Point was passed at night going south, and the soundings intended to define the 200-fathom line ranged from 293 to 426 fathoms, though not more than 5 miles from shore. To define the line more accurately, we made another series of soundings from 2 to 3 miles from land, which still exceeded the depth.

The naturalists were anxious to make further examinations of the shores of Monterey Bay, and to give them an opportunity to do so we ran in and anchored off the town at 4:20 p. m., remaining until 8:40 on the 11th, the time being utilized in shore collecting, seining, etc. Leaving the harbor at the time mentioned, we sounded an hour later in 881 fathoms, rocky bottom, Point Pinos bearing ESE. $\frac{1}{8}$ E., distant $8\frac{1}{4}$ miles, with decreasing depths and soft mud bottom in every direction. Submarine currents must sweep across this station with sufficient force to expose the bedrock. Two hauls of the trawl were made in the submarine valley off Monterey Bay, and we then steamed into Santa Cruz, anchoring at 7:30 p. m. Getting under way at 4:45 next morning, April 12, we steamed out to the 200-fathom line and made a series of dredgings, working to the northward. The coast wind was blowing very fresh, with a heavy sea, which seriously interfered with our work. The results, however, were quite satisfactory. The last haul was finished at 5:37 p. m., when we started for port, arriving at the navy-yard, Mare Island, at 5:50 a. m., April 13. The return of the vessel to the yard completed the work on the California coast for the season, and preparations were at once begun for the northern cruise.

Results of operations on the coast of California.—Active operations off the California coast continued from March 10 to April 13, and while the total results can not be given until the scientific branches are worked up, we can state in a general way what has been accomplished. In hydrography, 236 soundings were taken, between Point Arena and the Santa Barbara Channel. Many of them were for the sole purpose of ascertaining ocean depths outside of soundings given on the Coast Survey charts, while others were preliminary to trawl or dredge hauls. It has been our purpose to establish the 200-fathom line as the maximum depth in which deep-sea fishing can be profitably prosecuted, and within which are located the fishing-grounds of the Pacific coast.

Commencing at Point Arena, the 200-fathom curve lies almost 12 miles from shore, and extends in nearly a straight line to 14 miles off Salt Point, 20 miles off Russian River, and 26 miles off Tomales Point. The bottom is composed of alternating patches of black sand and green mud, the latter extending almost invariably between 100 and 200 fathoms. The otherwise smooth bottom is obstructed by occasional stony patches, usually between depths of 40 to 70 fathoms, seldom indicated by the lead but encountered by the beam trawl. From Point Reyes to the 200-fathom curve outside of Cordell Bank, it is 21 miles. This same depth is found 3 miles outside of Noonday Rock, 4 miles from North Farallon and 5 miles from South Farallon, increasing abruptly from the 100-fathom line. The curve gradually approaches the coast to the southward of the Farallones, and from 25 miles off Pillar Point it narrows to 16 at Pigeon Point. The line sweeps inward abruptly at Año Nuevo, and at El Jarrow Point it is but 8 miles from shore, maintaining this distance until off Santa Cruz.

Six lines of soundings were made across Monterey Bay, three inside and three outside of a line drawn from Point Pinos to Santa Cruz, developing the great submarine valley which begins at the mouth of the Salinas River. It was supposed to lie in a west-southwesterly direction, as indicated by inshore soundings; but our observations, while not sufficiently extended to define it positively, show it to trend S. by W. off Cypress Point, with a depth of 950 fathoms 8 miles from land. Less water was found to the northward and westward farther off shore, where there is an elevation of about 200 fathoms. Further examination of this ridge or plateau is desirable.

From 245 fathoms less than 1.5 miles from Cypress Point, the line of equal depth gradually leaves the coast until west from Point Sur it is between 9 and 10 miles from shore. Drawing in abruptly, 293 fathoms was found 5 miles southwest from the point, with 36 fathoms little more than a mile inside of it. Thence to Lopez Rock the shore is exceedingly bold, the 200-fathom line approaching within 2 miles or less, then diverging slightly until off Piedras Blancas it is between 6 and 7 miles from the point. This stretch of coast from Carmel Point to Piedras Blancas is entirely open and exposed to the full power of the ocean swell, which causes a tremendous surf, even with the ordinary coast winds. Slight protection may be found under Point Sur, but even that can not be depended upon in bad weather. Southward from Piedras Blancas the character of the coast line changes materially, and there are various points where fairly good anchorage may be found. San Simeon Bay affords the best protection north of San Luis Obispo.

As the shore line becomes less abrupt, shoal water extends farther seaward, 200 fathoms being found 7 miles off San Simeon Point, about 10 miles off Point Esteros and Point Buchon, and between 13 and 14 miles off Point San Luis; then, sweeping a little seaward off Points Sal and Purisima, it approaches within about 8 miles of the bold headland of Point Arguello and 10 miles from Point Conception.

The character of the bottom is so uniform along the coast that it may, for our purpose, be treated in a general way. The area between the Golden Gate, Point Pillar, the Farallones, and Point Reyes is sandy and free from rocks and stony patches, except in the immediate vicinity of the islands or shore line. Southward from Pillar Point, rocky patches near the shore will be frequently found, with fine gray sand farther off, which finally merges into green mud at varying distances from the land. There are stony patches also, usually between 30 and 70 fathoms, on sand or mud bottom, apparently the result of drift. The green mud has a strong odor, which is occasionally offensive.

The results of the fishing trials will be discussed at length in the report of the Fishery Expert, yet it may not be out of place to give a brief summary of the same in this connection. One hundred and eleven dredging and fishing stations were occupied. The principal fishes found inside the 50-fathom curve are enumerated in the following table, and those taken both inside and outside of that line are given in the second table.

Principal fishes found inside of the 50-fathom line.

Common name.	Systematic name.	Abundance.
Flounders	Hippoglossoides exilis	Abundant.
Do	Citharichthys sordidus	Do.
Do	Parophrys vetulus	Do.
Long-fin sole	Glyptocephalus zachirus	Do.
Turbot	Pleuronichthys decurrens	Common.
San Francisco sole	Psettichthys melanostictus	Do.
Do	Eopsetta jordani	Do.
Halibut	Atheresthes stomias	Rare.
Deep-sea sole	Microstomus pacificus	Few small ones.
Flounder	Citharichthys stigmæus	Rare.
Anchovy	Stolephorus	Common.
Roncador	Genyonemus lineatus	Do.
Tomcod	Microgadus proximus	Few.
Smelts	Atherinopsis, and other species	Common.
Perches	Abeona, and other species	Do.
Ratfish	Chimæra colliei	Do.
Midshipmen	Porichthys porosissimus	Very abundant.
Hag eel	Myxine glutinosa	Common.
	Zaniolepis latipinnis	Do.
	Related new species	Do.
Cultus-cod	Ophiodon elongatus	Few.
Red rockfish	Sebastodes ruber	Common.
Orange rockfish	Sebastodes pinniger	Do.
Yellow-tail rockfish	Sebastodes flavidus	Do.
Vermillion rockfish	Sebastodes miniatus	Do.
Rockfish	Sebastodes elongatus	Do.
Do	Sebastodes auriculatus	Do.
Do	Sebastodes goodei	Rare.
Do	Sebastodes chlorstictus	Do.
Do	Sebastodes, new species	Do.
Do	do	Very abundant.
Do	do	Do.
Do	do	Do.

Also many small species not yet named.

Principal fishes found outside of the 50-fathom line.

Common name.	Systematic name.	Abundance.
Deep-sea sole	Microstomus pacificus	Abundant in 200 fathoms.
Halibut (flounder)	Atheresthes stomias	Rare.
Long-fin sole	Glyptocephalus zachirus	Common in 100 fathoms.
Black-cod	Anoplopoma fimbria	Common.
Redfish	Sebastolobus	Abundant.
Rockfish	Sebastodes, new species	Do.
Do	do	Do.
Do	do	Do.
	Macrurus, three species	Few.
	Chauliodus	Do.
	Careproctus	Do.
	Alepocephalus	Do.
	Myctophum townsendi	Common.
	Lycodes, rare species	Large specimens.
Eel pouts (six species)		Abundant.
	Sternoptyx	

Shoal-water species were regularly distributed, flounders being the principal feature of every haul. Small specimens of deep-sea sole, *Microstomus pacificus*, were found in 50 fathoms and less, probably the young of the species so plentiful in greater depths, and described by Lockington from immature specimens taken in shoal water. The long-finned sole, *Glyptocephalus zachirus*, was found from the shore to 100 fathoms, the finest specimens in the latter depth. These two flounders approach nearest in edible qualities to the European sole of any fish on the Pacific coast. The flesh of mature specimens is white, gelatinous, and exceedingly delicate in flavor. From experiments made on board this vessel, they were found, when kept on ice, to improve until the fourth day, but deteriorated after the seventh. They can be taken only with the beam trawl, or other form of drag net.

Invertebrates found along shore and to the 100-fathom line differ from those of corresponding depths on the Oregon and Washington coasts. The edible red prawns, so abundant north, entirely disappear in this region, and shrimps take their place to a limited extent. Large prawns, 6 or 8 inches in length, were obtained occasionally in depths of 50 fathoms or more.

The common edible crab, *Cancer magister*, is abundant, and grows larger than it does farther north. Smaller species, *Cancer antennarius* and *Cancer productus*, both edible, common along the shores, were not met with north of the California boundary. Very few sea-urchins were taken in shoal water. Cup corals, as well as hydrocorallinæ, were met with on rocky or stony bottoms. Several small species of alcyonarians and comatulæ were abundant. Ophiurans and astrophytons were found, but not in as great numbers or variety of species as in more northern waters. Gorgonian corals are common close in shore. Starfishes appear to be much the same as those found on the Oregon coast. Holothurians are numerous and are represented by a variety of species; squids and octopi are common and usually very small. Shells were almost invariably small, and of obscure species; several species of brachiopods were dredged, some of them very beautiful. Sponges are rather scarce, ascidians and bryozoans common, and annelids abundant and varied in species.

The invertebrates found between 100 and 600 fathoms were greater in number and in variety of species than in the shoaler waters above described. Sea-urchins were particularly abundant, and a large proportion of the average haul was composed of them, either a species of *Schizaster* not yet named, or a large pinkish urchin. Large and small specimens were found together, but the species were seldom mixed.

Many large alcyonarian corals resembling *Verrillia* were taken in moderate depths, and a very few rare pennatulas and umbellulas came from the deeper hauls. Another rare polyp, *Anthomastus*, of which we had previously taken but a single specimen, was found in 550 fathoms. Deep-water shells were not abundant, and ophiurans were surprisingly scarce; but holothurians were common, a large brilliant-red species being the most abundant.

Crustacea were common, although the variety of species was rather limited, and annelids were also plentiful. A large crab, resembling *Lithodes*, and another very large, flat-legged species were most abundant. Annelids were common and the species quite varied.

The surface was practically barren of minute life, a few salpæ being about all that would be found in the tow net. This absence of surface life was due in great measure to the season of the year. Sea birds were about the ship constantly, and an occasional school of porpoises was seen. Sharks were not plentiful; in fact, there were but two or three observed during the season. Whales were very common, and were reported nearly every day, sometimes in large numbers. On one occasion we steamed slowly into a school that were so busily engaged in feeding that they paid little attention to us. Upon investigation it was ascertained that they were devouring a small globular jellyfish, half an inch in diameter, which could be seen in immense masses from 3 to 5 fathoms beneath the surface. Thousands of sea birds were hovering over or around the busy scene.

INVESTIGATIONS IN ALASKA WATERS, APRIL TO JUNE, 1890.

Preparations for the cruise.—The vessel was taken into the new stone dry-dock at the Mare Island navy-yard on April 16, her bottom scraped and painted, repairs made on one of the outboard connections, and the old tiller on the rudder blade replaced by a new one. We hauled out of the dock on the 28th. The commandant, rear-admiral A. E. K. Benham, and officers of the various departments in the navy-yard gave us every possible facility for making repairs and refitting generally, and tools and other appliances required in the shops were freely put at our disposal. The assistance rendered made it possible to give the vessel and her machinery a thorough overhauling at small expense. Ensign William W. Gilmer, U. S. Navy, reported for duty on the 30th.

The *Albatross* left the navy-yard May 1, at 11:20 a. m., and anchored off Washington street, San Francisco, at 2:10 p. m. The U. S. flagship *Charleston*, Acting Rear-Admiral George Brown; the U. S. S. *Marion*, revenue steamer *Bear*, and Coast Survey steamer *Hassler* were lying at anchor in the harbor. Prof. Charles H. Gilbert reported as chief naturalist.

San Francisco to Bering Sea.—We left San Francisco at 12:55 p. m., May 5, for Bering Sea, via Departure Bay, B. C., where we arrived safely at 8:50 p. m. on the 9th. The usual cloudy, misty weather was encountered with moderate northerly winds to the Columbia River, and southerly breezes thence to Cape Flattery. Whales were seen daily, and fur seals were observed off Cape Mendocino. An occasional school of porpoises passed, always at a safe distance from the ship, and sea birds hovered about night and day. A solitary shark was reported off Mendocino.

We commenced coaling at 10:15 a. m., May 10, and finished at 9:15 a. m. on the 13th, having taken on board 192 tons, 25 tons being in bags on deck. At 3:15 p. m. the same day we left Departure Bay for Bering Sea.

Schools of herring were seen in the Gulf of Georgia during the evening, pursued by sharks and porpoises. Among the latter several were observed with peculiar markings, the head, back, and sides being black or very dark; belly, tips of fins, and tip of tail white. It may be a common species, but I do not remember to have seen it before. Passing Seymour Narrows at 5:20 the following morning, we steamed through Johnstone and Broughton straits, Queen Charlotte Sound, and Goletas Channel, entering the Pacific at 5 p. m. We were under one boiler, as usual, consuming about 12 tons of coal per day.

The customary foggy and misty weather was encountered, with light to moderate SE. to SW. winds. A plover was captured on the 18th in latitude 52° 45′ N., longitude 148° W. Whales were seen, and a couple of large white albatrosses were about the ship for an hour or more. Floating kelp was observed for the first time since leaving Vancouver Island. Light flurries of snow passed occasionally and many evidences of our northerly course were apparent. Gulls were first noticed on the 19th and little auks on the 20th.

The high land of Sannakh Island was sighted on the morning of the 21st, and a line of soundings and dredgings, commenced in 483 fathoms, was carried over the position assigned to Anderson Rock, and thence to the westward of the islands through Unimak Pass into Bering Sea. The weather was squally and misty at times while working in the region of Anderson Rock, but there were frequent intervals when it was quite clear, and from the masthead we commanded a view of the horizon for 10 miles or more in every direction, but without detecting any surface signs of rocks or shoals; neither did the soundings indicate anything of the kind. Our observations do not prove the non-existence of the danger referred to, but simply show that it does not lie in the position indicated. The evidence seems so conclusive as to the existence of rocks somewhere in that vicinity that I am inclined to the belief that they will eventually be found and located properly. Our investigations are gradually narrowing the limits in which they may be searched for.

Bering Sea.—From Unimak Pass we took the general direction of the 100-fathom curve, carrying our investigations about 80 miles to the northward and westward, when a gale sprang up from that direction, and to save fuel we turned from it and ran a line of soundings and dredgings in the direction of Unalaska, finally anchoring in Iliuliuk Harbor at 7:40 p. m., May 23. We went to the coal wharf as soon as it was vacant and took on board 117 tons of coal during the 26th and 27th, filled up with fresh water, and made final preparations for departure.

Bristol Bay; Unalaska to the Nushagak River.—At 3:50 a. m., May 28, we cast off from the coal wharf and proceeded to sea en route for Bristol Bay. It was blowing a moderate gale from the southward, with fog and mist, which lifted at intervals, but was particularly disagreeable when crossing the several passes into the Pacific.

Reaching the northwest cape of Unimak about noon the next day, we found it too rough to use the trawl or hand lines, but ran a line of soundings along the land to Shaw Bay, where at 5:53 p. m. we anchored for the night. This bay is open to the northward, but affords protection from all winds to the southward of east or west. The approaches are clear, and the water shoals gradually to 6 fathoms, black sand, about three-quarters of a mile from shore. Our experience in coasting along the north shore of Unimak Island made it evident that very little dependence could be placed on the charts, except for a general, though inaccurate, marking of the coast line. They were totally devoid of topographical delineations near the shores, which are, as a rule, low, monotonous, and lacking in striking features to serve as landmarks. The mountain ranges and principal volcanic cones are indicated, it is true, but they are usually enveloped in fog or mist, and are, therefore, seldom available for navigating purpose. Overcast or foggy weather was so prevalent that we could not depend on making astronomical observations, and hence I decided to make a reconnaissance of the coast before attempting to explore the fishing-grounds.

Getting under way at daylight next morning, we ran as near the land as prudent, sounding frequently, angling on points, and locating features that might be useful as landmarks. This work was continued to the head of Bristol Bay, where we anchored off the Naknek River on the morning of the 31st. The naturalists and a surveying party spent the following day near the mouth of the river, the former in shore and shoal water collecting, the latter in making a reconnaissance of the entrance.

Nushagak River.—Leaving our anchorage on the morning of June 2, a line of dredgings and fishing stations was carried across the bay to the vicinity of Protection Point, where we arrived at 5:45 the same day. The charts of this dangerous region were of very little service; the land on both sides is low and without distinctive features; shoals extend off so far from the region of Etolin Point that we were frequently forced almost out of range; and the strong uncertain currents rendered compass courses entirely unreliable. The eye and lead are, in fact, the only safe guides. The Nushagak pilot, an aged Eskimo, boarded us at 1:30 a. m., and, getting under way at 8:53 with the flood tide, we steamed up to the anchorage above the native village of Ekuk, and came to near the establishment of the Nushagak Canning Company. A reconnaissance of the lower river was commenced by the officers, and the naturalists explored the surrounding regions. Taking Mr. Alexander, the fishery expert, with me, I visited the four packing establishments, all of which seemed in good working order, waiting for the first run of salmon. A detailed account of these works and their methods will be found in the report of the fishery expert.

I inspected the site of the proposed trap on Wood River in company with Messrs. P. H. Johnson and J. W. Clark, the projectors of the enterprise. It is located about 40 miles from the Nushagak cannery and 20 above the mouth of Wood River, at which point the latter is a swift-running stream of clear cold water, between 700 and 800 feet in width and 10 to 14 feet deep. Nothing had been done yet to indicate the extent and character of the proposed work. Ten slender piles, driven about 300 feet from shore, were all that could be seen, but the contemplated plans were detailed by the projectors as follows: An open channel in midstream 100 feet in width; two traps 40 feet square, one on each side of the open channel, with wings extending to the shores. This arrangement they considered to be clearly within the limits of the law.

The west bank of Wood River is covered with forests of spruce, the larger trees having been cut for domestic purposes. It was from this region that the Russians procured logs for house-building. There was no wood on the east bank as far as we could see, the land on that side being very low and marshy. The timber line is seen on the west side of the Nushagak, 5 or 6 miles below the mouth of Wood River, and is a notable feature in the landscape. The forest gradually thins out, trees diminish in size until at the margin they are dwarfed to mere shrubs, beyond which there is nothing but alder bushes, a few stunted birches, willows, etc. There is no visible cause for this phenomenon, but the line is distinctly drawn. Driftwood along the shores of Bristol Bay, brought down the rivers by floods, indicates the existence of great forests in the interior and constitutes the sole fuel supply of the natives on the peninsula and at other places in Bering Sea.

Mr. Ivan Petroff, United States census agent for the Territory of Alaska, came on board on the morning of the 5th, having with him 2 kaiaks and 3 Eskimo boatmen, and reported an unsuccessful attempt to reach the Kuskokwim River via the inland route up the Nushagak and over the portage. After working laboriously up the river several days against strong currents, until in fact they were approaching the portage, his crew mutinied, refusing positively to go any further, thus forcing him to return. It was of vital importance, he said, that he should reach the former river without delay, and, as there was no other means of transportation, he earnestly requested to be landed anywhere in the vicinity of Cape Newenham, from which point he could reach the native settlements. I knew the importance of his work, as well as the difficulty of procuring transportation along that unfrequented coast, and, while I was under no direct obligation to deviate from my course on his account, I did not hesitate a moment in extending the hospitalities of the ship to him and his people and assuring him of every practicable assistance in prosecuting his work.

Nushagak River to the Kuskokwim River.—We left the Nushagak on the morning of June 7 and ran a line of dredgings and fishing stations across the bay and back to the Walrus Islands. Fairly good cod banks were found outside of the extensive shoals surrounding Cape Constantine, but only scattering specimens of cod were taken between there and the head of the bay, and these were in poor condition. Reaching Round Island, the southernmost of the group, at 9:25 a. m. on the 8th, we came to for several hours to allow the naturalists to examine its shores. A dense fog prevailed during the night, but finally passed off, and we availed ourselves of the opportunity to locate the island astronomically. Getting under way at 2:25 p. m., we carried our investigations to the northward between the islands and the mainland, where the bottom proved exceedingly barren, with no signs of codfish. A black mud, which we frequently encountered, probably had something to do with their absence. A running survey was made in passing, which resulted in expunging two or three islands from the group and correcting the relative positions of others.

Having cleared the Walrus Islands we steamed to Hagemeister Channel, which lies between the island of that name and the mainland, anchoring at 7:30 p. m. to the westward of Tongue Point, a long gravel spit which makes out from the mainland. The tides were very strong, but our anchorage under the point was out of the strength of the current. Half a dozen Eskimos came off in their kaiaks ready to barter anything they had and drove quite a lively trade with the officers and men for a couple of hours.

We were delayed by fog next morning and lost several hours more by persistently attempting to follow the chart, which was very inaccurate and constantly leading us into shoal water; in fact, the day was nearly spent before we cleared the channel and off-lying banks. The bottom was still barren, with no sign of codfish. Work was carried on in a westerly direction until dark, when we lay to, intending to resume it at daylight, but a gale from SE. sprung up during the night and forced us to seek shelter under the lee of Cape Newenham, where we anchored at 3:45 a. m. June 10, in 7 fathoms, the extreme of the cape bearing SE. by S. magnetic. Furious squalls came down from the mountains and heavy tide rips surrounded us at times, but we rode them out safely and with little discomfort.

The disposal of our passengers became a serious problem. Two of the three Eskimos were quite ill, totally unable to handle a paddle or even help themselves. This not only rendered Mr. Petroff entirely helpless, as far as the management of his kaiaks was concerned, but imposed upon him the additional burden of caring for his invalids. The necessity of landing the party among natives was too apparent to require second thought. The Kuskokwim is considered the most difficult and dangerous to navigate of any of the streams visited by the vessels of the Alaska Commercial Company in Bering Sea. We had no knowledge of the region, and our charts were not only inaccurate, but misleading; hence, I looked upon a trip up the river with no little anxiety. Getting under way at 9:15 a. m. on the 11th, we entered the Kuskokwim and reached a point 10 or 15 miles above Goodnews Bay without accident or detention, and were then supposed to be near a native village at which the party wished to land. Shoal water had already driven us so far from the low, monotonous coast that it was difficult to distinguish objects on the beach, and, fearing we might pass the settlement without recognizing it, we came to anchor and the party, with their baggage and kaiaks, was landed in boats at a camp of native beluga-hunters, about 10 miles from our own anchorage. These people received the party very kindly, assisted in pitching their tents, built a large fire, etc., and promised to see them safely to the village. They agreed also to furnish new men in place of those who were disabled. Having seen the party comfortably provided for, the officer in charge of the boats returned to the ship. We furnished Mr. Petroff with everything he wished or would accept, and, landing him among friendly natives, left him to prosecute his difficult and dangerous task.

Getting under way as soon as the boats were hoisted, we steamed down the river, but soon found shoal water where our chart gave from 10 to 15 fathoms. We followed the bank or shoal several miles without result, then anchored in 10 fathoms, as night was approaching and the tide falling. Another trial was made at daylight, but the same impassable barrier was found to seaward. The channel was open in the direction of Goodnews Bay, however, and we availed ourselves of it, but were soon enveloped in a dense fog and forced to anchor. We were under way again at 2:50 a. m. on the 13th, and steamed to Cape Newenham without difficulty or delay, but found a gale blowing outside and were glad to seek shelter under the lee of the land near our old anchorage. Thick misty weather prevented our obtaining observations, but we took such angles as we could to correct the chart in our immediate vicinity, for it was woefully out.

Cape Newenham to Unalaska.—The gale subsided about noon, and at 2 p. m. we got under way and commenced a line of dredging and fishing stations in the direction of Northwest Cape of Unimak, the lack of fuel preventing the extension of our investigations farther north. The beam trawl showed a rich and varied fauna, but no codfish were taken with the trial lines until we were about 30 miles from Cape Newenham, the great body of fresh water flowing from the Kuskokwim being sufficient, probably, to account for their absence. Soundings were continued throughout the short night, the beam trawl and trial lines being brought into requisition at daylight, repeating our experience of the previous day, except that the bottom at the various stations was composed largely of black or green mud. Scattering specimens only of codfish were taken.

The sun came out during the afternoon, and we availed ourselves of the long-sought opportunity of swinging ship for the purpose of ascertaining compass errors. A dense fog shut down while we were taking the last azimuth, so we congratulated ourselves on the success of the evolution. Work was resumed until dark and sounding continued throughout the night, but a southeast gale sprung up suddenly on the morning of the 15th, which put a stop to our work and, in fact, drove us into port a day or two earlier than was intended. A heavy sea was encountered, particularly while crossing the several passes into the Pacific, and we were obliged to adopt measures never before considered necessary on board of this vessel, to protect skylights, windows, etc. Fog and mist obscured the land until we were within a few miles of Iliuliuk, Unalaska, where we arrived at 9 p. m. the same day.

The revenue cutter *Bear*, Alaska Commercial Company's steamers *Dora* and *Karluk*, and the North American Trading Company's steamer *Arago* were in the harbor, two of them requiring coal. The *Bear* left for the north at daylight on the 17th. The schooner *Mattie T. Dyer* arrived the same afternoon and was seized by the collector for illegal sealing in Alaskan waters. The deputy United States marshal made written application on the 18th for assistance in removing the captured schooner to a place of safety, and in compliance with his request she was taken to the inner harbor and securely moored by an officer and party of men from this ship.

The gale continued until the 19th. We coaled ship on the 20th and 21st, taking 100 tons, not enough to fill the bunkers, but all we could get, owing to a temporary scarcity at the station. The Alaska Commercial Company's steamer *St. Paul* arrived from San Francisco on the 23d, bringing us mail and supplies which were taken on board, and at 6:30 p. m. we got under way and proceeded to sea, bound for Bristol Bay. The weather was overcast with drizzling rain, mist, and fog, which frequently obscured the land.

Slime Bank.—Work was continued at daylight next morning off the Northwest Cape of Unimak, successive lines of dredging and fishing stations being run tangent to the coast. The beam trawl developed an abundance of life on the bottom and the use of the hand lines soon proved that we were on prolific codfish grounds. Fishermen have given it the name of Slime Bank, from the numbers of medusæ brought up on their gear. These jellyfishes are of a brownish or rusty color, from 6 to 18 inches in diameter, have long slender tentacles, and are well armed with stinging organs. They were not seen on the surface, but inhabit an intermediate space, probably near the bottom, for late in the season, when their numbers have greatly increased, the fishermen do not allow their hooks to reach the bottom, but fish over them, as they express it, in order to escape their sting, which soon makes their hands sore. An old codfisherman who has spent several seasons on this bank said the slime (medusæ) became so thick on the bottom late in the season that they had great trouble sometimes in lifting their dory anchors through it. Dread of handling the stinging cells had as much to do with the difficulty, probably, as the weight brought up by the rope and anchor.

We found the bank to extend from the Northwest Cape of Unimak to within 10 or 15 miles of Amak Island, embracing depths from 20 to 50 fathoms, scattering specimens being taken outside of this limit. It is about 85 miles in length, with an average width of 17 miles, covering an area of 1,445 square miles. The character of bottom as given by the lead was generally black sand and gravel, pebbles being frequently added, with rocks near shore and mud in the greater depths.

At 8:20 p. m., June 25, we anchored off Cape Glasenap, or Round Point, in 9 fathoms. The weather was foggy during the afternoon, with increasing wind, which induced us to seek protection under the land. An examination of the entrance to Izenbek Bay developed a bar extending from Cape Glasenap to the low island, over which not more than 2 fathoms could be carried at low water. A small vessel drawing from 8 to 10 feet might find a harbor inside of the cape, but its limits would be small, as most of the area is laid bare at low water. A school of walruses were playing outside of the surf for hours, but they did not come near the ship. Several being seen hauled out on a low protecting point of Cape Glasenap, Mr. Townsend landed and attempted to get within rifle range, but they were watchful and timid, and, as he was obliged to land to windward, soon scented him and took to the water. The fog continued next day, but lifted for a few minutes at a time, enabling us to see several miles. Being anxious to visit Amak Island, we got under way at 1:30 p. m., ran a line of dredging and fishing stations along the land for about 10 miles, then across to the island, where we anchored at 6 p. m. in 10 fathoms, the extremes of land bearing S. by E. ¾ E. and WSW. ⅜ W. (magnetic). This is a fairly good anchorage, with SW. winds.

Amak Island is of volcanic origin, between 2 and 3 miles in length, and about 1,700 feet in height. There are plateaus from 30 to 150 feet above the sea, extending back 500 or 600 yards from the beach, covered with a thick coating of moss, through which rank grass was showing. Flowers were beginning to bloom, giving the surface quite a cheerful aspect. Near the center was a rugged precipitous mountain of dark-brown rock entirely void of vegetation. No life was seen on the island, except three or four migratory birds, and it did not prove a profitable region for the naturalists. The weather was generally overcast with fog and mist on the morning of the 27th, but the sun came out at intervals. We could not reconcile our runs with the position assigned to the island on the charts, and, knowing that observations had not been made on it, in modern times at least, we considered the chance worth waiting for, and fortunately obtained good sights for latitude and longitude. The island is the one distinctive and unmistakable landmark in the vicinity; hence our anxiety to locate it exactly. The Southeast Point was found to be in latitude 55° 25′ 05.6″ N. and longitude 163° 07′ 33.6″ W. There is foul ground off the northwest extremity of the island, some rocks awash; and between 2 and 3 miles distant is Sea Lion Rock, several hundred yards in extent and about 150 feet in height, on which is a large rookery of sea lions. We found the schooner *Olga* at anchor off Amak Island, waiting favorable weather to secure a sufficient number of these animals to supply her native sea-otter hunters with skins for bidarkas.

No codfish were taken within 10 miles of Amak Island, or between it and the mainland, except scattering specimens. Sea lions and walrus doubtless destroy and drive away fish from their immediate vicinity, but over this large area there must be some other cause, and it may, I think, be attributed to the lack of food, as we found the bottom exceedingly barren.

Baird Bank.—Getting under way at 1:53 p. m., we continued our explorations in a northerly direction, and soon found ourselves approaching excellent codfish grounds. The bottom fauna was abundant, and the fish captured were large and in good condition. Near the shore, in depths less than 20 fathoms, the bottom was covered with mussels, sponges, and large barnacles in clusters, adhering firmly to rocks and stones, their elevated cutting edges soon wrecking the nets. Conditions improved with each line of stations, and, arriving off Port Möller, we found ourselves on the best fishing-ground we had yet found in Bering Sea. It was evident that we were developing a great cod bank, the extent of which was not yet defined.

The schooner *Vanderbilt*, of San Francisco, was found at anchor off Port Möller with nearly a full fare of codfish, which she had taken in that vicinity.

Port Möller.—Leaving the schooner at 2 p. m., June 29, we anchored outside of Entrance Point, Port Möller, at 5:45 p. m. We were, as before stated, unable to procure a full coal supply at Unalaska, and, rather than wait the arrival of a cargo which could not be expected for a month at least, decided to extend our explorations to this place and take our chances of replenishing the bunkers from a recently opened coal mine in Herendeen Bay, a branch of Port Möller. The delay could be no greater, at least, and we might be able to procure sufficient fuel for the completion of the work in Bristol Bay. The region is unsurveyed, and the entrance guarded by banks and shoals over which the tide sweeps with great force, making the channel difficult and dangerous, its ill repute having, in fact, caused the great bay and its tributaries to remain almost a *terra incognita* to the navigator. The discovery of coal will necessitate a survey, and with it many of the dangers will doubtless disappear.

It was blowing a moderate gale from the southeast when we anchored, and it had diminished but little in force next morning, but, the fog lifting, we got under way and picked our route carefully through narrow, intricate channels across Port Möller to the entrance to Herendeen Bay, and, two hours later, found a snug anchorage under Point Divide, where we were protected from the heavy southerly wind then blowing. I left the ship soon after anchoring, and, accompanied by Prof. Gilbert and Chief Engineer Roelker, visited the mine. Ten miles of the distance was made by boat, and about a mile and a half over a tramway recently constructed for transporting coal to the water front. A tunnel had been driven into the hillside about 200 feet, and between 70 and 100 tons of coal taken out. The superintendent estimated the average output for the mine for the next month at from 10 to 20 tons per day. A 40-ton lighter was in process of construction, and they only waited its completion to commence the delivery of coal.

The close of the fiscal year finds officers and crew in excellent health and the ship in good working order. The ship has maintained her usual reputation for excellent sanitary conditions during the entire year. There has not been a single case of sickness on board that was due to removable local causes, and no serious accident or serious illness has occurred.

Natural history results.—Work commenced south of the Sannak Islands on the 21st day of May, in 483 and 313 fathoms, extending to the westward of the group in gradually decreasing depths until 38 fathoms was reached. In the deeper waters several species of sea-urchins and shells were taken, and crinoids, shrimps, corals, alcyonarians, holothurians, and various species of fishes were marked features of the hauls, *Careproctus* and *Myctophum* being among them. Drawing shoreward, and changing the character of the bottom from mud to sand, the varieties of fish increased; *Bathymaster*, *Sebastodes*, and *Lycodes*, besides several species of flounders and sculpins, were abundant. Of invertebrates there were at least half a dozen species of sponges, an abundance of sand-dollars (*Echinarachnius*), shrimps, ophiurans, shells, and basket stars (*Astrophyton*).

The line of investigation was extended to Bering Sea, via Unimak Pass, in depths from 41 to 178 fathoms, and revealed a fauna of great abundance and variety of species, particularly in the pass and along the 100-fathom curve in the direction of the seal islands. Among the more conspicuous were many flounders, sculpins, skates, pollock, *Bathymasters*, and codfish, with small *Agonidæ*, eelpouts, etc. Invertebrates were abundant, ascidians, annelids, and miscellaneous crustacea occurring in addition to those before mentioned. A marked change in the fauna was found upon deepening the water to 225 fathoms north of Unalaska. The sandy bottom gave place to soft mud, the shrimp or prawns were larger, *Sebastolobus* took the place of *Sebastodes*, and the various shoal-water flounders were replaced by those of deeper habitat.

Commencing at the head of Bristol Bay, off the Naknek River, in depth of 3 to 8 fathoms, sand, a variety of fish were taken, such as sea trout (*Hexagrammus*), flounders, young salmon, rock-cod, sculpins and a few specimens of *Liparis*, with scattering specimens of shrimp, shells, starfish and other invertebrates.

Off the entrance to the Nushagak River, in depths of 5 to 12 fathoms, sandy bottom, with occasional patches of gravel or pebbles, half a dozen species of starfish were found in great numbers; sea-urchins were taken by the bushel; and shrimps, crabs, sponges, annelids, mollusca, sea-anemones, hydroids, and bryozoa were abundant. The fishes were represented by *Hexagrammus*, *Murænoides*, pollock, several species of sculpins and flounders, besides a variety of small obscure species.

Scattering specimens of codfish were taken with the hand lines, but they were more plentiful off Cape Constantine in from 12 to 18 fathoms, sand or gravel bottom. Our route from the Nushagak to the Kuskokwim was inside of the Walrus Group and through Hagemeister Channel. Fine sand bottom was found from Cape Constantine to Round Island, muddy bottom thence to the vicinity of Hagemeister Island, and sandy thence to Cape Newenham. Investigations were confined to 20 fathoms or less, yielding an occasional codfish or young halibut, pollock, five or six species of flounders; Arctic tomcod and sculpins were quite plentiful. Alligator-fish, capelin, and a variety of *Agonidæ*, besides several other species of small size, were found, many of them undescribed. Shrimp and prawns were large and conspicuous in the hauls; many of them are doubtless undescribed. The bulk of most of the hauls was composed of starfish. There was a greater variety among the ascidians found at the different stations than among other invertebrates. Shells, sand-dollars, ophiurans, hermit-crabs, and astrophytons of about the same species were generally distributed over the region, while hydroids and bryozoa occasionally appeared.

From Cape Newenham toward the northwest cape of Unimak the depth increased to 25 fathoms, gravel bottom, 6 miles from land; shoaled to 13½ fathoms, fine gray sand, at 26 miles, then gradually increased to 26 fathoms, with the same character of bottom at about 60 miles from the cape. From this point mud began to appear, and soon became the principal ingredient of the bottom soil.

Scattering codfish were found on the gravel bottom; were fairly abundant on the rise from 13½ to 25 fathoms, and gradually disappeared as we approached muddy bottom. Several species of flounders and sculpins were taken; alligator-fish and other small species were common; and clusters of large barnacles, mussels, and a few other shells were taken, besides the common forms of invertebrates. As the character of the bottom changed, and mud became mixed with the sand, great beds of ophiurans were found, 10 bushels or more having been brought up at a haul. Shells, such as *Trophon* and other forms, were abundant on the same ground, most of them being occupied by hermit-crabs. A number of large crabs were also taken. Large holothurians and astrophytons were common, and naked mollusks were conspicuous as we deepened the water. Flounders, sculpins, young pollock, alligator-fish, and the other small species were distributed generally over the ground; in fact, the contents of the net varied but little after the first few hauls.

From the Northwest Cape of Unimak to Port Möller, including the region called Slime Bank and a portion of Baird Bank, a uniform richness of life on the bottom was observed. The depths varied from 12 to 50 fathoms, with sand, or sand and gravel, bottom. Codfish were abundant, and the variety of fishes obtained exceeded anything seen in localities previously visited. While the great mass of invertebrates resemble those taken on other grounds in Bristol Bay, special attention was attached to the variety of sponges and the great numbers of medusæ. The latter float near the bottom in such masses as to become a serious detriment to the fishermen. Gorgonians of various kinds, and bryozoa were found near the shores.

There was one exception to the general richness of the fauna in this region, the vicinity of Amak Island being found exceedingly barren.

The following is a brief summary of the general movements and operations of the ship during the year:

Total number of days at sea	114
Total distance run by observation ....miles	12,963
Total distance run by log ....do	13,236
Total number of deep-sea soundings	1,025
Total number of dredging stations	275
Total number of deep-sea fishing stations	149

PERSONNEL.

The following officers were attached to the vessel at the end of the fiscal year: Lieut. Commander Z. L. Tanner, U. S. N., commanding; Lieut. C. G. Calkins, U. S. N., executive officer and navigator; Ensign Marbury Johnston, U. S. N.; Ensign E. W. Eberle, U. S. N.; Ensign C. M. McCormick, U. S. N.; Ensign Wm. W. Gilmer, U. S. N.; Passed Assistant Surgeon Jas. E. Gardner, U. S. N.; Passed Assistant Paymaster Charles S. Williams, U. S. N.; Passed Assistant Engineer C. R. Roelker, U. S. N.

The civilian staff was as follows: Prof. Charles H. Gilbert, naturalist in charge; Charles H. Townsend, resident naturalist; A. B. Alexander, fishery expert; N. B. Miller, assistant naturalist; H. C. Fassett, captain's clerk.

THE FISCAL YEAR 1890-91.

BERING SEA, JULY AND AUGUST, 1890.

Herendeen Bay.—The *Albatross* was at anchor under Point Divide, the entrance to Herendeen Bay, on June 30, 1890. We had called to ascertain if coal could be procured from a recently opened mine, and were informed by the superintendent that he could commence delivery in about a week, providing a lighter he was building could be completed. We sent a carpenter to assist in the work, and rendered all practicable aid in order to get a supply of fuel as quickly as possible. In the meantime we commenced a survey, which was continued during our stay, and resulted in a chart in sufficient detail for purposes of navigation. It includes the entrance to Port Möller; the channel from Entrance Point to Point Divide, called by us Hague Channel; the narrow and intricate channel from the last-mentioned point to Marble Point, which we named Johnston Channel, after the officer who surveyed it, and a general examination of the bay, including Mine Harbor, the shipping-point and headquarters of the company. On the morning of July 2 we moved about a mile inside of Point Divide and anchored in 15 fathoms. The tide ran ebb until 3 p. m., with a velocity of 3 or 4 knots per hour, with smooth water and nothing to indicate an insecure or undesirable anchorage. A few minutes later the flood tide came in with a bore between 2 and 3 feet in height, and when it struck the ship she picked up her anchor and started up the bay, but a second anchor with a long scope of chain brought her up. Heavy tide rips continued for hours, making it unsafe for a boat to approach the ship. The strength of current measured by the patent log was between 8 and 9 knots per hour.

It was evident that we could not remain in our new berth, so at slack water we worked our way through the narrow passage before mentioned between Point Divide and Marble Point, anchoring an hour later in the upper bay, within 3 miles of Mine Harbor. A small quantity of coal was procured on the 3d and tested in the steam gig. It burned freely, with a long flame and straw-colored smoke, to a white ash and cinder, but no clinker. This result was equally gratifying to us and the superintendent of the mine.

The 4th of July was celebrated by dressing ship with flags at the mastheads and peak, the first time the national holiday was ever observed in Herendeen Bay by a United States vessel.

We moved to Mine Harbor on the 5th, and moored in 17 fathoms, where we found good swinging room about a quarter of a mile from the coal dump on the beach. The lighter was launched on the evening of the 7th and brought alongside on the 9th, with the first load of 43 tons of coal from the new mine. The work of coaling continued until the evening of the 15th, when we had taken 137 tons, which nearly filled the bunkers. The weather during our stay was generally overcast with mist and fog, but the sun usually came out for a short time each day. An effort was made to locate Point Divide astronomically, and sufficient observations were made for longitude, but no opportunity occurred, either day or night, to obtain the latitude. We were more fortunate, however, in Mine Harbor, Low Point having been accurately located by excellent observations. The naturalists made numerous additions to their collections during our detention, and the hunters brought in several bears, reindeer, and other game.

Baird Bank.—Getting under way on the morning of the 16th, we steamed out without difficulty and resumed work. Lines of soundings were run off and on shore, the beam trawl being frequently used, and trial lines put over at every station occupied during daylight. We found that Port Möller was near the center of the most important cod bank yet discovered in Bering Sea. Commencing at Amak Island, it extends to the vicinity of Cape Chichagof, a distance of 230 miles, with an average breadth of 40 miles, having an area of 9,200 square miles, with depths from 15 to 50 fathoms. The character of the bottom was usually fine gray sand, varied by black sand, black sand and gravel, and occasional rocky patches near shore. While codfish were found at nearly every station, numbers and quality varied with the locality. They were smaller and in poorer condition near the shores, the best fish being found between 25 and 40 fathoms, and they seemed to be most plentiful in the Port Möller region.

As this is the largest and most valuable of the fishing-grounds yet developed in Bering Sea, we have called it Baird Bank, after Prof. Spencer F. Baird, the first U. S. Commissioner of Fish and Fisheries, through whose efforts these investigations were inaugurated.

Baird Bank and Slime Bank, having an area of 10,645 square miles, extend for more than 300 miles along the northern shores of Unimak and the Alaska Peninsula, without a single harbor that the fishermen have hitherto availed themselves of, yet it is a favorite fishing-ground. The weather is usually pleasanter than in the Pacific; it has a weather shore with the prevailing summer winds, and a well-found vessel may anchor anywhere on the banks and ride out the usual summer gales without much risk or discomfort.

Our survey of Port Möller entrance and Herendeen Bay will render those harbors available hereafter, and there is an excellent beach at Mine Harbor for hauling a schooner out if necessary. The rise and fall exceeds 15 feet, and would give several hours each tide to examine or make repairs on a vessel's bottom. Should the coal mine be developed, as seems likely, the place would afford some facilities for repairing and refitting. Water is easily procured, and fuel can be had in any quantity.

Port Haiden.—Port Haiden is said to be a good harbor, but we did not examine it. Should a survey show it to be safe and easy of approach, it will prove a great convenience to vessels employed on the northern portion of the bank.

Ugashik River.—The Alaska Commercial Company's schooner *Pearl* enters the Ugashik River, but there is a wide bar to cross having intricate channels, strong currents, and usually a heavy swell. Once inside, there is a good harbor, but it could hardly be considered available for the ordinary purposes of a fisherman.

Head of Bristol Bay.—The head of the bay to the northward of a line drawn from the Ugaguk River to Cape Constantine has no value as a cod-fishing ground. The water is not only too fresh, but the enormous discharge from various streams in the vicinity, in conjunction with the naturally strong tidal streams, induces a current which holds in suspension sufficient sand and mud to account for the absence of codfish without looking for other causes. We took scattering specimens, it is true, but their emaciated condition was sufficient evidence of their having strayed from their usual feeding-grounds.

Naknek River.—Salmon are found in the Naknek River, and there are one or more firms engaged in that industry. Vessels of any size may reach an anchorage off the mouth of the river by keeping the eastern shore aboard, notwithstanding the inaccuracy of the charts. Shoal water will be found whenever the western side is approached.

Nushagak River.—The salmon fisheries of the Nushagak River have assumed important proportions, and will doubtless attract numbers of people to that region. It will have little interest for the cod fishermen except as a possible port of refuge, where wood and water and such supplies as they would be likely to need can be obtained. It has not been considered a desirable place to visit, and the defective charts, strong tides, numerous shoals, and liability to encounter thick weather all militate against it; but with the surveys made by this vessel and the assistance of native pilots, to be found at Protection Point, a fishing schooner should be able to enter and leave the river with comparatively little risk or delay.

Kulukak Ground.—Kulukak Bay occupies a large portion of the region between Capes Constantine and Newenham, including the Walrus Group, Hagemeister Island, and Cape Peirce. As codfish are found in various isolated spots hardly deserving the appellation of banks, we have, for convenience, included the region under the single title of the Kulukak Ground. There are extensive shoals outside of Hagemeister and the Walrus islands, 6 fathoms being found about 18 miles to the southward of the latter. The spots are outside of these shoals, as well as to the eastward and westward of them, in from 12 to 25 fathoms, where codfish may be taken at times quite plentifully, but they are smaller than those on Baird Bank.

Mine Harbor, Herendeen Bay.—Our fuel being nearly expended, we returned to Herendeen Bay July 23 for another supply. This bay has a large area with several arms, and to distinguish the shipping-point more definitely we have called it Mine Harbor.

Work had progressed favorably during our absence, and we found over 100 tons of coal on the beach awaiting our arrival. The method of transporting it to the ship may be described as follows: A single lighter, having a maximum capacity of 40 tons, was moored near the shore at high tide and the coal wheeled on board in barrows over a gang-plank supported on trestles. As the tide fell it would be left high and dry, the work proceeding until the next high tide, when we would tow it alongside with the steam cutter, discharge the coal as soon as possible, and moor it again near the beach, when the process would be repeated. The mine is about 1¼ miles from the landing, the coal being transported by a small steam motor over a light tramway. As the opening of this mine is an event of no little importance to all vessels visiting Bering Sea, the following report of Passed Assistant Engineer C. R. Roelker, U. S. N., chief engineer of this vessel, on the results obtained by the consumption of 80 tons of this coal, will be read with more than usual interest. It is dated July 24, 1890:

The following statement regarding the coal received from the mine recently opened at Herendeen Bay is based on the results obtained with some 80 tons of this coal consumed while this vessel was engaged in her usual work at sea, under average conditions. The quantities of coal consumed, and of refuse matter, were carefully measured, the behavior of the coal in the furnaces was closely observed, and the results obtained have been deduced from the entries in the steam log.

The average consumption of the coal was at the rate of 25 pounds per square foot of grate per hour. The boilers furnished the same amount of steam as when we have been using a fair quality of Wellington coal; but to obtain this result we had to burn from 20 to 25 per cent more of the Herendeen Bay coal. The coal ignites readily and burns with considerable flame, forming a closely cohering coke, which easily breaks up into small pieces; thus a considerable amount of small particles of coal is lost through the grates. There was a large proportion of fine stuff in the coal, which burned well, but contained an excessive amount of refuse matter.

The refuse amounted to 26 per cent of the total weight of fuel consumed; it consists of ash and cinders, no glassy clinkers being formed. The smoke produced is lighter in color than that of Wellington coal, and less soot is formed.

To form a correct estimate of the value of this coal for steaming purposes from the foregoing statement, the following facts should be taken into consideration, viz: The coal received by us was the first lot taken out from the newly opened mine; it came from one of the smaller veins, through which a tunnel had been driven then a distance of 200 feet in order to get access to the main veins; no proper facilities for screening the coal existed, and in order to supply the quantity required by us, a large amount of fine coal containing much dirt was delivered. It may be reasonably expected that as the mine becomes further developed and proper screening facilities are provided, the amount of refuse matter in the coal will be greatly diminished, and its steam-generating power correspondingly increased. It will be, however, absolutely necessary to store this coal under shelter, as it appears to absorb moisture readily, and the constant rains which have prevailed in this region during the present season would soon saturate it to such an extent as to greatly diminish its value as a fuel.

This report gives an accurate statement of the steaming qualities of the coal received from the mine compared with the Wellington coal, and, considering that it was taken from a vein near the surface, the extra amount required to furnish the same quantity of steam will not seem excessive. It is shown that the coal possesses merits, and it will doubtless improve with the development of the deeper veins.

Work was resumed on the survey as soon as the vessel came to anchor, and, although the weather was unfavorable, many soundings were taken, besides some further triangulation. Reindeer and bears were plentiful in the mountains surrounding Herendeen Bay, and several were brought in by the naturalists and officers. We finished coaling on the evening of the 27th, having taken aboard 128 tons, 25 tons being in bags on deck.

Boisterous winds with driving mist and fog detained us during the 28th, but we were under way early the following morning and steamed out by the rough chart of our recent survey, which was found quite accurate and sufficient for the present purposes of navigation, except at the entrance to Port Möller, where more soundings are required to properly develop the channel and the region between Entrance Point and Walrus Island.

Strong southerly winds and heavy head seas were encountered, which, in addition to a dense fog, made our progress exceedingly slow and uncomfortable, but we finally arrived safely in Iliuliuk, Unalaska, at 10:50 a. m., July 31. Arrangements were made for a supply of coal on our return, and at daylight August 2 we proceeded to sea. A line of soundings was commenced off Cape Cheerful and carried to Bogoslof, an active volcano in 53° 55′ N. and 168° 1′ W. The maximum depth was 885 fathoms about midway between Cape Makushin and Bogoslof.

Bogoslof Island and Volcano.—The first authentic account of this interesting locality is from Capt. Cook, who passed between the position of Bogoslof and Umnak in 1778, and discovering a rock which at a distance resembled a ship under sail, he named it Sail Rock. It must have been the only conspicuous object near by at the time or he would have mentioned that fact. Old Bogoslof, as it is now called, was thrown up about 400 yards from Sail Rock in 1796, after an earthquake, and, according to Baranoff's report, remained active until 1815 at least; I do not know how much longer. It must have undergone many remarkable changes during its period of activity. Capt. Wassilieff reported that at one time it attained an altitude of 2,240 feet, whereas it is now but 370 feet in height and greatly diminished in bulk. New Bogoslof is located on the opposite extremity of the same platform, the total length of the island, including the old and new cones, being about 1¼ miles NW. by N. and SE. by S. (magnetic), and a little less than a mile in width.

The natives of southern Unalaska reported that Bogoslof was smoking in 1882, but there is no report from the island until September 27, 1883, when Capt. Anderson, of the schooner *Matthew Turner*, passed near it and reported a new Bogoslof, with flame, smoke, and steam issuing from the crater and numerous fissures in its sides. The revenue cutter *Corwin* examined it in 1884, when it was still active, and a subsequent visit in 1885 developed no material change. Sail Rock was reported to be 86 feet in height.

The *Albatross* passed within three quarters of a mile of the island on the afternoon of August 2, 1890, but did not land. It was an unusually clear day, Makushin and the high lands of Umnak being distinctly visible. Sail Rock had fallen, its original position being marked by the débris. New Bogoslof was enveloped in smoke and steam so dense that its outlines could not be accurately determined, but its altitude was not far from 400 feet. There were no outlying dangers visible, and a couple of soundings taken 2 miles from the old cone on different bearings gave 649 and 578 fathoms, the latter being on the reef marked on old charts as extending from Bogoslof to the north end of Umnak. It is needless to say that this reef does not exist. Myriads of guillemots were seen on the island and for 15 miles or more around it, and a part of the beach was occupied by a rookery of very large sea lions. Old Bogoslof is rapidly crumbling away, and will, like Sail Rock, eventually disappear.

Bering Sea.—A westerly course was continued during the night, and at six the following morning the trawl was lowered in 1,033 fathoms, latitude 55° 53′ N., longitude 170° 50′ W., making a successful haul. The bottom was composed almost wholly of diatomaceous ooze, the absence of foraminifera being a marked feature in the waters of Bering Sea. The course was then changed to the northward, and soundings made at 50-mile intervals, which gave 1,745, 1,818, 1,625, and 69 fathoms, the latter in latitude 56° 50′ N., longitude 172° 30′ W., and near the 100-fathom line. Seals were frequently seen after we reached soundings, and, the fog lifting for a short time, two sealing schooners were sighted, with their boats out in the successful prosecution of their enterprise.

The line of soundings was extended to latitude 58° 43′ N., longitude 174° 43′ W., in 144 fathoms, giving the trend of the 100-fathom line about NW. ½ N., magnetic. A southerly gale sprang up during the evening of the 4th, and work was carried on the next day under many difficulties and unusual wear and tear of machinery. The rough weather told on our supply of fuel also, and finally induced us to turn to the southward during the afternoon of the 5th. Standing on all night under low speed and short sail, a sounding was made next morning in 1,887 fathoms, latitude 56° 50′ N., and longitude 175° 15′ W. Another one was taken during the afternoon in 1,998 fathoms, green ooze, in latitude 56° 02′ N., longitude 175° 35′ W. A bottom temperature and water specimen were taken in sounding, and subsequently serial temperatures and water specimens were taken to 1,000 fathoms, the temperatures ranging from 48° F. at the surface to 34.9° F. at the bottom. The line was continued to the southward, with 50-mile intervals, the maximum depth, 2,145 fathoms, being found in latitude 54° 31′ N. and longitude 175° 32′ W. A very peculiar and irregular action was observed in the port engine during the 6th and 7th, which increased to such an extent that we stopped work and started for Unalaska. The trouble was traced to the port high-pressure valve, which was finally disconnected, and the low-pressure cylinder worked independently until our arrival in port.

Unalaska and vicinity.—We passed Bogoslof Volcano the morning of the 9th and arrived in Iliuliuk at 4:15 p. m. the same day. The revenue cutter *Rush* was in port, and the steamer *Arago* arrived from the seal islands on the 12th. Having made the necessary repairs to the machinery, we filled the bunkers with coal and left the harbor early on the morning of the 15th. Rumor placed valuable cod banks in the outer bay, but no one seemed to know their exact locality or extent. Such a resource at the doors of a populous settlement would be of inestimable value. Availing ourselves of the opportunity offered by a clear day, we ran several lines of soundings across the bay, making frequent hauls of the trawl and trials with the fishing lines, extending the examination to the 100-fathom line outside of Cape Kalekhta, or Priest Point, and Cape Cheerful, without finding indications of even ordinarily good fishing-ground. In fact, nearly every sounding inside of the capes gave muddy bottom. Spots were discovered, however, near the shore line, where cod were plentiful. An anchorage was found for the night in Wislow Bay, in 8 fathoms, near the small islet of that name, where there is good protection from southerly winds.

Work was resumed at daylight next morning and carried to Cape Makushin and thence to Makushin Bay, where we anchored for the night. The 100-fathom curve lies about 4 miles off shore at Cape Cheerful, but draws in abruptly to about a mile, and sometimes less, until up with Cape Makushin, and here, as in Unalaska Bay, codfish and halibut are found in spots along shore. From the cape a line of soundings was run to Makushin Bay, where we arrived at 5:50 p. m. A strong, southwest wind raised quite a swell in the bay, with an uninviting lee shore fronting the village, but we found a fair anchorage in 8 fathoms off the mouth of a glacial stream of yellow muddy water 3½ miles to the eastward of the settlement. The village of Makushin is composed of a small frame church painted white, a frame store belonging to the Alaska Commercial Company, and a dozen barabaras, or native earth huts, which were nearly buried beneath rank grass.

Unfavorable weather detained us during the 17th, but the seine was hauled with good results. Work was resumed on the morning of the 18th and continued with little interruption to the southwest end of Unalaska and north extremity of Umnak. From Cape Makushin to Umnak is about 60 miles, the 100-fathom curve extending from 12 to 23 miles from shore, giving an area of over 1,100 square miles on which the lead showed favorable bottom, and the trawl developed a varied and abundant fauna, such as we usually found on cod banks in Bering Sea. Very few fish were taken, however, until we reached the vicinity of Chernoffsky, where cod and halibut were plentiful. Prospects were so favorable that I am inclined to think fish would be found there at certain seasons, if not the year round, and, should it ever become a fishing-ground, there will be no lack of safe and convenient harbors, for the west coast of Unalaska from Cape Makushin to Chernoffsky is a series of deep bays, some of them almost bisecting the island. Chernoffsky Bay is easy of approach and one of the most secure harbors in Bering Sea. The only direction necessary in entering is to keep a midchannel course. The village of the above name is situated on a narrow neck of land between the harbor and the sea, and is conspicuous when passing along the coast. The Greek church, store, and residence of the Alaska Commercial Company's agent are frame buildings, and the native population, 46 souls, live in barabaras. The men, like those of the other villages on the island, are hunters, and were away on their summer cruise at the time of our visit.

The examination having been completed to the northeast end of Umnak, a line of dredgings was run thence to the vicinity of Cape Cheerful in from 100 to 600 fathoms with satisfactory results, although the rough bottom was frequently destructive to the nets.

We returned to Iliuliuk on the evening of August 21 after an interesting and successful trip. The search for cod banks in Unalaska Bay was resumed the following day, which was unusually clear and pleasant. The region from Ulakhta Head to Elder Point was carefully examined, and the examination was extended to Broad and Nateekin bays without developing anything that could be called a fishing-bank Near the shores, however, particularly on the west side of the bay, cod were plentiful and halibut were fairly abundant. These shore fisheries will supply the local demand indefinitely, but nothing more. There was a large school of finback whales feeding in Broad Bay, during the day, which paid but little attention to us, simply moving out of the way or diving under the ship when we approached them. On one occasion the same school was seen playing around a whaler, but no attention was paid to them. Nothing but merchantable bone will tempt the modern whaleman. We returned to port the same evening.

Hydrographic information.—Bristol Bay may be said to include all that part of Bering Sea lying east of a line drawn from the Northwest Cape of Unimak to the Kuskokwim River. The island of Unimak and the Alaska Peninsula bound it on the east and separate it from the Pacific Ocean. The Naknek River is at the head of deep-water navigation, while the bay itself terminates in the Kvichak River, a few miles to the northward. The region about the Nushagak River, Kulukak Bay, and the Kuskokwim forms its northwest boundary.

The shore lines are usually low and without distinctive features, but high mountain ranges and volcanic cones extend along the central parts of Unimak and the Alaska Peninsula. These rugged snow-covered mountains and lofty peaks would serve as unmistakable landmarks were they not obscured by the almost constant fogs which prevail in that region during the summer months. In fact they were so seldom visible during the season of 1890 that the officers of the *Albatross* made no pretense of using them as landmarks. The shore line and objects near the sea level were often visible beneath the fog when the higher lands were obscured, hence most of the available landmarks were found on or near the beach.

Unimak Pass to Port Möller.—The Northwest Cape of Unimak is low, with detached rocks, around which strong tidal currents sweep. The land falls away to the eastward in a gentle curve, forming an open bay about 4 miles in depth, between the cape and Cave Point, which lies NNE. ½ E., 16 miles from the former. It is a vertical rocky cliff about 150 feet in height, and takes its name from a cave on its face, inhabited by sea birds, which in summer time hover about it in thousands, making it conspicuous in clear weather by their numbers and in fogs by their constant cries. The snow-clad peak of Progrumnoi Volcano, rising to an altitude of 5,523 feet above the sea, forms a striking background to the low monotonous coast.

Passing Cape Lapin, a low bluff point 8 miles from Cave Point, the coast falls away slightly for 6 miles, when it turns abruptly to the eastward for about 5 miles, then takes a northerly direction, forming Shaw Bay. This bay is open to the northward, but affords protection from all winds from the southward of east or west. The approaches are clear and the water shoals gradually to 6 fathoms, black sand, about three-quarters of a mile from shore.

From Shaw Bay to Isanotski Strait the coast trends in a northeasterly direction, is very low and has several rocky patches extending from half a mile to a mile or more from shore, making navigation unsafe inside of the 12-fathom line. The volcano of Shishaldin rises 8,953 feet, about midway between the above points, and about 7 or 8 miles inland. Isanotski Strait is available only for vessels of the smallest class.

From the strait to Cape Glasenap, about 19 miles, the coast line retains the same general direction, and is very low until reaching the latter point, which is oval in form, about 150 feet in height, and has been called Round Point.

Izenbek Bay covers a large area at high tide, but much of it dries at low water; a small vessel may, however, find a secure harbor behind the cape. The channel follows close around the point and has from 10 to 12 feet depth on the bar.

Amak Island is of volcanic origin, about 2½ miles in length, 1½ in width, and 1,682 feet in height. It lies 11 miles northwest from Cape Glasenap. The beaches are mostly of huge water-worn bowlders, having vertical cliffs from 30 to 150 feet in height, with moss-covered plateaus, which in summer time are covered with a rank growth of grass and wild flowers. The central peak is of dark-brown rock, exceedingly rugged and precipitous, and entirely devoid of vegetation. The south-~st point was found to be in latitude 55° 25′ 05.6″ N., and longitude 163° 07′ 33.6″ W. There is foul ground off the northwest extremity of the island, several rocks awash or under water, and Sea Lion Rock between 2 and 3 miles distant. It is several hundred yards in extent, and about 150 feet high, its slopes being occupied by an extensive rookery of sea lions.

The Khudiakoff Islands extend about 19 miles NNE. ½ E. between Cape Glasenap and Moffett Point. They are but little above high water, and some of them are connected by narrow spits when the tide is out. From Moffett Point the low coast trends N. by E. 15 miles to Gerstle Bay; then to the northward and eastward about 55 miles to Wolf Point, on the west side of the entrance to Port Möller.

The Khudubine Islands occupy the last 23 miles of this distance. They are very low and it is difficult to distinguish them from the mainland, the only distinctive feature being a knob about 25 feet high on the east end of Kritskoi. The land between Herendeen Bay and Nelson Lagoon is very low. The snow-covered pinnacle of Aghileen, an extinct crater, and the still smoking cone of Pavloff Volcano, form an impressive background to the region north and east of Moffett Point.

Port Möller, Herendeen Bay, and vicinity.—Port Möller and Herendeen Bay have had no commercial importance until the recent opening of a coal mine in the latter, which has drawn attention to this almost unknown region. The *Albatross* visited the mine twice during the season of 1890 and made a survey which was found to be sufficiently accurate for purposes of navigation. The chart should be used with caution, however, until it is ascertained whether the extensive banks guarding the entrance are permanent or shifting.

To enter Port Möller from the southward, pass Walrus Island in from 10 to 12 fathoms and bring Entrance Point to bear ESE. It will then be about 8 miles distant, and have the appearance of being the southern extremity of a high and bold headland, the first that approaches the coast between that point and Cape Glasenap. Stand in, keeping the point on the above bearing until within 2 or 3 miles, when it will show as a low spit backed by a cluster of hillocks, the high land referred to being seen farther inland. Pass Entrance Point at a distance on 1 mile, steering about SSE. ½ E., and stand for Harbor Point, passing it within a quarter of a mile, where anchorage may be found. The point is low. A shoal makes off from Entrance Point about NW. by N., extending between 3 and 4 miles, and vessels making for the harbor from the northward are liable to run in behind it. Entrance Point should not be brought to bear to the southward of SE. after having approached within 4 miles of it.

To enter Herendeen Bay, bring Entrance Point to bear NE. ½ E., 1 mile distant, and Point Divide SSW. ⅜ W., 8¾ miles distant, then steer for the latter, keeping it on that bearing until within 2½ miles, when the course may be changed to about SW. ¾ S., passing in midchannel between Point Divide and Doe Point. The least water is 4 fathoms at the entrance to the channel. Having cleared Hague Channel, bring Coal Bluff to bear SE. ¼ S., and stand in for it until Point Divide bears S. by E. ½ E., 1½ miles distant and about 400 yards open of Doe Point; then SSE. ¾ E., until Eagle Rock is abeam, keeping the above points a little open to clear Half-tide Rock. Then steer S. by E. ¼ E. until Shingle Point is abeam, when a course may be laid for Mine Harbor, giving Bluff Point a berth of about a quarter of a mile.

Mine Harbor is small but free from dangers, except Midway Rock, which shows at half tide. Anchor in from 12 to 15 fathoms, and if a vessel intends to remain any length of time it is advisable to moor. It is high water in Mine Harbor, full and change, at $8^{h}\ 0^{m}\ 0^{s}$, rise 15 feet, and it occurs at Entrance Point about two hours earlier, with a rise of 10 to 12 feet.

Hague Channel is 1 mile in width at its northern entrance, and is contracted to less than half a mile between Point Divide and Doe Point. The tidal streams are very strong, and near high water they sweep across the narrow channel and over the flats, making it impossible to steer a compass course. They are more regular near low tide, which is the best time to make the passage, as the channel is indicated by the flats showing above water on either hand.

Johnston Channel has from 7 to 15 fathoms of water, but is very narrow, with steep sides. It is difficult to find, but, once in, the navigation is comparatively simple, as the tides follow the general direction of deep water. The width of the northern entrance is a quarter of a mile, which it maintains with little variation until near the southern extremity, when it contracts to 250 yards. Having cleared the channel and entered the upper bay, there is ample room and depth of water in every direction, Crow Reef being the only outlying danger.

Anchorages may be found anywhere between Walrus Island and Entrance Point in case of fog, and a vessel may anchor in Hague Channel, but the tides are strong. There are fairly good anchorages under the north side of Point Divide and Doe Point, where near the bank a vessel will be out of the strength of the current. The *Albatross* anchored in midchannel a mile inside of the above points at the time of spring tides, and the flood came in with a bore between 2 and 3 feet in height, the patent log registering a 9-knot current for some time, with a swell which occasionally splashed into the scuppers. There is fairly good anchorage off the northern entrance to Johnston Channel, and an excellent one at its southern extremity off Marble Point, in fact, almost anywhere in the upper bay where the water is not too deep. The last quarter of flood tide is the best time to pass through this channel.

High land rises at the base of Harbor Point and extends to the northward and eastward near the center of the peninsula. Point Divide is 50 feet high, and mountain ranges rise a few miles back. The coal measures are found between Mine Harbor and the head of Port Möller. Doe Point is 40 feet in height, while the rest of Deer Island and the mainland south and west of it is generally lower. The southern shores of Herendeen Bay are mountainous, with intervening valleys, the whole face of the country being covered with rank grass and wild flowers during the summer months; but there is no timber except occasional small poplars, alder bushes, and willows. Fresh winds with fog and mist blow across the low divides from the Pacific, obscuring the sun and greatly increasing the rainfall in Port Möller and vicinity.

The region is uninhabited except by men employed at the coal mine, yet bears and reindeer were plentiful and the waters teemed with salmon. There are no large fresh-water streams entering the bay, however, which probably accounts for the absence of Eskimos.

Port Möller to the Kuskokwim River.—The coast is low for 19 miles between Entrance Point and Cape Kutuzof, which rises in a rounded bluff to an elevation of 150 feet.

Cape Seniavin, 11 miles to the northward and eastward, is a rocky point 75 feet in height. Passing it, the low monotonous beach continues to the Seal Islands, a cluster of small hillocks near the beach, 12 miles from Cape Seniavin, being the only exception. The Seal Islands are composed of several small islets, but little above high water, strung along the coast for about 10 miles. Thence to Cape Strogonof the land continues very low.

Port Haiden is said to be a good harbor, but we did not examine it. Should a survey show it to be safe it will prove a great convenience to vessels employed on the northern part of Baird Bank. The approach to Port Haiden will be recognized by high, bold headlands which rise from its northern shore. Chestakof Island, low and crescent-shaped, forms the seaward side of the harbor, the channel lying between its northern extremity and a reef which makes out from the land. The same low coast extends to Cape Menchikof in nearly a direct line, the high land of Port Haiden gradually receding from the coast.

The Ugashik or Sulima River lies to the northward of Cape Menchikof and has been reported navigable for several miles by vessels of 14 feet draft. The schooner *Pearl* enters the river, but her captain reports a wide bar having intricate channels, strong currents, and usually a heavy swell. Ten feet is about all that can be carried in with safety. Once inside it is reported to be a good harbor, but it can hardly be considered available for the ordinary purposes of fishing vessels.

Cape Grey, a bluff 243 feet in height, and a peculiar-notched mountain some distance inland, are good landmarks for the river. The low coast continues from the cape to the Ugaguk River, and thence to the Naknek River, with hardly a distinguishing feature except Johnston Hill, a solitary elevation 5 miles from the beach and about 9½ miles S. ½ E. from the mouth of the Naknek. The coast sweeps in a graceful curve to the northward between Cape Grey and the Ugaguk, and thence to the eastward to the Naknek River. A narrow gravel bank lines the coast in several places, behind which a strip of water is seen particularly at or near high tide.

The Naknek River may be considered at the head of deep-water navigation in Bristol Bay. The *Albatross* found anchorage in 6 fathoms about 6 miles southwest from Cape Suworof, the water shoaling rapidly to 3 fathoms toward the head of the bay. Vessels of moderate depth can pass the bar at high water, but there is hardly depth enough to float a ship's boat when the tide is out. It is deeper inside, however, and a small vessel may find anchorage with swinging room. There is a fishing station on the river which is visited periodically by a small steam tender. The South Head is in latitude 58° 42′ 04.3″ N., and longitude 157° 02′ 45.4″ W. High water, full and change, 1^h 05^m; rise 23 feet, approximate. Shoal ground makes off from the west shore, confining the channel in one place to about 3 miles in width. It may possibly be a middle ground with a channel on the other side, but the conditions off Etolin Point seem to discredit it.

The Nushagak River is assuming considerable importance as the location of a trading station and several large and well-equipped salmon-canning establishments. Protection Point, at the entrance to the river, is 50 miles SW. by W. from Naknek River, and, owing to swift currents and extensive shoals, it may be classed among the most intricate pieces of navigation in Bristol Bay. A 6-knot current is frequently encountered; hence the shifting of banks and shoals must be expected, and the necessity for the constant use of the hand lead becomes too obvious to require remark; indeed, the warning from a lead on each side will leave but a small margin of safety at times. The land on both sides of the entrance is very low and it is difficult to recognize Etolin Point, even under favorable conditions. A vessel from the westward would make the Walrus Group and follow the coast to Cape Constantine, and, having cleared the outlying shoals, stand in for Protection Point, which is difficult of recognition from a distance.

Nichols Hills, 280 feet in height, are a cluster of rounded elevations 5 miles northwest of the above point, and they are the first natural objects distinguishable on the peninsula. Bring them to bear WNW. and stand in, keeping them on that bearing until Protection Point bears about south, and anchor, making due allowance for falling tide.

There is a pilot station on the point with a small flagstaff, on which a flag will be hoisted if the pilot is at home. He is an Eskimo and speaks very little English, but he knows the channel. If he is not at the point when the vessel arrives, he will probably be at Ekuk and may be expected on board within a few hours if the weather is not too rough for his kaiak. A stranger should not attempt to go above Protection Point without a pilot. Clark Point is a bluff 200 feet in height, 18 miles N. by W. from Protection Point. The land begins to rise below Ekuk, reaches its greatest elevation at Clark Point, and varies from 100 to 150 feet in height to Nushagak. The usual anchorage is from a mile to a mile and a half above Clark Point. Ekuk is an Eskimo village located on the bluff about 3 miles below the point. The west side is generally lower, but from Coffee Point to the northward bluffs rise from 50 to 200 feet.

The reconnaissance of the Lower Nushagak was made during the few days we were detained in the river. The principal points are located by triangulation and Clark Point by astronomical observations. The reduction of soundings to low water depended upon the tides during our stay. It is to be regretted that we were unable to extend the soundings to the west shore.

The Nushagak Packing Company have a cannery at Clark Point, and there are three others, also a trading station, on the river, the latter at Nushagak, formerly called Fort Alexander. Vessels of moderate draft can reach the canneries and with a little care find anchorage with sufficient water even during the lowest tides. The timber line is well defined about 3 miles below the mouth of Wood River and extends to the westward as far as the eye can reach. The weather was pleasant during our stay, and from all reports there is less fog in the Nushagak than in any other part of Bering Sea.

Clark Point, foot of bluff, is in latitude 58° 49′ 14″ N. and longitude 158° 31′ 43.9″ W. High water, full and change, $00^h\ 53^m\ 00^s$ (approximate); rise, 24 feet; variation, 23° 40′ E.

Cape Constantine, the southeast extremity of land at the entrance to the Nushagak, is very low, and shoals extend 10 or 12 miles to the southward and eastward, making its approach in thick weather very dangerous. There is said to be a channel between the cape and the first shoal, but the report requires verification. The coast increases in height to the westward of the cape, the headlands in Kulukak and Togiak bays reaching an altitude of 500 feet or more.

The Walrus Group is composed of three islands and three rocks, all above water, extending 16 miles east and west and about 6 miles north and south. Round Island, the easternmost of the group, lies W. ½ S., 36 miles from Cape Constantine. It is very nearly 2 miles in length, three-quarters of a mile wide, and about 800 feet high, its west end being in latitude 58° 36′ 09″ N. and longitude 159° 57′ 51.7″ W. Crooked Island is between 4 and 5 miles in length and 2 miles at its greatest width. The eastern part is rather low, but toward the western extremity the elevation is nearly equal to that of Round Island. There is quite a large bay on the northeast side, but we did not examine it. High Island, the westernmost of the group, is 4 miles in length, about a mile in width, and 900 feet or more in height.

The Twins, 4 miles to the southward of Crooked Island, are two isolated rocks the larger 300 and the smaller 100 feet in height. Black Rock, about 150 feet high, lies 1 mile to the northward of the south end of Crooked Island. No other outlying dangers were seen in passing between the islands and the mainland. From 6 to 10 fathoms were found abreast of the group, the depth gradually decreasing to 3 fathoms off the north end of Hagemeister Island. We were near the shore, however, and would doubtless have found more water in midchannel.

Hagemeister Island lies 9 miles west of High Island, is 14 miles in length and 8 in width. It is mountainous except for about 5 miles at the north end. Shoal ground surrounds the island and extends from 20 to 25 miles to the eastward, including the area between Hagemeister and the Walrus Group.

Hagemeister Channel is about 16 miles in length and lies between the island of that name and the mainland. It is from 3 to 4 miles in width, but long shingle spits contract it in two places to less than 2 miles. The least water was 4½ fathoms. Good anchorage was found under Tongue Point, the shingle spit making out from the mainland about midway of the channel. From the above anchorage the *Albatross* stood directly to sea, passing within a mile of the southwest extremity of Hagemeister Island, thence S. ½ W., shoaling the water to 3 fathoms 7 miles from the island. Greater depths might possibly be found by taking a more westerly course. The tides are very strong through the channel. We were visited by a number of Eskimos while at anchor under Tongue Point.

Cape Peirce is of moderate height and symmetrical form, while Cape Newenham is high with sharp peaks and rugged lines. The *Albatross* found anchorage under the latter cape near Seal Rock during a southerly gale and rode it out very comfortably, notwithstanding swift currents and heavy tide rips.

The Kuskokwim River is much dreaded by navigators on account of its extensive shoals, strong currents, etc. The *Albatross* ascended it between 35 and 40 miles without difficulty or delay, but encountered extensive shoals on her return; thick weather and the lack of time prevented an extended examination. These shoals commenced about 9 miles WSW. from Good News Bay and extended in a westerly direction for 10 miles or more. There was a channel between the shoal and the land about 4 miles wide, having a depth of 5 fathoms. From a point 5 miles WSW. from the west head of Good News Bay we stood direct for Cape Newenham, the least depth being 4 fathoms. Great quantities of fresh water are borne down the Kuskokwim by rapid currents, and, while there have been no surveys by which changes can be noted, there seems no reasonable doubt that great alterations have taken place since Cook ascended the river in the last century.

Meteorological conditions in Bering Sea.—The winds and weather in Bristol Bay and other parts of Bering Sea visited by the *Albatross* from the last of May to the 1st of September may be summarized in a few words. Southwest winds prevailed, but we had them from southeast to northwest. It was boisterous weather nearly half the time, but seldom rough enough to interfere with our work. We had several summer gales of moderate force, but no severe storms. Fog and mist prevailed and a clear day was a rare exception. The tidal currents were strongest in the vicinity of Unimak Pass and the head of the bay; they were greatly affected, however, by the winds. The flood stream set to the northward and slightly inshore along the coasts of Unimak and the peninsula; the ebb, to the southward and slightly offshore. The former was invariably the stronger and probably found an outlet by sweeping past Cape Constantine in the direction of Cape Newenham. There has been no systematic study of Bering Sea currents and the almost constant fogs prevent the navigator from adding much to our meager knowledge concerning them.

Well-equipped fishing vessels can anchor anywhere on Baird or Slime Banks and lay out such winds as they would be likely to encounter during the summer months. The peninsula will afford a weather shore for southeast winds and Amak Island offers fairly good protection on its southeast and southwest sides. Port Möller and Herendeen Bay will be ports of call for fishermen when they become better known. Port Haiden may also prove available after it has been surveyed.

UNALASKA TO SAN FRANCISCO, AUGUST AND SEPTEMBER, 1890.

We coaled ship on the 25th, and at 1:15 p. m. the following day left in company with the revenue cutter *Rush*, the latter bound to the Seal Islands. The atmosphere was unusually clear, and, as we had never used Akutan Pass, we availed ourselves of the favorable opportunity of passing through and examining it. There is a clear channel 2 miles or more in width between Cape Morgan and four small islets lying off Unalga Island, free from dangers except near the shores, with 26 fathoms, rocky bottom, in the narrowest part of the pass. We steamed to the eastward during the night, and at 6:17 the following morning cast the trawl in 280 fathoms in latitude 53° 56′ N. and longitude 163° 25′ W., about 9 miles from the reported position of Lenard Rock, but saw no indications of shoal water, although the weather was clear and a lookout was kept at the masthead.

A line of soundings and dredgings was run outside of the 100-fathom curve, past the Sannaks and Shumagins, to the vicinity of the Trinity Islands, where, in 67 fathoms, latitude 56° 02′ N. and longitude 153° 52′ W., we took our departure. Running E. 3° S. true 11 miles, we found 207 fathoms; then E. true, with intervals of 20 miles, the following depths were found across the line of the great submarine trough which extends along the Aleutian Islands, viz: 1,152, 2,197, 2,620, 2,935, and 2,925 fathoms. Increasing the interval to 30 miles, we found 2,776 fathoms, and a further distance of 62 miles gave us 2,414. The maximum depth was found in latitude 56° 02′ N. and longitude 151° 12′ W. It will be observed that, while the depths are less than those found farther west, they are at least 800 fathoms greater than the normal, showing that the easterly extension of the depression reaches that point. The line of soundings was extended to the Queen Charlotte Islands, where a successful haul of the trawl was made in 1,588 fathoms.

The high land of the above group was sighted on the 3d of September and we passed the Scott Islands the following evening.

Entering the straits of Fuca at midnight of September 5, we reached Port Townsend at 12:20 p. m. the following day, where we found a large mail awaiting our arrival. Many improvements were observed in and about the city; blocks of buildings had been erected during the year; electric and steam-motor street railways were in operation; and 20 miles of the Port Townsend and Southern Railroad was officially opened on the 12th. Repairs on the machinery were completed on the 15th and we left the following morning for Departure Bay for coal. A dense fog and smoke made navigation very difficult, and, after feeling our way through Rosario Straits, we anchored at the Sucie Islands for the night, finally reaching our destination at 2:25 p. m. the following day. Taking on board 183 tons of coal, we returned to Port Townsend, reaching that port at 1:30 p. m. on the 20th.

Getting under way again at 3 p. m., we passed Race light at 8 p. m. and made Cape Flattery light at 1 a. m., the fog having lifted. Two hauls of the trawl were made during the 21st in 516 and 831 fathoms off the Washington coast; and, steaming to the southward during the night, three hauls were made next day off the coast of Oregon in 759, 786, and 345 fathoms. Standing to southward during the night, through dense fog and smoke, we crossed Heceta Bank, made Cape Orford at 1 p. m. on the 23d, passing Fox Rock an hour later. Nothing more was seen until we reached Cape Mendocino the next morning. The weather had somewhat improved and objects could be seen from 1 to 2 miles.

Commencing at the cape we defined the 200-fathom line as far south as Point Arena and made a series of dredgings from 455 fathoms to the coast. The bank was very steep near Cape Mendocino, but gradually extended until, off Point Arena, the 200-fathom line was 10 miles from shore. There are no fishing-banks proper in that region, but the usual coast fishes will be found in spots along the shore. The beam trawl may be used in the region about Point Arena, but stony spots occur at intervals which would be liable to damage the nets. The bottom seems smoother to the southward toward Point Reyes, and the ground will doubtless be fished with nets of some description as the demand for flatfish increases in the San Francisco market.

Having completed our work, we started for port at 4 p. m., September 25, arriving in San Francisco at 8 o'clock on the morning of the 26th.

NATURAL HISTORY OBSERVATIONS.

The fauna of Bristol Bay, other parts of Bering Sea, and the Pacific Ocean, developed by the use of the trawl and dredge during the season, will be reported upon by Prof. C. H. Gilbert, but it may not be out of place to add here a few general remarks upon this subject. A marked feature of the dredging on Slime Bank was the great numbers of medusæ or jellyfishes brought up in every haul of the net. The species was not determined, but may be described as rusty-brown in color, from 6 to 18 inches in diameter, and with long, slender tentacles well provided with stinging cells. They inhabit an intermediate zone not far from the bottom, and their numbers increase with the advance of the season, until they become a great nuisance to the fishermen. Starfishes are abundant both in numbers and species. Sponges, sea-urchins, various species of crustaceans, shells, and other invertebrates, including many forms of hydroids, are generally found in large numbers.

The principal feature of the many hauls on Baird Bank was the great abundance of starfishes, of at least a dozen species, one large variety predominating. They composed the bulk of nearly every haul. Sponges, sea-urchins, shells, and other invertebrates were found in great numbers, about in the order mentioned as regards abundance. Much of Baird Bank is covered with hydroids, which were brought up in matted bunches containing many species. Sculpins, small alligator-fishes, flounders, and other species occurred in every haul, and an occasional large skate would appear among them. Codfish and halibut usually avoided the net, yet specimens were taken occasionally. Annelids were common in most hauls, and one haul in particular (No. 3287) contained fully 2 bushels, consisting mainly of one species, which probably furnished the chief food of codfish on that part of the bank. A variety of small crustaceans and naked mollusks may be added, as they were pretty evenly distributed over the bottom. It was observed that representatives of nearly every species found in similar depths on Slime Bank were included in each haul.

To the northward a marked change took place in the bottom fauna, ophiurans and astrophytons exceeding all other forms in abundance, while large bivalve shells resembling *Schizothærus* appeared for the first time. It will be observed that the bottom differed in character from that of Baird Bank, more or less mud entering into its composition.

In Herendeen Bay, during July and August, the streams were full of dog salmon. Excellent flounders and large edible prawns were taken in abundance at the anchorage in Mine Harbor. Later in the season dredging was carried to the deeper waters of Bering Sea, north and west of Unalaska, with very interesting results. It was new ground and most of the material obtained was so unfamiliar as to prevent identification. At station No. 3307 (1,103 fathoms), *Myctophum* (three species), *Macrurus*, *Antimora*, and several other genera of fishes were taken, while among invertebrates there were five species of starfishes, alcyonarians, sea-urchins, two species of large prawns, an octopus, etc. Increasing the depth to 1,600 fathoms at station No. 3308, there were, among fishes, *Synaphobranchus*, *Antimora*, *Notacanthus*, *Myctophum*, *Careproctus*, etc., and among the invertebrates, sea-anemones, holothurians, medusæ, starfishes, large crabs, crimson prawns, etc. Station No. 3311, in 85 fathoms, at the entrance to Captain Harbor, yielded several new fishes and sponges, besides some fine brachiopods and many common forms. A rare, if not new, *Antedon* was the chief prize from station No. 3316, in 309 fathoms. Station No. 3317, in 165 fathoms, off Makushin Volcano, furnished a dozen or more species of oddly shaped sponges and pink cup-corals, while station No. 3319, in 59 fathoms, was remarkable for a quantity of large branching flesh-colored alcyonaria, of the shape and general appearance of a sea fan. Station No. 3321, in 54 fathoms, gave us a remarkable massive red alcyonarian not previously observed.

After leaving Bering Sea en route for San Francisco, a line of dredgings was run along the chain of islands lying off the Pacific shores of the Alaska Peninsula, the specimens corresponding generally with those taken in the same region during the season of 1888. The first notable exception was at station No. 3340, in 695 fathoms, muddy bottom. In addition to a large number of deep-sea fishes and invertebrates, there were about 50 specimens of *Macrurus*, representing four species, two individuals being of extraordinary size, weighing 14 and 19 pounds each. Still farther southward, on September 3, station No. 3342 was made with the beam trawl in 1,588 fathoms, gray ooze and coarse sand, off the coast of Queen Charlotte Island, and within sight of the high lands. Among the fishes were two species of *Macrurus*, several specimens of *Antimora*, and others not recognized. Among the invertebrates were an octopus, barnacles, shrimps, sea-anemones, amphipods, starfishes, two species of corals, hydroids, and several beautiful stalked crinoids, which were secured in the best of order.

INVESTIGATIONS OFF THE WEST COAST OF MEXICO AND CENTRAL AMERICA AND OFF GALAPAGOS ISLANDS, JANUARY TO MAY, 1891.

Preparations for the cruise.—Prof. Charles H. Gilbert left for the East on September 27 and Passed Assistant Surgeon J. E. Gardner was relieved by Passed Assistant Surgeon N. H. Drake the same day. The specimens collected during the summer were shipped to Washington on the 29th. We went to the navy-yard, Mare Island, on the 30th of September and commenced the work of repairing and refitting. The long cruise in Bering Sea resulted in unusual wear and tear to the machinery, sails, and rigging.

Ensign Marbury Johnston was detached from the *Albatross* November 9; Ensign C. M. McCormick, on the 14th; and Ensign E. W. Eberle, on the 27th. These gentlemen had served three years on board of this vessel, and the Commission is indebted to them for much valuable service. Ensign Johnston is deserving of special mention. He was ordered as watch officer, but acted as executive and navigator about a year, performing the duties in a very satisfactory manner. He made the surveys of Herendeen Bay and the Lower Nushagak and lent material aid in the general corrections to the Bristol Bay charts.

I was ordered to proceed to Washington to confer with the Commissioner regarding the work of the vessel, and left for that purpose on the 20th of October, returning December 11. The repairs were practically completed on the first of January, 1891, and it only remained to dock, clean, and paint the bottom and take on board coal and paymaster's stores, to fit the vessel for sea.

We had a dock trial of the engines on the afternoon of January 7, when everything was found to work satisfactorily. E. A. Anderson, ensign, U. S. Navy, reported for duty January 13, and J. H. L. Holcombe, lieutenant (junior grade), U. S. Navy, on the 15th. The vessel went into the naval dry dock on the 21st, when the work of scraping and painting commenced. The bottom was very foul, between 15 and 20 tons of foreign matter being scraped from it. Chief Engineer C. R. Roelker, U. S. Navy, was sent to the naval hospital on the 22d, with acute bronchitis, and Assistant Engineer J. R. Wilmer, U. S. Navy, reported for duty the following day, Mr. Roelker being detached. We came out of the dock on the 26th and steamed down to San Francisco, anchoring at 4:30 p. m. Commenced coaling from a lighter the following morning.

At 10:30 p. m., after the crew were in their hammocks, cries of distress were heard, and it was soon ascertained that a boat had swamped, leaving a number of men struggling in the water. A strong tide was running and there was quite a heavy swell in the bay. The dingey was manned as quickly as possible, and Lieut. Holcombe, officer of the deck, took charge and went to the rescue, finally picking up seven men belonging to the American ship *Reuce*, and a boatman belonging to the Sailors' Home, some of them in an exhausted condition. They were brought on board, and under the hands of the surgeon and others made comfortable for the night. Some time after the return of the dingey the small flatboat was discovered astern attempting to reach the ship, but was unable to stem the tide. Assistance was sent, and it was found that John Kiely, captain of the hold, had rescued two more men, making nine in all. It seems that after the departure of the dingey, Kiely discovered by the cries of the drowning men that the party was becoming separated, and, lowering the small flatboat, went to the rescue, with the result mentioned above.

San Francisco to Panama.—We finished coaling on the morning of the 30th, having received 199 tons; stores were received in the meantime, and vacancies in the crew filled by enlistment. We left San Francisco at 1:07 p. m. the same day for Panama, using one boiler and consuming 10 tons of coal per day. The vessel displaced 1,140 tons on her departure.

The weather was hazy and squally at times, with southwest and southeast winds after leaving port. Passed through Santa Cruz Channel at 3 a. m. February 1; made Santa Catalina Island at daylight on the morning of the 2d, about 90 miles distant; and a little before sunset the same evening Guadeloupe was seen between 60 and 70 miles. Passed Cerros Island next day, it being distinctly visible at a distance of 60 miles. Very little surface life was seen; a few gulls were about the ship while near the coast; flying fish were first observed on the 5th in latitude 22° 00′ N.; and two species of booby were noticed. Man-of-war hawks, petrels, and turtles were first seen on the 6th in latitude 20° 00′ N., and a school of young porpoises passed the vessel on the 7th.

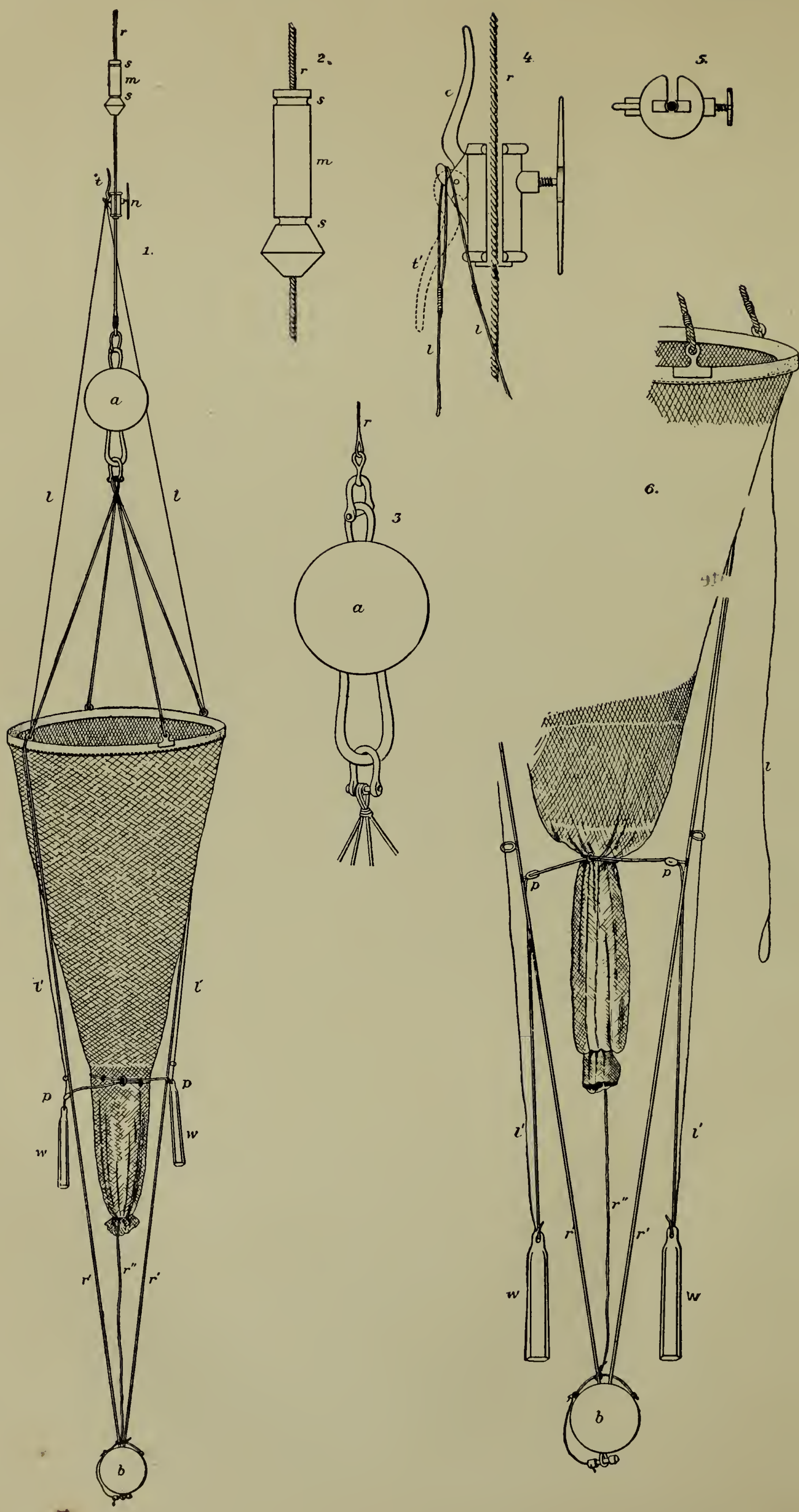
Reaching the vicinity of Acapulco on the evening of the 8th, it was thick and hazy over the land, and, not caring to enter the port before daylight, we hove to at 10 p. m., finally anchoring in the harbor at 8 a. m. on the morning of the 9th. Thirty tons of coal were taken on board during the day, the usual visits were made to the authorities, and at 4:35 p. m. we proceeded to sea, en route to Panama. The naturalists were busy with the collecting seine while in port, and brought in no less than twenty species of fishes besides other forms.

Tropical heat was encountered before reaching Acapulco, and carried without intermission until we reached the Gulf of California on our return. Light variable winds and fine weather were the rule from Acapulco to Panama, but we had a short northeast gale off Tehuantepec, a stiff norther in passing the Gulf of Dulce, and a brisk northerly wind from Cape Mala to Panama, where we arrived the morning of the 17th. Prof. Alexander Agassiz, under whose direction the scientific work of the cruise was to be conducted, reached Colon the same evening.

Cape Mala to Cocos and Malpelo islands.—Coal and stores were taken on board, and at 3 p. m. February 22 we left port for the purpose of exploring the waters from Cape Mala to Cocos and Malpelo islands, etc. Several schools of anchovies were seen near the islands, in Panama Road, with the usual number of frigate-birds, pelicans, gulls, porpoises, etc., feeding upon them. The surface net was put over for a few minutes at 8 p. m., but there was very little life found. Work commenced the following morning, and was continued through the day between Morro Puercos and Marieto Point, in depths ranging from 182 fathoms, gravel and shells, to 695 fathoms, green mud. Vegetable matter and occasionally quite large sticks were found at every station. The beam-trawl and surface tow-net were used, and while the results from the latter were meager, the former developed a rich and varied fauna. Serial temperatures and specific gravities were carefully taken, but the action of the thermometers was not wholly satisfactory.

Rich working ground was found to the southward of Coiba Island on the 24th, the soundings developing an unexpected elevation of the sea bottom. A depth of 869 fathoms was found 20 miles south of Jicarita Island, 791 fathoms at 35 miles, and at 50 miles there was but 465 fathoms, with rocky bottom—1,672 fathoms being found 14 miles to the southward and westward. Rocky patches were frequently encountered, especially on the submarine elevation, which played havoc with the trawl nets, but rich hauls were made in spite of unfavorable conditions, and the naturalists were greatly elated over the capture of rare and valuable specimens, some of them entirely new to science. A course was steered in the direction of Cocos Island during the night, and at

PLATE 1.



7:30 a. m. on the 25th a sounding was made in 1,471 fathoms, green ooze. Serial temperatures and specific gravities were taken, and a successful haul of the trawl followed, the surface net being towed during the interval of dredging.

Submarine tow net.—Experiments with a new design of submarine tow net were made later in the day, with unsatisfactory results. In fact, it was a failure, owing, doubtless, to the large size of the net and its small mesh, which caused undue tension on the bridles while towing.

The frame is composed of rods and tubing of brass. There is a fine screw-thread on the upper half of the central shaft, which works in a nut in the upper middle part of the frame. The lower end of the shaft is plain and passes through two studs in the frame, which serve as stops for the bridles. A propeller on the middle of the shaft holds it down while the apparatus is being lowered and slowly raises it while the net is towed through the water. The jaws are of two sizes, 3 feet and 2½ feet in diameter, with hinges which permit them to open and shut. The net is 7 feet in length, half-inch mesh, lined with mosquito net for 5 feet, and inside of this lining is another of silk gauze, extending 3 feet from the lower end of the net. A weight is attached to the lower end of the net to prevent its floating up and fouling the jaws or bridles.

To use the apparatus, close the mouth of the net, attach both bridles by their terminal rings to the central shaft and lower to the desired depth, then steam slowly through the water, when the propeller will be brought into action, the central shaft slowly raised, and the first pair of bridles released, opening the jaws. After towing about half a mile the shaft will have reached its upper limit, when the remaining bridle will be released and the net again closed, ready to be hoisted to the surface. This apparatus could be made to act by reducing the size of the net and removing one of the linings, but the chances of accident or irregularity in the working of the propeller were so great that there would always be a doubt as to its having properly performed its functions. Prof. Agassiz was greatly disappointed at its failure, for he considered the examination of intermediate depths among the most important problems to be worked out during the cruise. I had thought little of the matter, as my confidence in the apparatus just described was explicit, but I now set to work to devise something that would do the work.

The Tanner tow net is designed for the collection of pelagic forms at intermediate depths, and was used successfully during the cruise. The net is the same as that previously described, except that the mosquito-net lining is reduced to about half the length of the bag. The upper bridle has four legs attached at equal distances around the ring and shackled to a sinker on the end of the steel-wire dredge rope, which serves as a tow-line. The lower bridle has two legs, 10 feet in length, attached to opposite sides of the ring, and a 60-pound sounding shot is toggled on the bight at the lower extremity to act as a sinker. The lower end of the net being properly secured, the ends of the lashing are carried down to the sinker and made fast in order to keep the net in place while going down.

Four small brass rings are secured to the bag at equal distances, a few inches below the upper edge of the silk-gauze lining, and through them is rove a soft white tie line, which makes a complete round turn, the ends being passed through the same ring, then rove through small metal blocks on the lower bridle, and finally secured to leads weighing 14 pounds each. Two tripping lines, with eyes in their upper extremities, are hooked over a friction clamp on the tow rope, then rove through small eyes on the rim of the net, and through brass rings on the lower bridle, above the metal blocks before mentioned; the ends being hitched to the leads, support their weight, allowing the tie, or draw string, to hang loosely and the net to retain its natural form while sinking and being towed.

To use the apparatus, prepare it as in figure 1, plate 1, lower it vertically to the proper point, and tow it slowly through the water, veering and heaving in on the tow line in order to maintain the desired depth, which can be determined within a few fathoms by the dredging quadrant, an instrument in constant use on board of the *Albatross*. To recover it, stop and back until the tow rope is vertical, heaving in sufficient line during the operation to keep the net at the proper depth; then send the messenger (fig. 2, *m*) down to act on the friction clamp (fig. 4), release the tripping lines (*l*), and close the lower part of the net as shown in fig. 6. The net may be run up to the surface at any desired speed, the upper portion taking in anything it encounters en route, while the lower part remains closed against even the most minute forms. The messenger is in two parts, which, having been placed around the tow line, are seized together with marline(*s*). It sinks at the rate of about 650 feet per minute, and the impact can usually be distinctly felt by taking hold of the tow line.

To Cocos Island.—The course was continued towards Cocos Island during the night, and two hauls of the trawl made on the 26th in 1,175 and 978 fathoms. Rocky bottom was encountered in the first haul, which wrecked the net, but many valuable specimens were found in the remnants. Serial temperatures were taken at one station, but the results were not entirely satisfactory; it becomes more evident from day to day that our practice of using the dredge rope for a temperature line in the tropics, with the Negretti and Zambra thermometers, must be changed. The high temperature near the surface fills the bulbs so full that even the moderate jarring caused by the surging of the rope on the drum of the hoisting engine is liable to shake the mercury down into the catch reservoir, which, becoming filled, overflows into the tube, making it necessary to repeat many of the observations. The weather was overcast, with passing rain squalls during the day, and, toward evening, frequent flashes of distant lightning were observed, particularly in the direction of land. There were occasional showers on the 25th, with lightning during the night.

Three hauls of the beam-trawl were made on the 27th, in 902 and 1,067 fathoms, mud and sand, without a trace of foraminifera, while an intermediate station was in 1,010 fathoms, globigerina ooze. Serial temperatures were taken at both stations, and the surface tow net was used. At the first station the net came up badly torn and the trawl-frame was bent, showing that it had been in contact with some obstruction on the bottom, either rocks or water-logged driftwood, which is frequently encountered in the Gulf of Panama and proves very destructive to dredging gear.

The depth of 902 fathoms at the first station on the morning of the 27th, 50 miles to the eastward of Cocos Island, indicated that we were near the summit of another submarine ridge, the water having shoaled 770 fathoms since the evening of the 24th, deepening again to 1,067 fathoms 12 miles from the island. It was on this area only that foraminifera were found in appreciable quantities in the bottom specimens taken between Panama and the island. Four hauls of the trawl and tangles were made on the 28th in from 52 to 134 fathoms, east and north of Cocos, over rough, rocky bottom, which afforded a variety of shoal-water life; yet it would be considered meager in comparison with the same depths in the Caribbean Sea.

A party of collectors was landed in the morning, the vessel continuing work until 10:37 a. m., when she anchored in Chatham Bay, near the northeast extremity of Cocos Island. A seining party, volunteer collectors, photographers, etc., were sent on shore, and the whole crew given an opportunity for a run on the beach and a dip in the surf during the day.

The name of the discoverer and the date of the discovery of Cocos Island are unknown. It was visited by Lionel Wafer and Dampier; two Spanish vessels called in 1791, and Capt. Colnett visited it in 1793; Vancouver described it in 1795, and in 1838 Sir Edward Belcher surveyed a portion of the island, and located a point in Chatham Bay, astronomically. Many names and dates are roughly carved on bowlders near the beach, noticeably such dates as 1798, 1809, 1819, etc.

The island is about 4½ miles long, north and south, including outlying rocks and islets; 3 miles in width, 1,700 feet in height, and is of volcanic origin. Its contour is rugged and mountainous; the valleys very narrow and limited in extent. Copious rains water its surface, and numerous mountain streams roll down the wooded heights, through steep and tortuous gorges, and over rocky cliffs, small sand beaches usually marking their outlet to the sea. A dense tropical jungle, strongly resembling the forests of Central America, covers the entire surface of the island, enveloping it in an unbroken mantle of rich and varied shades of green. Cocoanut trees were found in such abundance by the discoverers that they gave their name to the island, and they are still conspicuous in the higher inaccessible localities, while on the lowlands near the shores they have been cut down by thoughtless visitors in order to procure their fruit without the labor of climbing. We found one vigorous young cocoanut tree on the beach in Chatham Bay at the time of our visit in the spring of 1891, the sole representative of the hundreds which formerly stood in the immediate vicinity, affording grateful refreshment to the exhausted or thirsty visitor. Tree-ferns were conspicuous; and every stump, rock, or trunk of tree was festooned with morning-glories. Pumpkin-vines, daisies, poke-berries, etc., gave a familiar air to the surroundings.

Tradition credits the buccaneers with having buried vast amounts of treasure on the island, which, for some reason, they were unable to recover, and that fortune awaits the lucky finder of this hidden wealth, The truth of this tradition has been so thoroughly impressed upon the minds of men that expeditions have been dispatched from time to time, at considerable expense, to search for the treasure. A few huts in various stages of dilapidation remain as evidence of the periodical visits of these parties, and the pigs, which run wild on the island, may have descended from those carried there for food by the gold-hunters. A solitary donkey, which we found passing a lonely existence on the shores of Chatham Bay, may owe his presence there to the same source.

Chatham Bay affords fairly good anchorage in fine weather, which is the rule, and is a convenient place to procure wood and water. Wafer Bay has the largest area of level land seen on the island, and several acres showed unmistakable evidence of having been cultivated. The anchorage, however, is open and exposed to heavy swells. We made a reconnaissance of the eastern shores of the island, which had not been charted, and sent a tracing to the U. S. Hydrographic Office.

To Malpelo Island and return to Panama.—Leaving Cocos Island on the morning of March 1, a line of dredging stations was run S. 54° E. true, about 300 miles, passing en route over the position of Rivadeneyra Shoal, the line of soundings crossing our line of 1888 without indicating shoal water or a decrease in the normal depth of the region. Turning to the northward and eastward from the extremity of the above line, observations were extended to Malpelo, the sea-bed being found remarkably level, shoaling regularly as the island was approached. We reached it on the morning of the 5th of March, made several hauls of the trawl in shoal water, and a little before noon lay to and sent a collecting party to the island, which succeeded in capturing a number of birds, lizards, etc., but could not land. Fish lines were used in 50 fathoms, but the waters were alive with sharks, which destroyed the gear as fast as it was put over. One large grouper represented the catch.

From observations taken on the deck of this vessel the highest peak of Malpelo is in 3° 59′ 07″ N. and 81° 34′ 27″ W. It is a double-peaked volcanic rock with vertical sides, 846 feet in height, a mile in length and about a fourth of a mile wide, surrounded by detached rocks, which increase its length to a mile and a half. The rocks are all high and bold, except one or two, which are but a few feet above water. The island is covered with guano, the deposit of myriads of sea birds which cover its heights, where they find congenial quarters and safe breeding-grounds. It is entirely devoid of vegetation, except a few low leafless bushes. The only sign of vegetable life is a small patch of grass a few feet in extent on one of the outlying rocks.

A cave was discovered on the northwestern side of the island, into which one of the ship's boats proceeded between 100 and 200 yards. The arched roof was 15 feet or more in height at the entrance, increasing as the cave was penetrated, the surface of the walls being quite smooth. The water swarmed with fish.

From Malpelo the line was continued about N. 36° E. true, in the direction of the Gulf of Panama, where three normals were run from deep water to the 100-fathom line, extending over two degrees of longitude. The surface net was in constant use, and the Tanner net was operated on several occasions. Serial temperatures were taken frequently, the sounding wire being successfully used as a temperature line. Several instruments were lost the first day by the parting of the wire, but no losses occurred afterward, and the trouble arising from the mercury shaking down was entirely eliminated.

Reaching Panama for the second time on the morning of the 12th, the ship was painted outside while repairs were being made in the engineer's department. The bunkers were filled with coal between the 16th and 19th, and we sailed at 1:10 p. m. on the 20th of March, steaming across the gulf.

Panama to the Galapagos Islands.—Reaching the vicinity of Galera Point on the morning of the 23d, a series of soundings was made, feeling our way to deep water, as it was desirable to cast the trawl and make other investigations on the slope from 1,000 to 1,500 fathoms in depth. Strong northeasterly currents were found in the vicinity, showing a maximum of 51 miles in 24 hours, and continuing with varying force nearly to the Galapagos. We were crossing the great Humboldt Current, which sweeps along the coast of South America into the Gulf of Panama. During nine months of the year, while the trades are blowing steadily, the stream is divided, a portion entering the Gulf and a broader belt taking a northwesterly direction. This division is not usually apparent from January to May, while the trades are interrupted, and the western part then takes a northerly direction, with its velocity greatly diminished.

The following series of observations extended from the South American coast to the Galapagos, crossing one of the great currents of the Pacific Ocean at the point where its cooling waters pour into the Gulf of Panama and where the faunas of the Southern and Central Pacific meet. Great care was observed in all the work on this line and the observations were varied and complete. The depths and serial temperatures were frequently obtained, the beam trawl and surface nets used at all the stations, and the Tanner net was frequently operated at intermediate depths, after getting well clear of the land, to ascertain the distribution of pelagic fauna.

The surface life was greater than we had found in the Gulf of Panama, and the results of the deep-sea hauls of the trawl were fairly good, but the southern approach to the Galapagos, where we anticipated a rich field, proved to be practically barren and did not compare favorably even with the northeast approach. The greatest depth, 1,832 fathoms, was found about 160 miles from the South American coast; thence to the vicinity of the islands it gradually decreased.

Galapagos Islands.—The highlands of Chatham Island were sighted at daylight, March 28, and after spending most of the day in running a line of dredging along its southern approach, we stood into Wreck Bay and anchored at 5:30 p. m. Señor Manuel A. Còbos came on board soon after our arrival to extend the hospitalities of the Hacienda del Prògreso, and Mr. Townsend returned with him that evening on a collecting trip. Prof. Agassiz, several officers, and myself went to the plantation next day, and were met and entertained by the proprietor, Señor Manuel J. Còbos. The rains had been unusually heavy during the season, and the fine carriage road from the port to the hacienda, which we admired so much three years ago, was a complete wreck.

At the time of our former visit cattle were the principal source of revenue, but that is changed now. A plant of modern sugar machinery has been installed, and the growing of cane and the manufacture of sugar is prosecuted with the greatest energy. The natural advantages of soil and climate, cheapness of labor, and the privileges of the McKinley bill insure large returns from this industry. The young coffee plantation, mentioned in my report of 1888, bids fair to realize the anticipations of the proprietor. I tested some of the product and found it excellent.

The settlement on Chatham Island was formerly a penal colony, the convicts performing all the labor on the plantation. This was the case at the time of our visit in 1888, but is no longer so, the criminals having been removed and free labor employed, greatly to the advantage of the estate. Supplies were procured from the hacienda and a fine young bullock was presented to the ship by Señor Còbos. The naturalists increased their list of specimens somewhat, besides procuring many duplicates. The weather was hot and rainy at Chatham Island, and during showers, when skylights, ports, etc., were closed, the interior of the vessel was as hot as an oven.

Leaving Wreck Bay at 10:25 a. m., March 31, we steamed to Charles Island direct, anchoring in Blackbeach Road at 8 p. m. The crew were given liberty the next day, when many of them went to the old plantation, where fruit was found in abundance, several bushels of oranges, limes, alligator pears, etc., being brought on board. The naturalists were out as usual during the day, and a number of officers went on a hunting expedition to Post-Office Bay, returning with eighteen flamingos.

Leaving Charles Island at 1:05 a. m., April 2, we ran over to Duncan Island and sent parties into the mountains for tortoises. They were away nearly all day, and returned with a single specimen only, although they searched carefully over the ground where three years ago they were quite numerous. A few years more and they will probably become extinct. An anchorage was found for the night in Conway Bay, Indefatigable Island, where we arrived at 5 p. m., giving the collectors an hour or two ashore before dark. Getting under way again at 3:15 a. m., April 3, we steamed to the northward between James and Indefatigable islands, commencing work in 551 fathoms, about 7 miles N. by W. from the Seymour Islands, in prolongation of our line of 1888, extending it to Bindloe, Abingdon, and Wenman islands. Here we were met by another surprise; excellent results having been obtained from contiguous stations occupied three years previously, we naturally expected to find the same rich fauna in similar depths a few miles to the westward. We did not, however; on the contrary, the bottom was foul and contained comparatively little life, while the surface was almost barren. Eight stations were occupied between Indefatigable and Wenman islands in from 327 to 1,270 fathoms.

Galapagos Islands to Acapulco and Guaymas.—From the latter island a line was run to Acapulco, nineteen stations being occupied in depths ranging from 2,232 to 94 fathoms. The same general plan of investigation was continued and the results were satisfactory in the ocean basin, but upon approaching the Mexican coast the bottom became very barren. This condition may be attributed largely to the great amount of decayed and decaying vegetable matter covering the sea bed. Every haul of the trawl brought up quantities in every stage of decomposition, and occasionally the net was loaded with vegetable muck, which emitted a highly offensive odor. This deposit was not evenly distributed over the bottom, but it prevailed to a sufficient extent to drive animal life from the ground. The same effect was noticed between the Pearl Islands and the mainland in the Gulf of Panama in 1888, where the deposit was even greater and the odor so vile that the chief naturalist requested that no more of it be brought up. The Tanner net was used at several stations with satisfactory results.

Surface life between the Galapagos and the Mexican coast may be summarized as follows: An occasional whale, porpoises, dolphins, and flying fish frequently seen, and green turtles in sight almost constantly floating on the surface. Birds were not numerous, though petrels were seen daily; tropic birds and boobies were noticed occasionally, besides gulls and other species which appeared as we approached the coast.

We anchored in the harbor of Acapulco at 3:30 p. m., April 12, after a successful cruise of nine days between the Galapagos and that point.

Having filled up with coal and taken on board supplies, we sailed, April 15, for a cruise along the Mexican coast and Gulf of California. The surface tow net and the Tanner net were used frequently, and a line of dredging stations was commenced to the southward of the Tres Marias, in 2,022 fathoms, where serial temperatures were taken. The trawl was lowered a few hours later, in 676 fathoms, and the line continued to 80 fathoms near the land. Passing the islands the depths increased, the sounding cups showing green mud or black sand, but there was sufficient clay in it to prevent its washing freely through the meshes of the trawl net, thus resulting in the loss of gear from overloading. Frequent patches of shale rock were also encountered, which made the use of the trawl still more difficult. The currents of the gulf seem to extend to the bottom, even in depths exceeding 1,000 fathoms, scouring out the mud and ooze, and occasionally exposing the native rock. Sticks, leaves, and other kinds of vegetable matter were marked features of the hauls on the eastern side of the gulf as well as in the Pacific, but were not brought up in as great quantities. The bottom fauna from the Tres Marias to Guaymas was unexpectedly meager; indeed, it was a great disappointment to us, for we had consoled ourselves for the barren ground off Acapulco in anticipation of rich fields in the gulf.

The work of the cruise ended with our arrival at Guaymas on the afternoon of April 23, where Prof. Agassiz left us to return to the Atlantic coast by rail. The explorations during the cruise were conducted under his general direction, and his great knowledge and experience were apparent in all our operations. He was always ready in a most genial and kindly way to impart information, which was given so plainly that it was always comprehended, even by laymen. We took leave of him with much regret, and it is our fond hope that some time in the near future we may again have his active coöperation in deep-sea investigation.

Scientific results of the cruise.—The scientific report of the expedition will be made by Prof. Agassiz, yet it may not be out of place to state in a general way some of the results obtained. The fauna of the region examined was not as rich as in the Atlantic, Gulf of Mexico, and Caribbean Sea. Decayed vegetable matter was found to a greater or less extent on most of the bottom examined. Foraminifera was, as a rule, very sparsely represented in the bottom soil, and was found in considerable quantities at but few stations. Many forms were identical with those of the Caribbean Sea, and others were closely allied to them. The repeated use of the Tanner net, remote from land, showed that the surface life extended down about 300 fathoms, the bottom life reaching up between 100 and 200 fathoms, and the intermediate space being practically barren. On one occasion in the Gulf of California, in the vicinity of land, life was found from surface to bottom. The ocean temperatures of the region were very low, considering that it lies within the tropics. The Humboldt current, the one great and constant movement of the waters from the southern polar regions into the Gulf of Panama, is a cold one, and its volume is so great in comparison with the warmer equatorial counter-current that the latter is soon absorbed and the whole mass reduced to a lower temperature than in any other oceanic area in the same latitudes. There are no coral reefs in the Gulf of Panama or about Malpelo, Cocos, and the Galapagos Islands; indeed, it is not until we reach Clipperton Island, in 10° north latitude and 109° west longitude, that the reef-builders find congenial temperatures for the prosecution of their work. These low temperatures doubtless exert a marked influence on the submarine fauna of the region.

We left Guaymas April 24, and arrived at San Diego May 1 without incident worthy of notice. Taking on board a supply of coal, we sailed the next evening for the navy-yard, Mare Island, arriving on the morning of the 5th.

The winds, weather, and currents encountered during the cruise may be summarized as follows:

Winds southwest to southeast from San Francisco to Santa Barbara Islands; light and variable with frequent calms to Acapulco. Light variable winds from the latter port to Panama, with the exception of a short sharp northeast gale off Tehuantepec; a stiff norther in passing the Gulf of Dulce, and a brisk northerly wind from Cape Mala to Panama. Light variable winds and frequent calms were experienced in the Gulf of Panama, and thence to Cocos Island, Malpego, and the Galapagos. The southeast trades were entirely interrupted, the prevailing winds being from southwest. There was very little wind among the islands of the archipelago or to the northward until we encountered the northeast trades in about 5° 00′ N. They were very strong for twenty-four hours, then moderate, dying out entirely in 11° 00′ N; thence to Acapulco, southwest airs prevailing. Along the Mexican coast to Cape Corrientes we had light to moderate northwest winds, thence to Guaymas, gentle westerly breezes. From the latter port to Cape San Lucas the same winds were found, and thence to San Diego light to moderate breezes from the northward and westward. From San Diego to San Francisco light southerly airs prevailed.

The sea was generally smooth during the cruise.

The weather was hazy and squally from San Francisco to the Santa Barbara Islands; mild and pleasant with passing clouds thence to Acapulco. There was a daily increase of temperature, but the full effect of tropical heat was not felt until the vessel was lying at anchor in the harbor. From Acapulco to Panama it was generally fair, with hazy or smoky atmosphere enveloping the land, as usual in the dry season. Three or four days of rainy, squally weather were encountered off the gulf between 6° 00′ and 7° 00′ N. latitude the latter part of February; thence to Cocos, Malpelo, and Panama the weather was invariably pleasant but warm, the same conditions prevailing until we arrived at the Galapagos with one notable exception, March 23, when in 1° 00′ N. and 80° 00′ W. we had an overcast rainy day. It was the height of the rainy season in the archipelago and showers were of frequent occurrence every day, the sun coming out brightly between them. There was more or less rain after leaving the islands to 5° 00′ N. Thence to Acapulco, Guaymas, and Cape San Lucas it was invariably bright and clear. The mornings were hazy or foggy off the coast of Lower California, generally clearing between 10 a. m. and meridian. From San Diego to the bay of San Francisco it was misty, but not sufficiently thick to interfere with navigation.

The currents from San Francisco to Acapulco were neither strong nor constant in direction; the aggregate was 70 miles against us during the trip. They were stronger thence to Panama, amounting to about 100 miles adverse set. From Panama to Cocos Island, Malpelo, and return, the general set was south and southeast from 6 to 39 miles per day. From Panama toward Cape San Francisco, on the coast of Ecuador, the set was southwest to west from 7 to 24 miles per day.

The Humboldt current was encountered about 2° 00′ N. and 80° 00′ W. from 29 to 51 miles a day, setting to the northward and eastward, trending more to the eastward as we left the coast, until in 87° 00′ W. it was S. 83° E. 17 miles in twenty-four hours; thence to the Galapagos but little current was noticed. The general set through the archipelago is to the westward, except from January to April or May, when currents are mostly confined to tidal influence.

A light easterly drift was apparent from the islands to 6° 00′ N.; then a westerly set, reaching a maximum of 50 miles per day to about 9° 00′ N.; thence to Acapulco very light. From the latter port a light northwesterly current was felt, increasing as we approached Cape Corrientes, and ceasing entirely to the northward of the Tres Marias Islands, from which point to Guaymas the drift was light to the eastward. From the latter port to Cape San Lucas and San Diego the currents were very light and variable. Thence to San Francisco, where the coast was followed closely, the influence of Davidson's countercurrent from the southward and eastward was felt.

The general health of officers and crew was excellent considering the rapid and extreme climatic changes they were subjected to.

Mare Island Navy-yard and San Francisco.—Many of the crew were discharged soon after our arrival at Mare Island, their terms of service having expired, leaving us with barely force enough to care for the vessel. Ensign W. W. Gilmer, U. S. N., was detached on May 8, and on the 18th Passed Assistant Engineer J. R. Wilmer, U. S. N., was sent to the naval hospital for treatment for insomnia and nervous prostration. On the 28th of the same month telegraphic orders were received to commence repairs necessary for the contemplated summer's cruise. It soon became apparent that Mr. Wilmer woul be unable to rejoin the vessel, and Assistant Engineer A. M. Hunt, U. S. N., was ordered to relieve him, reporting June 9, at which time the former was detached.

June 25 orders were received from the Navy Department reducing the number of the crew from 67 to 53 men after June 30, 1891, and also giving new ratings. The proposed crew would be able simply to navigate the vessel, but could not carry on the work for which she is employed. Authority was subsequently received from the Commissioner, however, to employ the additional men required to make the vessel efficient, placing them on the Fish Commission rolls. The necessary changes were made immediately.

Engines and boilers were tested at a dock trial June 27 and, much to our gratification, everything worked smoothly and satisfactorily. We went to San Francisco on the 29th and docked at the Union Iron Works the following morning to scrape and paint the vessel's bottom, which had become exceedingly foul during her cruise in tropical waters. We expected to dock at the navy-yard, but the dry-dock was required very unexpectedly for a French frigate which arrived a few days previously, needing extensive repairs.

The *Albatross* was in dry-dock at the end of the fiscal year when this report should properly close, yet it seems advisable to state that we were preparing for a season's work in Bering Sea, and would have sailed early in July had the vessel not been diverted from her work to convey the United States commissioners to the Seal Islands. We left San Francisco on the evening of July 16, having on board Dr. Thomas C. Mendenhall and Dr. C. Hart Merriam, United States commissioners, en route for the Pribilof Islands, Bering Sea.

Summary of work and condition of equipment.—The following brief summary gives in a graphic form a résumé of the work of the *Albatross* for the fiscal year 1890–91:

Number of days at sea	135
Distance run by observation, in knots	15,314
Distance run by log, in knots	15,706
Number of deep-sea soundings	377
Number of dredging stations	153
Number of fishing stations	95
Number of specific-gravity stations	330
Number of serial-temperature stations	35
Number of submarine tow-net stations	19

Mr. Charles H. Townsend, resident naturalist, has prosecuted an extended investigation regarding the oyster industry of San Francisco Bay and adjacent waters, having performed the work while the vessel was in port. All practical aid has been rendered him.

The deep-sea sounding apparatus has worked satisfactorily, although we have met with some losses. Our heaviest reel was disabled during the winter's cruise, involving the loss of several thousand fathoms of wire. The drum did not collapse, but the binding bolts gave way one by one, allowing the flanges to spring outward and the wire to find lodgment between them and the edges of the drum. The nip was so great that it ruined the wire even where it was possible to extricate it, but many of the parts were cut before they could be cleared. Fortunately, we had a heavy navy reel on board, which was mounted without causing delay in our work.

The dredging engine has continued to perform its work admirably. The service was particularly heavy during the winter in the greater depths, and near the end of the season the friction gear gave out, but it did not materially interfere with the working of the engine. The arms of the driving pinion and friction drum were lashed together, and the latter was operated directly by the engine in veering as well as hoisting. It was repaired at small cost.

The reeling engine still performs its work well without expense for repairs, further than the usual examination and adjustment. The dredge rope was subjected to unusual wear and tear during the southern cruise and parted several times, but there were no serious losses. The expenditure of trawls resulting from these breakages was of greater importance, but never resulted in the least delay, the apparatus in reserve being equal at all times to the demand.

The Negretti and Zambra thermometers have worked well except when used in series on the dredge rope, particularly in the tropics. After the substitution of the sounding wire as a temperature rope the instruments worked well, but several were lost by parting the wire, and this is liable to occur at any time, the margin of safety being very small. The expenditure of wire would be of little moment, but the loss of a dozen deep-sea thermometers is another matter and might bring that branch of work to an abrupt termination. We have now adopted the following plan: A sufficient amount of large strong wire is wound on a spare drum, and when serial temperatures are to be taken it is mounted on the sounding machine, arrangements having been made for the rapid interchange of reels.

PERSONNEL.

The following is the list of officers, June 30, 1891: Lieut. Commander Z. L. Tanner, U. S. Navy, commanding; Lieut. C. G. Calkins, U. S. Navy, executive officer and navigator; Lieut. (jr. grade) J. H. Lee Holcombe, U. S. Navy; Ensign E. A. Anderson, U. S. Navy; Passed Assistant Surgeon Nelson H. Drake, U. S. Navy; Passed Assistant Paymaster C. S. Willams, U. S. Navy; Assistant Engineer A. M. Hunt, U. S. Navy.

The civilian corps was as follows: Charles H. Townsend, resident naturalist; A. B. Alexander, fishery expert; N. B. Miller, assistant naturalist; Harry C. Fassett, clerk to commanding officer.

REPORT OF A. B. ALEXANDER, FISHERY EXPERT.

[Abstract.]

WASHINGTON, OREGON, AND CALIFORNIA.

On August 28, 1889, hydrographic operations were commenced off the coast of Washington, and were carried on thence southward along the coasts of Oregon and northern California as far as Cape Mendocino. The work of sounding, dredging, and fishing was assiduously carried on from the above date until October 13, with the exception of a short visit made to Portland, Oregon, and the time required for coaling. Off the coasts examined the fishing-grounds are entirely within the 100-fathom curve. Fishes are generally found in greatest numbers in depths of 15 to 30 fathoms and on rocky bottoms, but the numerous species of rockfish frequently congregate together on sandy patches, attracted, undoubtedly, by the quantity of food which they find there.

The greatest distance of the 100-fathom curve from the coast of Washington, between Cape Flattery and the Columbia River, is about 40 miles, the least distance about 18 miles, the average being about 25 miles. South of the Columbia River this curve takes an irregular course, but near the northern boundary line of California it rapidly approaches the shore, deep water being found only a short distance from the land. Heceta Bank is the largest and most important fishing-ground south of Cape Flattery.

The first trial for bottom fish was made on the afternoon of August 30 in 28 fathoms off Yaquina Head, Oregon, the catch consisting of 1 red rockfish and 2 ling or whiting. The wind was blowing fresh at the time, causing the ship to drift rapidly, and it was difficult to keep the hooks on the bottom. The following morning another trial was made some 30 miles south of the last locality in 29 fathoms of water, but no fish were taken. The bottom consisted of fine gray sand, and furnished no indications of a good fishing-ground.

On the morning of September 1 hand lines were used at hydrographic station No. 1958, latitude 44° 01′ N., longitude 124° 49′ 15″ W., depth 58 fathoms, both from the ship and from small boats. Nothing of importance was taken by the latter, and only 3 orange rockfish by the former. At hydrographic station No. 1978, later in the day, latitude 43° 58′ 30″ N., longitude 124° 44′ 20″ W., 61 fathoms, even poorer results were obtained, but at a few ship lengths from this berth 24 rockfish, of two species, were captured in the course of a few minutes. Undoubtedly at many places where we were unable to secure anything with hand lines excellent fishing could be obtained with the beam trawl. While flounders, soles, and some other edible species may occur in very great numbers, their presence might not be indicated by hand lines, as was frequently demonstrated during the investigations along this coast.

Subsequent to the trials above mentioned, the beam trawl was cast at station No. 3080, latitude 43° 58′ N., longitude 124° 36′ W., 93 fathoms, securing 3 species of rockfish, 1 black-cod, 1 cultus-cod, and 100 flounders, representing several species. A short distance from this spot a similar catch was made with the beam trawl, and in three hauls with the same appliance after night fall, large quantities of flounders were captured. The following day another large lot of flounders was obtained at station No. 3082, latitude 43° 52′ N., longitude 124° 15′ W., 43 fathoms, while 9 red rockfish and 2 whiting were caught on hand lines in the same locality. A rich spot was found between the Siuslaw River and Heceta Head, where 52 black rockfish (*Sebastodes melanops*) were landed on the deck in the course of a few minutes. We commenced fishing in a depth of 18 fathoms, and drifted into 13½ fathoms. The depth was, therefore, very favorable for hand-line fishing. Small-boat fishing could be successfully prosecuted all along this part of the coast, but the market demand is not sufficient to warrant it at present.

At hydrographic station No. 1981, latitude 44° 01′ 30″ N., longitude 124° 11′ 30″ W., 24 fathoms, 8 orange rockfish and 3 black-cod were caught on hand lines. At dredging station No. 3084, latitude 44° 12′ 31″ N., longitude 124° 19′ W., 46 fathoms, the beam trawl and hand lines were both used, the entire catch amounting to 10 black-cod and 9 whiting. The edible qualities of the latter seem to be as good as those of the red rockfish, and the species is abundant in many places. The next trial was at hydrographic station No. 1982, latitude 44° 16′ N., longitude 124° 12′ W., 31 fathoms, and comparatively good fishing was obtained, 24 whiting, 14 orange rockfish, and 2 flounders having been captured in the space of 45 minutes. Several trials in the neighborhood of Cape Perpetua, Oregon, proved that black-cod, whiting, and red rockfish occur there in considerable numbers. The depth of water and character of the bottom are suitable for small-boat fishing. The last trial for the day was in 31 fathoms, Cape Perpetua bearing ENE. (magnetic) 4 miles, but only one red rockfish was secured there. The total catch of edible fishes for the day amounted to about 600 pounds. The black-cod in this locality is smaller than in more northern waters, and lacks the sweet flavor which it has at the north.

On September 3 hand-line fishing was prosecuted with much diligence, the day's catch amounting to 41 black-cod, 60 orange rockfish, 3 whiting, 1 dogfish, and 1 shark. Had the wind blown less violently more fish would undoubtedly have been secured. Thirty-seven of the black-cod were taken during the first drift, Yaquina Head bearing NE. ½ N., and distant 8 miles. The depth was 44 fathoms. From our experience the best fishing-spots seemed to lie from 6 to 8 miles off shore.

Fishing was next taken up off Cape Falcon, or False Tillamook, and was continued at short intervals down the coast. The results were not as favorable as off Yaquina Head, but a strong tide was running at the time and may have had more or less effect on the distribution of the fish, as is known to be the case in other places. On many spots over which we were drifted the hand lines brought up flounders, and the beam trawl, put over just before dark, secured between 800 and 900 of these fishes.

The region about Cape Meares, 16½ miles south of Cape Falcon, was subsequently investigated, the beam trawl being first used at station No. 3091, latitude 45° 32′ N., longitude 124° 19′ 30″ W., depth 87 fathoms. Half a dozen squid, 100 flounders, 5 red rockfish, and about a peck of prawns composed the bulk of the catch. In 46 fathoms, Cape Meares bearing E. ⅝ S., 4 miles distant, only one red rockfish was taken on the hand lines. A berth nearer shore gave better results, as 14 red rockfish were quickly secured there. During the continuance of this drift a series of trials was also made about Arch Rocks by means of a dory. These rocks lie about 2 miles from Cape Meares and 5 miles from the entrance to Tillamook Bay. Our investigations, however, were not attended with success, although the search was made as thorough as the time permitted. Attention was first given to the northern side of the rock, but obtaining nothing there, we shifted to the south side, where we soon discovered the cause of the barren condition of the region. In all sheltered places where the warm rays of the sun could penetrate, hundreds of sea lions were hauled out upon the rocks. Sea birds also filled the air and covered the summits of the rocks. The latter likewise consume large quantities of surface fishes, such as herring and smelts, and although none of these species were observed, the presence of the birds indicated their occurrence.

Off the entrance to Tillamook Bay, 22 red rockfish, 2 orange rockfish, 1 black-cod, 4 cultus-cod, and 1 yellow-striped rockfish were captured. From about 3 miles north of Cape Lookout to some 3 or 4 miles below the cape a very thorough examination of the bottom was made close in shore. During fifteen trials none of the baits upon the hooks were disturbed, and it is probable that the sea lions occurring along this region have caused a scarcity of fish. While the inshore work was in progress, the ship ran 10 miles off the land and made trials with the beam trawl and hand lines. By means of the former a large quantity of flounders was secured, while with the latter 2 red rockfish, 1 salmon, and a flounder were taken.

Between Cape Lookout and Siletz Bay thirteen trials were made with hand lines. Fish seemed to be plentiful in a few places, but in the majority only a limited number were obtained. The bottom in this region is sandy. The true cod (*Gadus morrhua*) has been reported from time to time from this section of the coast, but it is very improbable that it occurs there, and none were taken by the *Albatross* south of the Strait of Juan de Fuca. A few vessels would have no trouble in obtaining good fares of red rockfish and black-cod between Tillamook Rock and Yaquina Head, but, as already mentioned, the latter species has not the same quality here as off Cape Flattery and the Queen Charlotte Islands. The water is shallow and the bottom sufficiently smooth to render fishing easy, and while the tide runs rapidly at times, it is not strong enough to carry a trawl buoy below the surface.

Running down the coast 48 miles, work was resumed off Heceta Head. Between this point and Coquille River, a distance of 63 miles, trials were made with hand lines in 15 different places. The bottom is not unlike that found farther north, and on many spots and ridges red rockfish were fairly abundant. In other localities, however, the bottom seemed to be more or less destitute of life.

Some time was occupied in hand-line fishing off Tsiltcoos River, in 13 fathoms, the mouth of the river bearing SE. by E. (magnetic), distant 2.7 miles, but without success. Better results were obtained during a ten-minute trial off Umpqua River, 12 miles south of Tsiltcoos River, 27 red rockfish being taken. The character of the bottom in these two places did not differ materially.

The ground adjacent to Cape Gregory was carefully examined in depths of 11 to 40 fathoms. The best fishing was found in the last-mentioned depth, Cape Gregory light bearing S. $\frac{3}{8}$ E. (magnetic), 14.5 miles distant. The catch consisted of 22 red rockfish. In six subsequent trials nearer the shore, in depths of 11 to 25 fathoms, no bites were obtained, notwithstanding the fact that the same kind of bait was used. At times, however, fish may be more abundant in this locality.

At hydrographic station No. 2066, lat. 43° 03′ 30″ N., long. 124° 33′ 30″ W., 44 fathoms, the ship lay to, drifting for an hour and twenty minutes, with twelve hand lines in use, but not a single fish was taken. As we worked farther southward fish became exceedingly scarce, and the ground in the immediate vicinity of Cape Orford proved as unproductive as that off Cape Gregory. Not a fish was obtained in the course of seven trials, while with the beam trawl, 11 miles from the cape, only a few shells, 1 starfish, and a small crab were secured.

Many trials were made in the vicinity of Orford Reef by means of the dory, fitted with hand lines of different sizes. This reef consists of several rough ledges, rising abruptly and in some places perpendicularly from the sea, and is inhabited by many sea lions. Unlike other similar localities, however, where the presence of sea lions seems to cause a great scarcity of other aquatic life, food-fishes of several species are abundant here. By far the best fishing was obtained on the south side of the reef, in 6 to 8 fathoms of water, hard, irregular bottom. In the beginning an anchorage was made for each trial, but as it proved very difficult to raise the anchor at times, it was found expedient to lay to and drift with the wind and tide. The hooks frequently caught on the rocks, causing the dory to bring up suddenly, but notwithstanding these difficulties a very good collection of fishes was made. Among these were red, orange, and vermilion rockfishes, the cultus-cod, black-cod, and several large sculpins. The cultus-cod were unusually abundant.

During the progress of this investigation the ship was engaged in dredging and fishing to the southward and westward of the reef. One haul with the beam trawl showed the bottom to be very rich in places. Only 1 cultus-cod, 1 rockfish, and 1 sculpin were taken with the hand lines.

This was the last fishing work carried on during the cruise, but after a trip to the Columbia River, soundings were begun off Cape Sebastian and were extended as far as Cape Mendocino, California. The character of the bottom along this part of the coast is not such as would lead one to expect the presence of fishes in large numbers, but some localities may be found where good fishing can be obtained.

The capture of halibut off Cape Mendocino has been reported on several occasions. The captain of the steam fishing schooner *George L. Chance*, of Portland, Oregon, states that in the latter part of July, 1889, he secured a number of halibut close to the cape, in a depth of 40 fathoms. As the feeding-ground in this locality covers only a very small area, it is not probable that many halibut need be looked for there. Heceta Bank is probably the only ground south of Cape Flattery where halibut may be expected to remain for any length of time. On the evening of August 7 the *George L. Chance* anchored on the southern part of that bank and put over hand lines. Several small halibut were caught in the course of a short time, and, thinking they must be abundant, a trawl line was set. The next morning, on hauling it, the heads of 11 halibut were found attached to the hooks, but sharks and dogfish had devoured the bodies. Further efforts also proved fruitless, and the vessel proceeded to Flattery Bank, where a fare was obtained.

POINT ARENA TO SANTA BARBARA, CAL. (MARCH AND APRIL, 1890).

The Italian and Greek fishermen of San Francisco fish the year round in various localities, both to the north and south of the Golden Gate. The most northern limit to their grounds is Point Arena, the most southern, Point Año Nuevo. Hand-line fishing is principally carried on between Point Reyes and Point Arena, in depths of 10 to 30 fathoms. Extra large red rockfish and cultus-cod are secured off Point Reyes, and as good fares may be obtained within 2 or 3 miles of the shore, attention is seldom paid to the adjacent deeper waters. Red rockfish are chiefly taken in this locality, but other species are also caught in smaller quantities. The red rockfish is also abundant in the vicinity of Bodega Head and Tomales Point. Fishing is carried on in Tomales Bay during the entire year, drag seines and three-mesh trammel nets being used for the capture of red rockfish, perch, flounders, smelt, sea bass, herring, and anchovies. From 30 to 40 fishermen confine their operations exclusively to this bay, making no attempts to try on any of the offshore grounds. The catch is marketed in San Francisco, being transported there by rail.

In Bodega Bay fishing is also prosecuted throughout the year, by means of hand lines and drag seines. The principal species obtained here are tomcod, red rockfish, and flounders.

The next important fishing-ground south of Point Reyes is Drake Bay. Drag seines are used exclusively, as the species which inhabit this locality are most readily captured by this method. Large boats engage in the fishery in this bay, from three to five going in company and each taking its turn in carrying the catch to market.

Ballenas Bay, not far from the Golden Gate, is a favorite locality for the use of the trammel net. Red rockfish, sea bass, and cultus-cod are the species chiefly taken.

Directly south of the Golden Gate, between Point Lobos and Point San Pedro, is a stretch of barren coast, about 11 miles long. The fishermen account for the scarcity of fish in this region by the presence of sea lions, which inhabit the ledges and all available places along the shore. From May to September trawl and hand-line fishing is carried on between Point San Pedro and Point Año Nuevo, mainly for red rockfish. As before mentioned, the San Francisco fishermen do not work farther south than Point Año Nuevo, but below that place other fishermen pursue their calling in close proximity to the coast.

About the Farallon Islands is located one of the chief fishing-grounds off the coast of California. Fishing is actively carried on in this region from September to May. The principal anchorage is off the south side of the South Farallon. The ground surrounding this island is, as a rule, more productive than that adjacent to either the Middle or North Farallones. The bottom is exceedingly rough and rocky, and much fishing gear is frequently lost upon it.

Fanny Shoal is a small spot of fishing-ground, on which large catches are sometimes made. The center of the shoal lies 3½ miles northwesterly from the North Farallon.

Cordell Bank is located some 16 miles northwest of Fanny Shoal, and during the winter months it is resorted to by a few of the large boats from San Francisco, which fish for cultus-cod and red rockfish. The fishermen, however, have very little knowledge respecting the size and characteristics of the bank, and take no pains to increase their stock of information regarding it.

The ground examined by the steamer *Albatross* during the early spring of 1890 extends from Point Arena to Santa Barbara. Time would not permit of an investigation of all the small bays and indentations, but attention was chiefly paid to localities of greatest importance. The fishing-grounds south of the Golden Gate, exclusive of the bays, do not differ greatly from those along the northern coast of California. The 30-fathom curve is about 1½ miles from the shore off Bodega Head, and at Point Reyes above 2½ miles. Its distance from the land increases rapidly from this point, and it turns abruptly seaward to inclose the Middle and South Farallones. At Pigeon Point, 38 miles south of the Golden Gate, it is again only about 2½ miles from shore, and thence to Santa Cruz it continues nearly parallel with the coast. The 100-fathom curve passes close to Cordell Bank and the Farallon Islands, and from the latter locality to off Point Año Nuevo it runs nearly parallel with the 30-fathom curve. It enters Monterey Bay a little over 9 miles south of Santa Cruz, and leaves the southern side of the bay abruptly.

The bottom food-fishes inhabiting this extensive area do not differ much from those found farther north, either as to species, quantity, or quality. Many rich spots occur as feeding-grounds for the various kinds of rockfish and other important species, but there are abundant muddy depressions where nothing of commercial value can be found.

The fishermen all confine their efforts to depths much under 100 fathoms. Were more attention paid to deep-water fishing it would undoubtedly result in a material improvement in the size and quality of the boats. A large number of the fishing boats hailing from San Francisco, Santa Cruz, and Monterey have great stability and sea-worthiness, and they are often good sailers, but very much could be done to increase the comfort of the crew, for which there are at present practically no accommodations.

On two occasions, while at anchor in Drake Bay, the bottom was tested with hand lines of different sizes, but nothing was captured, and the same negative results were obtained with the use of crab nets. A cod trawl, set for six hours across a rocky patch of ground on the northern side of the bay, afforded only 2 small flounders. Rockfish inhabit this ledge in summer, but they never occur there in large numbers. The principal edible fishes secured with the beam trawl about the Farallon Islands were flounders and soles, of several species, and red rockfish. Flounders, soles, anchovies, tomcod, crabs, and other invertebrates were taken by the same means in the vicinity of Noonday Rock, but only red rockfish were caught with hand lines.

A cod trawl was set for seven hours on the western part of Cordell Bank, in a depth of 30-odd fathoms, the catch consisting of 47 red rockfish, averaging 6½ pounds each, and 2 cultus-cod, weighing 18 and 20 pounds, respectively. One orange rockfish, 2 yellow-tails, and 2 cultus-cod were captured with hand lines during a drift which occupied about three-quarters of an hour. All subsequent trials with hand lines and trawls on grounds farther south proved less satisfactory. This, however, may have been partly due to a strong wind which prevailed during the greater part of the time.

Cordell Bank has not yet been fully explored. It covers approximately an area of 20 square miles, and its small extent precludes its being resorted to by many vessels at a time. A vessel operating with six to eight dories could, under favorable conditions, obtain from 4,000 to 5,000 pounds of fish a day, but whether this abundant supply would continue long can be only ascertained by experiment. The bottom consists of rocks, sands, and shelly patches, intermixed with mud.

On grounds contiguous to Point Reyes, Russian River, and Bodega Head, and off the entrance to Drake Bay edible fishes were taken in considerable quantities with the beam trawl, but nothing worthy of special mention was obtained in the immediate vicinity of Point Reyes. Hauls were made at short intervals along the coast southward, beginning off Drake Bay. In the first haul 100 flounders, of several species, half a dozen anchovies, a few herring, red rockfish, and tomcod were collected. Off Ballenas Bay, 4 miles SW. by W. from Duxbury Point, 50 anchovies, 1 smelt, 3 tomcod, 20 flounders, half a dozen perch, and a large mass of other material, composed the catch. One mile WNW. from the northern end of Four Fathom Bank, in 11 fathoms of water, flounders, soles, anchovies, and shrimps were taken.

The sole obtained in this region are small compared with those found in deep water off Monterey Bay and to the westward of the Farallon Islands. This species is pronounced by epicures to excel in edible qualities nearly all the other deep-sea fishes of the Pacific coast. It seldom reaches the San Francisco market, however, as the fishermen do not push into sufficient depth of water to procure them. The steamer *U. S. Grant*, of San Francisco, has been engaged for some time in deep-water drag-net seining, but its operations have been restricted to water of too slight a depth to procure more than scattering specimens.

Trials with hand lines and beam-trawl were made off Cypress Point, but without much success. During the summer fish are said to be abundant in this locality, but in winter the fishermen spend no time upon this ground. In deep water off Monterey Bay very large deep-sea sole * were taken in considerable numbers, and in nearly all hauls made farther to the southward, in depths over 90 or 100 fathoms, the sole and black-cod were obtained in greater or less abundance. The edible qualities of the latter species are inferior, however, to what they are in the neighborhood of Cape Flattery.

A cod trawl was set off the northern entrance to San Simeon Bay, on a sharp, rocky patch of ground, but no edible fishes were caught, although starfishes were numerous. San Simeon Bay has been for many years one of the principal whaling stations on the Pacific coast, and very little attention has been paid to other kinds of fishing. During the past winter ten boxes of smelts, holding 160 pounds per box, were secured by one man, using gill nets. This is the largest amount of fish ever taken during a single season.

Seven whales were taken during each of the seasons 1888 and 1889. Those obtained in 1888 yielded 180 barrels of oil, while 260 barrels were taken from the catch of 1889. This difference was due to the larger size of the whales in the latter year. Whales frequent this region during the months of December, January, and February, but in some years a few are seen as late as the middle of March. It is during these months that the "down run" takes place. The "up run" is of shorter duration, lasting, as a rule, from four to six weeks. While

* The deep-sea sole taken here were by far the largest found by the *Albatross* in the North Pacific. The largest specimens weighed 8 pounds, while specimens of 4 to 6 pounds were common. It was found that they improved by being kept on ice, and a considerable number were carried to San Francisco for distribution. They were highly appreciated by those who received them.

moving south the whales are invariably fat, containing 50 per cent more oil than on the return north. Twenty-one men and nine boats are employed at this station during the whaling season. Only two men are retained in the summer, to look after the boats and buildings. The crew receives a lay of one-fiftieth, the harpooner or shooter (the harpoon being fired from a gun) one-sixteenth.

From San Simeon Bay to and beyond Point Conception, whiting, red rockfish, black-cod, and deep-sea sole were taken in nearly every haul of the beam trawl, but not many specimens at any one time. Windy weather prevented the hand lines from being used successfully. One morning was spent in seining on the beach at Santa Barbara; viviparous perch were the predominating species. Summer is the best season for fishing in this vicinity. Crab nets were set in various places for the purpose of capturing specimens of the salt-water crayfish, but none were obtained, as this species is rare in the immediate neighborhood of Santa Barbara. The fishermen obtain their supplies about 11 miles farther south and among the outlying islands.

Fishing was next resumed in Monterey Bay, on the return trip toward San Francisco, and the work was actively carried on with several kinds of apparatus. Perch and smelt were taken in considerable numbers in the drag seines. One small striped bass* was also captured by the same means, and it is thought that this is the most southern point from which this species has been recorded. Gill nets and a cod trawl were set about 1½ miles from the anchorage in the harbor. One barracuda was taken in the former, but no fishes were secured with the latter, although starfishes of several species were attached to the hooks. The winter fishing-ground is from 5 to 6 miles farther off shore, but in very fine weather red rockfish are frequently caught close to the head of the bay. The Monterey fishermen generally fish in winter on grounds contiguous to the southern entrance to the bay. Those at Santa Cruz resort to a small rocky bank which lies a short distance southerly from Santa Cruz light. This bank is also extensively fished on in the summer. Gill nets and drag seines are employed on sandy bottoms and smooth beaches in different parts of the bay.

Fish of all kinds were unusually scarce the past winter in Monterey Bay. This was supposed to be due to the very extensive rainfall which had taken place. This bay seems to be much affected by storms. Twenty-four hours after a heavy rain the surface becomes covered with muddy water, which has the effect of driving the fish away, but they return shortly after the storm has subsided. Continuously stormy weather has a tendency to keep the fish away for comparatively long periods, frequently for a week or ten days at a time. Notwithstanding this fact, however, Monterey Bay is one of the most productive fishing-grounds on the California coast.

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* *Roccus lineatus*, introduced from the Atlantic and now becoming common.

BERING SEA, SUMMER OF 1890.

BRISTOL BAY.

Since 1882 from one to four vessels have fished each year in the shallow waters of Bristol Bay. The fish inhabiting this region do not run as large as in the North Atlantic Ocean, and vessels of large tonnage, therefore, find it impracticable to depend entirely upon these grounds for a season's work. Small vessels are more profitable, as they do not exhaust the bottom so quickly, and consequently have to change their berth less frequently.

The fishing vessels entering Bering Sea sometimes make trials in the vicinity of Unimak Pass and the Northwest Cape of Unimak Island, the latter being located near the western end of Slime Bank. It is not unusual in the spring that they find comparatively good fishing off Akutan, Akun, Tigaldi, and Avatanak islands, but full fares are never obtained in those places, and a large catch is never expected. The size and quality of these cod compare fairly well with those of Bristol Bay, but, finding them much less abundant, the vessels remain here only a few days. The natives of the region, however, find no difficulty in obtaining all the cod, flounders, etc., which they require for their own use.

Slime Bank has been so named by the fishermen on account of the great numbers of jellyfishes which occur upon it. It extends from the northwestern extremity of Unimak Island, parallel with the coast, to within about 10 miles of Amak Island, and has a total area of about 1,445 square miles; its average width is about 17 miles. The bottom consists of gray, yellow, and black sand, with occasional small rocky patches. The water is usually comparatively shallow, the greatest depth discovered being 75 fathoms.

After leaving the Akutan and Unimak grounds, the fishermen next anchor on the western part of Slime Bank, and thence work gradually to the eastward. Up to the middle or latter part of June the jellyfishes are not sufficiently abundant to be considered a nuisance, but immediately after that time they increase rapidly and soon become a serious obstacle to fishing operations. Their soft tentacles not only cover the baits on the hooks, making them unattractive to fish, but they also adhere so tenaciously to the lines that the latter can only be handled with difficulty. They also produce much irritation and at times cause severe sores to break out on the hands of the fishermen. By the 1st of July the mass of "slime" has become so thick and troublesome that it is almost useless to remain longer on the bank. Otherwise, Slime Bank is well adapted to fishing during the summer months, as cod are very abundant upon it. The largest and most thrifty fish are found some 6 or 8 miles off shore, a large percentage of those caught near the land being small and of inferior quality.

Although we had previously passed over Slime Bank, our first actual work upon it began on June 24. Eight trials with hand lines were made in the vicinity of Cape Lopin and the Northwest Cape, the catch amounting to 139 cod, weighing 1,612 pounds. Their stomachs contained crabs, holothurians, sand-lances, and the remains of other fishes. These trials occupied from twelve to twenty minutes each and were made in depths of 13 to 62 fathoms, the bottom being sandy. On the following day hand-line fishing was continued in connection with the sounding and dredging operations. The same number of fishing trials was made as on the previous day, but the aggregate weight of the cod, 59 in number, was only 596 pounds, making the average weight slightly less.

In the immediate vicinity of Amak Island cod occur only in small numbers, their scarcity being probably due to the presence of sea lions. The quantity of fish consumed in this vicinity by these animals must be very large, especially in the winter, when their numbers are greatly augumented by visitors from the north.

The walrus has always been abundant in this region, and while at anchor off Izenbek Bay, between Amak Island and the mainland, we observed some 30 or 40 individuals swimming about in the water about three-quarters of a mile from the ship; 8 or 10 more were hauled out upon the sand-spit at the entrance to the bay. The stretch of coast adjacent to Slime Bank has no available harbors, and should winter fishing ever be carried on there, which is improbable, the vessels would be exposed to very severe storms without the means of shelter. During the summer heavy winds rarely occur, but moderate gales of short duration are cocasionally experienced; yet, as a rule, the vessels ride them out without difficulty.

Trawl lines are not used in Bering Sea, the depth of water and character of the bottom making it more convenient to fish with hand lines from dories. A few attempts have been made to employ the trawl lines on Slime Bank, but they soon become thickly covered with the so-called slime, making them difficult to handle, while the catch was also small. While these difficulties would not be encountered elsewhere, the water is generally so shallow and the fish, in suitable places, so abundant, that the hand lines can be operated more readily and economically.

The fishermen have no trouble in obtaining bait. On leaving port a small quantity of salt salmon and salt herring is placed on board, to use for the first trials, but this is soon replaced by fresh bait taken on the hooks, such as sculpins, flounders, and other small fish. Halibut are also frequently obtained in sufficient quantities to serve for this purpose, for which they are regarded as nearly equal to squid. All of the halibut taken in Bristol Bay by the *Albatross* were of small size, and it is said that large individuals are rarely obtained.

Baird Bank is much the largest fishing-ground in Bristol Bay. It extends from off Izenbek Bay to the Ugaguk River, a distance of 235 miles, and has an extreme width of 59 miles, its total area amounting to about 9,200 square miles. The depths range from 13 to 53 fathoms, and the fauna living upon it is rich and varied. It is well supplied with cod. The name Port Möller Bank, which has been given to it by the fishermen, has been changed to Baird Bank by Capt. Tanner.

Many trials were made on this bank, and while they were never of long duration, the examination was sufficiently thorough to disclose its principal features. As on Slime Bank, the best fish were found some distance from the shore, the most favorable localities being from 15 to 20 miles from land. Those caught within 4 or 5 miles of the beaches and headlands were small and many were inferior in quality.

During the progress of the inquiry only one cod-fishing vessel was seen, the schooner *Vanderbilt*, of San Francisco, commanded by Capt. A. W. Smith. She was anchored on the Port Möller ground, about 20 miles off shore, and had been on the bank a little over a month. Only one berth had been made, and 43,000 cod had been taken up to that time. We subsequently learned that the *Vanderbilt* completed her trip with 48,500 count fish, measuring 28 inches and over, and several thousand small fish. Capt. Smith informed us that heavy winds prevailed from June 11 to 21, preventing any fishing during that period. The same wind on the Grand or Western Bank would not have interfered with fishing, as the sea there takes a different shape, and is less liable to trip or break into a dory. On the south banks of the Alaska Peninsula the sea is also much more uniform than in Bering Sea. Stormy weather is said to scatter the cod on the banks in Bristol Bay or to drive them into deeper water.

The halibut on Baird Bank seldom exceed 25 pounds in weight. They are always used as bait when taken, and are sometimes very abundant. During the past season, however, they proved to be unusually scarce. Capt. Smith considers the Port Möller ground to be superior to all other fishing-grounds in Bering Sea. The cod are not larger or of better quality than on Slime Bank, but there are fewer obstacles to fishing.

Nearly all the cod in Bristol Bay and other parts of Alaskan waters have black napes, specimens with white napes being rarely taken.

As we proceeded to the northward and eastward from the Port Möller region the fish gradually decreased in size and abundance, but while the difference is not great it is sufficient to induce the fishermen to remain in that locality. However, so little is known about the habits of the cod in this region that no reliable deductions can yet be made regarding this general subject. Good fares can undoubtedly be obtained to the eastward of the Port Möller ground, but at the eastern extremity of the bank the fish become scattering and greatly reduced in numbers, due no doubt to the volume of fresh water which issues from the Ugashik, Ugaguk, Naknek, Kvichak, and Nushagak rivers. The cod which visit the head of the bay are probably attracted there by young salmon, the remains of which were found in the stomachs of cod examined from this locality. In this same region cod are said to be more abundant and to range farther east on the flood tide than on the ebb.

The only available harbors for shelter adjacent to Baird Bank are Port Möller and Herendeen Bay, but as these places are not yet buoyed, their tortuous channels are especially difficult of navigation by sailing vessels. Southerly and westerly winds do not produce a heavy sea, but a very fresh breeze from the northwest or southwest is immediately followed by a choppy sea.

An examination of the stomachs of all the cod captured by the *Albatross* showed that they feed upon a wide range of both invertebrates and fishes. Pebbles, often of considerable size, seemed to occur more frequently in the cod of Bering Sea than in those of the North Atlantic. They are undoubtedly taken in with such articles of food as grow attached to hard objects, the sea-anemones, which are unusually abundant on the banks of Bristol Bay, being of this character.

That part of Bering Sea situated between Cape Constantine and Cape Newenham, and extending some 20 odd miles from the southern end of Hagemeister Island, has been named Kulukak Bank. The bottom and the fauna in this region do not differ materially in character from those of the other fishing-grounds in Bristol Bay. Sand is the predominant material, with an occasional mixture of mud and gravel. At the beginning of the Bristol Bay cod-fishery this ground was resorted to, but it was soon discovered that the fish were smaller and inferior in quality to those occurring on the more southern banks. One exception, however, is noted by the fishermen with respect to a small spot situated about 16 miles SSW. from the southern end of Hagemeister Island, called Gravel Bank, but its extent is slight; the depth of water ranges from 16 to 20 fathoms.

Small fish predominate among the islands of the Walrus Group. Larger individuals are reported from certain indentations and rocky patches, but they are not sufficiently abundant to attract fishermen.

Cod are plentiful in the vicinity of Cape Peirce, but the proportion of diseased individuals among them has led the fishermen to give the name Hospital Bank to these grounds. Nothing was obtained close to the rocky bluffs of Cape Newenham, and no success attended the trials made in the adjacent waters. The quantity of fresh water which issues from the Kuskokwim River probably accounts for this scarcity or absence of fish.

The total number of cod caught in the 113 trials made in Bristol Bay during the summer of 1890 was 946, having a combined weight of 9,919 pounds, an average of about 10½ pounds per fish. The highest average in any single catch was 15½ pounds on Slime Bank, and the next highest, 15⅓ pounds, on the Port Möller ground of Baird Bank. The average weight of several catches on Slime and Baird banks was more than 15 pounds. The largest cod captured during the cruise weighed 27½ pounds, the smallest 1 pound. Practically nothing is known respecting the abundance or movements as well as the condition of the cod on the banks of Bristol Bay during the winter months, as no fishing is prosecuted there at that season.

Nearly all the fishing trials by the *Albatross* were conducted while the ship was hove to, and rapidly drifting through the influence of the tide or wind. The length of each trial, moreover, seldom exceeded twenty minutes, and the tests were therefore insufficient to obtain a thorough knowledge of the bottom, yet it was satisfactorily demonstrated that the greater part of Bristol Bay affords good fishing-grounds. As a rule, vessels have better fishing after the lapse of two or three days, the bait which falls from the hooks or otherwise reaches the bottom tending to tole the fish from the surrounding area.

While all of the fish taken during the summer months were carefully examined, only one cod was secured in which the elements of reproduction were at all mature. It was a male containing ripe milt. The finding of occasional individuals thus sexually advanced outside of the breeding season has also been recorded with respect to the North Atlantic Ocean.

The investigations of the steamer *Albatross* probably covered all of the important cod banks on the eastern side of Bering Sea, as it is extremely doubtful if any rich banks will be found north of Cape Newenham. Certainly we have received no information of such areas up to the present time, although scattering specimens of cod have been reported from the vicinity of Nunivak Island and from along the coast as far north as St. Michaels. On the Siberian side the conditions are better suited to their occurrence in higher latitudes, and they are said to abound there farther north.

Salmon canneries of Bristol Bay.—The first salmon cannery was built on the Nushagak River by the Arctic Canning Company in 1884, having been the outgrowth of a salting station established there the previous year. Other canneries were soon afterwards constructed in the same vicinity. The buildings of the Arctic Canning Company are situated on the east bank of the river, some 12 or 15 miles above its mouth. The number of men and boats employed is as follows: One superintendent, Mr. H. C. Jeneen; 50 fishermen, 20 mechanics, including engineers, machinists, firemen, carpenters, coopers, cooks, and waiters; 92 Chinamen; 25 boats, and 1 steam launch 35 feet long, used for light towing and other purposes.

Each cannery has one large vessel to carry material to the field of labor—men, machinery, boxes, nets, boats, barrels, lumber, etc. As soon as she arrives at her destination she is immediately stripped of sails and running rigging, and moored for the summer. After the close of the salmon season she is again fitted up, receives the catch on board, and sets out on the home voyage. Scow lighters are used for discharging and loading the ships. They also serve as quarters to live in whenever fishing is carried on up the river a considerable distance from the cannery. The salmon are frequently most abundant 40 or 50 miles from the mouth of the river, at which time the entire force of fishermen repair to that place and work night and day until a change of location becomes desirable. When a scow is loaded with salmon it is generally taken in tow by the steam launch, but sometimes one or more will drop down the river on the ebb tide without this aid.

The cannery of the Nushagak Canning Company is also located on the east bank of the river, 9 miles below Fort Alexander. It was built in 1887, and is under the management of J. W. Clark and J. L. Wetherbee. The working force comprises 40 fishermen, 100 Chinamen, 1 engineer, 2 firemen, 1 carpenter, 1 box-maker, 1 cook, and 2 waiters. They use 1 steam launch, 20 boats, and 5 scows, of which one is sloop-rigged.

The Alaska Packing Company's cannery was established in 1886, and has paid a good interest on the investment. The men and boats employed are as follows: 50 fishermen, 95 Chinamen, several engineers and firemen, 2 carpenters, 1 box-maker, 1 cook, and 2 waiters; 25 boats, 8 scows, of which 1 is sloop-rigged, 1 steam launch 36 feet long, and 1 steamer of 40 tons burden.

The Bristol Bay Canning Company's establishment is on the west side of the river, nearly opposite Fort Alexander, in what is considered to be one of the best locations in the region; it was built in 1885. It employs 50 fishermen, 83 Chinamen, and 18 other persons, including engineers, carpenters, firemen, etc.; and is equipped with 25 boats, 5 scows, 1 sloop, and 1 steam launch.

All the canneries on the Nushagak River have adopted the same methods of fishing for salmon, namely, with gill nets, which yield the best results at all times. They are regarded as much superior to drag seines and traps. Two sizes of nets are employed, one for king salmon, the other for red and silver salmon. A king-salmon net is 100 fathoms long and 23¾ feet deep, or 30 meshes, measuring 9½ inches stretched. The nets for the red and silver salmon are 70 fathoms long and 13 feet or 24 meshes deep, the size of the mesh being 6½ inches. The floats are made of wood and are placed 3 feet apart; the leads on the foot line are 2½ feet apart. Attached to the lower corners of each net is a galvanized-iron ring, 1 foot in diameter, which prevents the net from fouling. Without their use the nets, when set in a strong current, tend to roll up into an inextricable ball. The nets seldom survive a season's fishing, for they are continually in the water, except when undergoing repairs. The fishermen generally regard the Barbour twine, manufactured in this country, as superior to that of Scotch manufacture, because it wears better, and some canneries have discarded the use of all foreign-made twine, notwithstanding its cheaper price. The fishermen rig and hang all nets and other gear used in the fishery, and also keep them in repair. When fish are abundant one or two men from each cannery are detailed to attend to the repairing.

The boats used by the Alaska Packing Company are of the Columbia River type, measuring 25 feet long, 8 feet beam, and 2 feet deep. They are provided with centerboard, and with a small half deck, both fore and aft, under which small articles can be stored. An 8-inch wash-rail affords some protection against a choppy sea in a stiff breeze. The sprit-sail rig is universally employed on the Nushagak as on the Columbia River, the sail area being from 40 to 60 square yards. All other canneries on this river use flat-bottomed boats, measuring 24 feet over all, and 7 feet beam, with an 8-inch washrail. This style of boat costs less than the other, and is equally efficient, especially as sand-bars and mudflats are scattered along the river.

The fishermen receive 10 cents each for catching king salmon and 3 cents each for red and silver salmon, besides $75 for assistance in handling the vessel on the passage to and from San Francisco. Previous to the present season the fishermen have been paid monthly wages, but the change is thought to be for the better, and all the canneries have agreed to the same terms.

Forty-five cents per case is paid for putting up salmon. This includes all the labor from the time the fish are taken from the fishermen until the cans are labeled and boxed for shipment. Each cannery employs one reliable Chinaman to attend to the mechanical part of the business, and he hires the remaining men of his class, who look to him for their pay. He is held rigidly to his agreement by the company.

The facilities for handling and putting up salmon are about the same at all the canneries on the Nushagak River. Twelve hundred is the largest number of cases that could be prepared in a day by each cannery, providing every effort was put forth, but the fish are not sufficiently abundant to attain that figure, and half the amount mentioned would be regarded as a fair day's work.

Salmon first make their appearance the first of June, and remain from 55 to 60 days. As the season is short all the needed preparations are made beforehand and from the middle of May until the first of June every man about the cannery is actively engaged in this work.

Formerly the machinery for manufacturing cans was sent out from San Francisco, but it has since been found more economical to ship them ready-made from the latter place. Another advantage is that the voyage is delayed until more settled weather generally prevails.

The first salmon were taken the past season on the morning of June 3 by boats belonging to the Bristol Bay Canning Company. The total catch on that date amounted to 660 fish, producing 250 cases. This small catch acted as an incentive and everybody rushed to the spot where they had been obtained, but several days elapsed before any more were taken.

The first species which enters the river is the king salmon. They remain about a fortnight, after which come the red salmon, followed closely by the silver salmon. The king salmon are first sought in the vicinity of Coffee Point, a high promontory situated on the west side of the river, where the fishermen are in the habit of coming together to drink their coffee after a hard night's fishing.

It is said that the ice has considerable effect upon the appearance of the salmon. It is sometimes unusually late in breaking up in the river, in which case the salmon remain outside until it has disappeared and the temperature of the water has somewhat increased. When the salmon are late in entering the river they immediately proceed up stream to Nushagak and Aleknagik lakes, where they spawn. If the season be an open one, however, they frequently loiter on the way, spending considerable time on their upward passage. The latter conditions are, of course, most favorable for the fishermen. During the past spring the river was blockaded with ice until May 20, and the run was a late one in consequence.

The fishermen consider that the salmon spawn about a month after entering the river. The superintendent of the Bristol Bay Canning Company, who has had much experience in this part of Alaska, states that from the first of August until October young salmon pass down stream, and enter the sea daily by the million. It takes, on an average, about 6 red salmon to make a case of the preserved product, and about the same number of silver salmon. Two and one-half of the king salmon are equivalent to about 6 of either of the other two species.

Heretofore each cannery has had from one to five traps, but returns from them have not compared favorably with the cost of keeping them in repair. The original cost of a trap is $250. The main body is made of twine, but the leaders are constructed of galvanized-iron wire netting, which is superior to common twine netting, offering more resistance to the drift material which comes down the river in large quantities. Notwithstanding, however, that every precaution is taken to make them secure, they are frequently torn from their fastenings and swept away. The king salmon is said not to enter the traps like the other species.

The Arctic Canning Company has this year built a trap in the Naknek River, which it is expected will give good results.

VICINITY OF UNALASKA ISLAND.

Along the Aleutian group of islands the bottom differs materially in character from that of Bristol Bay. Instead of large areas of sand, intermixed with patches of mud and rocks, nearly one continuous rocky bottom is found, upon which cod are fairly abundant. The investigations of the *Albatross* among the Aleutian Islands were mainly confined to the continental platform along the Bering Sea side of Unalaska Island as far as Umnak Island. However, a line of soundings was run between Atka Island and Unalaska Island, nearly parallel with the coast trend, which indicated the existence of much bottom suited to cod and halibut, and good fishing-grounds for those species will undoubtedly be found in that region, as well as about the other islands lying to the westward of Atka. Information to the same effect has been derived from other sources, but the occurrence of large fishing-banks is precluded by the fact that deep water approaches to within a very short distance of the islands.

Unalaska harbor and vicinity.—The fishing-grounds in the neighborhood of Iliuliuk, Unalaska, extend only a short distance from the shore, 3 to 6 miles being the width of area on which cod are likely to be found. The bottom consists mainly of rocky and muddy patches, of small to large extent, on which sand, gravel, and shells also occur in small quantities. The rocks have the appearance of being of volcanic origin, and are very rough and sharp. They would be very destructive to most kinds of fishing gear.

Cod are frequently caught from the wharf and beach in Iliuliuk Harbor, and native women may often be seen fishing for them from the rocks along the shore. Certain grounds in Captain's Harbor are sufficiently rich to supply the inhabitants of Iliuliuk during the entire year. The fish taken there, however, are not as good as those from the offshore grounds, but the Aleuts are not particular about their quality.

The cod in this locality will accept almost anything as bait, and among the articles used for this purpose may be mentioned seal meat, sculpins, flounders, pork, and bacon. Salmon being the principal diet of these people, a large stock of cod is never secured at one time, and the latter species is almost invariably eaten fresh. Such as are not immediately eaten, however, are cured in the same manner as salmon.

Considerable time was spent in testing the bottom in the vicinity of Priest Rock and Cape Cheerful, at the entrance of Iliuliuk Harbor. Trials were made with hand-lines in depths of from 22 to 58 fathoms. In close proximity to the cape, cod were found abundant, the average weight of those captured being 11 pounds. A halibut weighing 6½ pounds was caught in a depth of 40 fathoms, sandy bottom. This species has never been regarded as common in this region, but, as no one ever fishes for them, the real facts in the case have not yet been ascertained.

In approaching Priest Rock we met with less success, the scarcity of cod being due, no doubt, to the extent of muddy bottom which occurs there. By a careful series of trials productive spots could probably be found in that vicinity.

This part of Unalaska Island offers many inducements for the establishment of fishing stations, such as occur on the Sannak and Shumagin islands, and a profitable industry of this character could undoubtedly be built up at this place. Good bait can readily be obtained in the fishing season, such as herring, smelt, sculpins, flounders, and salmon, and the cost of catching the same would be slight.

Cape Cheerful to Makushin Bay.—Between these two points the bottom differs but little from that above described. A well-defined platform, from 5 to 6 miles wide, and with depths of 20 to 60 fathoms, runs parallel with the coast. At its outer edge the bottom drops off suddenly into deep water. In many places cod were fairly abundant, and small vessels could probably fish in this region with profit. Owing to the force of the wind, which interfered greatly with operations, nothing was obtained in many of the trials made by the *Albatross*. Had an anchorage been made in each instance it is reasonable to suppose that better results would have been secured. By far the greatest number of cod were found near the shore, but the best fish, as to size and quality, were taken some distance off the land. At other seasons, however, the conditions may be more favorable inshore.

Excellent fishing was obtained at the mouth of a small indentation or bay 11 miles east of Cape Makushin, both cod and halibut being captured. Three specimens of the latter species were secured, weighing 6½, 8, and 15 pounds, respectively. Two trials were made off the mouth of Makushin Bay, but a strong wind prevented satisfactory work.

Makushin Bay to Umnak Island.—The bottom in this region differs from that farther to the eastward chiefly in being better adapted to cod and halibut, especially the latter. The beam trawl and hand lines were used in the vicinity of Makushin Bay and Cape Hague. A rich bottom was disclosed by the former, but only five cod were taken in as many trials with the latter. They may, however, be more abundant here at other times. The bottom was found to be largely made up of sandy, muddy, and coral patches. With the latter were large quantities of sponges and other rich material, the combination suggesting the deep-water localities on the Grand Bank, where halibut are plentiful. This species is sometimes caught here by the natives, but whether they can be obtained in paying quantities or not has yet to be determined. Small vessels might probably engage in their capture with some show of success, but many years would elapse before all the good fishing-spots could be located, and at present there is no particular inducement to establish a commercial fishery in this region, as the halibut grounds south of the Alaska Peninsula and off the southeastern coast of the Territory offer better opportunities.

Chernoffsky and vicinity.—Near the harbor of Chernoffsky there is an excellent ground for both cod and halibut. Fifty-three cod and 5 halibut were captured on one trial lasting only thirty minutes. This would be a good fishing-place for a fleet of small vessels. Mr. Rankin, agent of the Alaska Commercial Company, who has lived at Chernoffsky seven years, states that the best halibut ground along this section of the coast is located in a small bay some 6 or 8 miles to the west of Chernoffsky. During the summer halibut are plentiful inshore, but on the approach of winter they invariably seek deeper water. They are sufficiently abundant to maintain a small fishery, providing there were convenient markets for the catch. From 10 to 12 pounds is the average size of those caught on the grounds near Chernoffsky and Umnak Pass.

Few halibut are found near the outer edge of the platform; the bottom a few miles nearer shore seems to be better adapted to them. All the halibut observed by the *Albatross* were white. Gray halibut are said to be seldom taken in Alaskan waters or off the Queen Charlotte Islands and on Flattery Bank.

Excellent cod-fishing was obtained at nearly every trial made off Chernoffsky, but as we approached Umnak Pass less success was met with. Fewer fish were found on the western side of the pass than on the eastern side, but it is probable that at some other season of the year cod may be more plentiful in the former locality, as the character of the bottom seems to be the same in both places. In fact the difference in their abundance may have been due to the state of the tide at the time the trials were made. Fishing was carried on in Umnak Pass in 30 to 60 fathoms. Trawl lines were not set, as the bottom was rough and rocky, and it was possible to cover the ground more rapidly by means of hand lines.

Bait is as abundant and varied at Chernoffsky as at Iliuliuk. Herring and other migratory fishes school about this part of the island in considerable numbers. There is a fine, smooth beach at Chernoffsky, well suited to the use of seines, and gill nets could also be set to good advantage in this locality, but the former method is preferable.

Makushin Bay and Chernoffsky are the best harbors on the north side of Unalaska, west of Cape Cheerful. They are accessible in most weather when fishing vessels would be likely to seek shelter on a coast unprovided with lights or buoys. Chernoffsky is landlocked and large enough to accommodate a good-sized fleet of small vessels.

But little profit could be realized by San Francisco merchants in the employment of the small vessels hitherto described to fish on banks so far from any market, yet vessels of this size would have a decided advantage in fishing here over the larger ones which visit the Okhotsk Sea. This is owing to the frequent change in position which would be necessary, the nearness of the grounds to the coast making it also possible readily to seek shelter. Should an extensive fishery grow up in this region, it would probably be conducted from local stations by means of small boats and small vessels, employing hand lines; and, after the preliminary curing of the cod, shipments could be made to market in vessels of large tonnage.

Miscellaneous.—In Makushin Bay large quantities of humpback salmon, trout, young cod, and flounders were captured by means of the drag seine. The beaches are smooth and comparatively free from rocks and other obstacles to seining. Two small streams enter the bay not far from the settlement. The larger one brings down considerable quantities of mud, which is deposited in the bay at half tide, discoloring the water for about 2 miles along the shore. The muddy water, however, has no apparent effect upon the salmon, as they run up this stream to the same extent as up the clearer one.

The humpback salmon enter the streams first, followed by the silver salmon. The same is true of the streams at Iliuliuk, Captain Harbor, and Chernoffsky. Considerable collecting was done at each of these places by means of drag seines and other appliances, with good results.

The harbors, bays, and streams of Unalaska are well supplied with salmon in their season, but the run is not sufficiently large to support extensive canning operations.

From the statement of fishing stations, which accompanies this report, it will be seen that 37 trials with hand lines were made between Priest Rock and Umnak Island. In 14 of these trials nothing was taken, but in the other 23 the combined catch amounted to 163 cod and 21 halibut. The total weight of the cod was 1,834 pounds, an average of something over 11 pounds each; and the total weight of the halibut 292½ pounds, an average of nearly 14 pounds to each fish.

TABLES.

Record of hydrographic soundings by the U. S. Fish Commission steamer Albatross from July 1, 1889, to June 30, 1891.

Serial No.	Date.	Time of day.	Position.		Depth.	Character of bottom.	Temperature.			Instrument used.	Weight of sinker.
			Lat. N.	Long. W.			Air.	Surface.	Bottom.		
	1889.		° ′ ″	° ′ ″	Fms.		° F.	° F.	° F.		Lbs.
1858	Aug. 28	11:50 p. m.	45 52 00	124 10 30	53	fne. gy. S	60	59	45.6	Tanner	25
1859	Aug. 29	12:47 a. m.	45 51 30	124 17 00	73	fne. gy. s. bk. Sp.	60	58	45.6	...do	25
1860	...do	1:47 a. m.	45 50 45	124 23 30	83	fne. gy. S. M	60	58	45.8	...do	25
1861	...do	2:45 a. m.	45 50 15	124 29 30	87	fne. gy. S. M	59	58	45.3	...do	25
1862	...do	3:42 a. m.	45 49 45	124 36 00	81	C	59	58	45.1	...do	25
1863	...do	4:44 a. m.	45 49 15	124 43 00	120	fne. gy. S	59	59	44.6	...do	25
1864	...do	6:15 a. m.	45 39 00	124 40 00	186	M	59	59	43.5	...do	25
1865	...do	7:02 a. m.	45 38 30	124 32 30	123	M	60	59	45.0	...do	25
1866	...do	7:45 a. m.	45 38 30	124 25 00	91	M	60	59	45 3	...do	25
1867	...do	8:31 a. m.	45 38 00	124 17 30	81	M. and fne. gy. S.	60	60	45.2	...do	25
1868	...do	9:14 a. m.	45 38 00	124 10 00	58	fne. gy. S	61	60	45.7	...do	25
1869	...do	9:55 a. m.	45 37 30	124 04 00	42	fne. gy. S. and Sh.	61	60	47.4	...do	25
1870	...do	10:40 a. m.	45 33 30	124 03 30	45	fne. gy. S	61	60	47.2	...do	25
1871	...do	11:23 a. m.	45 29 00	124 04 00	48	fne. gy. S	60	60	46.7	...do	25
1872	...do	12:03 p. m.	45 28 30	124 10 45	73	fne. gy. S	61	62	45.6	...do	25
1873	...do	12:48 p. m.	45 28 30	124 17 30	94	gn. M	62	62	45.3	...do	25
1874	...do	1:32 p. m.	45 28 30	124 25 00	120	gy. S. bk. Sp	62	61	45.1	...do	25
1875	...do	2:20 p. m.	45 28 30	124 32 00	259	gn. M	62	61	42.4	...do	25
1876	...do	3:05 p. m.	45 23 45	124 32 00	216	gn. M	63	62	42.8	...do	25
1877	...do	3:50 p. m.	45 18 30	124 32 15	238	yl. M	64	66	42.6	...do	25
1878	...do	4:35 p. m.	45 18 00	124 25 15	217	M	64	66	42.8	...do	25
1879	...do	5:18 p. m.	45 17 30	124 17 30	130	M	67	66	44.4	...do	25
1880	...do	6:01 p. m.	45 17 30	124 12 00	88	gn. M	68	64	45 6	...do	25
1881	...do	6:43 p. m.	45 17 30	124 05 00	52	fne. gy. S	68	64	46.1	...do	25
1882	...do	7:33 p. m.	45 12 30	124 05 45	49	fne. gy. S	63	61	45.9	...do	25
1883	...do	8:22 p. m.	45 07 30	124 06 00	48	fne. gy. S	62	61	46.8	...do	25
1884	...do	9:16 p. m.	45 07 00	124 13 00	85	gy. S. bk. Sp	62	61	45.6	...do	25
1885	...do	10:07 p. m.	45 06 45	124 19 45	119	gn. M	62	60	44.8	...do	25
1886	...do	11:00 p. m.	45 06 30	124 27 15	190	gn. M	62	60	43.4	...do	25
1887	...do	11:55 p. m.	45 06 15	124 34 30	191	gn. M	62	60	43.4	...do	25
1888	Aug. 30	12:43 a. m.	45 01 00	124 35 00	245	M	62	62	42.6	...do	25
1889	...do	1:37 a. m.	44 55 00	124 36 00	203	M	62	62	43.5	...do	25
1890	...do	2:25 a. m.	44 54 30	124 29 15	100	M	62	62	45.4	...do	25
1891	...do	3:13 a. m.	44 54 00	124 22 30	79	M	62	61	......	...do	25
1892	...do	4:00 a. m.	44 53 30	124 15 30	63	M and S	62	61	45.7	...do	25
1893	...do	4:44 a. m.	44 53 00	124 09 00	35	fne. gy. S	62	61	47.7	...do	25
1894	...do	5:30 a. m.	44 47 30	124 08 15	33	fne. gy. S	62	61	48.0	...do	25
1895	...do	6:02 a. m.	44 43 15	124 09 00	33	fne. gy. S	62	61	47.9	...do	25
1896	...do	6:46 a. m.	44 43 00	124 16 30	46	fne. gy. S	60	61	47.7	...do	25
1897	...do	7:29 a. m.	24 43 00	124 23 45	64	fne. gy. S	60	60	45.8	...do	25
1898	...do	8:14 a. m.	44 43 00	124 30 30	87	fne. gy. S	60	60	45.5	...do	25
1899	...do	8:56 a. m.	44 43 00	124 43 00	156	fne. gy.S.bk.Sp	60	60	44.2	...do	25
1900	...do	9:39 a. m.	44 43 00	124 46 00	217	yl. M	61	61	41.7	...do	25
1901	...do	10:27 a. m.	44 38 00	124 46 30	139	bk. S	62	61	44.7	...do	25
1902	...do	11:15 a. m.	44 38 00	124 54 00	311	gn. M	62	61	40.9	...do	25
1903	...do	12:08 p. m.	44 33 00	124 54 30	340	fne. bk. S	61	61	40.9	...do	25
1904	...do	12. 56 p. m.	44 33 30	124 48 00	185	gn. M	61	61	44.5	...do	25
1905	...de	1:42 p. m.	44 33 45	123 41 30	123	M	60	61	44.8	...do	25
1906	...do	2:31 p. m.	44 34 00	124 35 15	94	M	57	59	45.1	...do	25
1907	...do	3:16 p. m.	44 34 15	124 28 30	60	fne. bk. S	56	59	46.1	...do	25
1908	...do	4:01 p. m.	44 34 15	124 23 30	60	crs. S. brk. Sh	56	59	......	...do	25
1909	...do	4:45 p. m.	44 34 30	124 17 00	43	fne gy. S	56	59	46.7	...do	25
1910	...do	5:27 p. m.	44 30 30	124 10 00	28	fne. gy. S	56	56	48.5	...do	25
1911	...do	7:30 p. m.	44 30 00	124 11 00	28	fne. gy.S.bk.Sp	56	56	47.5	...do	25
1912	.. do	8:13 p. m.	44 25 30	124 12 30	28	fne. gy. S	57	56	46.7	...do	25
1913	...do	9:07 p. m.	44 26 00	124 19 30	43	fne. gy. S	56	56	45.8	...do	25
1914	...do	9:58 p. m.	44 26 30	124 26 15	42	rky	56	56	44.8	...do	25
1915	...do	10:46 p. m.	44 27 00	124 34 00	56	crs. bk. S	56	56	45.2	...do	25
1916	...do	11:32 p. m.	44 27 30	124 41 00	79	fne. gy. S	55	58	45.1	...do	25
1917	Aug. 31	12. 24 a. m.	44 28 00	124 48 00	167	G	55	58	43.1	...do	25
1918	...do	1:24 a. m.	44 28 30	124 54 45	265	M	56	57	41.3	...do	25
1919	...do	2:20 a. m.	44 23 15	124 54 45	293	M	56	57	40.9	...do	25
1920	...do	3:10 a. m.	44 18 00	124 54 45	282	M	56	58	41.3	.. do	25
1921	...do	4:02 a. m.	44 18 00	124 47 30	84	bk. S	59	58	45.7	...do	25
1922	...do	4:57 a. m.	44 18 00	124 41 00	51	C	56	57	46.4	...do	25
1923	...do	5:43 a. m.	44 18 15	124 34 00	56	bk. S. and G	56	57	46.2	...do	25
1924	...do	6:29 a. m.	44 18 15	124 28 00	54	gy. S. bk. Sp	56	56	45.7	...do	25
1925	...do	7:09 a. m.	44 18 30	124 21 00	45	gy. S. bk. Sp	56	56	46.5	...do	25

Record of hydrographic soundings by the U. S. Fish Commission steamer Albatross from July 1, 1889, to June 30, 1891—Continued.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Instrument used.	Weight of sinker.
	1889.		° ′ ″	° ′ ″	*Fms.*		° F.	° F.	° F.		*Lbs.*
1926	Aug. 31	7:49 a. m.	44 18 30	124 15 00	35	gy. S. bk. Sp...	57	56	47.2	Tanner ..	25
1927	...do ...	8:05 a. m.	44 18 30	124 12 30	31	yl. S. bk. Sp ...	57	56	47.7	...do	25
1928	...do ...	9:00 a. m.	44 13 30	124 12 30	31	fne. gy. S......	57	56	48.9	...do	25
1929	...do ...	9:40 a. m.	44 07 30	124 11 00	29	fne. gy. S......	58	57	47.7	...do	25
1930	...do ...	10:36 a. m.	44 07 00	124 18 00	45	fne gy. S......	57	57	46.9	...do	25
1931	...do ...	11:21 a. m.	44 06 30	124 25 00	60	M	57	57	46.2	...do	25
1932	...do ...	12:06 p. m.	44 06 00	124 31 30	69	gn. M	57	57	45.9	...do	25
1933	...do ...	12:56 p. m.	44 06 00	124 37 30	70	gn. M	59	59	45.7	...do	25
1934	...do ...	1:45 p. m.	44 05 30	124 44 15	63	gn. M..........	59	59	46.1	...do	25
1935	...do ...	2:30 p. m.	44 05 30	124 51 30	51	br. C. and P ...	59	59	47.1	...do	25
1936	...do ...	3:10 p. m.	44 05 00	124 56 00	346	M	59	59	40.9	...do	25
1937	...do ...	4:06 p. m.	43 59 30	124 59 00	326	fne.gy.S.bk.Sp.	59	59	41.8	...do	25
1938	...do ...	5:06 p. m.	43 53 00	124 59 00	602	gn. M..........	59	59	40.2	Sigsbee ..	35
1939	...do ...	5:40 p. m.	43 53 00	124 56 00	365	gn. M..........	68	63	40.4	...do	35
1940	...do ...	6:07 p. m.	43 52 45	124 53 00	284	gn. M..........	68	63	41.4	Tanner ..	25
1941	...do ...	6:32 p. m.	43 52 30	124 50 00	175	fne. bk. S	68	63	42.8	...do	25
1942	...do ..	6:55 p. m.	43 52 15	124 47 00	159	M. and bk. S...	61	61	43.7	...do	25
1943	...do ...	7:17 p. m.	43 52 00	124 44 00	159	M	61	61	43.7	...do	25
1944	...do ...	7:40 p. m.	43 52 00	124 40 30	159	M	60	60	43.7	...do	25
1945	...do ...	8:30 p. m.	43 47 45	124 37 00	185	gn. M..........	60	60	43.7	...do	25
1946	...do ...	9:20 p. m.	43 43 30	124 34 30	127	gn. M..........	60	60	45.1	...do	25
1947	...do ...	10:07 p. m.	43 39 15	124 30 30	97	gn. M..........	60	60	45.7	...do	25
1948	...do ...	10:56 p. m.	43 35 30	124 26 30	80	gn. M..........	59	59	45.7	...do	25
1949	...do ...	11:45 p. m.	43 31 00	124 24 15	66	fne. gy. S	59	59	45.8	...do	25
1950	Sept. 1	12:45 a. m.	43 36 00	124 22 30	65	gn. M..........	59	59	45.2	...do	25
1951	...do ...	1:44 a. m.	43 40 15	124 21 00	62	gn. M..........	56	56	45.7	...do	25
1952	...do ...	2:45 a. m.	43 45 30	124 19 00	57	gn. M..........	55	55	46.4	...do	25
1953	...do ...	3:31 a. m.	43 38 00	124 24 15	62	bk. S. and M...	56	55	46.2	...do	25
1954	...do ...	4:18 a. m.	43 50 30	124 29 00	72	M	56	55	46.1	...do	25
1955	...do ...	5:05 a. m.	43 53 00	124 34 00	92	gn. M..........	56	55	45.7	...do	25
1956	...do ...	5:50 a. m.	43 55 30	124 38 30	120	gn. M..........	59	59	45.1	...do	25
1957	...do ...	6:40 a. m.	43 58 00	124 44 00	87	bk. S. and M...	59	59	45.5	...do	25
1958	...do ...	8:10 a. m.	44 01 00	124 49 15	58	R..............	61	59	.....	...do	25
1959	...do ...	8:49 a. m.	44 02 00	124 50 15	58	R..............	61	59	46.2	...do	25
1960	...do ...	9:42 a. m.	43 59 30	124 49 30	77	C..............	60	59	45.7	...do	25
1961	...do ...	10:04 a. m.	43 59 30	124 47 00	74	C..............	60	59	45.8	...do	25
1962	...do ...	10:40 a. m.	44 00 15	124 49 30	75	C..............	60	59	45.7	...do	25
1963	...do ...	11:03 a. m.	44 01 00	124 52 00	61	R..............	59	59	45.7	...do	25
1964	...do ...	11:25 a. m.	44 01 30	124 54 30	74	P..............	59	59	45.8	...do	25
1965	...do ...	12:09 p. m.	43 59 15	124 54 30	79	Rky	60	60	45.6	...do	25
1966	...do ...	12.22 p. m.	43 58 00	124 54 15	174	gn.M.fne.gy. S.	60	60	43.6	...do	25
1967	...do ...	12:37 p. m.	43 57 45	124 52 30	88	rky............	60	60	45.5	...do	25
1968	...do ...	12:50 p. m.	43 57 30	124 50 30	92	No bottom specimen.	60	60	45.2	...do	25
1969	...do ...	1:07 p. m.	43 58 30	124 50 00	79	gn. M. and S ...	62	59	45.7	...do	25
1970	...do ...	1:38 p. m.	43 54 20	124 49 15	155	bk. S	62	60	43.7	...do	25
1971	...do ...	1:52 p. m.	43 54 10	124 47 30	139	bk. S. and M ...	62	62	43.9	...do	25
1972	...do ...	2:05 p. m.	43 54 00	124 46 00	124	bk. S. and M...	62	62	44.7	...do	25
1973	...do ...	2:21 p. m.	43 54 45	124 46 40	90	gn. M. and G..	62	62	45.5	...do	25
1974	...do ...	2:34 p. m.	43 55 30	124 45 20	78	bk. S. and G...	62	62	45.7	...do	25
1975	...do ...	2:50 p. m.	43 56 15	124 45 00	70	C. and G	69	59	45.7	...do	25
1976	...do ...	3:04 p. m.	43 57 00	124 44 30	70	C	60	59	45.7	...do	25
1977	...do ...	3:17 p. m.	43 57 45	124 44 00	67	gn. M. and G..	60	59	45.7	. .do	25
1978	...do ...	3:41 p. m.	43 58 30	124 44 20	61	Rky. brk. Sh..	60	59	45.7	...do	25
1979	...do ...	4:20 p. m.	44 00 00	124 45 00	52	Co	60	59	47.2	...do	25
1980	Sept. 2	8:16 a. m.	44 00 00	124 11 30	18	fne. gy. S......	56	56	.....	Hand lead	14
1981	...do ...	9:40 a. m.	44 01 30	124 11 30	24	yl. S	58	59	48.8	Tanner ..	25
1982	...do ...	2:25 p. m.	44 16 00	124 12 00	31	fne. gy. S......	60	59	47.7	...do	25
1983	...do ...	3:45 p. m.	44 16 30	124 09 00	19	fne. gy. S......	62	57	.....	Hand lead	14
1984	...do ...	4:28 p. m.	44 18 00	124 08 30	12	fne. gy. S......	62	56	.....	...do	14
1985	...do ...	5:38 p. m.	44 20 00	124 13 00	31	Wh. S. bk. Sp. Sh.	57	54	47.8	Tanner ..	20
1986	Sept. 3	5:43 a. m.	44 37 00	124 15 00	44	gy. S	56	54	47.5	...do	20
1987	...do ...	6:41 a. m.	44 35 00	124 13 00	43	fne. gy. S. and gn. M.	55	55	46.2	...do	20
1988	...do ...	7:23 a. m.	44 33 00	124 11 00	32	bk. S	56	55	46.7	...do	20
1989	...do ...	9:31 a. m.	44 28 30	124 23 00	45	C. and P	56	56	46.5	...do	20
1990	...do ...	9:50 a. m.	44 27 00	124 24 30	44	C	56	56	46.5	...do	20
1991	...do ...	10:40 a. m.	44 26 30	124 26 00	48	C	56	56	46.3	...do	20
1992	...do ...	11:52 a. m.	44 28 00	124 24 30	43	Rky	59	56	47.2	...do	20
1993	...do ...	4. 40 p. m.	44 39 00	124 08 30	29	fne. gy. S. bk. Sp.	57	56	48.2	...do	20
1994	...do ...	5:47 p. m.	44 41 00	124 09 00	28	fne. gy. S. bk. Sp.	55	52	46.9	...do	20
1995	Sept. 7	3:27 p. m.	45 46 15	124 04 45	46	fne. gy. S. and G.	63	60	45.1	...do	20

Record of hydrographic soundings by the U. S. Fish Commission steamer Albatross, from July 1, 1889, to June 30, 1891—Continued.

Serial No.	Date.	Time of day.	Position.		Depth.	Character of bottom.	Temperature.			Instrument used.	Weight of sinker.
			Lat. N.	Long. W.			Air.	Surface.	Bottom.		
	1889.		° ′ ″	° ′ ″	Fms.		°F.	°F.	°F.		Lbs.
1996	Sept. 7	3:46 p. m.	45 45 30	124 02 30	40	fne. gy. S	60	56	45.3	Tanner	20
1997	...do ...	4:35 p. m.	45 44 30	123 59 30	22	fne. gy. S	60	56	.....	Hand lead	14
1998	...do ...	5:12 p. m.	45 43 00	123 58 15	15	fne. gy. S	62	56	.....	...do	14
1999	Sept. 8	9:00 a. m.	45 31 15	124 00 45	25	fne. gy. S	57	52	47.2	Tanner	20
2000	...do ...	10:10 a. m.	45 35 00	123 58 15	18	gy. S. rd. Sp	57	52	48.4	...do	20
2001	...do ...	11:26 a. m.	45 30 00	123 59 45	18	fne. gy. S	57	51	48.5	...do	20
2002	...do ...	11:51 a. m.	45 28 30	124 00 00	16	fne. gy. S	57	53	48.2	...do	20
2003	...do ...	12:20 p. m.	45 26 30	124 00 15	21	Rky	57	56	48.0	...do	20
2004	...do ...	1:20 p. m.	45 23 00	124 00 30	18	fne. gy. S	54	50	.....	Hand lead	14
2005	...do ...	3:27 p. m.	45 19 00	124 02 30	39	fne. gy. S	54	50	46.7	Tanner	20
2006	...do ...	4:29 p. m.	45 19 00	124 00 30	23	fne. bk. S	57	51	47.2	...do	20
2007	Sept. 9	7:04 a. m.	45 17 30	124 00 30	19	fne. gy. S. bk. Sp.	51	48	47.7	...do	20
2008	...do ...	7:46 a. m.	45 13 00	124 00 30	27	fne. gy. S	51	48	47.7	...do	20
2009	...do ...	8:23 a. m.	45 11 30	124 00 00	19	fne. gy. S. yl. M	51	49	.....	Hand lead	14
2010	...do ...	8:50 a. m.	45 10 30	123 59 45	15	fne. bk. S	52	48	.....	...do	14
2011	...do ...	9:30 a. m.	45 11 00	124 03 30	34	fne. gy. S. bk. Sp.	52	48	45.8	Tanner	20
2012	...do ...	10:18 a. m.	45 12 00	124 07 00	52	fne. gy. S. bk. Sp.	52	48	45.9	...do	20
2013	...do ...	10:46 a. m.	45 13 00	124 10 30	69	fne. gy. S	52	48	45.6	...do	20
2014	...do ...	11:16 a. m.	45 09 30	124 10 45	69	fne. gy. S	55	50	45.4	...do	20
2015	...do ...	11:44 a. m.	45 07 30	124 06 00	49	crs. S	55	50	45.9	...do	20
2016	...do ...	12:04 p. m.	45 07 15	124 03 00	33	fne. gy. S	55	50	46.2	...do	20
2017	...do ...	12:52 p. m.	45 07 00	124 00 30	15	fne. gy. S	55	50	.....	Hand lead	14
2018	...do ...	1:45 p. m.	45 04 00	124 02 30	23	fne. gy. S	55	50	.....	...do	14
2019	...do ...	2:32 p. m.	45 04 00	124 06 15	51	fne. gy. S	52	48	46.0	Tanner	20
2020	...do ...	3:20 p. m.	45 04 00	124 11 00	68	fne. gy. S	52	48	45.5	...do	20
2021	...do ...	3:45 p. m.	45 02 00	124 13 00	71	fne. gy. S. bk. Sp.	54	57	45.2	...do	20
2022	...do ...	4:21 p. m.	45 01 15	124 07 00	52	bk. S	55	50	46.2	...do	20
2023	...do ...	5:01 p. m.	45 00 45	124 03 45	27	fne. gy. S	55	50	.....	Hand lead	14
2024	...do ...	5:28 p. m.	45 00 30	124 02 15	16	fne. gy. S. bk. Sp. brk. Sh.	55	51	.....	...do	14
2025	...do ...	6:16 p. m.	44 58 30	124 04 00	19	R. and Sh	55	49	47.7	Tanner	20
2026	Sept. 10	5:35 a. m.	44 03 45	124 12 00	30	fne. gy. S	49	51	.....	...do	20
2027	...do ...	6:33 a. m.	44 03 15	124 16 30	42	fne. gy. S. and Sh.	49	51	46.0	...do	20
2028	...do ...	8:03 a. m.	43 54 00	124 11 00	13	fne. gy. S	49	51	47.1	...do	20
2029	...do ...	9:00 a. m.	43 49 00	124 14 00	36	fne. gy. S	50	49	46.7	...do	20
2030	...do ...	9:46 a. m.	43 47 00	124 12 00	13	fne. gy. S	52	49	.....	Hand lead	14
2031	...do ...	10:45 a. m.	43 42 30	124 14 30	28	fne. gy. S	52	49	.....	...do	14
2032	...do ...	11:30 a. m.	43 40 30	124 15 00	28	fne. gy. S	57	50	.....	...do	14
2033	...do ...	12:14 p. m.	43 37 00	124 16 00	53	fne. gy. S	52	51	45.9	Tanner	20
2034	...do ...	12:57 p. m.	43 34 00	124 16 30	40	fne. gy. S	53	49	46.7	...do	20
2035	...do ...	1:46 p. m.	43 31 00	124 16 00	11	fne. gy. S	53	49	.....	Hand lead	14
2036	...do ...	2:30 p. m.	43 27 30	124 18 00	23	fne. gy. S	52	50	48.2	Tanner	20
2037	...do ...	3:13 p. m.	43 23 30	124 21 30	17	fne. gy. S	54	52	.....	Hand lead	14
2038	...do ...	3:50 p. m.	43 19 00	124 25 30	28	fne. gy. S	54	52	48.7	Tanner	20
2039	...do ...	4:28 p. m.	43 13 00	124 26 00	27	fne. gy. S	55	52	47.7	...do	20
2040	...do ...	5:31 p. m.	43 08 30	124 28 00	25	Rky. Co	55	52	46.1	...do	20
2041	...do ...	6:44 p. m.	43 09 00	124 35 00	64	P	57	50	45.8	...do	20
2042	...do ...	7:40 p. m.	43 09 30	124 42 00	134	fne. gy. S	55	51	44.7	...do	20
2043	...do ...	8:38 p. m.	43 10 00	124 49 00	165	bk. S	54	52	44.7	...do	20
2044	...do ...	10:16 p. m.	43 14 15	124 52 00	234	bk. S	54	54	42.2	...do	20
2045	Sept. 11	12:37 a. m.	43 17 30	124 55 30	384	gn. M	56	57	40.1	Sigsbee	35
2046	...do ...	2:54 a. m.	43 17 00	124 42 00	116	gn. M	59	59	44.9	Tanner	20
2047	...do ...	3:54 a. m.	43 17 00	124 34 30	64	C	55	59	46.0	...do	20
2048	...do ...	6:17 a. m.	43 21 00	124 27 00	46	fne. gy. S	51	51	45.8	...do	20
2049	...do ...	7:11 a. m.	43 23 00	124 35 00	68	C	51	51	45.7	...do	20
2050	...do ...	7:51 a. m.	43 24 00	124 42 00	113	gn. M	51	51	45.3	...do	20
2051	...do ...	8:41 a. m.	43 25 30	124 48 30	326	gn. M	53	54	41.1	...do	20
2052	...do ...	9:22 a. m.	43 20 30	124 49 00	306	bk. S. and M	53	54	41.7	Sigsbee	35
2053	...do ...	10:03 a. m.	43 16 00	124 48 00	233	gn. M	55	54	42.7	...do	35
2054	...do ...	10:40 a. m.	43 12 00	124 47 30	188	gn. M	56	54	44.2	...do	35
2055	...do ...	11:17 a. m.	43 06 30	124 47 00	141	fne. bk. S	56	54	45.2	...do	35
2056	...do ...	12:05 p. m.	43 06 30	124 40 00	91	gn. M	56	53	45.7	Tanner	20
2057	...do ...	12:47 p. m.	43 06 30	124 32 00	58	gn. M	56	53	45.9	...do	20
2058	...do ...	1:45 p. m.	42 59 00	124 36 00	49	fne. gy. S	56	53	45.9	...do	20
2059	...do ...	2:25 p. m.	42 58 30	124 44 00	76	gn. M	55	49	45.9	...do	20
2060	...do ...	3:06 p. m.	42 58 00	124 52 30	120	gn. M	53	51	45.5	...do	20
2061	...do ...	4:00 p. m.	42 58 00	124 00 00	407	gn. M	53	51	40.9	Sigsbee	35
2062	...do ...	4:46 p. m.	42 49 30	124 00 00	382	gn. M. and P	53	51	39.9	...do	35
2063	...do ...	5:38 p. m.	42 48 30	124 53 00	140	Rky	53	51	44.8	Tanner	20
2064	...do ...	6:27 p. m.	42 49 00	124 46 00	114	fne. gy. S	54	50	45.7	...do	20
2065	...do ...	7:15 p. m.	42 59 30	124 40 30	47	fne. gy. S. bk. Sp.	53	49	46.7	...do	20

Record of hydrographic soundings by the U. S. Fish Commission steamer Albatross from July 1, 1889, to June 30, 1891—Continued.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Instrument used.	Weight of sinker.
	1889.		° ′ ″	° ′ ″	Fms.		° F.	° F.	° F.		Lbs.
2066	Sept. 12	5:30 a. m.	43 03 30	124 33 30	44	G	50	48	45.8	Tanner	20
2067	...do...	6:20 a. m.	43 04 30	124 26 30	21	fne. gy. S	50	47	46.2	...do	25
2068	...do...	7:57 a. m.	43 08 00	124 27 30	25	Rky	50	48	.....	Hand lead	14
2069	...do...	10:12 a. m.	43 00 00	124 27 30	17	fne. gy. S	50	48	47.2	Tanner	25
2070	...do...	11:11 a. m.	42 55 00	124 32 30	28	fne. gy. S	50	48	46.1	...do	25
2071	...do...	11:45 a. m.	42 53 00	124 34 00	17	fne. gy. S	52	47	.....	Hand lead	14
2072	...do...	12:23 p. m.	42 51 15	124 37 00	34	fne. gy. S	52	47	47.7	Tanner	25
2073	...do...	1:00 p. m.	42 48 15	124 37 45	29	fne. gy. S	51	47	.....	Hand lead	14
2074	...do...	1:27 p. m.	42 46 45	124 38 00	44	R. and brk. Sh.	53	48	.....	Sigsbee	35
2075	...do...	1:43 p. m.	42 45 30	124 38 15	34	St. and brk. Sh.	53	48	46.8	Tanner	25
2076	...do...	3:40 p. m.	42 44 15	124 33 00	23	fne. gy. S	54	48	47.5	...do	25
2077	Sept. 13	7:51 a. m.	42 42 30	124 30 30	26	bk. S	56	48	47.7	...do	25
2078	...do...	8:35 a. m.	42 43 00	124 37 00	62	fne. gy. S	56	48	45.7	...do	25
2079	...do...	9:18 a. m.	42 43 00	124 42 00	161	fne. gy. S	50	48	44.7	...do	25
2080	...do...	10:02 a. m.	42 42 00	124 50 00	329	gn. M	50	48	40.8	Sigsbee	35
2081	...do...	10:57 a. m.	42 35 30	124 50 00	492	gn. M	53	49	39.3	...do	35
2082	...do...	11:49 a. m.	42 35 30	124 42 30	151	gn. M	53	49	45.7	...do	35
2083	...do...	12:34 p. m.	42 35 00	124 35 30	61	br. M	53	49	46.7	Tanner	25
2084	...do...	1:15 p. m.	42 34 30	124 29 00	34	fne. gy. S	52	49	46.5	...do	25
2085	...do...	1:55 p. m.	42 28 30	124 33 00	35	fne. gy. S	51	49	46.8	...do	25
2086	...do...	2:52 p. m.	42 29 00	124 40 00	63	fne. gy. S	51	49	46.9	...do	25
2087	...do...	3:55 p. m.	42 29 00	124 46 30	206	C	51	48	43.8	Sigsbee	35
2088	...do...	4:57 p. m.	42 22 00	124 51 00	505	bk. S G	52	48	39.2	...do	35
2089	...do...	5:52 p. m.	42 21 00	124 44 00	236	bk. S	52	48	42.7	Tanner	25
2090	...do...	6:42 p. m.	42 21 00	124 36 00	79	gn. M	52	48	45.4	...do	25
2091	...do...	7:09 p. m.	42 21 00	124 33 00	62	gn. M	52	48	45.5	...do	25
2092	Sept. 14	8:56 a. m.	43 23 30	124 24 00	40	fne. gy. S	53	51	46.8	...do	25
2093	...do...	9:25 a. m.	43 25 00	124 27 00	59	fne. gy. S	53	51	46.2	...do	25
2094	...do...	10:07 a. m.	43 28 30	124 32 30	79	fne. gy. S	54	52	45.7	...do	25
2095	...do...	10:50 a. m.	43 32 00	124 37 30	157	gn. M	55	53	44.2	...do	25
2096	...do...	11:33 a. m.	43 35 30	124 42 30	277	gn. M	56	56	41.2	...do	25
2097	Oct. 12	11:25 a. m.	42 25 00	124 32 30	39	fne. gy. S	58	57	51.8	...do	25
2098	...do...	11:59 a. m.	42 22 30	124 32 30	44	fne. gy. S	58	57	51.8	...do	25
2099	...do...	1:06 p. m.	42 13 30	124 27 30	51	bk. S	61	59	52.0	...do	25
2100	...do...	1:48 p. m.	42 14 00	124 34 00	94	fne. gy. S	61	59	47.7	...do	25
2101	...do...	2:28 p. m.	42 14 00	124 41 00	273	M	58	59	42.0	...do	25
2102	...do...	3:16 p. m.	42 05 30	124 37 30	244	No bottom obtained.	60	59	.....	...do	25
2103	...do...	3:56 p. m.	42 04 30	124 31 00	65	bk S. & M.	60	59	49.5	Sigsbee	35
2104	...do...	4:28 p. m.	42 03 30	124 23 00	46	fne. gy. S. & M.	61	60	51.8	Tanner	26
2105	...do...	5:12 p. m.	42 00 30	124 20 00	21	fne. dk. gy. S	66	62	54.2	...do	26
2106	...do...	5:28 p. m.	41 58 30	124 17 00	18	fne. dk. gy. S	67	61	53.8	...do	26
2107	...do...	6:10 p. m.	41 58 00	124 22 30	43	gn. M	64	60	51.8	...do	26
2108	...do...	6:48 p. m.	41 58 00	124 29 00	68	gn. M	58	59	48.9	...do	26
2109	...do...	7:27 p. m.	41 58 00	124 36 00	261	gn. M	58	59	42.2	...do	26
2110	...do...	8:20 p. m.	41 52 00	124 36 00	336	gn. M	58	59	40.9	...do	26
2111	...do...	9:06 p. m.	41 50 30	124 30 00	120	gn. M	59	59	46.7	...do	26
2112	...do...	9:34 p. m.	41 50 00	124 26 00	59	bk. S	59	59	50.7	...do	26
2113	...do...	10:20 p. m.	41 44 30	124 26 00	80	gn. M	58	57	47 7	...do	26
2114	...do...	10:47 p. m.	41 45 00	124 32 00	256	gn. M	58	57	42.2	...do	26
2115	...do...	11:40 p. m.	41 38 30	124 31 30	277	gn. M	58	57	42.7	...do	26
2116	Oct. 13	12:22 a. m.	41 38 00	124 25 00	70	gn. M	58	57	49.3	...do	26
2117	...do...	12:51 a. m.	41 38 00	124 17 30	38	M	57	56	52.3	...do	26
2118	...do...	1:30 a. m.	41 38 00	124 12 30	25	M	57	56	54.0	...do	26
2119	...do...	2:10 a. m.	41 32 00	124 13 30	27	dk. gy. S	57	55	53.8	...do	26
2120	...do...	2:40 a. m.	41 32 00	124 19 00	42	M	57	55	51.9	...do	26
2121	...do...	3:15 a. m.	41 32 00	124 24 00	58	M	57	55	49.3	...do	26
2122	...do...	3:40 a. m.	41 32 00	124 30 00	94	M	56	55	47.9	...do	26
2123	...do...	4:28 a. m.	41 32 00	124 35 00	412	C	56	55	39.6	Sigsbee	25
2124	...do...	5:26 a. m.	41 26 15	124 33 30	488	gn. M	56	55	39.1	...do	35
2125	...do...	6:16 a. m.	41 26 15	124 27 00	80	gn. M	56	56	48.7	Tanner	26
2126	...do...	6:52 a. m.	41 26 15	124 20 00	49	gn. M	56	56	50.7	...do	26
2127	...do...	7:28 a. m.	41 26 15	124 13 30	38	gn. M	56	56	51.8	...do	26
2128	...do...	8:05 a. m.	41 26 30	124 07 00	18	fne. gy. S	56	56	54.3	...do	26
2129	...do...	8:56 a. m.	41 20 00	124 11 00	36	brk. Sh. & P	56	56	51.2	...do	26
2130	...do...	9:34 a. m.	41 20 00	124 17 30	52	gn. M	56	56	49.9	...do	26
2131	...do...	10:12 a. m.	41 20 00	124 24 30	86	gn. M	56	56	48.7	...do	26
2132	...do...	10:55 a. m.	41 20 00	124 31 00	373	gn. M	58	58	39.8	Sigsbee	35
2133	...do...	11:50 a. m.	41 13 00	124 31 00	465	gn. M	58	58	39.4	...do	35
2134	...do...	12:36 p. m.	41 12 30	124 23 30	167	gn. M	58	58	45.3	Tanner	26
2135	...do...	1:13 p. m.	41 12 00	124 17 00	58	gn. M	58	58	49.7	...do	26
2136	...do...	1:47 p. m.	41 12 30	124 11 00	29	fne. gy. S. & P.	57	56	54.6	...do	26
2137	...do...	2:42 p. m.	41 05 30	124 13 00	26	fne. dk. gy. S	57	56	52.4	...do	26
2138	...do...	3:21 p. m.	41 04 30	124 19 00	75	gn. M	57	56	53.8	...do	26

Record of hydrographic soundings by the U. S. Fish Commission steamer Albatross from July 1, 1889, to June 30, 1891—Continued.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Instrument used.	Weight of sinker.
	1889.		° ′ ″	° ′ ″	*Fms.*		° F.	° F.	° F.		*Lbs.*
2139	Oct. 13	4:03 p. m.	41 03 30	124 26 00	268	gn. M	57	56	42.7	Sigsbee	35
2140	...do...	4:50 p. m.	40 57 15	124 25 30	182	gn. M	57	56	44.1	...do	35
2141	...do...	5:31 p. m.	40 57 00	124 20 00	65	gn. M	57	56	49.0	Tanner	26
2142	...do...	6:11 p. m.	40 56 00	124 14 00	30	fne. gy. S	57	56	53.8	...do	26
2143	...do...	6:53 p. m.	40 59 15	124 15 00	36	gn. M	57	52	50.2	...do	26
2144	...do...	7:38 p. m.	40 50 00	124 22 00	70	gn. M	56	52	48.2	...do	26
2145	...do...	8:25 p. m.	40 50 00	124 28 00	254	M	55	52	42.1	Sigsbee	35
2146	...do...	9:17 p. m.	40 44 30	124 33 30	294	M	56	56	41.7	Tanner	26
2147	...do...	10:03 p. m.	40 43 00	124 27 00	50	M	56	56	49.2	...do	26
2148	...do...	10:40 p. m.	40 43 00	124 22 00	27	M	56	56	53.3	...do	26
2149	...do...	11:26 p. m.	40 37 30	124 25 00	23	fne. dk. gy. S	56	55	.....	...do	26
2150	Oct. 14	12:09 a. m.	40 39 00	124 31 00	355	M	56	55	41.7	...do	26
2151	...do...	1:02 a. m.	40 32 00	124 34 00	65	bk. S. & M	56	55	48.9	Sigsbee	35
2152	...do...	1:48 a. m.	40 29 00	124 40 00	627	gn. M	56	55	38.7	...do	35
	1890.										
2153	Mar. 11	3:52 p. m.	37 18 50	122 28 30	21	fine. bk. S	55	53	52.8	Tanner	20
2154	...do..	4:30 p. m.	37 16 00	122 25 50	10	brk. Sh. R	60	53	.....	Hand lead	14
2155	Mar. 12	11:45 a. m.	37 05 00	122 19 00	17	Rky. Sh	55	54	.....	..do	12
2156	...do...	2:17 p. m.	36 55 00	122 17 00	122	bk. S. M	56	55	47.8	Tanner	25
2157	Mar. 15	1:19 p. m.	36 58 00	122 21 00	97	crs. bk. S. M	57	55	47.6	...do	25
2158	Mar. 22	10:00 a. m.	37 47 55	123 10 00	37	Sh	53	53	52.0	...do	25
2159	...do...	10.07 a. m.	37 47 50	123 10 50	39	Rky	53	53	51.3	...do	25
2160	...do...	10.14 a. m.	37 47 45	123 11 10	45	Sh. & Rky	53	53	50.8	...do	25
2161	...do...	10.26 a. m.	37 47 35	123 11 00	29	Rky	53	53	51.4	...do	25
2162	...do...	1:00 p. m.	37 47 30	123 19 00	324	R. & C	52	53	42.0	...do	25
2163	...do...	3:32 p. m.	37 48 30	123 30 20	900	gn. M	52	53	36.8	Sigsbee No. 2.	38
2164	Mar. 24	9:09 a. m.	38 00 00	123 22 20	60	S. Sh	51	51	49.7	Tanner	25
2165	...do...	9:28 a. m.	38 01 00	123 24 18	39	R	51	51	51.2	...do	25
2166	...do...	9:35 a. m.	38 01 05	123 24 55	35	Rky	51	51	.....	...do	25
2167	...do...	9:42 a. m.	38 01 10	123 25 40	37	Rky	52	52	51.3	...do	25
2168	...do...	9:51 a. m.	38 01 15	123 26 15	30	Rky. Co	52	52	51.3	...do	25
2169	...do...	11:00 a. m.	38 01 35	123 26 50	40	Rky	52	52	.....	...do	25
2170	...do...	11:16 a. m.	38 01 45	123 28 00	55	crs.bk.S.brk.Sh	52	52	.....	...do	25
2171	...do...	11:26 a. m.	38 00 45	123 28 30	65	gy.S.G.brk.Sh.	52	52	.....	...do	25
2172	...do...	11:38 a. m.	37 59 40	123 28 55	139	G. brk. Sh	52	52	.....	...do	25
2173	...do...	11:50 a. m.	37 59 20	123 27 45	73	R	55	55	.....	...do	25
2174	...do...	12:01 p. m.	37 58 55	123 26 35	56	brk. Sh	55	55	.....	...do	25
2175	...do...	12.13 p. m.	37 58 50	123 26 10	34	R. Co	55	55	.....	...do	25
2176	...do...	12:27 p. m.	38 00 40	123 25 55	33	Rky	54	55	.....	...do	25
2177	...do...	1:00 p. m.	38 02 45	123 27 35	44	R. Co	54	55	.....	...do	25
2178	...do...	1:13 p. m.	38 02 25	123 26 20	42	R. Co	54	55	.....	...do	25
2179	...do...	1:25 p. m.	38 02 00	123 25 05	47	Rky	54	55	.....	...do	25
2180	...do...	1:38 p. m.	38 01 40	123 23 50	57	yl. S	54	55	.....	...do	25
2181	...do...	1:59 p. m.	37 59 45	123 24 25	41	yl. S	54	55	.....	...do	25
2182	...do...	2:11 p. m.	37 58 45	123 25 00	39	R. Co. & S	57	55	.....	...do	25
2183	...do...	2:21 p. m.	37 57 45	123 25 15	45	Yl. S	57	55	.....	...do	25
2184	...do...	2:35 p. m.	37 58 00	123 26 35	67	R. yl. S	57	55	.....	...do	25
2185	...do...	2:47 p. m.	37 58 20	123 27 45	231	M	57	55	.....	...do	25
2186	...do...	3:09 p. m.	38 00 10	123 27 00	36	R. Co	54	55	.....	...do	25
2187	...do...	4:42 p. m.	38 02 15	123 27 30	47	Rky	52	55	.....	...do	25
2188	...do...	5:01 p. m.	38 04 25	123 28 00	84	G	52	52	.....	...do	25
2189	...do...	5.21 p. m.	38 06 15	123 29 00	180	fne.gy.S.bk.Sp.	52	52	.....	...do	25
2190	...do...	6,09 p. m.	38 17 00	123 30 00	269	gn. M	51	52	42.5	Sigsbee No. 2.	38
2191	...do...	7.02 p. m.	38 15 40	123 31 30	246	gn. M	51	52	42.9	...do	38
2192	...do...	7:53 p. m.	38 20 30	123 32 50	186	M	51	52	44.9	...do	38
2193	...do...	8:40 p. m.	38 25 10	123 34 25	134	M	50	52	47.9	...do	38
2194	...do...	9:32 p. m.	38 30 00	123 35 40	121	M	50	52	47.1	...do	38
2195	...do...	10:21 p. m.	38 34 50	123 37 00	88	M	50	52	46.7	Tanner	25
2196	...do...	11:04 p. m.	38 39 10	123 38 30	78	M	50	52	.....	...do	25
2197	...do...	11:48 p. m.	38 44 00	123 40 00	66	M	50	52	47.4	...do	25
2198	Mar. 25	12:32 a. m	38 48 30	123 42 00	58	gn.M	50	52	47.9	...do	25
2199	...do...	1:17 a. m.	38 52 50	123 46 00	51	Rky	49	52	47.9	...do	25
2200	...do...	1:57 a. m.	38 57 10	123 48 30	55	bk. S	49	52	48.9	...do	25
2201	...do...	2:29 a. m.	38 55 50	123 52 00	67	bk. S	49	51	47.9	Sigsbee No. 2.	38
2202	...do...	3:18 a. m.	38 53 30	123 57 35	189	br. M	49	51	44.9	...do	38
2203	...do...	4:21 a. m.	38 48 00	123 55 50	486	M	49	50	39.5	...do	38
2204	...do...	4:59 a. m.	38 49 30	123 52 20	91	bk. S	49	51	47.3	...do	38
2205	...do...	5:27 a. m.	38 51 00	123 49 00	69	M	49	51	49.4	Tanner	25
2206	...do...	5:51 a. m.	38 52 25	123 45 30	49	hrd. M	49	50	.....	...do	25
2207	...do...	6:40 a. m.	38 47 15	123 40 30	55	R. gn. M	50	51	48.3	...do	25
2208	...do...	7:05 a. m.	38 46 00	123 44 00	69	gn. M. sh	50	51	47.1	...do	25
2209	...do...	7:34 a. m.	38 44 30	123 47 10	90	bk. S	50	51	46.7	...do	25

Record of hydrographic soundings by the U. S. Fish Commission steamer Albatross from July 1, 1889, to June 30, 1891—Continued.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Instrument used.	Weight of sinker.
	1890.		° ′ ″	° ′ ″	*Fms.*		°F.	°F.	°F.		*Lbs.*
2210	Mar. 25	7:49 a. m.	38 41 00	123 49 00	143	M	50	51	45.4	Sigsbee No. 2.	38
2211	...do...	8:09 a. m.	38 43 20	123 51 00	249	M	50	51	42.9	...do	38
2212	...do...	9:15 a. m.	38 38 40	123 46 30	314	bk. S	51	51	.....	...do	38
2213	...do...	9:46 a. m.	38 39 30	123 44 00	103	bk. S	50	51	46.6	Tanner	25
2214	Mar. 28	5:42 a. m.	38 37 45	123 30 00	58	gn. M	48	51	.....	...do	25
2215	...do...	6:33 a. m.	38 35 45	123 34 15	82	gn. M	48	50	.....	...do	25
2216	...do...	7:14 a. m.	38 32 45	123 39 30	128	bk. S	49	50	46.0	...do	25
2217	...do...	7:38 a. m.	38 31 30	123 42 00	314	gn. M	49	50	41.6	...do	25
2218	...do...	8:37 a. m.	38 26 00	123 37 00	273	gn. M	51	51	43.0	Sigsbee No. 2.	38
2219	...do...	9:05 a. m.	38 27 00	123 35 00	113	bk. S	51	51	46.2	...do	38
2220	...do...	9:49 a. m.	38 29 40	123 29 45	82	gy. S	51	51	48.4	Tanner	18
2221	...do...	10:25 a. m.	38 32 00	123 25 30	67	br. M	51	51	47.5	...do	18
2222	...do...	10:37 a. m.	38 32 50	123 24 30	60	br. M. R	51	51	48.0	...do	18
2223	...do...	11:17 a. m.	38 28 30	123 19 00	54	br. M	52	52	48.5	...do	18
2224	...do...	11:47 a. m.	38 25 40	123 24 00	74	bk. S	52	52	48.5	...do	18
2225	...do...	12:27 p. m.	38 23 00	123 29 00	107	M	52	52	47.5	...do	18
2226	...do...	1:08 p. m.	38 20 00	123 34 00	242	M	51	52	42.8	...do	18
2227	...do...	2:02 p. m.	38 14 00	123 36 00	518	gn. M	52	52	39.3	Sigsbee No. 2.	38
2228	...do...	5:16 p. m.	38 18 15	123 25 50	124	gn. M	52	52	45.6	Tanner	26
2229	Apr. 2	11:45 p. m.	36 56 30	122 24 40	208	gn. M	51	52	43.6	Sigsbee No. 2.	38
2230	Apr. 3	12:45 a. m.	36 51 40	122 24 00	921	br. M	51	52	36.9	...do	38
2231	...do...	2:20 a. m.	36 47 30	122 20 10	860	br. M	51	52	37.0	...do	38
2232	...do...	3:22 a. m.	36 43 20	122 16 25	620	br. M	51	52	38.1	...do	38
2233	...do...	4:14 a. m.	36 39 20	122 12 50	739	M	51	52	37.9	...do	38
2234	...do...	5:08 a. m.	36 34 00	122 07 30	958	gn. M	51	52	37.4	...do	38
2235	...do...	6:06 a. m.	36 33 30	122 04 00	575	gn. M	51	52	39.0	...do	38
2236	...do...	6:36 a. m.	36 32 35	122 02 00	450	M	51	52	39.9	...do	38
2237	...do...	7:04 a. m.	36 32 30	122 00 00	246	gn. M	51	52	42.9	Tanner	26
2238	...do...	9:22 a. m.	36 27 20	121 58 00	59	fne. gy. S	52	51	46.9	...do	26
2239	...do...	11:58 a. m.	36 19 00	122 00 00	62	crs. S	53	52	46.5	...do	26
2240	...do...	12:14 p. m.	36 19 20	122 05 00	99	G	53	52	47.2	Sigsbee No. 2.	38
2241	...do...	8:14 p. m.	36 04 00	121 45 20	426	br. M	53	53	40.1	...do	38
2242	...do...	9:06 p. m.	35 59 00	121 40 20	426	br. M	52	53	40.1	...do	38
2243	...do...	9:59 p. m.	35 55 15	121 37 20	342	br. M	52	53	41.7	...do	38
2244	...do...	11:31 p. m.	35 50 50	121 33 00	240	br. M	52	54	43.5	...do	38
2245	Apr. 4	6:55 a. m.	35 39 30	121 28 00	271	gn. M	53	54	42.5	...do	38
2246	...do...	8:40 a. m.	35 36 05	121 22 00	144	gy. S	54	53	46.2	Tanner	26
2247	...do...	10:35 a. m.	35 32 15	121 16 00	198	gn. M	55	52	44.2	Sigsbee No. 2.	38
2248	Apr. 5	6:38 a. m.	35 30 50	121 11 00	113	M	51	51	.....	Tanner	25
2249	...do...	7:06 a. m.	35 29 20	121 13 20	191	gn. M	50	51	43.9	Sigsbee No. 2.	38
2250	...do...	11:12 a. m.	35 18 50	121 05 00	146	gn. M	53	52	44.9	...do	38
2251	...do...	1:54 p. m.	35 08 40	121 02 00	224	gn. M	56	54	43.0	...do	38
2252	...do...	2:27 p. m.	35 09 50	120 58 00	119	gn. M. Rky	56	54	45.0	Tanner	25
2253	...do...	3:15 p. m.	35 04 00	120 57 30	143	gn. M	55	54	45.0	Sigsbee No. 2.	38
2254	...do...	7:36 p. m.	34 58 30	120 58 00	182	gn. M	54	53	44.7	...do	38
2255	...do...	8:26 p. m.	34 51 40	120 54 30	142	gn. M	54	53	45.9	...do	38
2256	...do...	9:11 p. m.	34 45 30	120 55 00	133	gn. M	54	54	46.0	...do	38
2257	...do...	9:55 p. m.	34 46 00	120 49 50	62	R. M	54	54	47.9	Tanner	25
2258	...do...	10:22 p. m.	34 46 15	120 45 35	47	gn. M. R	54	54	48.9	...do	25
2259	...do...	11:19 p. m.	34 37 30	120 45 00	44	R. and M	54	54	49.0	...do	25
2260	Apr. 6	12:07 a. m.	34 36 00	120 50 40	158	....	54	54	45.6	...do	25
2261	...do...	12:38 a. m.	34 34 50	120 50 05	274	M. and S	54	54	42.3	Sigsbee No. 2.	38
2262	...do...	1:35 a. m.	34 29 25	120 50 00	312	gn. M	54	54	41.9	...do	38
2263	...do...	2:17 a. m.	34 30 00	120 47 25	242	gn. M	54	54	42.2	...do	38
2264	...do...	2:45 a. m.	34 30 40	120 44 55	139	M	54	54	46.4	Tanner	25
2265	...do...	3:01 a. m.	34 31 10	120 43 20	67	bk. S. M	53	52	48.0	...do	25
2266	...do...	3:21 a. m.	34 31 50	120 42 00	53	bk. S. M	52	53	48.7	...do	25
2267	...do...	4:48 a. m.	34 26 55	120 40 20	174	gn. M	53	52	46	Sigsbee No. 2.	38
2268	...do...	7:55 a. m.	36 00 00	121 38 10	299	gn. M. R	67	61	41.8	Tanner	25
2269	...do...	8:43 a. m.	36 02 30	121 41 00	346	M	67	61	43.8	...do	25
2270	...do...	9:40 a. m.	36 07 10	121 43 00	228	M. and G	63	56	42.9	...do	25
2271	...do...	10:17 a. m.	36 09 40	121 45 30	356	M	61	54	41.1	...do	25
2272	...do...	10:45 a. m.	36 11 00	121 47 00	183	S. M	61	54	44.7	...do	25
2273	...do...	11:40 a. m.	36 13 05	121 52 15	101	fne. gy. S	61	55	46.7	...do	25
2274	...do...	12:23 p. m.	36 15 00	121 57 50	36	Rky	60	54	49.3	...do	25

Record of hydrographic soundings by the U. S. Fish Commission steamer Albatross, from July 1, 1889, to June 30, 1891—Continued.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Instrument used.	Weight of sinker.
	1890.		° ′ ″	° ′ ″	*Fms.*		°F.	°F.	°F.		*Lbs.*
2275	Apr. 11	0:30 a. m.	36 42 50	122 04 10	881	Rky	55	53	38.1	Sigsbee, No. 2.	38
2276	...do ...	11:26 a. m.	36 45 45	122 04 40	519	gn. M	54	52	39.3	...do	38
2277	...do ...	2:25 p. m.	36 45 40	121 53 05	66	bk. S. R	54	53	47.7	Tanner ..	25
2278	May 21	1:35 p. m.	54 02 25	162 50 30	271	M. S. P	44	44	39	Sigsbee ..	35
2279	May 22	9:00 a. m.	54 15 00	164 53 00	42	R. brk. Sh	41	42	38.5	Tanner ..	25
2280	...do ...	6:17 p. m.	54 34 00	165 37 00	178	bk. S	39	43	38.5	...do	25
2281	...do ...	11:43 p. m.	54 55 40	166 06 00	80	yl. M	38	42	38.2	...do	25
2282	May 23	1:22 a. m.	54 58 30	166 24 30	81	....	39	43	.....	...do	25
2283	...do ...	3:03 a. m.	55 00 50	166 41 30	80	M	38	41	.....	...do	25
2284	...do ...	5:17 a. m.	55 00 00	166 59 00	88	Sh	36	41	.....	...do	25
2285	...do ...	6:33 a. m.	54 59 00	167 17 00	117	S. Sh	36	41	38	...do	25
2286	...do ...	10:03 a. m.	54 49 20	167 10 00	186	gn. M	38	43	38.6	Sigsbee ..	35
2287	...do ...	2:54 p. m.	54 23 45	166 38 30	320	gn. M	38	43	38.2	...do	35
2288	...do ...	4:49 p. m.	54 09 20	166 28 00	593	gn. M	38	42	37	...do	35
2289	May 28	11:25 a. m.	54 27 00	165 18 00	99	bk. S	42	44	.....	Tanner ..	28
2290	...do ...	12:08 p. m.	54 29 30	165 10 00	47	bk. S	42	43	38	...do	28
2291	...do ...	12:48 p. m.	54 28 20	165 08 00	45	gy. S	42	45	39	...do	28
2292	...do ...	1:14 p. m.	54 31 40	165 09 00	32	bk. S. brk. Sh	42	43	.....	...do	28
2293	...do ...	2:11 p. m.	54 34 30	164 55 45	24	bk. S	41	42	.....	...do	28
2294	...do ...	2:49 p. m.	54 39 00	164 51 00	30	bk. S	41	42	.....	...do	28
2295	...do ...	3:11 p. m.	54 41 15	164 48 30	28	crs. S. G	41	42	.....	...do	28
2296	...do ...	3:55 p. m.	54 47 30	164 46 00	34	G	41	42	40	...do	28
2297	...do ...	4:45 p. m.	54 57 40	164 36 50	31	bk. P	41	42	41	...do	28
2298	...do ...	5:23 p. m.	54 57 30	164 31 20	18	fne. bk. S	40	44	41.5	...do	28
2299	May 29	6:58 a. m.	54 54 45	164 19 30	16	bk. S	45	44	.....	...do	28
2300	...do ...	8:16 a. m.	54 59 00	164 05 35	12	Rky	44	44	39.3	...do	28
2301	...do ...	9:49 a. m.	55 03 10	163 49 30	15	fne. G	44	44	41	...do	28
2302	...do ...	10:40 a. m.	55 03 50	163 37 30	16	fne. bk. S	44	44	41	...do	28
2303	...do ...	11:06 a. m.	55 04 15	163 30 45	11	fne. bk. S	44	44	41	...do	28
2304	...do ...	12:16 p. m.	55 10 00	163 13 45	15	S	42	44	.....	Hand lead	12
2305	...do ...	2:00 p. m.	55 16 10	163 01 30	14	fne. gy. S	44	46	.....	...do	12
2306	...do ...	2:46 p. m.	55 22 00	162 53 30	13	bk. G	44	46	.....	...do	12
2307	...do ...	3:10 p. m.	55 27 40	162 44 15	16	fne.gy.S.bk.Sp.	44	45	.....	...do	12
2308	...do ...	4:21 p. m.	55 32 30	162 38 00	22	fne. gy. S	44	45	.....	...do	12
2309	...do ...	5:02 p. m.	55 36 40	162 30 20	23	Rky. brk. Sh	44	47	.....	...do	12
2310	...do ...	5:40 p. m.	55 39 45	162 24 00	22	G. brk. Sh	44	45	.....	...do	12
2311	...do ...	6:20 p. m.	55 42 45	162 18 00	20	fne. bk. S	44	45	.....	...do	12
2312	...do ...	7:02 p. m.	55 46 15	162 12 00	16	Rky. Sh	45	45	41	Tanner ..	28
2313	...do ...	7:35 p. m.	55 48 15	162 07 15	17	P. bk. S	44	45	.....	Hand lead	12
2314	...do ...	8:16 p. m.	55 51 00	162 01 00	15½	G	45	45	.....	...do	12
2315	...do ...	8:36 p. m.	55 52 00	161 58 00	13	R	45	45	.....	...do	12
2316	May 30	4:25 a. m.	55 54 40	161 51 40	16	bk. S. brk. Sh	41	42	.....	..do	12
2317	...do ...	5:12 a. m.	55 57 00	161 45 00	16	G. brk. Sh	42	43	.....	...do	12
2318	...do ...	5:30 a. m.	55 59 40	161 35 45	22	bk. S	41	42	.....	...do	12
2319	...do ...	6:53 a. m.	56 01 00	161 26 00	16	bk. S	41	42	.....	...do	12
2320	...do ...	7:25 a. m.	56 01 30	161 16 45	14	bk. S	43	43	.....	...do	12
2321	...do ...	8:00 a. m.	56 01 40	161 12 30	12	bk. S	43	43	.....	...do	12
2322	...do ...	8:53 a. m.	56 02 45	161 03 30	12	crs. bk. S	43	43	.....	...do	12
2323	...do ...	9:30 a. m.	56 04 15	160 55 20	13	fne. br. S	43	44	.....	...do	12
2324	...do ...	10:20 a. m.	56 04 15	160 46 00	11	crs. S. and G	43	44	.....	...do	12
2325	...do ...	10:40 a. m.	56 04 00	160 43 45	12	fne. G	44	43	.....	...do	12
2326	...do ...	12:00 m.	56 09 15	160 30 30	14	fne. gy. S	44	45	.....	...do	12
2327	...do ...	12:40 p. m.	56 12 00	160 23 15	13	fne. bk. S	44	45	.....	...do	12
2328	...do ...	12:58 p. m.	56 14 15	160 21 15	13	crs. bk. S	48	46	.....	...do	12
2329	...do ...	1:30 p. m.	56 18 00	160 18 00	11	bk. S. G	46	48	.....	...do	12
2330	...do ...	2:44 p. m.	56 25 40	160 06 20	13	G	47	46	39	Tanner...	28
2331	...do ...	4:07 p. m.	56 33 20	159 49 30	16	bk. G	47	42	.....	Hand lead	12
2332	...do ...	5:51 p. m.	56 42 20	159 25 20	18	bk. G	45	41	.....	...do	12
2333	...do ...	7:03 p. m.	56 46 30	159 08 30	14	bk. G	45	44	.....	Tanner...	28
2334	...do ...	7:53 p. m.	56 48 30	158 58 30	12	gy. S	45	44	.....	Hand lead	12
2335	...do ...	8:39 p. m.	56 52 00	158 51 00	9	fne. gy. S	44	43	.....	...do	12
2336	...do ...	8:58 p. m.	56 54 00	158 48 30	11	fne. bk. S	44	43	.....	...do	12
2337	...do ...	10:15 p. m.	57 02 45	158 40 30	10	fne. gy.S.bk.Sp.	44	42	.....	...do	12
2338	...do ...	10:32 p. m.	57 05 00	158 39 00	12	fne. gy.S.bk.Sp.	44	42	.....	...do	12
2339	May 31	4:06 a. m.	57 08 30	158 36 15	13	fne. bk. S	44	43	.....	...do	12
2340	...do ...	4:46 a. m.	57 13 30	158 32 00	19	bk. S. G	44	43	.....	...do	12
2341	...do ...	5:27 a. m.	57 19 00	158 25 30	19	bk. S. G	44	43	.....	Tanner...	28
2342	...do ...	6:22 a. m.	57 24 30	158 19 30	16	bk. S. G	43	43	.....	...do	28
2343	...do ...	7:07 a. m.	57 29 30	158 13 30	15	fne. gy. S. G	42	43	.....	Hand lead	12
2344	...do ...	7:31 a. m.	57 32 00	158 09 00	14¾	fne. gy. S. G	43	43	.....	...do	12
2345	...do ...	7:47 a. m.	57 34 50	158 06 00	13	fne. gy. S. G	42	43	.....	...do	12
2346	...do ...	8:40 a. m.	57 38 00	157 57 00	10	gy. S	43	42	.....	...do	12
2347	...do ...	9:10 a. m.	57 40 00	157 53 00	7½	gy. S	43	43	.....	...do	12

Record of hydrographic soundings by the U. S. Fish Commission steamer Albatross from July 1, 1889, to June 30, 1891—Continued.

Serial No.	Date.	Time of day.	Position.		Depth.	Character of bottom.	Temperature.			Instrument used.	Weight of sinker.
			Lat. N.	Long. W.			Air.	Surface.	Bottom.		
	1890.		° ′ ″	° ′ ″	Fms.		°F.	°F.	°F.		Lbs.
2348	May 31	9:42 a. m.	57 44 00	157 52 30	10	gy. S	44	44	.....	Hand lead	12
2349	...do ...	10:14 a. m.	57 48 40	157 49 00	8	crs. bk. S	44	44	.....	...do	12
2350	...do ...	10:40 a. m.	57 52 40	157 46 30	10	gy. S	44	44	.....	...do	12
2351	...do ...	11:12 a. m.	57 57 00	157 43 00	7	gy. S	46	45	.....	...do	12
2352	...do ...	11:36 a. m.	58 00 40	157 41 00	7	gy. S	45	44	.....	...do	12
2353	...do ...	11:57 a. m.	58 03 40	157 40 00	5¼	gy. S	46	45	.....	...do	12
2354	May 31	12:20 p. m.	58 07 00	157 41 30	7	gy. S	46	45	.....	...do	12
2355	...do ..	12:28 p. m.	58 08 40	157 42 00	5	fne. gy. S	45	44	.....	...do	12
2356	...do ...	1:15 p. m.	58 14 00	157 44 00	4½	G	45	44	.....	...do	12
2357	...do ...	2:20 p. m.	58 22 20	157 42 00	4½	P	45	44	.....	...do	12
2358	...do ...	3:00 p. m.	58 27 10	157 39 00	5	P	46	45	.....	...do	12
2359	...do ...	3:45 p. m.	58 32 00	157 33 00	5½	G	46	45	.....	...do	12
2360	...do ...	4:00 p. m.	58 34 00	157 31 00	6¼	bk. S	45	44	.....	...do	12
2361	...do ...	4:17 p. m.	58 35 00	157 28 30	4	S	48	49	.....	...do	12
2362	...do ...	5:17 p. m.	58 39 00	157 19 30	7½	P	48	49	.....	...do	12
2363	June 2	6:25 a. m.	58 40 45	157 16 20	4¼	bk. S	43	45	.....	...do	12
2364	...do ...	6:50 a. m.	58 40 30	157 21 30	4½	fne. gy. S	44	45	.....	...do	12
2365	...do ...	6:52 a. m.	58 40 30	157 22 30	5 feet.	fne. gy. S	44	45	.....	...do	12
2366	...do ...	7:24 a. m.	58 39 00	157 24 00	5½	fne.gy.S.bk.Sp.	45	45	.....	...do	12
2367	...do ...	7:42 a. m.	58 37 45	157 26 30	12	fne.gy.S.bk Sp.	45	45	.....	...do	12
2368	June 7	11:15 p. m.	58 07 00	158 54 00	22¼	fne. gy. S	35	40	.....	Tanner ..	28
2369	June 8	12:39 a. m.	58 12 00	159 06 15	21½	fne.gy.S. and R.	38	41	.....	Hand lead	12
2370	...do ...	3:02 a. m.	58 18 40	159 17 30	10½	fne. gy. S	40	41	.....	...do	12
2371	...do ...	2:52 p. m.	58 40 00	160 00 00	8	....	46	48	.....	...do	12
2372	...do ...	3:15 p. m.	58 42 15	160 04 00	8½	....	43	45	.....	...do	12
2373	...do ...	3:32 p. m.	58 44 15	160 07 30	11½	....	45	46	.....	...do	12
2374	June 9	10:01 p. m.	58 28 30	161 53 00	12½	G	39	38	35	Tanner ..	28
2375	...do ...	11:03 p. m.	58 35 30	162 11 00	25	G	39	38	37	...do	28
2376	June 13	7:40 p. m.	58 18 30	162 50 00	16½	fne. gy. S	38	39	35.5	...do	28
2377	June 14	12:16 a. m.	58 00 00	163 24 30	23	fne. gy. S	38	39	.....	...do	28
2378	...do ...	2:17 a. m.	57 49 50	163 44 00	24	fne. gy. S	38	39	37	...do	28
2379	...do ...	10:30 p. m.	56 05 00	164 38 00	51	gn. M	43	44	36	...do	28
2380	June 15	12:35 a. m.	55 52 30	164 47 00	46	bk. S. and M	42	43	35	...do	28
2381	...do ...	2:52 a. m.	55 37 30	164 51 00	58	bk. S. and M	42	43	39	...do	28
2382	June 24	2:48 a. m.	54 40 30	165 41 00	148	M. & fne. S	43	44	38.5	...do	28
2383	...do ...	10:06 a. m.	54 37 40	164 58 00	30	bk. G	42	44	40.8	...do	28
2384	...do ...	1:32 p. m.	54 46 00	164 55 30	37	crs. S. G. and P.	45	45	40.2	...do	28
2385	...do ...	4:35 p. m.	54 56 30	165 15 30	62	bk. M	43	45	40	...do	28
2386	...do ...	9:43 p. m.	54 54 00	164 36 00	40	bk. G	43	45	41.3	...do	28
2387	...do ...	10:14 p. m.	54 53 15	164 33 00	24	bk. G	42	44	41.4	...do	28
2388	...do ...	11:36 p. m.	54 59 00	164 13 00	25	crs. S. G	43	44	41.2	...do	28
2389	June 25	1:16 a. m.	55 08 45	164 18 00	46	bk. G	42	44	40	...do	28
2390	...do ...	2:48 a. m.	55 18 30	164 23 15	56	bk. M. and G	42	44	39	...do	28
2391	...do ...	4:15 a. m.	55 25 00	164 05 20	53	bk. S. and G	42	45	38.8	...do	28
2392	...do ...	9:59 a. m.	55 14 00	163 21 30	26	bk. S	44	46	42.6	...do	28
2393	...do ...	1:43 p. m.	55 34 30	163 37 00	44	gy. S	45	46	40	...do	28
2394	...do ...	3:34 p. m.	55 38 00	163 20 45	42	gy. S	49	48	39.5	...do	28
2395	...do ...	4:17 p. m.	55 33 30	163 16 15	36	bk. S	45	47	40	...do	28
2396	...do ...	6:34 p. m.	55 23 40	163 07 30	20	bk. G	42	45	42.6	...do	28
2397	June 26	2:16 p. m.	55 21 30	162 56 00	16	crs. bk. S. Sh	43	47	43.8	...do	28
2398	June 27	3:08 p. m.	55 36 15	163 09 00	35	fne. gy. S	43	45	39	...do	28
2399	...do ...	6:28 p. m.	55 37 45	162 40 30	26	fne. gy. S	42	46	41	...do	28
2400	...do ...	10:37 p. m.	55 51 10	162 30 30	34	fne. gy. S	42	44	.....	...do	28
2401	June 28	12:03 a. m.	55 57 45	162 43 00	46	fne. gy. S	42	44	.....	...do	28
2402	...do ...	1:29 a. m.	56 05 15	162 31 00	41	fne. gy. S	42	45	37	...do	28
2403	...do ...	2:50 a. m.	55 58 30	162 18 00	40	fne.gy.S.bk.Sp.	42	45	37	...do	28
2404	...do ...	8:11 a. m.	56 06 15	161 58 00	34	bk. S	42	44	40.6	...do	28
2405	...do ...	11:58 a. m.	56 19 00	162 26 00	40	fne.gy.S.and G.	43	45	38	...do	28
2406	...do ...	3:46 p. m.	56 33 45	162 26 00	41	fne. gy. S	44	45	39	...do	28
2407	...do ...	7:12 p. m.	56 20 30	161 54 45	48	fne.gy.S.bk.Sp.	42	45	38.2	...do	28
2408	...do ...	10:42 p. m.	56 06 30	161 25 30	21	P	42	45	43	...do	28
2409	...do ...	11:58 p. m.	56 10 45	161 09 15	21	gy. S	42	44	43.5	...do	28
2410	June 29	1:35 a. m.	56 17 20	161 22 00	30	bk. S. G	43	46	41	...do	28
2411	...do ...	2:58 a. m.	56 24 10	161 37 00	37	gy. S	42	45	40	...do	28
2412	...do ...	6:34 a. m.	56 38 30	161 38 00	46	fne. gy. S	44	45	38.8	...do	28
2413	...do ...	9:59 a. m.	56 21 15	161 03 00	35	fne.gy.S.bk.Sp.	42	44	41	...do	28
2414	...do ...	3:11 p. m.	56 10 15	160 42 30	15	fne. gy. S	45	46	.....	...do	28
2415	July 16	4:30 p. m.	56 04 30	160 39 30	8½	fne. gy. S	50	54	.....	Hand lead	12
2416	...do ...	5:59 p. m.	56 09 45	160 33 00	14¾	crs. bk. S	48	54	.....	...do	12
2417	...do ...	6:57 p. m.	56 14 15	160 26 45	12	bk. G	48	49	.....	...do	12
2418	...do ...	8:55 p. m.	56 22 00	160 37 30	28	fne. gy. S	47	48	44	Tanner ..	28
2419	...do ...	10:35 p. m.	56 29 30	160 49 00	37	fne. gy. S	45	47	.....	...do	28
2420	July 17	12:16 a. m.	56 36 30	161 00 30	38	fne. gy. S	45	46	41	...do	28
2421	...do ...	2:06 a. m.	56 44 15	161 12 30	38	fne. gy. S	44	46	40.5	...do	28
2422	...do ...	3:29 a. m.	56 52 15	160 58 00	40	fne. gy. S	44	46	40	...do	28

Record of hydrographic soundings by the U. S. Fish Commission steamer Albatross from July 1, 1889, to June 30, 1891—Continued.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Instrument used.	Weight of sinker.
	1890.		° ′ ″	° ′ ″	Fms.		° F.	° F.	° F.		Lbs.
2423	July 17	1:20 p. m.	56 33 20	159 43 30	15	bk. S. G	44	45	.....	Hand lead	12
2424	...do...	3:08 p. m.	56 40 40	159 54 30	30	fne. gy. S. G	43	45	.....	Tanner	28
2425	...do...	4:55 p. m.	56 48 00	160 05 30	35	crs. bk. S	42	42	.....	...do	28
2426	...do...	6:56 p. m.	56 55 30	160 17 30	36	gy. S	42	43	38	...do	28
2427	...do...	8:54 p. m.	57 03 20	160 29 00	39	bk. S	41	43	.....	...do	28
2428	...do...	10:25 p. m.	57 10 30	160 15 00	38	bk. S	41	43	38	...do	28
2429	...do...	11:50 p. m.	57 04 20	160 00 00	34	fne. gy. S. bk. Sp	41	43	38.5	...do	28
2430	July 18	1:34 a. m.	56 57 45	159 46 00	34	gy. S	40	42	.....	...do	28
2431	...do...	3:10 a. m.	56 57 00	159 31 00	30	bk. g	40	43	41	...do	28
2432	...do...	11:29 a. m.	57 06 20	159 23 00	31	gy. S. G	42	46	40	...do	28
2433	...do...	3:21 p. m.	57 21 30	159 46 30	32	bk. S. G	43	44	40	...do	28
2434	...do...	7:02 p. m.	57 23 15	159 17 00	31	fne. gy. S	43	44	40	...do	28
2435	...do...	10:39 p. m.	57 10 15	158 49 00	25	gy. S	41	43	41.6	...do	28
2436	...do...	11:28 p. m.	57 07 30	158 42 30	20	S	41	43	.....	Hand lead	12
2437	...do...	11:58 p. m.	57 05 45	158 39 00	17	S	41	44	.....	...do	12
2438	July 19	12:31 a. m.	57 05 30	158 37 30	12¾	bk. S	41	44	.....	...do	12
2439	...do...	5:52 p. m.	57 48 30	158 48 00	24	gy. S	45	48	43.5	Tanner	28
2440	...do...	11:22 p. m.	57 45 15	157 56 00	13	fne. gy. S	46	50	.....	Hand lead	12
2441	July 20	6:38 a. m.	57 56 45	108 17 00	20	gy. S. bk. sp	47	50	40.4	Tanner	28
2442	...do...	12:18 p. m.	58 00 30	159 13 30	21	bk. S	51	55	44.2	...do	28
2443	...do...	2:34 p. m.	58 01 00	159 33 15	23	gy. S	49	55	45	...do	28
2444	...do...	7:16 p. m.	58 24 00	160 17 30	6½	gy. S. G	49	53	.....	Hand lead	12
2445	July 21	6:01 a. m.	57 59 00	160 24 45	26	fne. gy. S	49	50	40.1	Tanner	28
2446	...do...	10:36 a. m.	57 32 40	160 00 00	29	fne. gy. S	48	47	41	...do	28
2447	...do...	3:33 p. m.	57 39 00	160 39 30	31	fne. gy. S	50	52	39.5	...do	28
2448	...do...	5:51 p. m.	57 50 40	160 57 00	27	fne. gy. S	50	52	39.8	...do	28
2449	...do...	10:00 p. m.	58 10 20	161 24 30	23	fne bk. S	47	49	40.6	...do	28
2450	...do...	10:46 p. m.	58 14 20	161 30 30	22	fne. gy. S. G	47	49	40.2	...do	28
2451	July 22	6:29 a. m.	58 05 00	161 52 15	31	fne. gy. S	46	49	41	...do	28
2452	...do...	11:03 a. m.	57 38 15	161 28 30	30	fne. gy. S	47	50	41.2	...do	28
2453	...do...	12:20 p. m.	57 31 20	161 23 00	32	gy. S	47	51	....	Tanner	28
2454	...do...	3:47 p. m.	57 11 15	161 05 00	29	dk. S	45	50	41.8	...do	28
2455	...do...	5:52 p. m.	56 57 30	160 52 30	38	fne. gy. S	45	48	41	...do	28
2456	...do...	9:48 p. m.	56 31 15	160 23 30	32	gy. S. G	45	49	.....	...do	28
2457	...do...	10:15 p. m.	56 27 45	160 25 30	30	fne. gy. S	46	49	.....	...do	28
2458	...do...	10:43 p. m.	56 25 20	160 23 30	22	G	46	50	.....	...do	28
2459	...do...	11:05 p. m.	56 22 45	160 21 30	20	fne. gy. S	46	50	.....	Hand lead	12
2460	July 29	12:03 p. m.	56 05 30	161 02 00	18	G	53	51	.....	Tanner	28
2461	...do...	5:30 p. m.	55 55 15	161 15 00	14	G	49	51	.....	...do	28
2462	Aug. 2	7:22 a. m.	54 02 45	166 33 00	61	bk. S. G	47	50	.....	...do	28
2463	...do...	9:37 a. m.	54 03 00	166 52 30	365	gn. M	48	48	43	Sigsbee	38
2464	...do...	11:51 a. m.	54 01 40	167 09 00	802	gn. M	48	48	36.2	...do	38
2465	...do...	2:10 p. m.	53 58 40	167 35 00	885	M	48	50	35.8	...do	38
2466	...do...	4:02 p. m.	53 54 10	167 52 00	643	bk. S. G	48	51	36.7	...do	38
2467	...do...	4:41 p. m.	53 53 00	167 56 00	578	fne. bk. S	48	51	37	...do	38
2468	Aug. 3	2:35 p. m.	54 43 00	171 16 00	1745	gn. Oz	50	52	35	...do	35
2469	...do...	9:52 p. m.	55 31 00	171 42 00	1818	gn. Oz	48	51	35	...do	35
2470	Aug. 4	3:13 p. m.	56 51 00	172 28 00	69	gn. M	46	50	38.5	...do	38
2471	...do...	8:03 p. m.	57 00 30	173 25 00	314	gn. M	46	50	38.2	...do	38
2472	...do...	11:30 p. m.	57 19 30	174 07 00	445	gn. M	45	50	37.5	...do	38
2473	Aug. 5	3:45 a. m.	57 46 00	174 35 00	1740	gn. Oz	47	50	35	...do	38
2474	...do...	8:18 a. m.	58 14 00	174 35 00	977	fne. dk. S	47	50	35.8	...do	38
2475	...do...	12:10 p. m.	58 43 00	174 33 00	144	fne. dk. S	47	50	38	...do	35
2476	Aug. 6	7:35 a. m.	56 50 00	175 15 00	1887	gn. Oz	46	50	35	...do	35
2477	...do...	3:23 p. m.	56 02 10	175 35 00	1998	gn. Oz	48	50	34.9	...do	35
2478	Aug. 7	12:45 a. m.	55 17 00	175 32 00	2036	gn. Oz	46	50	35	...do	60
2479	...do...	8:06 a. m.	54 30 30	175 32 00	2147	gn. Oz	48	49	35	...do	35
2480	...do...	3:12 p. m.	53 42 00	175 33 00	2053	bn. Oz	49	50	35	...do	60
2481	Aug. 15	6:56 a. m.	53 56 02	166 27 05	25	fne. gy. S	50	54	.....	Tanner	28
2482	...do...	7:46 a. m.	53 57 32	166 30 20	79	fne. S. sh. M	50	54	41	...do	28
2483	...do...	7:58 a. m.	53 58 06	166 31 26	95	fne. S. M	50	54	40.8	...do	28
2484	...do...	8:06 a. m.	53 58 50	166 33 10	118	fne. S. bn. M	50	54	41.6	...do	28
2485	...do...	8:18 a. m.	53 59 18	166 34 27	53	fne. dk. S	50	54	42.3	...do	28
2486	...do...	8:50 a. m.	53 59 42	166 35 29	22	rd. and bk. G	56	54	45.8	...do	28
2487	...do...	9:21 a. m.	53 59 47	166 33 48	71	fne. S. M	56	52	41.3	...do	28
2488	...do...	9:36 a. m.	53 59 42	166 31 44	99	fne. S. M	56	52	40.6	...do	28
2489	...do...	10:21 a. m.	53 59 26	166 28 00	66	fne. S, M	56	56	41.3	...do	28
2490	...do...	11:31 a. m.	54 00 08	166 24 14	37	G. sh. P	57	55	44.3	...do	28
2491	...do...	11:56 a. m.	54 01 23	166 23 37	40	fne. G	60	55	44.5	...do	28
2492	...do...	12:26 p. m.	54 01 29	166 25 08	57	fne. S. G	60	55	42.5	...do	28
2493	...do...	1:35 p. m.	54 01 59	166 29 32	103	fne. bk. S	55	55	40.9	...do	28
2494	...do...	1:48 p. m.	54 02 13	166 30 50	97	bk. S	55	55	40.9	...do	28
2495	...do...	2:51 p. m.	54 02 24	166 35 19	77	bk. S. Sh	56	55	40	...do	28
2496	...do...	3:16 p. m.	54 02 50	166 37 00	58	bk. S. G. Sh	56	55	42.1	...do	28
2497	...do...	3:52 p. m.	54 04 30	166 40 00	322	bk. S	56	55	38.3	...do	28

Record of hydrographic soundings by the U. S. Fish Commission steamer Albatross from July 1, 1889, to June 30, 1891—Continued.

Serial No.	Date.	Time of day.	Position.		Depth.	Character of bottom.	Temperature.			Instrument used.	Weight of sinker.
			Lat. N.	Long. W.			Air.	Surface.	Bottom.		
	1890.		° ′ ″	° ′ ″	Fms.		° F.	° F.	° F.		Lbs.
2498	Aug. 15	5:18 p. m.	54 02 00	166 42 00	148	bk. S	53	54	.....	Tanner	28
2499	...do...	5:36 p. m.	54 00 45	166 40 30	37	bk. S	53	54	44.5	...do	28
2500	Aug. 16	5:34 a. m.	54 00 25	166 46 00	52	bk. S. G	62	53	44	...do	28
2501	...do...	7:34 a. m.	54 00 25	166 48 00	179	bk. S	59	54	39	...do	28
2502	...do...	7:50 a. m.	53 59 30	166 48 30	50	bk. S	60	54	43.5	...do	28
2503	...do...	8:34 a. m.	53 58 50	166 51 30	22	Sh	60	54	44.1	...do	28
2504	...do...	9:28 a. m.	54 00 00	166 58 00	316	gn. M	60	52	38.2	...do	28
2505	...do...	10:56 a. m.	53 56 30	167 03 00	36	fne. rd. and bk. S.	60	54	46	...do	28
2506	...do...	11:33 a. m.	53 55 40	167 06 20	97	bk. S. Sh. G	60	54	40.9	...do	28
2507	...do...	12:12 p. m.	53 52 35	167 09 00	22	gy. S	60	54	46	...do	28
2508	...do...	12:53 p. m.	53 52 00	167 12 15	40	R. G	54	53	44	...do	28
2509	...do...	1:13 p. m.	53 52 00	167 14 00	166	bk. M	59	52	39	...do	28
2510	...do...	1:50 p. m.	53 50 25	167 13 00	55	bk. G	59	52	43	...do	28
2511	...do...	2:03 p. m.	53 50 15	167 15 00	59	bk. G	59	52	42	...do	28
2512	...do...	2:17 p. m.	53 50 05	167 16 15	106	bk. S. G	59	52	38.8	...do	28
2513	...do...	4:06 p. m.	53 50 05	167 07 20	47	bk. S. G	54	52	44.1	...do	28
2514	Aug. 18	9:32 a. m.	53 43 50	167 00 00	103	bk. M	50	52	.....	...do	28
2515	...do...	9:55 a. m.	53 43 05	167 02 30	109	dk. gn. M	49	50	40.3	...do	28
2516	...do...	10:25 a. m.	53 43 00	167 09 00	62	bk. S. M	49	50	.....	...do	28
2517	...do...	10:57 a. m.	53 41 45	167 16 00	54	S. G	49	48	43	...do	28
2518	...do...	11:50 a. m.	53 42 00	167 21 30	58	bk. S. M	49	48	.....	...do	28
2519	...do...	12:21 p. m.	53 41 45	167 27 20	69	bk. S	49	50	40	...do	28
2520	...do...	1:08 p. m.	53 41 00	167 33 25	394	gn. M	51	52	38	Sigsbee	38
2521	...do...	2:56 p. m.	53 36 30	167 23 25	43	crs. bk. S	50	50	42.4	Tanner	28
2522	...do...	5:01 p. m.	53 30 40	167 11 40	32	bk. S	51	50	43.9	...do	28
2523	...do...	5:51 p. m.	53 30 25	167 17 30	37	bk. S	51	50	42 9	...do	28
2524	..do..	8:00 p. m.	53 30 55	167 31 10	44	bk. S	50	50	41.5	...do	28
2525	...do...	8:40 p. m.	53 32 55	167 36 50	136	bk. S. M	48	47	39.5	...do	28
2526	...do...	11:01 p. m.	53 37 00	167 41 50	524	gn. M	47	47	37	Sigsbee	38
2527	Aug. 19	5:10 a. m.	53 37 30	167 43 50	247	gn. M	45	45	38.5	Tanner	28
2528	...do...	5:40 a. m.	53 30 55	167 36 20	49	bk. S. M	45	45	41.5	...do	28
2229	...do...	6:20 a. m.	53 28 25	167 33 40	43	bk. S	45	45	41.8	...do	28
2530	...do...	8:05 a. m.	53 24 30	167 34 05	42	bk. S. Sh	46	46	42	...do	28
2531	...do...	8:50 a. m.	53 23 15	167 32 50	15	bk. S. G	48	50	44.4	...ao	28
2532	Aug. 20	7:53 a. m.	53 24 20	167 37 05	60	bk. S. G	48	48	42	...do	28
2533	...do...	8:31 a. m.	53 23 30	167 39 25	47	G. Sh	48	48	42.3	...do	28
2534	...do...	9:11 a. m.	53 23 30	167 42 40	39	bk. G. Sh	48	48	42.1	...do	28
2535	...do...	9:46 a. m.	53 24 00	167 46 10	30	bk. S	47	48	42.9	...do	28
2536	...do...	10:24 a. m.	53 25 20	167 48 20	37	bk. S	47	48	42.1	...do	28
2537	...do...	11:10 a. m.	53 28 15	167 45 50	35	bk. S. G	47	48	42.2	...do	28
2538	...do...	11:53 a. m.	53 31 45	167 43 45	43	bk. S	47	48	41.5	...do	28
2539	...do...	10:55 p. m.	53 48 00	167 24 00	624	bn. M	48	47	38	Sigsbee	38
2540	Aug. 22	6:35 a. m.	53 53 45	166 30 05	19	M	46	48	.....	Hand lead	12
2541	...do...	6:50 a. m.	53 54 00	166 29 30	17	gn. M	46	48	.....	...do	12
2542	...do...	7:10 a. m.	53 55 35	166 27 45	19	S. M	46	48	.....	...do	12
2543	...do...	7:21 a. m.	53 56 00	166 28 30	35	fne. gy. S	47	48	43.3	Tanner	28
2544	...do...	7:56 a. m.	53 56 45	166 30 15	63	fne. S. M	47	48	41.8	...do	28
2545	...do...	8:16 a. m.	53 57 30	166 32 15	65	fne. S. M	47	47	41.1	...do	28
2546	...do...	9:21 a. m.	53 58 45	166 34 25	23	bk. G	47	48	.....	Hand lead	12
2547	...do...	9:53 a. m.	53 58 20	166 34 45	17	bk. S	50	50	.....	...do	12
2548	...do...	10:12 a. m.	53 58 05	166 34 10	54	fne. bk. S	50	50	41.8	Tanner	28
2549	...do...	11:10 a. m.	53 55 55	166 33 55	45	fne. bk. S	50	52	42.4	...do	28
2550	...do...	11:40 a. m.	53 55 05	166 34 35	47	bn. M	54	54	43.3	...do	28
2551	...do...	12:03 p. m.	53 54 15	166 35 35	58	bn. M	54	54	42.1	...do	28
2552	...do...	12:22 p. m.	53 53 20	166 36 20	13	crs. bk. S	54	54	.....	Hand lead	12
2553	Aug. 26	4:01 p. m.	54 02 15	166 11 20	41	R	46	47	34.3	Tanner	28
2554	...do...	4:30 p. m.	54 00 25	166 05 40	26	sh. R	46	47	45.7	...do	28
2555	...do...	5:17 p. m.	53 59 00	165 57 20	48	G	54	46	44.9	...do	28
2556	Aug. 27	11:58 a. m.	53 58 00	162 37 00	619	gn. M	60	55	37.8	Sigsbee	38
2557	...do...	5:03 p. m.	54 01 00	161 42 30	542	R	59	53	38.1	...do	38
2558	...do...	11:04 p. m.	54 11 00	160 37 00	756	gn. M	52	52	36.6	...do	38
2559	Aug. 29	12:03 p. m.	55 41 00	154 48 00	494	gn. M. S	54	51	37.9	...do	38
2560	...do...	7:50 p. m.	56 00 00	153 30 00	207	M	53	52	39.5	...do	38
2561	...do...	10:45 p. m.	56 00 00	152 56 00	1,152	gn. M	54	52	35.5	...do	60
2562	Aug. 30	2:08 a. m.	56 00 30	152 26 00	2,197	bl. M	55	54	34.9	...do	60
2563	...do...	5:52 a. m.	56 01 00	152 26 00	2,620	gn. M	55	54	34.5	...do	60
2564	...do...	9:29 a. m.	56 01 00	151 00 00	2,935	bn. M. S. Oz	54	53	35.1	...do	60
2565	...do...	1:55 p. m.	56 02 00	150 38 00	2,925	gy. Oz	54	54	35.3	...do	60
2566	...do...	7:11 p. m.	55 59 30·	149 44 00	2,776	gy. Oz	54	54	34.9	...do	60
2567	Aug. 31	4:16 a. m.	55 54 00	147 57 00	2,414	bn. M	54	54	35.1	Sigsbee	60
2568	...do...	7:42 p. m.	55 49 00	144 57 00	2,132	gy. oz	55	54	35.1	...do	60
2569	Sept. 1	4:46 p. m.	54 53 00	141 06 00	1,963	gy. oz. bk. S	57	56	35.1	...do	60

Record of hydrographic soundings by the U. S. Fish Commission steamer Albatross from July 1, 1889, to June 30, 1891—Continued.

Serial No.	Date.	Time of day.	Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Instrument used.	Weight of sinker.
	1890.		° ′ ″	° ′ ″	*Fms.*		° F.	° F.	° F.		*Lbs.*
2570	Sept. 2	1:15 p. m.	54 22 00	137 24 00	1,655	lt. bn. oz	56	56	35.3	Sigsbee	60
2571	Sept. 3	8:29 a. m.	53 06 30	133 53 30	1,566	oz. bn. M. S	57	57	35.3	...do	60
2572	Sept. 24	9:05 a. m.	40 26 00	124 29 45	26	bk. G. P	53	51	50.4	Tanner	28
2573	...do...	10:00 a. m.	40 27 40	124 33 00	52	dk. M. S	53	52	49.6	Sigsbee	38
2574	...do...	10:33 a. m.	40 27 45	124 36 55	226	bk. S. M	53	52	44.8	...do	38
2575	...do...	11:10 a. m.	40 24 35	124 37 40	489	gn. M	53	52	39.8	...do	38
2576	...do...	11:54 a. m.	40 23 50	124 33 30	337	gn. M. S	55	54	42.6	...do	38
2577	...do...	1:43 p. m.	40 13 30	124 25 45	55	R. G. Sh	58	52	49.6	Tanner	28
2578	...do...	4:20 p. m.	40 00 30	124 06 30	23	fne. gy. S	56	52	52.7	...do	28
2579	...do...	5:18 p. m.	39 55 45	124 10 45	184	gn. M	55	52	.....	...do	28
2580	...do...	6:05 p. m.	39 51 25	124 07 50	159	fne. gy. S	55	53	47.6	...do	28
2581	...do...	6:23 p. m.	39 52 05	124 06 00	80	crs. g	55	53	48	...do	28
2582	...do...	7:08 p. m.	39 47 30	124 03 00	110	bk. S. M	55	54	47.6	...do	28
2583	...do...	7:34 p. m.	39 46 25	124 05 50	263	gn. M	55	54	43.6	...do	28
2584	...do...	8:25 p. m.	39 42 00	124 03 00	270	gn. M	54	54	43.4	...do	28
2585	...do...	9:05 p. m.	39 43 25	123 59 10	93	gn. M	55	53	.....	...do	28
2586	...do...	9:25 p. m.	39 44 00	123 57 40	81	gn. M	55	53	.....	...do	28
2587	...do...	10:20 p. m.	39 38 05	123 58 30	102	gn. M	55	53	47.6	...do	28
2588	...do...	10:45 p. m.	39 37 15	124 00 55	246	gn. M	55	53	44.1	...do	28
2589	...do...	11:40 p. m.	39 32 15	123 59 00	226	gn. M	55	53	44.6	...do	28
2590	Sept. 25	12:05 a. m.	39 32 05	123 56 50	140	S. M	55	53	46.4	...do	28
2591	...do...	12:55 a. m.	39 27 00	123 57 25	82	fne. S. bk. G	54	53	48	...do	28
2592	...do...	1:09 a. m.	39 27 00	123 58 30	157	M	54	53	46.4	...do	28
2593	...do...	1:21 a. m.	39 27 00	124 00 00	234	M	54	53	44.3	...do	28
2594	...do...	2:12 a. m.	39 22 00	124 00 00	238	M	54	53	43.7	...do	28
2595	...do...	2:35 a. m.	39 22 00	123 58 00	132	fne. S. M	54	53	47	...do	28
2596	...do...	2:55 a. m.	39 22 00	123 56 05	77	M	54	53	48.4	...do	28
2597	...do...	3:38 a. m.	39 17 15	123 55 55	77	fne. S. M	54	53	48.5	...do	28
2598	...do...	3:53 a. m.	39 16 50	123 57 45	86	M	54	53	47.6	...do	28
2599	...do...	4:10 a. m.	39 16 10	123 58 35	161	gn. M	54	55	47.6	...do	28
2600	...do...	5:00 a. m.	39 11 05	123 59 00	183	gn. M	54	55	46.4	...do	28
2601	...do...	5:28 a. m.	39 12 20	123 56 00	77	gn. M	54	54	47.6	...do	28
2602	...do...	5:45 a. m.	39 13 10	123 54 00	69	gn. M	54	54	48.1	...do	28
2603	...do...	6:00 a. m.	39 13 50	123 52 30	64	gn. M	54	54	44.6	...do	28
2604	...do...	6:27 a. m.	39 12 10	123 50 50	60	gn. M	53	54	49.4	...do	28
2605	...do...	6:51 a. m.	39 09 30	123 49 00	54	gn. M	53	54	49.6	...do	28
2606	...do...	7:18 a. m.	39 08 10	123 52 30	59	gn. M	53	54	46.1	...do	28
2607	...do...	7:45 a. m.	39 07 50	123 56 00	71	gn. M	53	54	48.6	...do	28
2608	...do...	8:15 a. m.	39 06 30	123 59 30	199	gn. M	53	54	45.5	...do	28
	1891.										
2609	Feb. 23	3:50 p. m.	7 12 30	80 56 00	127	G. S. Sh	79	[illegible]	57.7	Sigsbee	38
2610	Feb. 28	5:07 a. m.	5 29 30	86 49 30	1,009	glob. oz	81	82	37.2	...do	35
2611	...do...	9:22 a. m.	5 35 10	86 57 10	82	R	84	83.6	58.2	...do	38
2612	Mar. 1	6:58 a. m.	5 28 20	86 55 30	94	fne. wh. S	78	82	57.2	...do	38
2613	Mar. 5	5:04 a. m.	3 50 00	81 44 20	1,181	bn. glob. oz	77	77	36.5	...do	35
2614	Mar. 8	5:55 p. m.	7 34 35	79 18 20	226	S. Sh	76	74	49.8	Tanner	26
2615	...do...	6:22 p. m.	7 36 20	79 18 10	191	crs. gy. S	76	74	53.8	...do	26
2616	...do...	6:51 p. m.	7 38 10	79 18 00	151	gy. S	77	74	50.3	...do	26
2617	Mar. 11	3:25 a. m.	7 26 40	78 52 40	1,681	R	72	70	36	Sigsbee	38
2618	...do...	5:19 a. m.	7 27 10	78 46 40	1,708	gn. glob. oz	71	69	36	...do	35
2619	...do...	7:06 a. m.	7 31 00	78 42 30	1,100	gn. glob. oz	72	68	36.5	...do	35
2620	...do...	12:03 p. m.	7 29 00	78 43 30	1,482	gn. glob. oz	76	70	36	...do	35
2621	...do...	1:20 p. m.	7 30 00	78 40 30	1,104	gn. M	77	70	36.5	...do	38
2622	Mar. 23	4:21 a. m.	1 27 10	80 02 10	809	sft. M	78	79	40.1	...do	38
2623	...do...	6:00 a. m.	1 21 30	80 01 40	750	gn. oz	78	78	39.2	...do	38
2624	...do...	7:05 a. m.	1 18 00	80 01 00	724	gn. oz	77	80	39	...do	38
2625	...do...	9:18 a. m.	1 11 00	79 59 30	536	gn. M	78	80	41.2	...do	38
2626	...do...	10:25 a. m.	1 07 00	79 59 00	90	gn. M. S	79	80	57.3	...do	38
2627	Mar. 25	5:09 a. m.	0 36 00	82 45 00	1,832	gn. glob. oz	80	81	36	...do	35
			South.								
2628	Mar. 26	9:14 a. m.	0 13 00	84 52 00	......	....	81	81	.....	...do	.....
2629	...do.	1:15 p. m.	0 20 00	85 08 00	1,488	glob. oz	85	83	36	...do	38
			North.								
2630	Apr. 4	4:19 p. m.	1 24 30	91 38 00	1,270	glob. oz	82	83	36.2	...do	35
2631	Apr. 11	5:24 a. m.	16 20 00	99 41 30	1,823	yl. S. bk. sp	77	80	35.8	...do	35
2632	Apr. 12	6:05 a. m.	16 42 00	100 11 00	838	gn. M	79	80	38.5	...do	38
2633	...do...	9:42 a. m.	16 45 00	100 06 00	912	dk. gn. M	82	82	37	...do	38
2634	...do...	10:42 a. m.	16 46 30	100 02 30	602	dk. gn. M	81	82	40	...do	38
2635	Apr. 18	5:05 a. m.	20 47 15	106 15 30	2,022	dk. gn. M	72	74	36	...do	60
2636	...do...	8:49 a. m.	21 03 00	106 21 30	2,102	gn. oz. bk. sp	73	74	35.8	...do	35
2637	Apr. 22	7:02 p. m.	27 20 00	110 54 00	773	bn. M. bk. sp	72	71	38	...do	38
2638	Apr. 23	7:06 a. m.	27 38 00	111 04 00	622	bn. M. bk. sp	72	72	39.2	...do	38

Record of dredging and trawling stations of the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891.

Serial No.	Date.	Time.	Position.		Temperatures.			Depth.	Character of bottom.	Wind.		Drift (mag.).		Instrument used.
			Latitude N.	Longitude W.	Air.	Surface.	Bottom.			Direction.	Force.	Direction.	Distance.	
	1889.		° ′ ″	° ′ ″	° F.	° F.	° F.	Fms.					Miles.	
3077	July 23	4:00 p. m.	55 46 00	132 24 00	63	60	42.4	322	gn. M. G	North	2	SE. by S	0.75	L. B. T.
3078	Sept. 1	7:44 a. m.	43 59 15	124 46 00	62	60	45.7	68	G. M	NW	2	W. ½ S	0.75	S. B. T.
3079	...do	4:00 p. m.	43 59 15	124 44 40	60	59	46.7	55	Rky	NW	2	NW. by W. ¾ W.	1.0	Tangles.
3080	...do	6:47 p. m.	43 58 00	124 36 00	64	60	45.6	93	gn. M	NNW	2	NE. ¼ N	1.5	L. B. T.
3081	...do	8:55 p. m.	43 59 00	124 20 00	60	58	45.8	61	gn. M. S	NNW	2	NE. ½ N	1.25	L. B. T.
3082	Sept. 2	5:26 a. m.	43 52 00	124 15 00	59	57	46.2	43	fne. gy S	NW	1	NNW	0.75	L. B. T.
3083	...do	7:06 a. m.	43 59 00	124 14 30	59	56	47.8	32	fne. gy S. bk. Sp	ESE	1	N. by W. ¾ W	0.7	L. B. T.
3084	...do	12:17 p. m.	44 12 30	124 19 00	59	58	46.9	46	fne. gy. S. bk. Sp	NW	4	NE	1.5	L. B. T.
3085	...do	8:28 p. m.	44 29 30	124 17 00	58	56	45.7	42	fne gy S	NW	4	N. ¼ W	0.5	L. B. T.
3086	Sept. 3	5:03 a. m.	44 36 00	124 18 30	56	54	46.2	46	fne. gy S. bk. Sp	North	2	NE. ½ E	1.25	L. B. T.
3087	...do	11:04 a. m.	44 28 00	124 26 00	56	56	45.9	46	C. and P	NW	4.5	NE. ¼ N	1.0	Tangles.
3088	...do	11:22 a. m.	44 28 00	124 25 30	56	56	46.3	46	C. P	NW	4.5	NE. ¼ N	1.0	S. B. T.
3089	Sept. 7	6:34 p. m.	45 40 30	123 58 45	62	56	......	20	fne. gy S	NW	2	West	1.25	L. B. T.
3090	...do	8:22 p. m.	45 43 00	124 12 00	58	57	45.8	62	fne. gy S	NW	2	WSW	1.5	L. B. T.
3091	Sept. 8	5:35 a. m.	45 32 00	124 10 30	57	56	......	87	gn. M	NW	3	East	2.25	L. B. T.
3092	...do	8:02 a. m.	45 31 15	124 05 00	57	56	45.9	46	bk. S	N. by W	2	ESE	1.5	L. B. T.
3093	...do	2:28 p. m.	45 20 30	124 06 30	54	50	44.9	57	fne gy S	NW	3	SE. by E. ½ E	2.0	L. B. T.
3094	Sept. 12	9:36 a. m.	43 01 00	124 30 30	50	48	46.7	35	crs. S. Sh	NNW	1	ENE	1.0	S. Dr.
3095	...do	2:08 p. m.	42 44 45	124 38 10	53	48	47.0	42	R. St. brk. Sh	North	5	E. by S	0.5	Tangles.
3096	...do	2:55 p. m.	42 45 00	124 36 15	53	48	46.7	33	St. brk. Sh	North	6	East	0.3	Tangles.
	1890.													
3097	Mar. 5	11:43 a. m.	37 59 08	122 25 45	56	51	......	12	bu. M	SSE	1	South	0.75	L. B. T.
3098	...do	12:18 p. m.	37 58 25	122 26 30	56	51	......	13	bu. M	South	1	South	0.75	L. B. T.
3099	Mar. 10	2:14 p. m.	37 44 50	122 43 00	50	51	50.8	20	fne. gy S	WNW	4	WSW	0.5	L. B. T.
3100	...do	3:22 p. m.	37 43 20	122 43 00	50	51	50.4	29	cra. G	WNW	4	WSW	0.7	L. B. T.
3101	...do	4:29 p. m.	37 42 00	122 53 20	49	51	50.8	33	yl. S	WNW	4	S. by W. ¾ W	1.1	L. B. T.
3102	...do	5:43 p. m.	37 40 40	122 59 00	49	51	51.8	27	C. brk. Sh	WNW	4	S. ½ W	1.0	L. B. T.
3103	...do	6:49 p. m.	37 38 00	123 02 30	49	49	57.9	67	fne. dk. S	WNW	4	West	2.0	L. B. T.
3104	Mar. 11	6:38 a. m.	37 23 00	123 08 00	47	49	40.8	391	C	WNW	4	SE. by E. ½ E	1.5	L. B. T.
3105	...do	9:02 a. m.	37 21 00	123 00 00	52	51	44.2	217	fne. gy. S	NNE	2	SE. by E	1.2	L. B. T.
3106	...do	10:52 a. m.	37 21 00	122 51 00	52	51	......	77	fne. gy. S	NNE	2	SE. by S	1.0	L. B. T.
3107	...do	12:12 p. m.	37 20 00	122 44 00	52	52	......	51	fne. gy. S	NNE	2	E. ¼ N	1.0	L. B. T.
3108	...do	1:26 p. m.	37 19 00	122 36 00	53	53	50.8	43	R. brk. Sh	WNW	3	ESE	0.5	L. B. T.
3109	...do	1:50 p. m.	37 18 30	122 35 00	53	53	50.8	40	Rky	WNW	3	NW. by W	1.2	Tangles.
3110	...do	3:02 p. m.	37 19 00	122 32 00	53	53	51.0	39	Rky	WNW	3	NE. ¾ N	0.7	Tangles.
3111	...do	5:27 p. m.	37 13 30	122 26 00	60	53	52.8	20	gy. S	NW	3	S. by E. ½ E	0.25	Tangles.
3112	Mar. 12	6:00 a. m.	37 08 00	122 47 00	51	52	41.8	296	fne. gy. S	NNW	2	SE. by E	2.0	L. B. T.
3113	...do	7:50 a. m.	37 06 40	122 37 30	54	52	48.8	70	fne. gy. S	NNW	2	ENE	1.0	L. B. T.
3114	...do	9:12 a. m.	37 06 00	122 32 00	56	52	......	62	M	ESE	2	E. ¼ N	1.3	L. B. T.
3115	...do	10:17 a. m.	37 05 00	122 24 00	53	52	......	43	fne. bk. S	ESE	2	E. ½ N	1.3	L. B. T.
3116	...do	11:37 a. m.	37 05 30	122 19 00	55	54	......	16	Rky	ESE	2	SE. by E	0.3	S. Dr.

3117	...do	12:28 p. m.	37	01	20	122	18	20	53	52	50.7	43	bk. S. M	ESE	1	S. by E. ½ E	1.0	L. B. T.
3118	...do	1:22 p. m.	36	57	10	122	18	00	56	55	50.9	54	Rky. Co	NW	1	S. by E. ½ E	0.75	S. Dr.
3119	...do	1:54 p. m.	36	56	30	122	17	40	56	55	50.9	54	Rky. Co	NW	1	.....	.....	Tangles.
3120	...do	2:43 p. m.	36	55	40	122	15	10	56	54	49.7	54	gn. M. S. R	NW	1	NNW. ½ W	0.5	Tangles.
3121	...do	3:16 p. m.	36	57	20	122	15	00	55	53	49.8	48	gn. M. S	NW	1	NNW. ½ W	0.25	Tangles.
3122	...do	3:42 p. m.	36	59	00	122	15	00	55	52	52.3	38	gy. S. M	NW	1	N. by W	0.25	Tangles.
3123	...do	4:44 p. m.	36	57	00	122	10	00	56	54	52.8	37	fne. gy. S. M	NW	2	.....	.....	Tangles.
3124	Mar. 13	6:42 a. m.	36	55	10	122	04	00	45	51	52.3	21	Rky	NE	2	.....	.....	L. B. T.
3125	...do	7:41 a. m.	36	52	00	122	11	00	49	52	48.4	65	fne. gy. S. Sh	ENE	3	SE. by E	0.8	L. B. T. and mud bag.
3126	...do	9:00 a. m.	36	49	20	122	12	30	54	53	52.8	456	gn. M	East	4	SE. by E. ½ E	1.0	L. B. T.
3127	...do	11:15 a. m.	36	45	00	122	10	20	56	53	40.5	418	gn. M. S	East	3	SE. by S	0.5	L. B. T. and mud bag.
3128	...do	1:00 p. m.	36	41	50	122	07	30	56	53	38.9	627	bu. M	Calm	0	ESE. ⅜ E	2.6	L. B. T. and mud bag.
3129	...do	3:33 p. m.	36	39	40	122	01	00	66	57	43.7	204	S. and M	Calm	0	.....	.....	L. B. T. and mud bag.
3130	Mar. 14	12:20 p. m.	36	36	40	121	53	00	67	58	.....	9	S	North	1	.....	.....	S. B. T.
3131	...do	1:34 p. m.	36	41	30	121	54	10	67	58	50.8	48	br. M. R	North	2	NE. by N	0.5	S. B. T.
3132	...do	2:30 p. m.	36	44	00	121	51	00	62	55	52.1	33	br. M	NW	2	NW	0.4	S. B. T.
3133	...do	3:23 p. m.	36	47	50	121	49	00	59	55	52.3	37	br. M	NW	2	NNE. ¾ E	0.5	S. B. T.
3134	...do	4:24 p. m.	36	51	40	121	51	20	59	54	54.5	13	fne. S. M	NW	2	W. ¼ N	0.5	L. B. T.
3135	...do	5:15 p. m.	36	54	10	121	55	00	59	54	54.7	15	fne. gy. S	West	2	W. ¼ S	0.5	L. B. T.
3136	Mar. 15	6:26 a. m.	36	57	00	122	01	00	49	52	.....	7	gy. S	NNW	1	S. ¼ W	1.0	S. B. T.
3137	...do	6:44 a. m.	36	56	00	122	01	20	50	52	.....	11	S. P	NNW	1	S. ¼ W	2.0	S. B. T.
3138	...do	7:10 a. m.	36	55	30	122	02	00	52	52	55.4	19	fne. S. M. St	North	1	SSW	0.2	S. Dr.
3139	...do	7:32 a. m.	36	54	10	122	03	00	52	52	52.9	27	gn. M	North	1	WSW. ⅝ W	0.2	S. Dr.
3140	...do	8:01 a. m.	36	54	30	122	05	00	53	52	52.3	30	M	NNE	1	NW	0.2	S. Dr.
3141	...do	8:25 a. m	36	56	00	122	06	00	53	52	53.0	24	fne. gy. S. M	NNE	1	NE. by N	0.2	S. Dr.
3142	...do	8:43 a. m.	36	56	20	122	03	20	53	52	.....	13	fne. S. rky	NNE	1	East	0.2	S. Dr.
3143	...do	9:04 a. m.	36	56	10	122	02	40	57	53	.....	9	Rky	NNE	1	E. ¾ N	0.2	S. Dr.
3144	...do	9:38 a. m.	36	55	40	122	03	10	57	54	.....	20	S. G. R. M	NNE	1	S. ¼ E	0.2	S. Dr.
3145	...do	10:36 a. m.	36	51	05	122	05	30	57	54	49.5	56	fne. gy. S	NNE	1	W. ¼ N	1.0	L. B. T.
3146	...do	11:53 a. m.	36	53	30	122	12	00	57	54	49.5	62	gn. M. R	NW	1	.....	.....	S. B. T.
3147	...do	2:05 p. m.	37	00	00	122	20	00	57	55	49.2	56	br. M	West	1	WNW	0.5	S. B. T.
3148	...do	4:03 p. m.	37	08	00	122	28	10	56	54	51.3	47	br. M	WNW	2	.....	.....	S. B. T.
3149	...do	5:10 p. m.	37	13	50	122	32	30	55	54	51.1	45	gn. M	NW	2	.....	.....	S. B. T.
3150	Mar. 21	12:24 p. m.	37	47	00	122	44	10	51	55	52.3	21	fne. gy. S	West	1	NW. by W	1.2	L. B. T.
3151	...do	2:05 p. m.	37	49	00	122	55	30	52	55	51.6	37	crs. S. rd. Sp	West	1	SE	1.5	L. B. T.
3152	...do	3:23 p. m.	37	53	30	122	56	30	52	55	50.6	36	fne. gy. S	West	1	.....	.....	L. B. T.
3153	...do	5:06 p. m.	37	57	10	122	56	20	52	52	51.3	32	gn. M	West	1	North	0.5	L. B. T.
3154	...do	5:46 p. m.	37	59	20	122	55	30	51	52	51.8	20	bk. S. M	West	1	NW. by W. ½ W.	0.3	L. B. T.
3155	Mar. 22	6:42 a. m.	37	57	30	122	59	00	51	52	.....	35	gn. M	SW	1	SSW	0.75	L. B. T.
3156	...do	7:46 a. m.	37	53	30	123	04	00	51	52	45.3	50	S	SE	1	.....	.....	L. B. T.
3157	...do	9:02 a. m.	37	49	30	123	06	00	51	53	50.6	47	fne. gy. S	S	2	S. ¾ E	1.5	T. B. T.
3158	...do	10:55 a. m.	37	47	30	123	10	40	53	53	51.4	29	Rky	S	2	.....	.....	Tangles.
3159	...do	11:22 a. m.	37	47	20	123	10	00	53	53	.....	27	Rky	S	2	.....	.....	Tangles.
3160	...do	12:05 p. m.	37	48	35	123	12	40	52	52	51.8	39	Rky	SSW	2	.....	.....	Tangles.
3161	...do	2:01 p. m.	37	49	30	123	23	40	52	52	44.5	191	fne. gy. S	SSW	2	NW. by W. ½ W.	1.5	L. B. T. and mud bag.
3162	...do	4:50 p. m.	37	54	10	123	30	00	52	53	39.0	552	gn. M	W	3	N. by W	2.5	L. B. T.
3163	...do	7:13 p. m.	37	56	40	123	25	30	50	52	48.5	69	fne. gy, S	WSW	2	NE. by N	2.0	L. B. T.

Record of dredging and trawling stations of the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Serial No.	Date.	Time.	Position.		Temperatures.			Depth.	Character of bottom.	Wind.		Drift (mag).		Instrument used.
			Latitude N.	Longitude W.	Air.	Surface.	Bottom.			Direction.	Force.	Direction.	Distance.	
	1890.		° ′ ″	° ′ ″	°F	°F	°F	*Fms.*					*Miles.*	
3164	Mar. 23	5:37 a. m.	37 59 40	123 14 25	49	50	48.5	61	Rky	NW. by N	4	ENE. ½ E.	1.0	S. Dr.
3165	...do	6:32 a. m.	37 59 45	123 08 35	49	50	49.0	50	gn. M	NW. by N	4	NE. by E	0.7	S. Dr.
3166	...do	7:23 a. m.	37 57 30	123 04 30	52	52	50.3	47	gn. M	NW. by N	5	E. ½ N.	1.5	S. B. T.
3167	...do	8:25 a. m.	37 57 30	122 59 30	53	52	49.5	33	gn. M	NW	5	E. ½ S.	1.5	S. B. T.
3168	Mar. 24	10:36 a. m.	38 01 25	123 26 55	52	52	......	34	Rky. Co	Calm	0	NNW	0.5	Tangles.
3169	Mar. 28	3:41 p. m.	38 16 30	123 30 00	53	52	44.0	202	M	WNW	2	NE. by N	1.0	L. B. T.
3170	...do	4:17 p. m.	38 17 00	123 29 00	53	52	......	167	M	WNW	3	NE. by N	1.25	L. B. T.
3171	...do	6:01 p. m.	38 20 30	123 20 00	52	52	48.0	76	Rky. S	WNW	3	NNE	1.0	L. B. T.
3172	...do	7:00 p. m.	38 23 35	123 14 00	52	52	48.0	62	bk. S	SW	1	NNE	1.0	L. B. T.
3173	...do	8:10 p. m.	38 19 25	123 14 30	51	52	48.2	62	M	SW	1	SE. by E	1.0	S. B. T. and mud bag.
3174	...do	9:14 p. m.	38 15 30	123 14 15	50	53	49.5	65	gn. M	NW	1	SE. by E	1.5	L. B. T.
3175	Mar. 29	5:48 a. m.	38 07 35	123 13 30	49	49	......	57	br. M	West	2	SE. by E. ½ E.	1.0	L. B. T.
3176	...do	7:09 a. m.	38 01 30	123 06 00	49	49	......	37	gy. S	West	2	SE. by E. ½ E.	1.0	L. B. T.
3177	...do	7:52 a. m.	37 59 30	123 03 05	49	50	......	25	crs. S. G	West	2	......	......	S. B. T.
3178	...do	8:45 a. m.	37 57 00	122 57 25	49	50	49.0	32	S	West	2	E. by S	1.0	L. B. T.
3179	...do	9:52 a. m.	37 53 30	122 52 00	50	53	50.0	30	fne. gy. S	NW	2	E. by S	1.0	L. B. T.
3180	...do	10:53 a. m.	37 50 00	122 47 00	53	53	50.7	24	fne. gy. S	NW	1	ESE	1.5	L. B. T. and mud bag
3181	...do	11:45 a. m.	37 50 10	122 41 30	53	53	51.0	16	fne. gy S	NW	1	E. by S	1.0	L. B. T.
3182	...do	12:29 p. m.	37 49 50	122 37 10	55	54	52.2	11	fne. gy S	NW	1	......	......	L. B. T.
3183	Apr. 3	7:54 p. m.	36 31 00	121 59 00	51	52	44.5	162	gy S. R	NNW	1	E. SE	0.25	S. B. T.
3184	...do	8:33 p. m.	36 26 40	122 00 05	52	51	46.4	77	S. G	NNW	2	S. E	2.0	S. B. T.
3185	...do	10:17 p. m.	36 27 10	121 57 00	52	51	48.4	41	crs. S	NNW	1	S. by E	1.0	S. B. T.
3186	...do	12:57 p. m.	36 18 50	122 06 00	53	52	41.3	328	bk. S. M	NNW	3	SE. by E	1.0	L. B. T.
3187	...do	3:10 p. m.	36 14 00	121 58 40	55	54	41.1	298	yl. S. M	NNW	3	NE. ½ N	1.5	L. B. T.
3188	...do	5:55 p. m.	36 08 15	121 49 40	54	54	45.0	316	gn. M	NNW	3	ESE	3.0	L. B. T.
3189	Apr. 4	5:35 a. m.	35 45 30	121 29 00	53	54	43.2	218	M	NW	4	SE	2.5	L. B. T.
3190	...do	7:47 a. m.	35 40 30	121 22 40	53	54	49.0	53	fne. gy S	NW	4	SE	1.5	L. B. T.
3191	...do	9:06 a. m.	35 35 15	121 23 00	54	53	44.0	211	br. M	NW	4	E. ½ S	1.5	L. B. T.
3192	...do	11:03 a. m.	35 33 40	121 15 00	55	52	47.2	101	bk. S. M	NW	5	NE. by N	0.75	L. B. T.
3193	Apr. 5	8:05 a. m.	35 25 50	121 09 10	51	51	44.4	160	gn. M	West	1	ENE	2.0	L. B. T.
3194	...do	9:42 a. m.	35 23 30	121 02 30	52	53	45.9	92	gy. S	NW	2	SE	1.0	L. B. T.
3195	...do	12:11 p. m.	35 14 00	121 07 00	57	54	43.2	252	gn. M	NW	4	SE. by E	0.8	L. B. T.
3196	...do	4:07 p. m.	35 02 55	120 59 40	54	54	44.1	200	gn. M	WNW	5	E. by N	3.5	L. B. T.
3197	...do	5:40 p. m.	35 01 30	120 50 30	54	53	48.4	77	gn. M	NW. by W.	5	E. ½ N.	1.5	L. B. T.
3198	Apr. 6	6:44 a. m.	34 19 25	120 38 30	52	53	42.1	278	gn. M	NW	3	ENE	2.6	L. B. T. and mud bag.
3199	...do	9:16 a. m.	34 16 45	120 25 30	56	52	43.9	233	gn. M	WNW	2	ENE	1.5	L. B. T.
3200	...do	11:24 a. m.	34 15 00	120 14 30	56	52	43.1	265	gn. M	WNW	2	NE. ½ N	1.0	L. B. T.
3201	...do	2:37 p. m.	34 14 45	119 54 00	60	55	42.9	280	gn. M	West	4	NE	2.0	L. B. T.

3202	Apr. 11	12:20 p. m.	36	46	10	121	58	45	54	52	41.1	382	gn. M	NW	4	NE	0.5	L. B. T.
3203	...do	3:01 p. m.	36	48	00	121	53	50	55	54	44.7	138	br. M	W. by N	4	N. by W	0.2	L. B. T.
3204	Apr. 12	7:30 a. m.	36	54	45	122	20	15	48	55	44.1	202	bk. S	NW	4	NW. by N	1.5	L. B. T.
3205	...do	9:40 a. m.	36	55	10	122	23	50	50	51	43.7	240	bk. S. R	NW	5	NW. ½ N	0.5	L. B. T.
3206	...do	11:31 a. m.	36	57	30	122	27	30	50	51	....	169	....	NW	6	NW	0.8	L. B. T.
3207	...do	2:01 p. m.	37	00	30	122	35	30	43	50	45.8	108	fne. gy S	NW	5	NNW	1.5	L. B. T.
3208	...do	3:38 p. m.	37	01	10	122	39	45	49	50	44.3	203	fne. gy S	NW	5	NW	1.4	L. B. T.
3209	...do	5:46 p. m.	37	05	15	122	42	05	50	50	45.4	141	gn. M	NW	5	NW	0.7	L. B. T.
3210	May 21	9:04 a. m.	54	00	00	162	40	30	42	43	38.5	483	S. gn. M	NE	2	SW. by S	1.5	L. B. T.
3211	...do	11:34 a. m.	54	02	00	162	52	00	41	44	38.7	313	gn. M	NE	4	SSW. ½ W	3.0	L. B. T.
3212	...do	2:26 p. m.	54	05	30	162	54	00	39	43	38.0	49	gy. S. bk. Sp	NE	4	NNW	0.5	L. B. T.
3213	...do	3:45 p. m.	54	10	00	162	57	30	39	40	....	41	bk. S	NE	5	NNW. ¼ W	1.0	L. B. T.
3214	...do	5:27 p. m.	54	13	00	163	06	00	39	40	....	38	gy. S. G	ENE	5	NNW	1.0	L. B. T.
3215	...do	7:24 p. m.	54	14	40	163	24	00	39	43	38.5	43	G	N. by E	5	NW. ½ W	1.5	L. B. T.
3216	...do	9:08 p. m.	54	20	30	163	37	00	39	43	....	61	bk. S. M	N. by E	4	NW. ½ N	2.0	L. B. T.
3217	May 22	3:33 a. m.	54	14	50	164	06	00	39	42	....	42	bk. G	WNW	1	SW. ¾ W	0.75	L. B. T.
3218	...do	5:08 a. m.	54	15	40	164	21	00	39	42	37.7	41	bk. S	WNW	3	W. by S	1.0	L. B. T.
3219	...do	6:49 a. m.	54	14	00	164	35	00	39	42	38.0	59	bk. S. G	West	1	SW. by W	1.0	L. B. T.
3220	...do	11:12 a. m.	54	15	00	165	06	00	41	42	....	34	G. brk. Sh	W. by N	5	WSW	0.8	L. B. T.
3221	...do	1:44 p. m.	54	15	20	165	23	30	40	42	39.1	66	bk. S. Sh	W. by N	4	WNW. ⅜ W	2.0	L. B. T.
3222	...do	3:07 p. m.	54	20	00	165	30	00	40	40	39.7	50	bk. S. P. Sh	NW. by W	4	WSW. ½ W	1.5	L. B. T.
3223	...do	4:42 p. m.	54	26	15	165	32	00	40	42	39.0	56	bk. P	WNW	4	SW. by W. ½ W.	1.0	L. B. T.
3224	...do	7:36 p. m.	54	42	50	165	37	00	39	43	38.7	121	bk. S. G	WNW	3	WNW	1.0	L. B. T.
3225	...do	9:28 p. m.	54	48	30	165	49	00	39	41	38.6	85	bk. S	SW	4	NW. ½ N	1.0	L. B. T.
3226	May 23	7:39 a. m.	55	01	00	167	25	00	37	42	38.5	128	M. S. Sh	West	5	N. by E	0.75	S. B. T.
3227	...do	12:01 p. m.	54	36	30	166	54	00	37	42	38.6	225	gn. M	NW	4	NE. by E	1.0	L. B. T.
3228	May 31	5:57 p. m.	58	39	20	157	17	30	48	49	....	8	gy. S. P	East	3	NE. ¾ E	1.0	S. B. T.
3229	...do	6:24 p. m.	58	40	00	157	15	00	50	50	....	8	gy. S. P	East	2	NE. ¾ E	1.0	S. B. T.
3230	...do	6:42 p. m.	58	31	30	157	13	30	50	50	....	3¼	gy. S. P	East	2	NE. ¾ E	0.1	S. B. T.
3231	June 2	8:09 a. m.	58	35	00	157	28	50	45	47	....	12	S	East	2	S. by E	1.0	L. B. T.
3232	...do	9:35 a. m.	58	31	30	157	34	15	45	47	....	10½	P. St	SW	2	SE. by S	0.75	L. B. T.
3233	...do	11:17 a. m.	58	23	45	157	42	45	44	45	44.5	7¼	S. P	SW	1	WSW	0.6	L. B. T.
3234	...do	12:40 p. m.	58	27	00	157	52	00	48	47	....	5	gy. S	Calm	....	....	....	L. B. T.
3235	June 7	3:40 p. m.	88	16	30	158	13	00	44	44	....	11	bk. S	SW	3	SE. by S	1.0	L. B. T.
3236	...do	5:10 p. m.	58	11	00	158	05	30	37	42	39.0	14¾	G. S. Sh	SW	3	S. ½ E	1.0	L. B. T.
3237	...do	7:04 p. m.	58	08	00	158	19	00	36	41	....	19	gy. S. G. Sh	S. by W	4	S. ¼ W	1.25	L. B. T.
3238	...do	9:21 p. m.	58	03	40	158	37	30	35	39	....	18	fne. gy. S	S	3	South	1.0	L. B. T.
3239	June 8	4:34 a. m.	58	22	20	159	23	15	40	44	....	11½	fne. gy. S	SW	2	West	1.0	L. B. T.
3240	...do	6:17 a. m.	58	30	00	159	35	50	42	43	....	14½	fne. bk. S	SSW	2	WNW	1.0	L. B. T.
3241	...do	8:46 a. m.	58	38	30	159	33	30	48	47	38.0	14	bk. M	SSW	2	W. ½ S	1.0	L. B. T.
3242	...do	3:45 p. m.	58	44	30	160	08	45	43	45	....	11	bk. M	S	2	WSW	0.8	L. B. T.
3243	...do	5:32 p. m.	58	45	10	160	28	00	45	46	....	4½	fne. gy. S	SE	2	WSW	0.8	L. B. T.
3244	June 9	5:19 p. m.	58	37	20	161	05	00	40	43	....	4½	fne. gy. S	ESE	2	S. by W	1.0	L. B. T.
3245	...do	7:05 p. m.	58	31	20	161	13	00	41	44	....	11½	S. and P	SE	2	SSE	0.75	L. B. T.
3246	...do	8:45 p. m.	58	26	30	161	36	00	41	40	38	17½	G	NE	2	S. by W	1.0	L. B. T.
3247	June 13	2:00 p. m.	58	40	45	162	08	30	41	43	40.6	17	P. St	ESE	4	S. by W	0.25	L. B. T.
3248	...do	3:41 p. m.	58	34	15	162	22	00	40	41	43	21	fne. gy. S. G	ESE	3	S. by W	0.75	L. B. T.
3249	...do	5:54 p. m.	58	27	30	162	36	00	39	39	37	13½	fne. gy. S. bk. Sp	ESE	2	ESE	1.5	L. B. T.
3250	...do	9:40 p. m.	58	11	30	163	02	45	38	40	46.2	17½	gy. S	SE	3	S. by W	1.5	L. B. T.
3251	June 14	4:39 a. m.	57	35	50	164	05	00	38	39	37.5	25½	fne. gy. S	SE	2	S. by W	0.75	L. B. T.
3252	...do	7:16 a. m.	57	22	20	164	24	40	39	40	44.8	29½	bk. M	SSE	2	SSW	1.0	L. B. T.
3253	...do	10:07 a. m.	57	05	50	164	27	15	40	42	35	36	M. S	S	2	S. by W	1.5	L. B. T.

Record of dredging and trawling stations of the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Serial No.	Date.	Time.	Position. Latitude N.	Position. Longitude W.	Temperatures. Air.	Temperatures. Surface.	Temperatures. Bottom.	Depth.	Character of bottom.	Wind. Direction.	Wind. Force.	Drift (mag.). Direction.	Drift (mag.). Distance.	Instrument used.
	1890.		° ′ ″	° ′ ″	° F.	° F.	° F.	Fms.					Miles.	
3254	June 14	12:33 p.m.	56 50 00	164 27 50	41	43	36.2	46	gn. M. S	S	2	S. ¼ W	1.0	L. B. T.
3255	...do	3:34 p.m.	56 33 30	164 31 40	42	44	37	43	gn. M. S	SE	2	SSW. ½ W	0.5	L. B. T. and surface tow net.
3256	...do	8:03 p.m.	56 18 00	164 34 10	42	45	35	49	gn. M. bk. Sh	E. by N	1	SW. by S	0.5	L. B. T.
3257	June 24	4:21 a.m.	54 49 00	165 32 00	43	45	39	81	gy. S. G	SSW	1	N. by E. ¾ E	0.75	L. B. T.
3258	...do	6:33 a.m.	54 48 00	165 13 30	43	44	39	70	bk. S. G	SSE	1	N. ½ E	0.75	L. B. T.
3259	...do	8:56 a.m.	54 40 50	165 05 30	42	44	40.6	41	bk. S. G	S	1	ESE	0.8	L. B. T.
3260	...do	11:05 a.m.	54 36 15	164 52 00	42	44	42	13	fne. bk. S	W	1	N. ½ W	0.5	L. B. T.
3261	...do	12:21 p.m.	54 42 15	164 49 15	44	45	41.2	27	bk. G. P	W	1	N. by E	0.75	L. B. T.
3262	...do	2:51 p.m.	54 49 30	165 02 00	44	45	40.7	43	bk. S. R	SW	2	W. ½ N	0.5	L. B. T.
3263	...do	6:20 p.m.	55 04 00	165 04 00	43	45	39.5	61	bk. m	NW	1	E. by N	1.0	L. B. T.
3264	...do	8:39 p.m.	54 57 00	164 48 00	43	45	40.5	40	crs. S. G	W	2	SE	0.5	L. B. T.
3265	June 25	6:01 a.m.	55 16 30	163 52 45	42	45	39.8	38	bk. S	W	2	SE. ½ S	0.8	L. B. T.
3266	...do	8:01 a.m.	55 08 30	163 30 30	42	45	42	24	bk. S	W	2	SE. ½ S	0.8	L. B. T.
3267	...do	12:01 p.m.	55 23 30	163 29 00	44	46	41	32	bk. S	W	2	NW. by W. ¾ W	1.0	L. B. T.
3268	...do	5:28 p.m.	55 29 00	163 13 00	45	47	41.2	26	bk. S. G	SW	3	SSE. ¾ E	1.0	L. B. T.
3269	...do	7:36 p.m.	55 19 00	163 04 30	42	44	42.3	16	fne. gy. S. bk. sh	SW	3	SE	0.75	L. B. T.
3270	June 26	3:13 p.m.	55 26 30	162 52 00	43	47	43.5	16	bk. S	SW	2	WNW	0.8	L. B. T.
3271	...do	4:37 p.m.	55 29 15	162 58 00	43	47	41.9	25	bk. S	SW	2	W. ½ S	0.5	L. B. T.
3272	June 27	3:11 p.m.	55 31 40	163 07 00	43	45	42	31	bk. & rd. S	SW	3	NW. ⅝ W	0.5	L. B. T.
3273	...do	4:56 p.m.	55 44 30	162 56 00	44	45	38.5	39	gy. S. M	WSW	3	SSE	1.0	L. B. T.
3274	...do	7:33 p.m.	55 34 30	162 31 45	42	45	......	19	bk. S. Sh	SW	3	ESE	0.3	L. B. T.
3275	...do	8:59 p.m.	55 44 20	162 17 30	42	45	42.8	22	fne. bk. S	SSW	3	W. ½ S	1.5	L. B. T.
3276	June 28	4:38 a.m.	55 51 15	162 03 00	41	43	42	18	G. S. R	W	3	SE. by S	0.5	S. B. T.
3277	...do	6:32 a.m.	55 58 45	161 46 30	45	46	43.2	18	G. S. R	SW. by S	3	W. ½ S	1.0	Tangles.
3278	...do	10:19 a.m.	56 12 30	162 13 00	42	44	38.8	47	fne. gy. S	SW. by S	3	W. ½ S	0.75	L. B. T.
3279	...do	2:06 p.m.	56 25 40	162 39 15	43	55	37	41	fne. gy. S	SW	3	NE. by E. ½ E	0.5	L. B. T.
3280	...do	5:53 p.m.	56 27 00	162 08 00	44	55	41	36	fne. gy. S	SW	3	ESE	0.75	L. B. T.
3281	...do	8:58 p.m.	56 14 00	161 41 15	42	55	......	36	gy. S. bk. Sp	SW	3	SE	0.75	L. B. T.
3282	June 29	5:04 a.m.	56 30 45	161 50 15	42	55	38.2	53	fne. S. gn. M	SW. by S	3	NE. ¾ N	1.25	L. B. T.
3283	...do	8:18 a.m.	56 28 00	161 16 30	41	44	40.3	39	fne. gy. S	SW. by S	3	ESE	1.0	L. B. T.
3284	...do	12:15 p.m.	56 16 30	160 53 00	44	47	43	25	fne. G	S	2	E. by S	1.5	L. B. T.
3285	July 17	5:24 a.m.	56 45 45	160 42 45	43	44	41	35	gy. S. bk. Sp	SW	4	ESE	0.8	L. B. T.
3286	...do	7:29 a.m.	56 39 30	160 29 00	43	45	41.5	37	fne. gy. S. sh. G	SW	5	ESE	1.5	L. B. T.
3287	...do	9:35 a.m.	56 33 00	160 14 00	44	46	42	30	crs. bk. S	SW	5	SE. ¼ E	1.0	L. B. T.
3288	...do	11:35 a.m.	56 26 30	160 00 00	44	46	45.5	15	bk. G	SW	5	SE. ¼ E	1.0	L. B. T.
3289	July 18	5:04 a.m.	56 44 30	159 16 00	42	45	......	16	bk. S	WSW	2	SE. ¼ E	1.0	L. B. T.
3290	...do	7:07 a.m.	56 50 30	159 01 00	43	47	......	16	gy. S. G	WSW	2	SSE	1.25	L. B. T.
3291	...do	9:37 a.m.	56 58 30	159 11 00	42	45	41.2	26	bk. S. G	WSW	2	WNW	0.6	L. B. T.
3292	...do	1:3 p.m.	57 14 00	159 35 00	44	45	......	22	bk. S. G	SW	2	WNW	0.8	L. B. T.

3293	...do	5:26 p. m.	57	30	00	159	33	00	43	44	40	30	fne. gy. S	SW	2	SE. ½ E	1.5	L. B. T.
3294	...do	8:53 p. m.	57	16	45	159	03	30	42	45	41	30	bk. G	W	2	ESE	0.75	L. B. T.
3295	July 19	9:57 a. m.	57	14	30	158	26	30	47	50	......	11½	fne. gy. S	SSW	3	WNW	1.0	L. B. T.
3296	...do	12:33 p. m.	57	26	30	158	46	00	45	47	43	24	gy. S. bk. Sp	SW	3	W. ½ S	1.3	L. B. T.
3297	...do	3:25 p. m.	57	38	00	159	07	30	46	47	41.5	26	gy. S	SSW	2	NE. ¾ N	1.0	L. B. T.
3298	...do	8:52 p. m.	57	38	30	158	22	30	45	48	43.8	20	fne. gy. S	WSW	3	SE. by S	1.7	L. B. T.
3299	July 20	9.37 a. m.	57	59	00	158	44	00	49	54	44	20	fne. gy. S. yl. Sp	S	2	West	0.5	L. B. T.
3300	...do	5:04 p. m.	58	12	30	159	55	00	50	51	42.2	15	P	SSW	2	WNW	0.5	L. B. T.
3301	...do	9:56 p. m.	58	12	45	160	37	30	48	52	......	17	fne. gy. S	SSW	2	WNW	0.7	L. B. T.
3302	July 21	8:32 a. m.	57	45	45	160	12	15	48	51	40.2	30	fne. gy. S	SW. by W	3	SE. ½ E	1.0	L. B. T.
3303	...do	1:15 p. m.	57	27	00	160	23	30	48	50	39.5	33	bk. S	SW	2	NW. by W. ½ W	0.6	L. B. T.
3304	...do	8:21 p. m.	58	02	30	161	13	45	47	49	......	28	fne. gy. S	SW. by W	2	NW. by W. ½ W	1.0	C. R. D.
3305	July 22	9:03 a. m.	57	51	30	161	40	00	47	56	41.8	23	fne. gy. S	SW. by W	2	SE	0.5	C. R. D.
3306	...do	1:39 p. m.	57	24	30	161	17	00	46	52	38.9	33	fne. gy. S	SW. by W	2	SE	1.0	C. R. D.
3307	Aug. 3	6:27 a. m.	53	55	00	170	50	00	47	50	35.4	1,033	gn. oz	S. by E	5	NW. by W	4.5	D. S. T.
3308	Aug. 4	6:07 a. m.	56	12	00	172	07	00	47	50	35	1,625	gn. oz	NNE	3	NW. by N	6.5	D. S. T.
3309	...do	5:17 p. m.	56	56	00	172	55	00	46	50	37.9	71	gn. M	S	3	SW. by W	1.0	L. B. T.
3310	Aug. 15	7:14 a. m.	53	56	51	166	28	53	50	54	41.5	58	fne. dk. S. M	E	1	W. ¾ S	0.75	S. B. T.
3311	...do	9:55 a. m.	53	59	36	166	29	43	56	52	41	85	gn. M	SE	1	ENE. ½ E	1.0	S. B. T.
3312	...do	10:50 a. m.	53	59	11	166	25	09	57	55	43.0	45	fne. S. M	SE	1	N. ½ W	0.5	S. B. T.
3313	...do	12:53 p. m.	54	01	51	166	27	38	55	55	42.7	68	fne. bk. s	NE. by E	2	W	0.3	S. B. T.
3314	...do	2:05 p. m.	54	02	24	166	32	47	55	55	42.5	74	bk. S	NE. by N	2	S. by W. ½ W	1.1	S. B. T.
3315	...do	4.29 p. m.	54	02	40	166	42	00	56	55	38.5	277	gn. M. S	NE. by N	3	SE. ½ E	0.5	S. B. T.
3316	Aug. 16	6:25 a. m.	54	01	00	166	48	45	62	56	38.2	309	bk. S. G	SE	3	SW. by W. ¼ W	0.8	S. B. T.
3317	...do	10:04 a. m.	53	57	40	166	59	00	60	54	39.5	165	crs. S. G. R	SW. by S	3	S. by W. ¾ W	0.25	S. B. T.
3318	...do	2:55 p. m.	53	47	40	167	14	00	54	52	42.0	61	bk. S. G. Sh	SE	4	ESE	1.0	S. B. T.
3319	Aug. 18	1:38 p. m.	53	40	30	167	30	00	51	52	40.8	59	bk. S	W	2	SE. by E	0.5	L. B. T.
3320	...do	2:03 p. m.	53	40	00	167	29	45	51	52	40.8	59	bk. S. Co	W	2	SE. by E	0.8	Tangles.
3321	...do	4:13 p. m.	53	33	30	167	15	40	50	50	41.5	54	dk. M	NNE	1	......	......	L. B. T.
3322	...do	6:58 p. m.	53	28	45	167	23	50	51	50	42.4	35	bk. S	W	1	SW. by W	0.5	L. B. T.
3323	Aug. 19	7:18 a. m.	53	26	00	167	31	10	46	46	42.0	51	fne. bk. S	S	1	......	......	L. B. T
3324	Aug. 20	12:47 p. m.	53	33	50	167	46	50	47	47	......	109	crs. bk. S. G. R	S	2	WSW. ½ W	1.5	L. B. T.
3325	...do	2:10 p. m.	53	37	10	167	50	10	50	49	38.0	284	gn. M	WNW	2	ENE	2.0	L. B. T.
3326	...do	4:58 p. m.	53	40	25	167	41	40	50	49	37.5	576	M	S	2	SE. by E. ½ E	2.0	L. B. T.
3327	...do	7:59 p. m.	53	43	40	167	29	30	48	49	38.2	322	bk. S	NW	1	NE. by N	2.5	S. B. T.
3328	Aug. 21	6:25 a. m.	53	51	45	167	19	25	47	48	37.0	578	M	S	2	NNE	1.0	L. B. T.
3329	...do	9:45 a. m.	53	56	50	167	08	15	52	51	37.7	399	fne. bk. S	NW	2	NE. ½ N	1.0	L. B. T.
3330	...do	11:57 a. m	54	00	45	166	53	50	52	51	37.8	351	bk. S. M	NW	2	NE. by E. ¼ E	0.7	L. B. T.
3331	...do	1:30 p. m.	54	01	40	166	48	50	51	52	......	350	M	NW	2	NE. by E. ¼ E	0.7	L. B. T.
3332	...do	3.25 p. m.	54	02	50	166	45	00	52	52	......	406	Rky. S	NW	2	NE. ½ E	1.2	L. B. T.
3333	Aug. 22	6:33 a. m.	53	53	35	166	30	15	46	48	43.9	19	gn. M	WNW	1	NNE	0.7	S. B. T
3334	...do	7:33 a. m.	53	56	20	166	29	15	47	48	42.6	50	M. S	SSW	1	WNW. ½ W	0.7	S. B. T.
3335	...do	8:34 a. m.	53	58	05	166	33	25	47	47	40.8	93	M	SSW	1	WNW	0.25	S. B. T.
3336	...do	10:46 a. m.	53	56	55	166	33	35	50	50	41.6	55	fne. bk. S	Calm	0	S	0.3	S. B. T.
3337	Aug. 27	6:17 a. m.	53	55	30	163	26	00	50	51	39.3	280	gn. M. R	W. by S	2	ENE	1.0	L. B. T.
3338	Aug. 28	5:32 a. m.	54	19	00	159	40	00	52	51	37.3	625	gn. M. S	SE. by S	2	NE. by E	3.5	L. B. T.
3339	...do	5:13 p. m.	54	46	00	157	43	30	53	52	37.4	138	M. G	SSE	4	ENE	2.0	L. B. T.
3340	Aug. 29	6:25 a. m.	55	26	00	155	26	00	54	52	36.8	695	M	SSE	4	ENE	2.0	L. B. T.
3341	...do	5:53 p. m.	56	01	30	153	52	00	55	54	41.1	67	fne. gy. S	SE. by S	4	NE. by N	1.0	L. B. T.
3342	Sept. 3	4:37 p. m.	52	39	30	132	38	00	56	57	35.3	1,588	gy. oz. crs. S	NW	4	SE. by E	1.0	L. B. T.
3343	Sept. 21	9:27 a. m.	47	40	40	125	20	00	53	54	38.2	516	gn. M	NW	2	SE. by S	2.0	L. B. T.
3344	...do	1:24 p. m,	47	20	00	125	07	30	55	52	36.8	831	gn. M	NNW	2	......	......	L. B. T.

Record of dredging and trawling stations of the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Serial No.	Date.	Time.	Position.		Temperatures.			Depth.	Character of bottom.	Wind.		Drift (mag.).		Instrument used.
			Latitude N.	Longitude W.	Air.	Surface.	Bottom.			Direction.	Force.	Direction.	Distance.	
	1890.		° ′ ″	° ′ ″	°F.	°F.	°F.	Fms.					Miles.	
3345	Sept. 22	5:51 a. m.	45 39 00	124 53 00	56	57	37.3	759	gn. M	ESE	1	SW. ½ S	3.3	L. B. T.
3346	...do	9:27 a. m.	45 30 00	124 52 00	55	54	37.3	786	gn. M	SE. by S	2			L. B. T.
3347	...do	3:19 p. m.	45 09 35	124 45 00	54	54	40.9	345	M	SSE	3	SSW	2.5	L. B. T.
3348	Sept. 25	9:31 a. m.	39 02 40	124 06 15	53	54	47.6	455	fne. gy. S	NNW	2	SE.	1.5	L. B. T.
3349	...do	11:27 a. m.	38 57 45	124 03 05	55	54	44.1	239	bk. S	NNW	2	NE	1.5	L. B. T.
3350	...do	1:00 p. m.	38 58 10	123 57 05	55	54	48.4	75	fne. S. M	NNW	1	NE	0.7	L. B. T.
3351	...do	2:10 p. m.	38 59 40	123 50 50	55	54	50.0	51	M	NNW	2	NE	0.5	S. B. T.
3352	...do	3:13 p. m.	39 01 10	123 44 00	55	54	51.5	26	fne. br. S	NNW	1	S. ⅝ E	0.3	S. B. T.
	1891.													
3353	Feb. 23	8:56 a. m.	7 06 15	80 34 00	75	73	39	695	gn. M	Calm	0			L. B. T.
3354	...do	1:25 p. m.	7 09 45	80 50 00	80	78	46	322	gn. M	SE.	1	NNW. ¾ W	3.0	L. B. T.
3355	...do	3:01 p. m.	7 12 20	80 55 00	80	81	54.1	182	bk. G. Sh	ESE	1	NW. ½ W	0.5	L. B. T.
3356	...do	7.30 p. m.	7 09 30	81 08 30	80	83	40.1	546	sft. bl. M	SE.	1	SW. ½ S	1.4	L. B. T.
3357	Feb. 24	6:17 a. m.	6 35 00	81 44 00	80	83	38.5	782	gn. S	E	1	W. by S	0.8	L. B. T.
3358	...do	10:38 a. m.	6 30 00	81 44 00	83	83	40.2	555	gn. S	E	1	SW. by W. ¼ W.	1.0	L. B. T.
3359	...do	2:04 p. m.	6 22 20	81 52 00	82	83	42	465	rky	ENE	2	SSE	1.2	Tangles.
3360	...do	5:20 p. m.	6 17 00	82 05 00	81	83	36.4	1,672	fne. bk. & gn. S	SE.	1	W. by S	1.0	L. B. T.
3361	Feb. 25	7:33 a. m.	6 10 00	83 06 00	81	82	36.6	1,471	gn. Oz	SE.	1	WSW	2.0	L. B. T.
3362	Feb. 26	7:20 a. m.	5 56 00	85 10 30	80	84	36.8	1,175	gn. M. S. R.	SSW	2	SSW	1.8	L. B. T.
3363	...do	4:37 p. m	5 43 00	85 50 00	79	83	37.5	978	wh. glob. Oz	SW.	1	SSW	2.0	L. B. T.
3364	Feb. 27	6:58 a. m.	5 30 00	86 08 30	79	81	38	902	yl. glob. Oz	NW	1	W. ½ S.	1.3	L. B. T.
3365	...do	1:30 p. m.	5 31 00	86 31 00	82	85	37	1,010	yl. glob. Oz	NNE	1	W. by S	0.2	Agassiz, B. T.
3366	...do	8:04 p. m.	5 30 00	86 45 00	83	84	37	1,067	yl. glob. Oz	Calm	0	W	0.5	L. B. T.
3367	Feb. 28	6:38 a. m.	5 31 30	86 52 30	81	82	57	100	rky	SE.	1	WNW	0.5	S. B. T.
3368	...do	7:21 a. m.	5 32 45	86 54 30	81	82	58.4	66	rky	SE.	1	WNW	0.8	S. B. T.
3369	...do	8:07 a. m.	5 32 45	86 55 20	86	82	62.2	52	rky	SSE	1	WNW	0.2	L. B. T.*
3370	...do	10:03 a. m.	5 36 40	86 56 50	85	84	54.8	134	R. Sh	SSE	1	N. by E.	0.5	Tangles.
3371	Mar. 1	7:49 a. m.	5 26 20	86 55 00	78	82	39	770	glob. Oz	E	1	W. by S	0.5	Agassiz, B. T.
3372	...do	5:51 p. m.	4 49 00	86 11 20	85	84	38.8	761	gy. glob. Oz	E. by N	2	NE. by E.	1.5	Agassiz, B. T.
3373	Mar. 2	10:33 a. m.	4 02 00	84 58 00	83	82	36.6	1,877	bn. M. bk. Sp	NE. by E.	2	SE. ⅜ E	3.7	Agassiz, B. T.
3374	Mar. 3	10:35 a. m.	2 35 00	83 53 00	81	80	36.4	1,823	gn. Oz	E. by N		E	2.5	L. B. T.
3375	Mar. 4	6:36 a. m.	2 34 00	82 29 00	76	77	36.6	1,201	gy. glob. Oz	ENE	2	NE	1.0	L. B. T. and mud bag.
3376	...do	4:27 p. m.	3 09 00	82 08 00	79	78	36.3	1,132	gy. glob. Oz	NE. by N	3	NNE	1.0	Do.
3377	Mar. 5	8:38 a. m.	3 56 00	81 40 15	79	77	38.0	764	M	NE. by E	3	NE. by N	1.5	Do.
3378	...do	11:45 a. m.	3 58 20	81 36 00	79	78	55.9	112	brk. Sh	NE	3	N. by E	0.8	S. B. T.
3379	...do	2:15 p. m.	3 59 40	81 35 00	79	78		52	R	NE	3			Tangles.
3380	...do	4:51 p. m.	4 03 00	81 31 00	79	79	37.2	899	R	NNE	3	ESE	1.0	L. B. T.
3381	Mar. 6	8:38 a. m.	4 56 00	80 52 30	78	77	35.8	1,772	gn. M	NE	2	ENE	1.0	L. B. T.
3382	Mar. 7	10:46 a. m.	6 21 00	80 41 00	77	75	35.8	1,793	gn. M	N	3	ENE	2.0	L. B. T. †
3383	Mar. 8	6:51 a. m.	7 21 00	79 02 00	75	74	36.0	1,832	gn. glob. Oz	N	1	NW. by N	2.5	L. B. T.

3384	...do....	1:20 p. m.	7 31 30	79 14 00	79	74	42.0	458	gn. S	NNW	1	NW	0.5	L. B. T.
3385	...do....	3:07 p. m.	7 32 36	79 16 00	75	72	45.9	286	gn. M	N	1	NW	1.0	L. B. T.
3386	...do....	4:54 p. m.	7 33 12	79 17 15	76	73	48.0	242	fne. gy. S	N	1	NNW	0.5	L. B. T.
3387	...do....	7:21 p. m.	7 40 00	79 17 50	77	74	56.2	127	fne. gy. S	N	2	NNW	0.8	L. B. T.
3388	Mar. 9	6:41 a. m.	7 06 00	79 48 00	75	73	36.2	1,168	gn. glob. Oz	N	3	NW. ½ N	2.3	L. B. T.‡
3389	...do....	2:10 p. m.	7 16 45	79 56 30	77	74	48.8	210	gn. M	N. by E	2	N. ½ E	0.7	L. B. T.
3390	...do....	4:25 p. m.	7 26 10	79 53 50	77	74	62.6	56	fne. gy. S. G	N. by E	2	N. by E	2.0	L. B. T.
3391	...do....	7:15 p. m.	7 33 40	79 43 20	77	73	55.8	153	gn. M	N. by E	3	W. ¼ N	0.7	L. B. T.
3392	Mar. 10	6:30 a. m.	7 05 30	79 40 00	76	73	36.4	1,270	hrd	N	4	NNE	1.5	L. B. T.
3393	...do....	1:21 p. m.	7 15 00	79 36 00	77	74	36.8	1,020	gn. M	N	5	NNW	1.5	L. B. T.
3394	...do....	5:43 p. m.	7 21 00	79 35 00	76	73	41.8	511	dk. gn. M	N	4	NNW	1.0	L. B. T.
3395	Mar. 11	2:20 p. m.	7 30 36	78 39 00	77	70	38.5	730	rky	NW	2	NE	1.0	L. B. T.
3396	...do....	5:15 p. m.	7 32 00	78 36 30	77	70	47.4	259	hrd. gy. M. S	E	1	E. by N	0.5	L. B. T.
3397	...do....	6:32 p. m.	7 33 00	78 34 20	76	71	57.3	85	sft. gn. M. brk. Sh	NE	1	N. by W	0.7	L. B. T.
3398	Mar. 23	3:16 p. m.	1 07 00	80 21 00	84	84	36.0	1,573	gn. Oz	Calm	0	SW	2.3	Blake B. T.
3399	Mar. 24	6:37 a. m.	1 07 00	81 04 00	79	80	36.0	1,740	gn. Oz	Calm	0	SW	2.0	L. B. T.
			South.											
3400	Mar. 27	6:10 a. m.	0 36 00	86 46 00	81	81	36.1	1,322	lt. gy. glob. Oz	SE	1	SW	1.5	L. B. T.
3401	Mar. 28	4:45 a. m.	0 59 00	88 58 30	81	82	43.8	395	glob. Oz	S. by E	2	SW. by W	0.2	L. B. T.
3402	...do....	7:13 a. m.	0 57 30	89 03 30	81	82	42.3	421	R. glob. Oz	S. by E	2	W. by S	1.2	S. B. T.
3403	...do....	10:19 a. m.	0 58 30	89 17 00	82	82	43.3	384	fne. gy. S. bk. Sp	S. by E	2	SW. ½ S	1.3	S. B. T.
3404	...do....	1:16 p. m.	1 03 00	89 28 00	84	83	43.2	385	R	S. by E	2	N. by W	0.3	S. B. T.
3405	...do....	3:42 p. m.	0 57 00	89 38 00	84	83	59.9	53	P. Co. Sh	SSW	2	WNW	0.2	Tangles.
3406	Apr. 3	6:47 a. m.	0 16 00	90 21 30	79	81	41.3	551	R	S	1	NW	0.5	S. B. T.
3407	...do....	10:48 a. m.	0 04 00	90 24 30	80	81	37.2	885	glob. Oz	N	2	NW. by W	1.5	L. B. T.
			North.											
3408	...do....	4:07 p. m.	0 12 30	90 32 30	83	83	39.5	684	glob. Oz	Calm	0	NNW. ½ W	0.5	L. B. T.
3409	...do....	7:24 p. m.	0 18 40	90 34 00	80	82	42.3	327	bk. S	N	1	NW. ½ W	1.5	S. B. T.
3410	...do....	8:48 p. m.	0 19 00	90 34 00	79	82	44.0	331	bk. S	NW	1	NW	1.0	S. B. T.
3411	Apr. 4	7:35 a. m.	0 54 00	91 09 00	79	82	36.2	1,189	yl. glob. Oz	WSW	2	NW. ⅜ W	1.3	L. B. T.
3412	...do....	6:11 p. m.	1 23 00	91 43 00	81	82	38.0	918	R	W. by S	3	SW	1.8	L. B. T.
3413	Apr. 5	8.34 a. m.	2 34 00	92 06 00	79	82	36.0	1,360	glob. Oz. dk. Sp	NW	1	NW. by N	1.7	L. B. T.
3414	Apr. 8	11:14 a. m.	10 14 00	96 28 00	81	82	35.8	2,232	gn. M	ENE	3	NE	2.5	L. B. T.†
3415	Apr. 10	9:39 a. m.	14 46 00	98 40 00	84	83	36.0	1,879	bn. M. glob. Oz	Calm	0	N. by W	1.5	L. B. T.
3416	Apr. 11	9:46 a. m.	16 32 30	99 42 40	82	81	40.5	419	bn. M	WSW	1	NW	0.3	L. B. T.
3417	...do....	11:44 a. m.	16 32 00	99 48 00	83	82	40.6	493	gn. M	WSW	1	SE. by E	0.4	S. B. T.
3418	...do....	2:57 p. m.	16 33 00	99 52 30	82	82	39.0	660	bn. S. bk. Sp	SW. by W	2	WSW. ½ W	1.5	S. B. T.
3419	...do....	5:59 p. m.	16 34 30	100 03 00	82	81	39.0	772	gn. M. bk. Sp	WSW	2	W. by S	1.0	S. B. T.
3420	Apr. 12	7:48 a. m.	16 46 00	100 08 20	81	82	39.6	664	dk. gn. M	WNW	3	E. by S	0.7	S. B. T.
3421	...do....	11:32 a. m.	16 47 20	100 00 10	82	82	42.9	388	dk. gn. M	WNW	2	NE. by E. ¾ E	0.5	S. B. T.
3422	..do....	12:35 p. m.	16 47 30	99 59 30	84	83	53.3	141	gn. M	WSW	2	....	....	S. B. T.
3423	...do....	1:31 p. m.	16 47 30	99 59 20	84	83	55.8	94	gn. M	WSW	2	....	....	S. B. T.
3424	Apr. 18	11:18 a. m.	21 15 00	106 23 00	76	76	38.0	676	gy. S. bk Sp	NW	2	NW	0.5	S. B. T.
3425	...do....	2:14 p. m.	21 19 00	106 24 00	75	76	39.0	680	gn. M. S	W	1	NNW	0.5	S. B. T.
3426	...do....	3:45 p. m.	21 21 00	106 25 00	75	76	51.2	146	rky	W	1	....	....	S. B. T.
3427	...do....	4:03 p. m.	21 22 15	106 25 00	75	76	51.2	80	rky	W	1	N	0.4	Tangles.
3428	..do....	6:40 p. m.	21 36 30	106 25 00	75	76	48.1	238	dk. gy. S	SW	2	NNW	0.6	S. B. T.
3429	Apr. 19	5:39 a. m.	22 30 30	107 01 00	73	73	37.5	919	gn. Oz. rky	SE. by S	1	NW. by W	1.2	S. B. T.
3430	...do....	3:27 p. m.	23 16 00	107 31 00	74	73	37.9	852	bk. S	W	2	NW	0.5	S. B. T.

* Bottom also known as Nullipore. † Three trials submarine tow net. ‡ Lowered submarine tow net.

Record of dredging and trawling stations of the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Serial No.	Date.	Time.	Position.		Temperatures.			Depth.	Character of bottom.	Wind.		Drift (mag.).		Instrument used.
			Latitude N.	Longitude W.	Air.	Surface.	Bottom.			Direction.	Force.	Direction.	Distance.	
	1891.		° ′ ″	° ′ ″	°F	°F	°F	*Fms.*					*Miles.*	
3431	Apr. 20	6:33 a. m.	23 59 00	108 40 00	69	70	37.0	995	lt. bn. M	W. by N.	2	NNW. ¼ W	1.0	S. B. T.
3432	...do	2:38 p. m.	24 22 30	109 03 20	72	70	37.8	1,421	bn. M. bk. Sp	WNW	2	....	....	L. B. T.
3433	Apr. 21	6:34 a. m.	25 26 15	109 48 00	73	69	36.5	1,218	bn. M. bk. Sp	WNW	2	NW	1.5	S. B. T.
3434	...do	10:14 a. m.	25 29 30	109 48 00	71	70	36.4	1,588	bn. M. bk. Sp	WNW	2	NW	1.0	S. B. T.
3435	Apr. 22	8:56 a. m.	26 48 00	110 45 20	72	70	37.3	859	bn. M. bk. Sp	WNW	1	NW. ½ N	1.0	S. B. T.
3436	...do	3:10 p. m.	27 03 40	110 53 40	75	72	37.2	905	bn. M. bk. Sp	WNW	1	WNW	1.0	S. B. T.*
3437	Apr. 23	5:31 a. m.	27 39 40	111 00 30	71	70	40.0	628	bn. M. bk. Sp	E	1	....	....	Submarine tow net.

* Lowered submarine tow net.

Table of fishing stations, coasts of Oregon and Washington, season of 1888.

Date.	Serial number.		Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Bottom temp.	Instrument used.	Length of time.	Food fishes taken.
1888.			° ′ ″	° ′ ″	Fms.		°		hrs. m.	
Sept. 6	Dredge	2864	48 22 00	122 51 00	48	M. brk. Sh. &S	47.7	Beam trawl	0 11	Nothing.
6	...do	2865	48 12 00	122 49 00	40	P	51.7	....do	0 08	Do.
20	...do	2866	48 09 00	125 03 00	171	gy. S	43.2	....do	0 17	Rose-fish, 3 species, prawns.
20	...do	2867	48 07 00	124 55 00	37	fne. gy. S		....do	0 12	Tomcod, flounders, prawns.
20	...do	2867						Trawl lines		1 halibut.
21	...do	2868	47 52 00	124 44 00	31	gy. S	46.9	Beam trawl	0 18	Tomcod, black cod, red rock-cod.
21	...do	2868						6 hand lines	0 10	Nothing.
21	...do	2868						Trawl lines	0 30	Do.
21	...do	2869	47 38 00	124 39 00	32	bk. S	48.4	Beam trawl	0 20	Flounders, halibut, tomcod, prawns.
23	...do	2870	46 44 00	124 32 00	58	rky	46.5	....do	0 20	Tomcod, red rock-cod, black-cod, prawns.
23	...do	2870						Trawl lines	0 30	2 black-cod, 10 red rock-cod.
23	...do	2870						8 hand lines	0 15	3 red rock-cod.
23	...do	2871	46 55 00	125 11 00	559	br. Oz	38.4	Beam trawl	0 32	Rose-fish, grenadier.
24	...do	2872	48 17 00	124 52 00	38	gy. S	45.5	....do	0 17	2 species flounders.
24	...do	2872						Trawl lines	0 30	Nothing.
24	...do	2872						3 hand lines	0 15	2 red rock-cod.
24	...do	2873	48 30 00	124 57 00	40	rky	47.8	Beam trawl	0 08	2 species rock-cod, halibut, prawns.
24	...do	2873						Trawl lines	0 30	4 halibut, 4 red rock-cod.
25	...do	2876	48 33 00	124 53 00	59	bk. S. & M	45.5	Beam trawl	0 10	Red rock-cod, halibut.
25	...do	2876						Trawl lines	0 30	2 halibut, 1 red rock-cod.
25	...do	2876						3 hand lines	0 15	1 red rock-cod.
25	...do	2878	48 37 00	125 32 00	66	P	45.5	Ship's dredge	0 09	Black-cod.
25	...do	2878						Trawl lines	0 40	3 black-cod.
29	Hyd	1575	48 27 00	125 09 00	60	S & R	45.2	....do	0 30	3 halibut, 2 black-cod.
Oct. 10	...do	1576	48 16 00	123 40 00	101	S & G	45.2	....do	1 00	Nothing.
11	...do	1577	46 34 00	124 12 30	20	gy. S	52.9	8 hand lines	0 15	Do.
13	Dredge	2882	46 09 00	124 22 30	68	gy. S	45.9	Beam trawl	0 27	Flounders, red rock-cod, black-cod.
13	...do	2882						Trawl lines	0 35	1 black-cod.
18	...do	2883	45 56 00	124 01 30	29	fne. gy. S	50.2	Ship's dredge	0 09	Nothing.
18	...do	2883						Trawl lines	0 30	Do.
18	...do	2884	45 55 00	124 02 00	29	fne. gy. S	50.2	Ship's dredge	0 16	Do.
18	...do	2885	45 56 00	124 02 30	30	fne. gy. S	49.1	....do	0 22	Do.
18	...do	2885						8 hand lines	0 10	1 red rock-cod.
19	...do	2886	43 59 00	124 56 30	50	rky	48.1	Ship's dredge	0 06	Nothing.
19	...do	2886						Trawl lines	2 00	1 halibut.
19	...do	2886						8 hand lines	0 20	Nothing.
19	...do	2887	43 58 00	124 57 00	42	C. & P	47.1	Beam trawl	0 15	Halibut, black-cod, red rock-cod, orange rock-cod, rosy rock-cod, yellow-tail rock-cod, reina rock-cod, sea trout.
19	...do	2888	43 58 00	124 57 30	41	C. & P	47.6	....do	0 05	Nothing.
19	...do	2889	43 59 00	124 56 30	46	C. & St	47.7	....do	0 16	Do.
19	...do	2890	43 46 00	124 57 00	277	gy. C	42.2	....do	0 37	Grenadier.

Table of fishing stations, coasts of Oregon and Washington, season of 1889.

Date.	Serial number.		Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Bottom temp.	Instrument used.	Length of time.	Food-fishes taken.
1889.			° ′ ″	° ′ ″	Fms.		°		hrs. m.	
June 7	Dredge	3046	46 48 30	124 28 00	48	fne. gy. S	46.1	Beam trawl	0 28	Flounders, tomcod, shrimps.
7	...do	3047	46 47 00	124 30 15	50	......do	45.9	....do	0 35	Do.
7	...do	3048	46 45 30	124 33 00	52	rky	45.1	....do	0 30	Do.
7	Hyd	1835	46 44 45	124 32 45	52	......do	45.1	7 hand lines	....	3 orange rock-cod, 1 black rock-cod.
7	Dredge	3049	44 31 00	124 22 00	43	fne. bk. S	46.7	Beam trawl	0 24	Flounders, tomcod, shrimps.
8	...do	3050	43 01 15	124 57 00	46	Co. brk. Sh	56.1	Trawl lines	3 15	12 red rock-cod, 1 sea trout.
8	...do	3050	....	....	46	......do	56.1	9 hand lines	0 37	2 orange rock-cod, 5 red rock-cod.
8	...do	3052	43 00 00	124 57 00	48	Co. brk. Sh. rky	49.0	....do	1 05	21 red rock-cod, 2 orange rock-cod, 1 cutter's cod, 4 yellow-tail rock-cod.
8	Hyd	1839	44 59 30	124 50 30	43	M. & G	52.1	10 hand lines	1 10	34 red rock-cod, 1 yellow-tail rock-cod.
8	Dredge	3054	44 13 00	124 44 30	53	rky	48.0	11 hand lines	....	1 yellow-tail rock-cod.
9	...do	3055	44 41 30	124 09 15	28	fne. gy. S	47.4	Beam trawl	0 24	Flounders, crabs, shrimps.
9	...do	3055	....	....	28	......do	47.4	Trawl lines	0 55	Nothing.
9	...do	3056	44 41 30	124 09 15	28	......do	47.4	Beam trawl	0 22	Flounders, crabs, shrimps.
9	...do	3057	44 43 30	124 15 45	43	crs. gy. S	45.7	....do	0 33	Flounders, red rock-cod, shrimps.
9	...do	3057	....	....	43	......do	45.7	3 hand lines	1 15	20 orange rock-cod.
9	...do	3058	44 48 00	124 10 00	38	crs. gy. S. Sh	45.8	Beam trawl	0 16	Several species flounders.
9	...do	3058	....	....	38	......do	45.8	8 hand lines	0 22	Nothing.
9	...do	3059	44 56 00	124 12 30	77	M	45.1	Beam trawl	0 30	Flounders.
9	...do	3060	45 56 15	124 01 30	28	br. M	....	....do	0 14	Flounders, tomcod, crabs, shrimps.
13	...do	3060	....	....	28	......do	....	Trawl lines	0 50	Nothing.
13	...do	3061	45 55 30	124 01 00	23	fne. bk. S	48.4	Beam trawl	0 22	Flounders, tomcod, smelt, crabs, shrimps.
13	...do	3062	46 55 45	124 05 00	44	......do	45.2	....do	0 13	Flounders, shrimps.
13	...do	3062	....	....	44	......do	45.2	9 hand lines	0 25	1 orange rock-cod.
13	...do	3063	46 55 15	124 04 30	42	fne. gy. S	45.8	Beam trawl	0 21	Flounders, shrimps.
13	...do	3063	....	....	42	......do	45.8	9 hand lines	0 15	Nothing.
13	...do	3063	....	....	42	......do	45.8	Trawl lines	1 05	1 halibut.
13	Hyd	1854	45 55 30	124 01 15	25	......do	48.6	10 hand lines	0 35	Nothing.
13	Dredge	3064	46 03 15	124 09 00	46	fne. gy. S. & G	45.6	Beam trawl	0 18	Flounders, tomcod, shrimps.
13	Dredge	3064	46 03 15	124 09 00	46	fne. gy. S. and G	45.6	9 hand lines	0 15	Nothing.
13	...do	3065	46 14 30	124 13 00	27	fne. bk. S	....	Beam trawl	0 14	6 species flounders, tomcod, shrimps.
13	...do	3065	....	....	....	....	....	7 hand lines	0 15	Nothing.
13	...do	3066	46 26 30	124 26 00	55	S. and M	45.6	Beam trawl	0 17	4 species flounders, shrimps.
13	...do	3066	....	....	....	....	....	9 hand lines	0 13	Nothing.
13	Hyd	1856	48 29 30	124 56 30	31	G. and brk. Sh	47.1	8 hand lines	1 10	1 halibut, 4 red rock-cod.
13	...do	1856	....	....	....	....	....	Trawl lines	3 25	8 halibut, 1 cultus-cod, 10 red rock-cod, 2 orange rock-cod, 1 sea trout.
18	Dredge	3067	47 36 00	122 23 15	82	gn. M	....	Beam trawl	0 20	2 species flounders, shrimps.
18	...do	3068	47 35 30	122 27 00	135	......do	51.1	....do	0 22	3 species flounders, shrimps.
28	...do	3069	47 25 30	125 42 00	760	......do	37.6	....do	0 38	Shrimps.
28	...do	3070	47 29 30	125 43 00	636	......do	37.9	....do	0 38	Norway haddock, macrurus, shrimps.
28	...do	3071	47 29 00	125 33 30	685	......do	38.0	....do	0 35	Do.
28	...do	3072	47 28 30	125 24 00	584	......do	38.2	....do	0 42	Small fishes, undetermined.

	28	...do	3073	47	28	00	125	15	00	477	......do	49.2	....do	0	45	Sole, Norway haddock, macrurus, shrimps.
	29	...do	3074	47	22	00	125	48	30	877	......do	36.6	....do	0	28	Macrurus, shrimps.
	29	...do	3075	47	22	00	125	41	00	859	......do	36.6	....do	0	44	Black-cod, Norway haddock, macrurus, shrimps.
	29	...do	3076	47	46	00	125	10	00	178	......do	43.4	....do	0	20	Red rock-cod, Norway haddock, flounders, shrimps.
Aug.	30	Hyd	1910	44	34	30	124	10	00	28	fne. gy. S	48.5	9 hand lines	0	40	1 orange rock-cod, 3 whiting.
	31	...do	1929	44	07	30	124	11	00	29	......do	47.7	11 hand lines	0	12	Nothing.
Sept.	1	Dredge .	3078	43	59	15	124	46	00	68	G. and M	45.7	Beam trawl	0	10	Shrimps, prawns.
	1	Hyd	1958	44	01	00	124	49	15	58	rky		7 hand lines	0	20	3 orange rock-cod.
	1	...do	1958										Hand lines,	1	00	1 red rock-cod, 1 whiting.
	1	Dredge .	3079	43	59	15	124	44	40	55	rky	46.7	3 hand lines	1	15	3 yellow-tail rock-cod.
	1	Hyd	1979	44	00	00	124	45	00	52	......do	47.2	8 hand lines	0	35	13 orange rock-cod, 6 red rock-cod, 6 yellow-tail rock-cod.
	1	Dredge .	3080	43	58	00	124	36	00	93	gn. M	45.6	Beam trawl	0	30	4 species flounders, 1 black-cod, 3 species rockfish, 6 cultus-cod, small fish.
	1	...do	3081	43	59	00	124	20	00	61	gn. M. & S	45.8	....do	0	25	6 species flounders, 2 black-cod, 4 species rockfish, crabs, prawns.
	2	...do	3032	43	52	00	124	15	00	43	fne. gy. S	46.2	....do	0	12	3 species flounders.
	2	Dredge .	3082	43	52	00	124	15	00	43	fne. gy. S	46.2	8 hand lines	0	11	Nothing.
	2	...do	3083	43	59	00	124	14	30	32	fne. gy. S. bk. Sp	47.8	Beam trawl	0	16	7 species flounders.
	2	...do	3083										11 hand lines	0	22	9 red rock-cod, 2 whiting.
	2	Hyd	1980	44	00	00	124	11	30	18	fne. gy. S		....do	1	00	52 black rock-cod.
	2	...do	1981	44	01	30	124	11	30	24	yl. S	48.8	10 hand lines	0	30	5 black rock-cod, 8 orange rock-cod.
	2	Dredge .	3084	44	12	30	124	19	00	46	fne. gy. S. bk. Sp	46.9	Beam trawl	0	18	4 species flounders.
	2	...do	3084										11 hand lines	0	45	10 black-cod, 9 whiting.
	2	Hyd	1982	44	16	00	124	12	00	31	fne. gy. S	47.7	....do	0	53	2 flounders, 24 whiting, 14 red rock-cod.
	2	...do	1983	44	16	30	124	09	00	19	......do		....do	0	35	3 whiting, 3 black-cod, 2 red rock-cod.
	2	...do	1984	44	18	00	124	08	30	12	......do		7 hand lines	0	25	3 black rock-cod.
	2	...do	1985	44	20	00	124	13	00	31	wh. S. bk. Sp. Sh	47.8	9 hand lines	0	20	1 orange rock-cod,
	2	Dredge .	3085	44	29	30	124	17	00	42	rky	45.7	Beam trawl	0	16	1 flounder, prawns.
	3	...do	3086	44	36	00	124	18	30	46	fne. gy. S. bk. Sp	46.2	....do	0	22	1 species flounder.
	3	Hyd	1986	44	37	00	124	15	00	44	gy. S	47.5	8 hand lines	0	28	37 black-cod.
	3	...do	1987	44	35	00	124	13	00	43	fne. gy. S. gn. M	46.2	9 hand lines	0	10	3 orange rock-cod, 1 black-cod.
	3	...do	1988	44	33	00	124	11	00	32	bk. S	46.7	7 hand lines	0	30	45 orange rock-cod, 2 whiting, 1 black-cod.
	3	...do	1990	44	27	00	124	24	30	44	C	46.5	11 hand lines	0	21	3 red rock-cod, 1 flounder.
	3	Dredge .	3088	44	28	00	124	25	30	46	Co. and R	46.3	Beam trawl	0	10	Nothing.
	3	Hyd	1992	44	28	00	124	24	30	43	rky	47.2	11 hand lines	0	28	6 orange rock-cod.
	3	...do	1993	44	39	00	124	08	30	29	fne. gy. S. bk. Sp	48.2	9 hand lines	0	35	2 orange rock-cod, 1 black-cod, 1 whiting.
	3	...do	1994	44	41	00	124	09	00	28	......do	46.9	10 hand lines	0	30	1 orange rock-cod.
	7	...do	1996	45	45	30	124	02	30	40	fne. gy. S	45.3	12 hand lines	0	26	1 salmon.
	7	...do	1997	45	44	30	123	59	30	22	......do		....do	0	15	1 orange rock-cod.
	7	...do	1998	45	43	00	123	58	15	15	......do		11 hand lines	0	12	Do.
	7	Dredge .	3089	45	40	30	123	58	45	20	......do		Beam trawl	0	19	12 tomcod, flounders, shrimps.
	7	...do	3089										10 hand lines	0	30	11 orange rock-cod, 2 flounders.
	7	...do	3090	45	43	00	124	12	00	62	fne. gy. S	45.8	Beam trawl	0	26	1 species rock-cod, 3 species flounders, whiting, shrimps.
	8	...do	3091	45	32	00	124	19	30	87	gn. M		....do	0	28	Red rock-cod, 4 species flounders, small fish, prawns.
	8	Dredge .	3092	45	31	15	124	05	00	46	bk. S	45.9	Beam trawl	0	15	4 species flounders, crabs.
	8	...do	3092										11 hand lines	0	32	1 red rock-cod.
	8	Hyd	1999	45	31	15	123	00	45	25	fne. gy. S	47.2	10 hand lines	0	20	14 orange rock-cod.
	8	...do	2000	45	35	00	123	58	15	18	gy. S. rd. Sp	48.4	....do	0	35	21 red rock-cod, 1 orange rock-cod, 1 black rock-cod, 1 yellow-striped rock-cod, 1 cultus-cod.

Table of fishing stations, coasts of Oregon and Washington, season of 1889—Continued.

Date.	Serial number.		Position. Lat. N.	Position. Long. W.	Depth.	Character of bottom.	Bottom temp.	Instrument used.	Length of time.	Food-fishes taken.
1889.			° ′ ″	° ′ ″	Fms.		°		hrs. m.	
Sept. 8	Hyd	2001	45 30 00	124 59 45	18	fne. gy. S	48.5	7 hand lines	1 10	Nothing.
8	...do	2002	45 28 30	124 00 00	16	......do	48.2	10 hand lines	0 15	1 orange rock-cod.
8	...do	2003	45 26 30	124 00 15	21	rky	48.0	8 hand lines	0 23	1 red rock-cod, 1 cultus-cod.
8	...do	2004	45 23 00	124 00 30	18	fne. gy. S	....	9 hand lines	0 14	1 flounder.
8	Dredge .	3093	45 20 30	124 06 30	57	......do	44.9	Beam trawl	0 11	Nothing.
8	...do	3093	....	....	....	....	....	9 hand lines	0 18	Do.
8	Hyd	2005	45 19 00	124 02 30	39	fne. gy. S	46.7	....do	0 22	2 orange rock-cod, 1 salmon.
8	...do	2006	45 19 00	124 00 30	23	fne. bk. S	47.2	10 hand lines	0 15	Nothing.
9	...do	2007	45 17 30	124 00 30	19	fne. gy. S. bk. Sp	47.7	....do	0 07	Do.
9	...do	2008	45 13 00	124 00 30	27	fne. gy. S	47.7	....do	0 08	Do.
9	...do	2009	45 11 30	124 00 00	19	fne. gy. S. yl. M	....	9 hand lines	0 10	1 orange rock-cod.
9	...do	2010	45 10 30	123 59 45	15	fne. bk. S	....	....do	0 17	1 orange rock-cod, 1 black rock-cod.
9	...do	2011	45 11 00	124 03 30	34	fne. gy. S. bk. Sp	45.8	10 hand lines	0 20	8 black-cod, 2 orange rock-cod.
9	...do	2016	45 07 15	124 03 00	33	fne. gy. S	46.2	9 hand lines	0 24	2 black-cod, 12 orange rock-cod.
9	...do	2017	45 07 00	124 00 30	15	......do	....	11 hand lines	0 22	2 orange rock-cod, 1 flounder.
9	...do	2018	45 04 00	124 02 30	23	......do	....	....do	0 14	3 orange rock-cod.
9	...do	2019	45 04 00	124 06 15	51	......do	46.0	10 hand lines	0 17	7 black-cod.
9	...do	2022	45 01 15	124 07 00	52	bk. S	46.2	....do	0 10	1 black-cod.
9	...do	2023	45 00 45	124 03 45	27	fne. gy. S	....	12 hand lines	0 13	4 orange rock-cod.
9	...do	2024	45 00 30	124 02 15	16	fne. gy. S. bk.; sp. brk. Sh.	....	10 hand lines	0 20	Nothing.
9	...do	2025	44 58 30	124 04 00	19	rky. and Sh	47.7	8 hand lines	0 12	Do.
10	...do	2026	44 03 45	124 12 00	30	fne. gy. S	....	....do	0 15	5 orange rock-cod.
10	...do	2027	44 03 15	124 16 30	42	fne. gy. S. and Sh	46.0	7 hand lines	0 15	3 orange rock-cod.
10	...do	2028	43 54 00	124 11 00	13	fne. gy. S	47.1	10 hand lines	0 10	Nothing.
10	Hyd	2029	43 49 00	124 14 00	36	fne. gy. S	46.7	10 hand lines	0 10	1 red rock-cod.
10	...do	2030	43 47 00	124 12 00	13	......do	....	8 hand lines	0 08	Nothing.
10	...do	2031	43 42 30	124 14 30	28	......do	....	11 hand lines	0 29	27 orange rock-cod.
10	...do	2032	43 40 30	124 15 00	28	......do	....	....do	0 12	1 orange rock-cod.
10	...do	2033	43 37 00	124 16 00	53	......do	45.9	10 hand lines	0 15	1 black rock-cod; 3 orange rock-cod.
10	...do	2034	43 34 00	124 16 30	40	......do	46.7	11 hand lines	0 25	22 orange rock-cod.
10	...do	2035	43 31 00	124 16 00	11	......do	....	10 hand lines	0 10	Nothing.
10	...do	2036	43 27 30	124 18 00	23	......do	48.2	9 hand lines	0 10	Do.
10	...do	2037	43 23 30	124 21 30	17	......do	....	....do	0 10	Do.
10	...do	2038	43 19 00	124 25 30	28	......do	48.7	8 hand lines	0 10	Do.
10	...do	2039	43 13 00	124 26 00	27	......do	47.7	....do	0 20	Do.
10	...do	2040	43 08 30	124 28 00	25	rky. and Co	46.1	....do	0 10	Do.
12	...do	2066	43 03 30	124 33 30	44	G	45.8	6 hand lines	0 20	Do.
12	...do	2067	43 04 30	124 26 30	21	fne. gy. S	46.2	8 hand lines	0 15	Do.
12	...do	2068	43 08 00	124 27 30	25	rky	....	9 hand lines	0 20	1 orange rock-cod; 1 cultus-cod.
12	Dredge .	3094	43 01 00	124 30 30	35	crs. S. and Sh	46.7	Ship's dredge	0 11	Crabs.
12	...do	3094	....	....	....	....	....	8 hand lines	0 15	Nothing.

12	Hyd	2069	43	00	00	124	27	30	17	fne. gy. S.	47.2	....do	0	17	Do.
12	...do	2070	42	55	00	124	32	30	28	......do	46.1	....do	0	18	Do.
12	...do	2071	42	53	00	124	34	00	17	......do	....	5 hand lines	0	14	Do.
12	...do	2072	42	51	15	124	37	00	34	......do	47.7	7 hand lines	0	13	Do.
12	...do	2073	42	48	15	124	37	45	29	......do	....	....do	0	10	Do.
12	...do	2073	...	...	...	...	...	...	....	....	....	Dory hand lines	2	22	2 vermilion rock-cod; 7 red rock-cod; 1 black rock cod; 5 cultus-cod; 1 orange rock-cod.
12	...do	2075	42	45	30	124	38	15	34	St. and brk. Sh.	46.8	10 hand lines	0	20	14 red rock-cod; 1 brown rock-cod; 1 cultus-cod.
12	Dredge .	3096	42	45	00	124	36	15	33	......do	46.7	9 hand lines	0	15	1 orange rock-cod; 1 red rock-cod.
12	Hyd	2076	42	44	15	124	33	00	23	fne. gy. S.	47.5	8 hand lines	0	10	Nothing.

Table of fishing stations for cod, Alaskan cruise of 1890, chiefly in Bristol Bay and off the north side of Unalaska Island.

Date.	Serial number.		Position. Lat. N.	Position. Long. W.	Depth.	Nature of bottom.	Length of trial.	No. of lines used.	No. of cod taken.	Range in weight.	Average weight.	Range in length.	Average length.	Bait used.
1890.			° ′ ″	° ′ ″	*Fathoms.*		*Min.*			*Pounds.*	*Pounds.*	*Inches.*	*Inches.*	
May 21	Dredge	3213	54 10 00	162 57 30	41	bk. S	20	10	1		10			Salt salmon.
21	Dredge	3213	54 10 00	162 57 30	41	......do		Beam trawl.	3	1 to 6	2¾	13 to 26	16	
21	Dredge	3214	54 13 00	163 06 00	38	gy. S. G	33	10	12	7 to 18½	13¼	26 to 36	32⅓	Do.
22	Hyd	2279	54 15 00	164 53 00	42	rocky	20	12	5	6 to 13	11	25 to 32	28⅔	Fresh salmon, sculpins.
22	Dredge	3224	54 42 50	165 37 00	121	bk. S. G		Beam trawl.	1		7½			
23	Dredge	3226	55 01 00	167 25 00	128	M. S. Sh		Beam trawl.	1		10			
28			Shaw Bay, at anchor		6	bk. S	60	12	19	6 to 9½	8⅓	26 to 31	27	Salt salmon.
29			Vicinity of Nelson Lagoon.		9	......do	40	3	4	10 to 14	11½	28 to 32		Do.
June 2	Dredge	3233	58 23 45	157 42 45	7¼	S. P	10	10	1		11			Do.
7	Dredge	3235	58 16 30	158 13 00	11	bk. S	10	10	*12	7 to 14	11½	29 to 33	31½	Do.
7	Dredge	3236	58 11 00	158 05 30	14¾	G. S. Sh	10	10	3	7 to 12	9	26 to 31	28⅔	Do.
7	Dredge	3238	58 03 40	158 37 30	18	fne. gy. S	10	Beam trawl.	1		7			
8	Dredge	3239	58 22 20	159 23 15	11½	......do	10	10	1		17			Do.
8	Dredge	3240	58 30 00	159 35 50	14½	fne. bk. S	10	10	None.					Salt salmon and capelins.
8	Dredge	3241	58 38 30	159 33 30	14	bk. M	10	10	None.					Do.
8			East side of Walrus Islands.		6	S. M	180	6	8	8 to 18½	13	31 to 36	33¼	Salmon and flounders.
9	Dredge	3244	58 37 20	161 05 00	4½	fne. gy. S	5	10	None.					Do.
9	Dredge	3245	58 31 20	161 13 00	11½	S. P	8	10	None.					Do.
9	Dredge	3246	58 26 30	161 36 00	17½	G	10	10	None.					Do.
13	Dredge	3247	58 40 45	162 08 30	17	P. St	10	10	None.					Salmon.
13	Dredge	3248	58 34 15	162 22 00	21	fne. gy. S. G	10	10	2	8 to 12	10	29 to 32	30½	Do.
13	Dredge	3249	58 27 30	162 36 00	13½	fne. gy. S. bk. sp	11	10	None.					Do.
13	Dredge	3250	58 11 30	163 02 45	17½	gy. S	10	9	2	6 to 9	7½	26 to 27	26½	Do.
13	Hyd	2376	58 18 30	162 50 00	16½	fne. gy. S	12	11	15	5 to 10	7½	24 to 30	27¾	Do.
14	Hyd	2378	57 49 50	163 44 00	24	......do	10	7	1		11			Do.
14	Dredge	3251	57 35 50	164 05 00	25½	......do	10	10	2	6 to 8	7	26 to 30	27⅓	Do.
14	Dredge	3252	57 22 20	164 24 40	29½	bk. M	10	10	1		13			Do.
14	Dredge	3255	56 33 30	164 31 40	43	gn. M. S	15	9	3	5 to 13	10⅓	23 to 31	28	Do.
14	Dredge	3256	56 18 00	164 34 10	49	gn. M. br. Sh	10	10	1		16			Do.
24	Dredge	3259	54 40 50	165 05 30	41	bk. S. G	10	11	18	9 to 21	15	29 to 35	32	Salt herring.
24	Hyd	2383	54 37 40	164 58 00	30	bk. G	14	12	18	9 to 20	15½	26 to 36	32⅓	Do.
24	Dredge	3260	54 36 15	164 52 00	13	fne. bk. S	15	12	42	4½ to 18	10¼	23 to 34	28⅔	Do.
24	Dredge	3261	54 42 15	164 49 15	27	bk. S. P	12	12	11	6 to 23	14	25 to 36	30⅔	Do.
24	Hyd	2384	54 46 00	164 55 30	37	crs. S. G. P	15	12	16	7 to 22½	10¾	27 to 37	30⅔	Do.

24	Dredge	3262	54 49 30	165 02 00	43	bk. S. R	15	12	26	4 to 15	7½	23 to 33	26⅔	Do.
24	Hyd	2385	54 56 30	165 15 30	62	bk. M	16	11	7	9 to 21½	12	28 to 37	30¾	Do.
24	Dredge	3264	54 57 00	164 48 00	40	crs. S. G	15	9	1		16			Do.
25	Dredge	3265	55 16 30	163 52 45	38	bk. S	10	8	2		15	31 to 32	31½	Do.
25	Dredge	3266	55 08 30	163 30 30	24	do	10	8	6	14 to 19		20½ to 36	24⅔	Do.
25	Hyd	2392	55 14 00	163 21 30	26	do	17	9	14	4 to 14	8	21 to 33	28	Do.
25	Dredge	3267	55 23 30	163 29 00	32	do	17	10	18	4 to 21	12½	22 to 36	31	Do.
25	Hyd	2393	55 34 30	163 37 00	44	gy. S	25	10	13	4 to 17	10⅔	23 to 32	29	Salmon.
25	Dredge	3268	55 29 00	163 13 00	26	bk. S. G	10	11	None.					Do.
25	Hyd	2396	55 23 40	163 07 30	20	bk. G	8	10	1		4			Do.
25	Dredge	3269	55 19 00	163 04 30	16	fne. gy. S. brk. Shs	9	9	4	6 to 8	6½	25 to 27	26¼	Herring.
26			Off Izenbek Bay (at anchor).		16	S	45	3	3		7			Do.
26	Dredge	3270	55 26 30	162 52 00	16	bk. S	5	8	None.					Do.
26	Dredge	3271	55 29 15	162 58 00	25	do	17	8	13	4 to 17½	9	21 to 34	27	Do.
27			Off Amak Island (at anchor).		10	gy. S	10	3	5	2½ to 9	5	18 to 29	23	Do.
27	Dredge	3272	55 31 40	163 07 00	31	bk. ord. S	9	11	4	8 to 11	9½	24 to 28	26¾	Do.
27	Hyd	2398	55 36 15	163 09 00	35	fne. gy. S	11	11	3	6 to 12	9⅔	27 to 30	29⅔	Herring and flounders.
27	Dredge	3273	55 44 30	162 56 00	39	gy. S. M	10	10	8	3 to 16	10	16 to 35	27	Do.
27	Hyd	2399	55 37 45	162 40 30	26	fne. gy. S	8	9	1		12			Do.
27	Dredge	3274	55 34 30	162 31 45	19	bk. S. Sh	10	10	3	10 to 12½	11⅓	28 to 32	29⅔	Do.
28	Dredge	3276	55 51 15	162 03 00	18	G. S. R	8	5	None.					Herring.
28	Dredge	3277	55 58 45	161 46 30	18	do	18	8	5	5½ to 12½	8½	24 to 31	27	Do.
28	Hyd	2404	56 06 15	161 58 00	34	bk. S	18	10	13	5 to 16	11	24 to 32	30	Do.
28	Dredge	3278	56 12 30	162 13 00	47	fne. gy. S	17	9	3	2½ to 3	2⅔	16 to 18	16⅔	Do.
28	Hyd	2405	56 19 00	162 26 00	40	gy. S. G	14	9	4	3 to 16	8¼	9 to 32	25	Do.
28	Dredge	3279	56 25 40	162 39 15	41	fne. gy. S	16	9	4	14 to 19	12½	14 to 33	27¾	Do.
28	Hyd	2406	56 33 45	162 26 00	41	do	12	11	2	12 to 13	12½	31 to 32	31½	Do.
28	Dredge	†3280	56 27 00	162 08 00	36	do	14	11	None.					Do.
28	Hyd	2407	56 20 30	161 54 45	48	do	8	11	4	5 to 20	9½	22 to 35	27½	Do.
28	Dredge	3281	56 14 00	161 41 15	36	gy. S. bk. Sp	14	9	11	4 to 19	6⅓	21 to 33	25	Do.
29	Hyd	2411	56 24 10	161 37 00	37	gy. S	20	7	6	5 to 15	9⅔	22 to 33	28	Do.
29	Dredge	3282	56 30 45	161 50 15	53	S. M	15	5	1		18			Do.
29	Dredge	3283	56 28 00	161 16 30	39	fne. gy. S	15	9	9	3 to 18	13	20 to 33	31½	Do.
29	Hyd	2413	56 21 15	161 03 00	35	do	27	9	29	3 to 27½	15⅓	19 to 39	32	Do.
29	Dredge	3284	56 16 30	160 53 00	25	fne. G	19	9	27	3½ to 22½	11	22 to 35	29	Do.
July 16	Hyd	2415	56 04 30	160 39 30	8½	fne. gy. S	10	7	None.					Salt salmon.
16	Hyd	2416	56 09 45	160 33 00	10¾	crs. bk. S	14	8	None.					Do.
16	Hyd	2417	56 14 15	160 26 45	12	bk. G	20	8	10	7 to 14	10	26 to 32	28½	Do.
17	Dredge	3285	56 45 45	160 42 45	35	gy. S. bk. Sp	10	9	None.					Do.
17	Dredge	3286	56 39 30	160 29 00	37	fne. gy. S. Sp. G	15	9	6	10 to 21	14	29 to 35	30½	Do.
17	Dredge	3287	56 33 00	160 14 00	30	crs. bk. S	15	9	1		5½			Do.
17	Dredge	3288	56 26 30	160 00 00	15	bk. G	12	5	None.					Do.
17	Hyd	2424	56 40 40	159 54 30	30	fne. gy. S. G	11	9	33	5 to 18	11½	26 to 35	31	Do.
17	Hyd	2425	56 48 00	160 05 30	35	crs. bk. S	20	10	9	5 to 25	12	24 to 36	30	Do.
17	Hyd	2426	56 55 30	160 17 30	36	gy. S	15	9	9	5 to 13	9⅔	22 to 32	27½	Do.
17	Hyd	2427	57 03 20	160 29 00	39	bk. S	11	9	1		10			Do.
18	Dredge	3289	56 44 30	159 16 00	16	bk. S	51	8	5	8 to 13	10	28 to 33	30½	Do.

* Eight of these cod were taken in beam trawl.

† Wind fresh, which caused the ship to drift rapidly.

Table of fishing stations for cod, Alaskan cruise of 1890, chiefly in Bristol Bay and off the north side of Unalaska Island—Continued.

Date.	Serial number.		Position. Lat. N.	Position. Long. W.	Depth.	Nature of bottom.	Length of trial.	No. of lines used.	No. of cod taken.	Range in weight.	Average weight.	Range in length.	Average length.	Bait used.
1890.			° ′ ″	° ′ ″	*Fathoms.*		*Min.*			*Pounds.*	*Pounds.*	*Inches.*	*Inches.*	
July 18	Dredge	3290	56 50 30	159 01 00	16	gy. S. G	15	8	None.	....	....	....	....	Salt salmon.
18	Dredge	3291	56 58 30	159 11 00	26	bk. S. G	12	10	25	7 to 15	11	29 to 34	29¼	Do.
18	Hyd	2432	57 06 20	159 23 00	31	bk. S. G	15	10	39	4 to 17	8	24 to 35	29	Do.
18	Dredge	3292	57 14 00	159 35 00	32	bk. S. G	15	10	34	8 to 18	12¼	26 to 34	30	Do.
18	Hyd	2433	57 21 30	159 46 30	31	bk. S. G	15	9	7	6 to 17	11	23 to 36	28½	Do.
18	Dredge	3293	57 30 00	159 33 00	30	fne. gy. S	18	10	7	8 to 14	9½	26 to 31	29	Do.
18	Hyd	2434	57 23 15	159 17 00	31	fne. gy. S	14	8	15	6 to 19	11	23 to 34	29¼	Do.
18	Dredge	3294	57 16 45	159 03 30	30	bk. G	13	9	2	11 to 12	11½	28 to 29	28½	Do.
19	Dredge	3295	57 14 30	158 26 30	11½	fne. gy. S	5	8	None.	....	....	....	....	Do.
19	Dredge	3296	57 26 30	158 46 00	24	gy. S. bk. sp	15	8	22	9 to 18	12¼	28 to 33	31	Do.
19	Dredge	3297	57 38 00	159 07 30	26	gy. S	15	10	37	6 to 20	12	26 to 33	30	Do.
19	Hyd	2439	57 48 30	158 48 00	24	gy. S	14	10	4	10 to 13	10¾	29 to 32	30¼	Do.
19	Dredge	3298	57 38 30	158 22 30	20	fne. gy. S	15	10	21	9 to 17	12¼	29 to 34	29¼	Do.
20	Hyd	2441	57 56 45	158 17 00	20	gy. S	17	9	3	12 to 12	12	31 to 32½	31¾	Do.
20	Dredge	3299	57 59 00	158 44 00	20	fne. gy. S	15	10	12	8 to 18	12¼	28 to 33	30½	Do.
20	Hyd	2442	57 00 30	159 13 30	21	bk. S	13	9	20	7 to 20	12¼	26 to 34	31	Do.
20	Hyd	2443	58 01 00	159 33 15	23	gy. S	15	10	3	5 to 10	7	23 to 31	27	Do.
20	Dredge	3300	58 12 30	159 55 00	15	P	15	10	10	8 to 16	11	27 to 30	29¼	Do.
20	Hyd	2444	58 24 00	160 17 30	6½	gy. S. G	15	10	None.	....	....	....	....	Do.
20	Dredge	3301	58 12 45	160 37 30	17	fne. gy. S	20	8	13	6 to 17	10	28 to 34	31	Do.
21	Hyd	2445	57 59 00	160 24 45	26	fne. gy. S	15	9	7	8 to 14	11	26 to 30	28½	Do.
21	Dredge	3302	57 45 45	160 12 16	30	fne. gy. S	17	9	13	4 to 20	10	21 to 33	27¼	Do.
21	Hyd	2446	57 32 40	160 00 00	29	fne. gy. S	17	10	19	8 to 16¼	11	26 to 32	30	Do.
21	Dredge	3303	57 27 00	160 23 30	33	bk. S	11	10	3	2½ to 16	9	18 to 33	26⅓	Do.
21	Hyd	2447	57 39 00	160 39 30	31	fne. gy. S	12	10	None.*	....	....	....	....	Do.
21	Hyd	2448	57 50 40	160 57 00	27	fne. gy. S	13	10	5	6 to 15	10	26 to 30	29	Do.
21	Dredge	3304	58 02 30	161 13 45	28	fne. gy. S	15	10	8	8 to 13	9½	28 to 30	28¾	Do.
22	Hyd	2450	58 14 20	161 30 30	22	fne. gy. S. G	15	7	17	9 to 17	13¼	28 to 36	31½	Do.
22	Hyd	2451	58 05 00	161 52 15	31	fne. gy. S	31	8	4	9 to 16	12	28 to 32	30¼	Do.
22	Dredge	3305	57 51 30	161 40 00	23	fne. gy. S	15	10	7	7 to 12	10¾	26 to 33	29	Do.
22	Hyd	2452	57 38 15	161 28 30	30	fne. gy. S	15	10	4	8 to 10	9	23 to 30	27½	Do.
22	Dredge	3306	57 24 30	161 17 00	33	fne. gy. S	18	10	5	7½ to 13½	8¼	29 to 31	....	Do.
22	Hyd	2454	57 11 15	161 05 00	29	dk. S	15	10	5	5 to 14	10	25 to 31	28¾	Do.
22	Hyd	2455	56 57 30	160 52 30	38	fne. gy. S	15	10	2	10 to 11	10½	29 to 30	29½	Do.
23	Hyd	2459	56 22 45	160 21 30	20	fne. gy. S	150	4	41	5 to 16	9	20 to 33	27¾	Do.
Aug. 15	Hyd	2485	Between Priest Rock and Cape Cheerful.		53	fne. dk. S	17	8	9	7 to 14	11	27 to 32	29	Do.
15	Hyd	2486	......do		22	red & bk. G	10	8	10	8 to 14	$10\frac{3}{10}$	27 to 33	29¼	Do.
15	Dredge	3312	......do		45	S. M	7	10	None.	....	....	....	....	Do.
15	Hyd	2490	......do		37	G. Sh. P	10	10	None.	....	....	....	....	Do.
15	Hyd	2491	......do		40	fne. G	15	7	None.	....	....	....	....	Do.
15	Hyd	2492	......do		57	fne. S. G	10	8	1	....	10	....	....	Do.

15	Hyd	2496	......do..................	58	bk. S. G. Sh	10	8	None.	....	....	....	....	Do.
16	Hyd	2500	Near western side of Cape Cheerful.	52	bk. S. G...............	20	6	None.	....	....	....	....	Do.
16	Hyd	2502	......do..................	50	bk. S..................	11	7	None.	....	....	....	....	Do.
16	Hyd	2503	11 miles E. of Cape Makushin.	22	Sh	15	9	13	7 to 15½	9¾	26 to 33	29	Do.
16	Hyd	2505	53 56 30 167 03 00	36	fne. S	7	10	None.	....	....	....	....	Do.
16	Hyd	2507	53 52 35 167 09 00	22	Gy. S	15	9	6	8 to 15	10	27 to 33	30	Do.
16	Hyd	*2508	53 52 00 167 12 15	40	R. G	15	9	None.	....	....	....	....	Do.
16	Hyd	2518	Off mouth of Makushin Bay.	58	bk. S. M	10	10	None.	....	....	....	....	Do.
16	Hyd	2519	In mouth of Makushin Bay.	69	bk. S..................	10	10	None.	....	....	....	....	Do.
18	Hyd	2517	Cape Odd Fellow, E. 5¾ miles.	54	S. G....................	10	10	None.	....	....	....	....	Herring.
18	Hyd	2521	Sprog Cape, E. by N. 5.8 miles.	43	Crs. bk. S	15	10	5	3 to 11	7½	19½ to 30	25½	Herring and salmon.
18	Dredge .	3321	High Cape, SE. by S. 3¼ miles.	54	M	10	10	None.	....	....	....	....	Do.
18	Hyd	2522	High Cape, NE. ½ N. 1.3 miles.	32	bk. S..................	9	10	None.	....	....	....	....	Do.
18	Dredge .	3322	Off Cape Hague	35	bk. S..................	10	10	None.	....	....	....	....	Do.
19	Hyd	2528	53 30 55 167 36 20	49	bk. S. M...............	15	7	7	8 to 16	11	27 to 33	29	Herring.
19	Hyd	2529	53 28 25 167 33 40	43	bk. S..................	15	8	None.	....	....	....	....	Do.
19	Dredge .	3323	53 26 00 167 31 10	51	fne. bk. S............	10	9	None.	....	....	....	....	Do.
19	Hyd	2530	53 24 30 167 34 05	42	bk. S. Sh	30	10	53	7 to 16	9½	25 to 34	29¼	Do.
20	Hyd	2532	53 24 20 167 37 05	60	bk. S. G...............	19	9	None.	....	....	....	....	Do.
20	Hyd	2533	53 23 30 167 39 25	47	G. Sh	15	10	7	8 to 22	15	28 to 37	33½	Do.
20	Hyd	2534	53 23 30 167 42 40	39	bk. G. Sh..............	12	9	10	9 to 15	11¾	29 to 33	30	Do.
20	Hyd	2535	53 24 00 167 46 10	30	bk. S..................	15	9	28	6 to 18	10	24 to 34	28¼	Do.
20	Hyd	2536	53 25 20 167 48 20	37	bk. S..................	15	10	1	....	10	....	....	Do.
20	Hyd	2537	53 28 15 167 45 50	35	bk. S. G...............	7	9	None.	....	....	....	....	Do.
20	Hyd	2538	53 31 45 167 43 45	43	bk. S..................	16	10	1	....	....	....	....	Do.
22	Hyd	2546	53 58 45 166 34 25	23 †	bk. G	20	10	22	6 to 16	10¾	24 to 33	29½	Herring and salmon.
22	Hyd	2547	Eider Point, S. ½ E. ¾ mile.	17	bk. S..................	8	10	None.	....	....	....	....	Do.
22	Hyd	2548	Near Eider Point.......	54	fne. bk. S	14	10	None.	....	....	....	....	Do.
22	Hyd	2549	North end Hog Island, 1 mile.	45	fne. bk. S	15	7	3	4 to 13	9⅔	22 to 31	27	Do.
22	Hyd	2550	53 55 05 166 34 35	47	bn. M..................	15	7	2	4½ to 21	13¼	23 to 36	29	Do.
26	Hyd	2554	54 02 15 166 11 20	26	Sh. R	10	6	None.	....	....	....	....	Do.

The fractional parts of pounds and inches of cod are approximate. * Strong flood tide; ship drifted rapidly. † Suddenly drifted from 40 into 160 fathoms.

Record of Tanner intermediate tow-net stations of the U. S. Fish Commission steamer Albatross.

Serial No.	Date.	Time.	Position. Lat. N.	Position. Long. W.	Temperatures. Air.	Temperatures. Surface.	Temperatures. Bottom.	Depth.	Character of bottom.	Wind. Direction.	Wind. Force.	Drift. Towed at a depth.	Drift. Time towing.	Mean depth.	Remarks.
	1891.		° ′ ″	° ′ ″				*Fath.*				*Fath.*	*Min.*	*Fath.*	
3382 Dr.	Mar. 7	8:50 a. m.	6 21 00	80 41 00	77	75	35.8	1,793	gn. M	N	3	200	15		
3382 Dr.	...do	9:53 a. m.	6 21 00	80 41 00	77	75	35.8	1,793	gn. M	N	3	200	......	......	Hauled direct from 200 fathoms in 10 minutes; ship stationary.
3382 Dr.	...do	10:23 a. m.	6 21 00	80 41 00	77	75	35.8	1,793	gn. M	N	3	100	......	......	Hauled direct from 100 fathoms in 5 minutes; ship stationary.
3388 Dr.	Mar. 9	10:31 a. m.	7 06 00	79 48 00	75	73	36.2	1,168	gn. glob. Oz	N	2	400	17		
2619 Hyd.	Mar. 11	8:25 a. m.	7 31 00	78 42 30	72	68	36.5	1,100	gn. glob. Oz	N	2	300	19		
2619 Hyd.	...do	9:44 a. m.	7 31 00	78 42 30	72	68	36.5	1,100	gn. glob. Oz	N	2	1,000	16	......	Sounded at 7:06 a. m. in 1,100 fms. Took second trial of net at 9:44 a. m., and finished at 11:56 a. m., having drifted into deeper water, as shown by soundings taken at 12:03 p. m. in 1,482 fms. Greatest amount of wire out while towing, 1,160 fms., the angle equaling depth of 1,000 fms.
2627 Hyd.	Mar. 25	6:49 a. m.	0 36 00	82 45 00	80	81	36.0	1,832	gy. glob. Oz	WNW	1	{1,773 1,739}	20	1,756	Fathoms=mean depth at which towed net. Net was lowered to 1,740 fms. vertically, and veered to 1,800 fathoms at an angle between 10° and 15°, equaling a depth varying between 1,773 and 1.739 fms.
			South lat.												
2628 Hyd.	Mar. 26	9:14 a. m.	0 13 00	84 52 00	81	81	......	......	......	Calm	0	{214 234}	20	224	Fathoms=mean depth at which towed net. Towed 14 minutes between 200 fathoms and surface to fill upper bag.
			North lat.												
3414 Dr.	Apr. 8	6:57 a. m.	10 14 00	96 28 00	81	82	35.8	2,232	gn. M	ENE	2	{85 105}	14	95	Fathoms=mean depth at which towed net.
3414 Dr.	...do	7:47 a. m.	10 14 00	96 28 00	81	82	35.8	2,232	gn. M	ENE	2	{195 200}	10	198	
3414 Dr.	...do	8:49 a. m.	10 14 00	96 28 00	81	82	35.8	2,232	gn. M	ENE	3	300	15		
3414 Dr.	...do	10:00 a. m.	10 14 00	96 28 00	81	82	35.8	2,232	gn. M	ENE	3	300	15		
3414 Dr.	Apr. 9	10:04 a. m.	12 34 00	97 21 00	84	82	......	......	......	NNW	1	175	8	......	No soundings taken; depth estimated approximately as over 2.000 fathoms.
3414 Dr.	...do	8:03 p. m.	13 33 30	97 57 30	82	83	......	......	......	Calm	0	175	10	......	
3414 Dr.	Apr. 11	8:45 a. m.	16 32 00	99 42 00	79	80	......	......	......	WSW	1	300	10	......	
3414 Dr.	Apr. 16	10:10 a. m.	17 39 30	102 11 30	77	76	......	......	......	W	2	175	15	......	
3436 Dr.	Apr. 22	1:22 p. m.	27 03 40	110 53 40	75	72	37.2	905	bn. M. bk. Sp.	WNW	1	800	15	......	Net dragged on bottom.
2637 Hyd.	...do	7:21 p. m.	27 20 00	110 54 00	72	71	38.0	773	bn. M. bk. Sp.	WNW	1	700	15		
3437 Dr.	Apr. 23	5:31 a. m.	27 39 40	111 00 30	71	70	40.0	628	bn. M. bk. Sp.	E	1	600	15	......	Do.
2638 Hyd.	...do	7:26 a. m.	27 38 00	111 04 00	72	72	39.2	622	bn. M. bk. Sp.	ENE	2	509	15		

Record of ocean temperatures and specific gravities by the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891.

Date.	Time of day.	Station.	Lat. N.	Long. W.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temp. of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 15° C., with pure water at 4° C. as standard.
1889.			° ′ ″	° ′ ″	*Fms.*	°	°	°		
July 8	4 p. m....	Seymour Narrows			Surface.	54	70	67	1.0220	1.022167
9	11 a. m....	Queen Charlotte Sound			...do	58	61	67	1.0164	1.016567
9	6 p. m....	Millbank Sound			...do	61	65	66	1.0180	1.018020
9	11 p. m....	Carter Bay			...do	59	61	66	1.0160	1.016020
10	12 m	Wright Sound			...do	54	60	66	1.0206	1.020620
10	9 p. m....	Kennedy Island			...do	56	57	66	1.0182	1.018220
11	10 a. m....	Tongas Narrows...................			...do	58	59	66	1.0182	1.018220
12	10 a. m....	Port Chester.....................			...do	60	63	66	1.0206	1.020620
13	10 a. m....	Fort Wrangell....................			...do	57	61	66	1.0200	1.020020
13	4 p. m....	Wrangell Narrows.................			...do	57	65	67	1.0196	1.019767
14	6 a. m....	Killsinoo Bay....................			...do	54	56	67	1.0202	1.020367
14	12 m	Sitka Narrows....................			...do	59	62	67	1.0220	1.022167
15	12 m	Sitka Harbor			...do	57	56	67	1.0228	1.022967
17	12 m	Freshwater Bay			...do	54	56	67	1.0206	1.020767
18	1 p. m....	Glacier Bay			...do	40	45	67	1.0162	1.016367
19	3 p. m....	Chillcat.........................			...do	56	61	67	1.0040	1.004167
22	3 p. m....	Juneau			...do	54	58	67	1.0080	1.008167
Aug. 6	12 m	....	51 34 00	131 16 00	...do	58	58	68	1.0234	1.023716
7	12 m	....	52 35 00	136 02 00	...do	57	57	68	1.0236	1.023916
8	12 m	....	51 44 50	133 24 00	...do	58	59	68	1.0234	1.023716
9	12 m	....	50 15 00	128 57 00	...do	62	63	68	1.0234	1.023716
28	12 m	....	47 05 00	124 19 30	...do	56	58	68	1.0236	1.023916
29	12 m	....	45 29 30	124 11 00	...do	62	61	68	1.0236	1.023916
30	12 m	....	44 34 00	124 54 30	...do	61	61	68	1.0234	1.023716
31	12 m	....	44 08 00	124 32 00	...do	57	57	68	1.0236	1.023916
Sept. 1	12 m	....	44 00 30	124 55 30	...do	60	60	68	1.0236	1.023916
2	12 m	....	44 12 00	124 19 00	...do	58	59	68	1.0236	1.023916
8	6 p. m....	Cape Lookout, Oregon			...do	51	56	68	1.0242	1.024516
11	12 m	....	43 07 00	124 41 00	...do	53	56	68	1.0240	1.024316
1890.										
Mar. 10	2 p. m....	....	37 44 50	122 43 00	...do	51	50	69	1.0236	1.024067
11	12 m	....	37 27 20	122 44 00	...do	52	52	69	1.0240	1.024467
12	6 p. m....	Santa Cruz, Cal..................			...do	53	58	69	1.0212	1.021667
13	6 p. m....	Monterey Bay			...do	55	60	69	1.0236	1.024067
21	7 p. m....	Drake Bay........................			...do	53	52	69	1.0220	1.022467
22	12 m	Off Farallones			...do	52	52	69	1.0222	1.022667
24	12 m	Cordell Bank			...do	55	55	69	1.0236	1.024067
Apr. 3	9 a. m....	Cedar Point			...do	51	52	69	1.0244	1.024867
4	4 p. m....	San Simeon Bay			...do	53	55	69	1.0244	1.024867
5	12 m	....	35 14 00	121 07 00	...do	52	53	69	1.0242	1.024667
6	4 a. m....	Point Conception			...do	52	53	69	1.0242	1.024667
6	12 m	Santa Barbara Channel............			...do	58	60	69	1.0244	1.024867
7	12 m	Santa Barbara....................			...do	56	57	69	1.0244	1.024867
7	6 p. m....	Santa Rosa Island			...do	54	55	69	1.0244	1.024867
12	12 m	....	36 59 00	122 27 00	...do	50	49	69	1.0240	1.024467
May 14	7 p. m.....	Off Cape Scott, Van Island			...do	55	55	67	1.0236	1.023767
15	12 m	....	51 09 00	132 35 00	...do	52	49	66	1.0238	1.023820
16	12 m	....	51 52 00	137 27 00	...do	54	46	65	1.0240	1.023870
17	12 m	....	52 25 30	142 41 30	...do	46	44	65	1.0244	1.024270
18	8 a. m....	....	52 36 50	146 51 10	...do	44	39	65	1.0244	1.024270
18	12 m	....	52 43 30	147 44 00	...do	44	39	65	1.0244	1.024270
18	8 p. m....	....	52 48 00	149 14 00	...do	44	41	66	1.0242	1.024220
19	8 a. m....	....	53 07 35	151 43 57	...do	44	40	66	1.0242	1.024220
19	12 m	....	53 13 00	152 48 17	...do	43	40	66	1.0242	1.024220
19	8 p. m....	....	53 21 54	154 48 17	...do	44	41	66	1.0242	1.024220
20	8 a. m....	....	53 50 00	157 08 30	...do	43	41	66	1.0242	1.024220
20	12 m	....	53 55 00	158 04 10	...do	44	42	66	1.0242	1.024220
20	8 p. m....	....	53 57 34	159 46 40	...do	44	42	66	1.0236	1.023620
21	8 a. m....	....	54 00 00	162 33 00	...do	43	42	66	1.0236	1.023620
21	12 m	....	54 00 40	162 57 00	...do	44	44	66	1.0236	1.023620
21	8 p. m....	....	54 16 00	163 26 00	...do	42	39	66	1.0236	1.023620
22	8 a. m....	Unimak Pass, Alaska			...do	43	42	66	1.0236	1.023620
22	12 m	....	54 16 00	165 13 00	...do	42	40	66	1.0236	1.023620
22	8 p. m....	....	54 44 00	165 39 00	...do	42	39	66	1.0236	1.023620
23	8 a. m....	....	55 01 50	167 24 00	...do	42	37	66	1.0222	1.022220
23	12 m	....	54 36 30	166 53 00	...do	43	39	66	1.0222	1.022220
24	12 m	Unalaska Harbor, Alaska			...do	46	43	66	1.0220	1.022020

Record of ocean temperatures and specific gravities by the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Date.	Time of day.	Station.	Lat. N.	Long. W.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temp. of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 15° C., with pure water at 4° C. as standard.
1890.			° ′ ″	° ′ ″	*Fms.*	°	°	°		
May 28	12 m		54 29 00	165 10 20	Surface	43	42	66	1.0232	1.023220
28	8 p. m	Shaw Bay, Unimak Island			...do	45	44	66	1.0232	1.023220
29	12 m		55 11 30	163 17 00	...do	44	42	66	1.0232	1.023220
29	10 p. m	Cape Lapin, Unimak Island			...do	44	42	66	1.0226	1.022620
30	12 m		56 10 00	160 31 30	...do	45	44	66	1.0220	1.022020
30	9 p. m	Cape Strogonof, Alaska Peninsula.			...do	43	44	66	1.0214	1.021420
31	12 m		58 03 30	157 46 00	...do	46	45	66	1.0186	1.018620
31	6 p. m	Head of Bristol Bay, Alaska			...do	50	50	66	1.0130	1.013020
June 2	12 m		58 28 10	157 36 00	...do	45	46	66	1.0130	1.013020
2	6 p. m	Protection Point, Alaska			...do	50	52	66	1.0132	2.013220
3	1 p. m	Nushagak River, high water			...do	50	51	66	1.0080	1.008020
3	8 p. m	Nushagak River, low water			...do	52	52	66	1.(000	1.008020
7	7 p. m	Off Cape Constantine			...do	41	36	63	1.0208	1.020391
8	12 m	Round Island, Walrus group			...do	48	46	63	1.0204	1.019991
8	8 p. m	Hagemeister Island			...do	48	45	63	1.0202	1.019791
10	12 m	Cape Newenham, Alaska			...do	44	44	63	1.0222	1.021791
11	12 m	Kuskokwim River, Alaska			...do	41	41	63	1.0226	1.022191
14	12 m		56 55 30	164 30 00	...do	43	41	63	1.0242	1.023791
15	12 m		54 43 00	166 01 00	...do	44	43	63	1.0242	1.023791
24	12 m		54 41 30	164 51 00	...do	45	44	63	1.0240	1.023591
25	12 m		55 23 00	163 10 00	...do	46	44	63	1.0238	1.023391
25	9 p. m	Cape Glasenap, Alaska Peninsula.			Surface	46	42	63	1.0236	1.023191
26	8 p. m	Amak Island, Bristol Bay			...do	46	43	63	1.0238	1.023391
27	9 p. m		55 44 20	162 17 30	...do	44	42	63	1.0234	1.022991
28	12 m		56 29 50	162 26 00	...do	45	43	63	1.0234	1.022991
29	12 m		56 18 30	160 53 00	...do	47	44	63	1.0228	1.022391
30	12 m	Port Möller, Alaska Peninsula.			...do	50	48	63	1.0220	1.021591
July 6	12 m	Herendeen Bay			...do	51	42	63	1.0204	1.019991
16	3:30 p. m.	Entrance Port Möller			...do	54	50	68	1.0212	1.021516
17	7:30 a. m.		56 39 30	160 29 00	...do	45	43	67	1.0230	1.023167
17	12 m		56 22 00	160 13 00	...do	49	45	67	1.0230	1.023167
18	7:30 a. m.		56 50 30	159 01 00	...do	48	43	67	1.0230	1.023167
18	12 m		57 08 45	159 23 00	...do	46	42	67	1.0230	1.023167
19	12 m		57 25 00	158 44 00	...do	46	45	67	1.0226	1.022767
20	12 m		58 00 10	159 01 00	...do	55	51	67	1.0196	1.019767
20	7 p. m		58 24 00	160 17 30	...do	43	49	67	1.0200	1.020167
21	12 m		57 30 00	160 12 00	...do	45	45	67	1.0220	1.022167
21	6 p. m		57 50 40	160 57 00	...do	52	50	67	1.0208	1.020967
22	12 m		57 34 00	161 25 30	...do	51	47	67	1.0224	1.022567
Aug. 2	12 m		54 02 00	167 14 00	...do	48	48	64	1.0246	1.024328
2	6 p. m	Bogoslof Island			...do	57	48	64	1.0246	1.024328
3	6 a. m		53 55 00	170 50 00	...do	50	48	64	1.0246	1.024328
3	12 m		54 20 00	171 03 15	...do	50	48	64	1.0246	1.024328
3	10 p. m		55 31 00	171 42 00	...do	51	48	64	1.0246	1.024328
4	6 a. m		56 12 00	172 07 00	...do	50	47	64	1.0242	1.023928
4	12 m		56 27 30	174 14 30	...do	50	46	64	1.0242	1.023928
4	5:30 p. m.		56 56 00	172 55 00	...do	50	47	64	1.0242	1.023928
5	8 a. m		58 14 00	174 35 00	...do	50	47	64	1.0242	1.023928
5	12 m		58 43 00	174 43 00	...do	50	47	64	1.0242	1.023928
6	7 a. m		56 50 00	175 15 00	...do	50	46	64	1.0242	1.023928
6	12 m		56 25 30	175 27 10	...do	50	47	64	1.0242	1.023928
6	4:20 p. m.		56 02 10	175 35 00	...do	50	48	64	1.0242	1.023928
6	4:20 p. m.		56 02 10	175 35 00	25	42.5	48	64	1.0242	1.023928
6	4:20 p. m.		56 02 10	175 35 00	50	37	48	64	1.0242	1.023928
6	4:20 p. m.		56 02 10	175 35 00	100	38.2	48	64	1.0244	1.024128
6	4:20 p. m.		56 02 10	175 35 00	200	38.8	48	64	1.0248	1.024528
6	4:20 p. m.		56 02 10	175 35 00	300	38.7	48	64	1.0252	1.024928
6	4:20 p. m.		56 02 10	175 35 00	400	37.6	48	64	1.0254	1.025128
6	4:20 p. m.		56 02 10	175 35 00	500	36.9	48	64	1.0256	1.025328
6	4:20 p. m.		56 02 10	175 35 00	600	36.5	48	64	1.0256	1.025328
6	4:20 p. m.		56 02 10	175 35 00	700	36.3	48	64	1.0256	1.025328
6	4:20 p. m.		56 02 10	175 35 00	800	35.5	48	64	1.0258	1.025528
6	4:20 p. m.		56 02 10	175 35 00	900	36	48	64	1.0258	1.025528
6	4:20 p. m.		56 02 10	175 35 00	1,000	35.4	48	64	1.0260	1.025728
6	4.20 p. m.		56 02 10	175 35 00	1,998	34.9	48	64	1.0264	1.026125
7	8 a. m		54 30 30	175 32 00	Surface	49	48	64	1.0242	1.023928

Record of ocean temperatures and specific gravities by the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Date.	Time of day.	Station.	Lat. N.	Long. W.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temp. of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 15° C., with pure water at 4° C. as standard.
1890.			° ′ ″	° ′ ″	Fms.	°	°	°		
Aug. 7	12 m		54 06 00	175 32 00	Surface	51	48	64	1.0242	1.023928
8	12 m		54 08 00	171 55 00	...do	57	50	64	1.0242	1.023928
15	12 m		54 01 23	166 23 37	...do	55	60	70	1.0236	1.024230
15	6 p. m	Wislow Island			...do	54	53	70	1.0234	1.024030
16	12 m		53 56 00	167 00 00	...do	52	60	70	1.0234	1.024030
17	12 m	Makushin Bay			...do	55	60	70	1.0226	1.023230
18	12 m		53 41 23	167 16 00	...do	50	49	70	1.0234	1.024030
19	12 m	Chernoffsky Bay			...do	49	48	70	1.0232	1.023830
20	12 m	Umnak Pass			...do	48	47	70	1.0234	1,024030
21	12 m		54 01 00	166 52 30	...do	52	49	70	1.0234	1.024030
22	12 m	Off Hogg Island			...do	54	54	70	1.0230	1.023630
26	4 p. m	Akutan Pass			...do	47	56	70	1.0234	1.024030
27	6 a. m		53 55 30	163 26 00	...do	50	50	70	1.0230	1.023630
27	12 m		53 58 00	162 37 00	...do	55	60	70	1.0230	1.023630
27	11 p. m		54 11 00	160 37 00	...do	52	50	70	1.0232	1.023830
28	6 a. m		54 19 00	159 40 00	...do	51	52	70	1.0232	1.023830
28	12 m		54 34 00	158 47 00	...do	52	52	70	1.0232	1.023830
28	6 p. m		54 46 00	157 43 30	...do	51	53	70	1.0230	1.023630
29	6 a. m		55 26 00	155 26 00	...do	53	54	70	1.0230	1.023630
29	12 m		55 41 00	154 48 00	...do	51	54	70	1.0232	1.023830
29	6 p. m		56 01 30	153 52 00	...do	53	54	70	1.0232	1.023830
30	12 m		55 49 00	150 41 00	...do	53	54	70	1.0232	1.023830
31	12 m		55 19 00	147 16 30	...do	52	53	70	1.0232	1 023830
Sept. 1	12 m		55 49 00	141 58 00	...do	55	55	70	1.0232	1.023830
2	12 m		54 27 00	137 37 00	...do	56	56	70	1.0232	1.033830
3	12 m		52 55 30	132 25 30	...do	58	59	64	1.0240	1.023728
3	5 p. m		52 39 30	132 38 00	...do	58	65	64	1.0238	1.023528
4	12 m		51 09 30	130 12 45	...do	58	59	64	1.0232	1.022928
5	12 m		49 05 00	126 24 00	...do	54	58	64	1.0232	1.022928
5	10 p. m	Entrance Straits Fuca			...do	56	56	64	1.0230	1.022728
21	12 m		47 27 20	125 17 00	...do	54	57	64	1.0230	1.022728
22	12 m		45 22 00	125 05 00	...do	57	55	64	1.0240	1.023728
23	12 m		43 00 00	124 36 00	...do	52	53	64	1,0242	1.023928
24	12 m		40 24 20	124 33 30	...do	53	54	64	1.0242	1.023928
25	12 m		38 58 30	124 01 20	...do	54	55	64	1.0242	1.023928
1891.										
Feb. 1	12 m		33 11 00	118 58 00	...do	59	55	80	1.0230	1.025340
1	6 p. m		32 30 00	118 32 00	...do	57	57	80	1.0226	1.024940
1	12 p. m		31 40 00	118 02 00	...do	59	56	80	1.0230	1.025340
2	6 a. m		31 06 00	117 34 00	...do	60	55	80	1.0230	1.025340
2	12 m		30 18 30	116 57 00	...do	61	60	80	1.0230	1.025340
2	6 p. m		29 30 30	116 37 00	...do	61	65	80	1.0232	1.025540
2	12 p. m		28 49 00	116 18 00	...do	60	59	80	1.0234	1.025740
3	6 a. m		28 05 00	116 02 00	...do	62	61	80	1.0232	1.025540
3	12 m		27 06 30	115 47 00	...do	61	64	80	1.0234	1.025740
3	6 p. m		26 30 00	115 20 00	...do	66	66	80	1.0234	1.025740
3	12 p. m		25 45 00	114 42 00	...do	66	66	80	1.0236	1.025940
4	6 a. m		25 07 00	114 06 00	...do	65	65	80	1.0236	1.025940
4	12 m		24 25 00	113 25 00	...do	68	66	80	1.0238	1.026140
4	6 p. m		23 49 00	112 52 00	...do	70	80	80	1.0238	1.026140
4	12 p. m		23 10 00	112 11 30	...do	70	69	80	1.0238	1.026140
5	6 a. m		22 33 00	111 35 00	...do	69	67	80	1.0238	1.026140
5	12 m		21 57 00	110 57 00	...do	72	74	80	1.0238	1.026140
5	6 p. m		21 30 00	110 17 00	...do	72	79	80	1.0240	1.026340
5	12 p. m		20 52 00	109 40 00	...do	72	71	80	1.0240	1.026340
6	6 a. m		20 20 00	108 55 00	...do	75	72	80	1.0234	1.025740
6	12 m		19 52 00	108 18 00	...do	76	76	80	1.0230	1.025340
6	6 p. m		19 25 00	107 30 00	...do	76	76	80	1.0230	1.025340
6	12 p. m		19 02 00	106 45 00	...do	75	75	80	1.0230	1.025340
7	6 a. m		18 38 00	105 58 00	...do	75	74	80	1.0232	1.025540
7	12 m		18 14 00	105 06 00	...do	79	81	80	1.0230	1.025340
7	6 p. m		17 58 00	104 15 00	...do	81	90	82	1.0232	1.025900
7	12 p. m		17 42 00	103 22 00	...do	78	77	82	1.0230	1.025700
8	6 a. m		17 26 00	102 30 00	...do	79	77	82	1.0230	1.025700
8	12 m		17 14 00	101 38 00	...do	81	81	82	1.0226	1.025300
8	6 p. m		16 59 00	100 43 00	...do	80	84	82	1.0226	1.025300
8	12 p. m	Off Acapulco			...do	75	77	82	1.0228	1.025500
9	4 p. m	Acapulco, Mexico			...do	80	76	82	1.0230	1.025700

Record of ocean temperatures and specific gravities by the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Date.	Time of day.	Station.	Lat. N.	Long. W.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temp. of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 15° C., with pure water at 4° C. as standard.
1891.			° ′ ″	° ′ ″	*Fms.*	°	°	°		
Feb. 9	12 p. m		16 22 00	99 05 00	Surface	79	78	82	1.0228	1.025500
10	6 a. m		15 55 00	98 22 00	...do	79	77	82	1.0228	1.025500
10	12 m		15 39 00	97 37 00	...do	80	81	82	1.0228	1.025500
10	6 p. m		15 15 00	96 50 00	...do	79	81	82	1.0228	1.025500
10	12 p. m		14 53 00	96 05 00	...do	77	79	82	1.0230	1.025700
11	6 a. m		14 28 00	95 22 00	...do	79	77	82	1.0228	1.025500
11	12 m		14 05 00	94 41 40	...do	79	79	82	1.0228	1.025500
11	6 p. m		13 47 00	93 57 00	...do	78	81	82	1.0228	1.025500
11	12 p. m		13 28 00	93 15 00	...do	79	78	82	1.0228	1.025500
12	6 a. m		13 17 00	92 35 00	...do	79	78	82	1.0226	1.025300
12	12 m		13 00 00	91 51 00	...do	80	81	82	1.0226	1.025300
12	6 p. m		12 30 00	91 10 00	...do	81	83	82	1.0224	1.025100
12	12 p. m		12 05 00	90 32 00	...do	80	80	82	1.0224	1.025100
13	6 a. m		11 41 00	89 55 00	...do	80	80	82	1.0222	1.024900
13	12 m		11 17 00	89 16 00	...do	79	80	82	1.0222	1.024900
13	6 p. m		10 45 00	88 43 00	...do	78	82	82	1.0222	1.024900
13	12 p. m		10 20 00	88 12 00	...do	77	79	82	1.0226	1.025300
14	6 a. m		9 55 00	87 35 00	...do	78	77	82	1.0228	1.025500
14	12 m		9 34 00	87 01 00	...do	80	80	82	1.0226	1.025300
14	6 p. m		9 10 00	86 17 00	...do	82	85	82	1.0226	1.025300
14	12 p. m		8 48 00	85 26 00	...do	81	82	85	1.0204	1.023680
15	6 a. m		8 25 00	84 37 00	...do	82	81	85	1.0212	1.024480
15	12 m		8 17 00	83 55 00	...do	85	86	85	1.0204	1.023680
15	6 p. m		7 54 00	83 10 00	...do	85	85	85	1.0206	1.023880
15	12 p. m		7 25 00	82 33 00	...do	83	83	85	1.0205	1.023780
16	6 a. m		7 18 00	81 52 00	...do	81	81	85	1.0205	1.023780
16	12 m		7 05 00	81 06 00	...do	80	83	85	1.0212	1.024480
16	6 p. m		7 06 00	80 23 00	...do	73	79	85	1.0224	1.025680
16	12 p. m		7 28 00	79 45 00	...do	70	75	85	1.0220	1.025280
17	6 a. m		8 06 00	79 32 00	...do	72	74	85	1.0222	1.025480
18	12 m	Panama, U. S. C.			...do	74	74	85	1.0222	1.025480
23	12 m		7 07 00	80 43 00	...do	76	79	85	1.0222	1.025480
23	7 p. m		7 09 30	81 05 30	...do	83	79	85	1.0216	1.024880
23	...do		7 09 30	81 05 30	25	68.4	79	85	1.0220	1.025280
23	...do		7 09 30	81 05 30	50	65.9	79	85	1.0224	1.025680
23	...do		7 09 30	81 05 30	100	58.5	79	85	1.0228	1.026080
23	...do		7 09 30	81 05 30	200	52.9	79	85	1.0230	1.026280
23	...do		7 09 30	81 05 30	300	44.9	79	85	1.0230	1.026280
23	...do		7 09 30	81 05 30	400	48.7	79	85	1.0230	1.026280
23	...do		7 09 30	81 05 30	546	40.1	79	85	1.0232	1.026480
23	12 p. m		6 59 30	81 15 00	Surface	81	79	85	1.0220	1.025280
24	9 a. m		6 35 00	81 44 00	...do	83	83	85	1.0206	1.023880
24	...do		6 35 00	81 44 00	25	74.4	83	84	1.0216	1.024692
24	...do		6 35 00	81 44 00	50	76	83	84	1.0228	1.025892
24	...do		6 35 00	81 44 00	100	......	83	84	1.0230	1.026092
24	...do		6 35 00	81 44 00	200	51.8	83	84	1.0230	1.026092
24	...do		6 35 00	81 44 00	300	46	83	84	1.0232	1.026292
24	...do		6 35 00	81 44 00	400	43	83	84	1.0230	1.026092
24	...do		6 35 00	81 44 00	500	41	83	84	1.0230	1.026092
24	...do		6 35 00	81 44 00	600	......	83	84	1.0230	1.026092
24	6 p. m		6 17 00	82 05 00	Surface	83	81	84	1.0210	1.024092
24	12 p. m		6 16 00	82 23 00	...do	83	81	84	1.0210	1.024092
25	6 a. m		6 10 00	83 06 00	...do	82	81	84	1.0208	1.023892
25	...do		6 10 00	83 06 00	25	76.9	81	84	1.0220	1.025092
25	...do		6 10 00	83 06 00	50	59	81	84	1.0222	1.025292
25	...do		6 10 00	83 06 00	100	55.7	81	84	1.0226	1.025692
25	...do		6 10 00	83 06 00	200	50.5	81	84	1.0230	1.026092
25	...do		6 10 00	83 06 00	300	46.8	81	84	1.0232	1.026292
25	...do		6 10 00	83 06 00	400	43.6	81	84	1.0232	1.026292
25	...do		6 10 00	83 06 00	500	41.9	81	84	1.0232	1.026292
25	...do		6 10 00	83 06 00	600	40.2	81	84	1.0232	1.026292
25	...do		6 10 00	83 06 00	700	38.3	81	84	1.0232	1.026292
25	...do		6 10 00	83 06 00	800	38.9	81	84	1.0232	1.026292
25	...do		6 10 00	83 06 00	900	37.5	81	84	1.0234	1.026492
25	...do		6 10 00	83 06 00	1,000	36.5	81	84	1.0236	1.026692
25	12 m		6 11 00	83 16 30	Surface	84	84	84	1.0210	1.024092
25	6 p. m		6 05 00	83 55 00	...do	84	84	84	1.0208	1.023892

Record of ocean temperatures and specific gravities by the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Date.	Time of day.	Station.	Lat. N.	Long. W.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temp. of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 15° C., with pure water at 4° C. as standard.
1891.			° ′ ″	° ′ ″	*Fms.*	°	°	°		
Feb. 26	6 a. m		5 56 00	85 10 30	Surface	84	80	83	1.0216	1.023906
26	...do		5 56 00	85 10 30	50	......	80	83	1.0228	1.025706
26	...do		5 56 00	85 10 30	100	55.8	80	83	1.0232	1.026106
26	...do		5 56 00	85 10 30	200	51.3	80	83	1.0232	1.026106
26	...do		5 56 00	85 10 30	300	46.7	80	83	1.0234	1.026306
26	...do		5 56 00	85 10 30	400	......	80	82	1.0234	1.026100
26	...do		5 56 00	85 10 30	500	49.3	80	82	1.0234	1.026100
26	...do		5 56 00	85 10 30	600	......	80	82	1.0234	1.026100
26	...do		5 56 00	85 10 30	700	39.1	80	82	1.0234	1.026100
26	...do		5 56 00	85 10 30	800	......	80	82	1.0236	1.026300
26	...do		5 56 00	85 10 30	900	37.3	80	82	1.0236	1.026300
26	...do		5 56 00	85 10 30	1,000	36.8	80	82	1.0236	1.026300
26	12 m		5 51 00	85 23 30	Surface	83	80	82	1.0212	1.023920
26	6 p. m		5 50 00	85 41 00	...do	84	79	82	1.0210	1.023720
27	6 a. m		5 30 00	86 08 30	...do	81	79	85	1.0208	1.024080
27	...do		5 30 00	86 08 30	25	76.4	79	85	1.0214	1.024680
27	...do		5 30 00	86 08 30	50	58.9	79	85	1.0222	1.025480
27	...do		5 30 00	86 08 30	150	54.4	79	85	1.0224	1.025680
27	...do		5 30 00	86 08 30	250	48.8	79	85	1.0226	1.025880
27	...do		5 30 00	86 08 30	350	44.9	79	85	1.0226	1.025880
27	...do		5 30 00	86 08 30	450	42.8	79	85	1.0226	1.025880
27	...do		5 30 00	86 08 30	550	41	79	85	1.0226	1.025880
27	...do		5 30 00	86 08 30	650	......	79	85	1.0228	1.026080
27	...do		5 30 00	86 08 30	900	38	79	85	1.0230	1.026280
27	12 m		5 30 00	86 23 00	Surface	85	82	85	1.0205	1.023780
27	6 p. m		5 30 00	86 45 00	...do	84	83	85	1.0205	1.023780
27	...do		5 30 00	86 45 00	25	73.7	83	85	1.0208	1.023980
27	...do		5 30 00	86 45 00	50	58.9	83	85	1.0220	1.025280
27	...do		5 30 00	86 45 00	100	55.8	83	85	1.0222	1.025480
27	...do		5 30 00	86 45 00	200	50.9	83	85	1.0224	1.025680
27	...do		5 30 00	86 45 00	300	45.9	83	85	1.0224	1.025680
27	...do		5 30 00	86 45 00	400	44.7	83	85	1.0226	1.025880
27	...do		5 30 00	86 45 00	500	41.5	83	85	1.0226	1.025880
27	...do		5 30 00	86 45 00	600	40.4	83	85	1.0226	1.025880
27	...do		5 30 00	86 45 00	700	38.8	83	85	1.0228	1.026080
28	12 m		5 33 20	86 58 20	Surface	84	84	85	1.0205	1.023780
28	6 p. m		5 32 45	86 54 30	...do	84	85	85	1.0205	1.023780
Mar. 1	12 m		5 11 00	86 40 00	...do	83	84	80	1.0214	1.023740
1	6 p. m		4 49 00	86 11 20	...do	82	85	80	1.0214	1.023740
2	12 m		4 01 00	84 55 00	...do	82	84	80	1.0220	1.024340
2	6 p. m		3 50 00	84 45 00	...do	81	83	80	1.0220	1.024340
3	12 m		2 32 00	83 55 00	...do	80	82	80	1.0220	1.024340
3	6 p. m		2 33 00	83 29 00	...do	80	82	80	1.0224	1.024740
3	12 p. m		2 34 30	83 03 00	...do	79	78	80	1.0226	1.024940
4	6 a. m		2 34 00	82 29 00	...do	77	77	80	1.0230	1.025340
4	12 m		2 49 00	82 23 30	...do	78	80	80	1.0228	1.025140
4	6 p. m		3 09 00	82 10 30	...do	77	79	80	1.0228	1.025140
4	12 p. m		3 30 00	81 57 30	...do	77	77	80	1.0228	1.025140
5	6 a. m		3 50 00	81 44 20	...do	77	77	80	1.0226	1.024940
5	12 m	Malpelo Island			...do	78	79	80	1.0228	1.025140
5	6 p. m		4 03 00	81 31 00	...do	78	83	80	1.0228	1.025140
5	12 p. m		4 30 00	81 12 00	...do	77	78	80	1.0230	1.025340
6	7 a. m		4 56 00	80 52 30	...do	77	78	80	1.0228	1.025140
6	12 m		4 58 30	80 52 00	...do	77	80	80	1.0228	1.025140
6	6 p. m		5 08 30	80 34 00	...do	77	78	80	1.0230	1.025340
6	12 p. m		5 29 00	80 16 00	...do	76	77	80	1.0230	1.025340
7	6 a. m		5 48 00	79 58 00	...do	75	76	80	1.0230	1.025340
7	12 m		6 19 20	79 37 40	...do	76	79	80	1.0230	1.025340
7	6 p. m		6 40 00	79 25 30	...do	75	78	83	1.0230	1.025906
7	12 p. m		6 59 00	79 13 00	...do	75	77	83	1.0232	1.026106
8	6 a. m		7 21 00	79 02 00	...do	74	75	83	1.0232	1.026106
8	12 m		7 26 00	79 07 00	...do	74	79	83	1.0233	1.026206
8	7 p. m		7 40 00	79 17 50	...do	74	77	83	1.0232	1.026106
9	12 m		7 00 00	79 55 00	...do	73	77	83	1.0232	1.026106
10	...do		7 13 30	79 39 00	...do	73	77	83	1.0232	1.026106
11	...do		7 29 00	78 43 30	...do	70	76	83	1.0234	1.026306
20	6 p. m		8 34 00	79 35 00	...do	75	82	83	1.0232	1.026106

Record of ocean temperatures and specific gravities by the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Date.	Time of day.	Station.	Lat. N.	Long. W.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temp. of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 15° C., with pure water at 4° C. as standard.
1891.			° ′ ″	° ′ ″	*Fms.*	°	°	°		
Mar. 20	12 p. m.	....	7 42 00	79 52 00	Surface.	73	78	83	1.0234	1.026306
21	6 a. m.	....	6 50 00	80 09 00	...do....	74	75	83	1.0232	1.026106
21	12 m.	....	5 56 10	80 28 00	...do....	74	78	83	1.0232	1.026106
21	6 p. m.	....	5 13 00	80 32 00	...do....	75	81	83	1.0230	1.025906
21	12 p. m.	....	4 32 00	80 30 00	...do....	75	76	83	1.0228	1.025706
22	6 a. m.	....	3 51 00	80 28 30	...do....	78	77	83	1.0228	1.025706
22	12 m.	....	3 00 30	80 30 30	...do....	79	81	83	1.0226	1.025506
22	6 p. m.	....	2 31 00	80 24 00	...do....	80	82	83	1.0226	1.025506
22	12 p. m.	....	2 02 00	80 19 00	...do....	80	80	83	1.0226	1.025506
23	6 a. m.	....	1 33 00	80 12 00	...do....	79	78	83	1.0225	1.025406
23	12 m.	....	1 07 30	80 05 00	...do....	80	80	83	1.0225	1.025406
23	6 p. m.	....	1 05 00	80 21 00	...do....	84	83	83	1.0225	1.025406
23	12 p. m.	....	1 05 30	80 37 00	...do....	80	80	83	1.0223	1.025206
24	6 a. m.	....	1 04 00	80 53 00	...do....	80	79	83	1.0223	1.025206
24	12 m.	....	1 01 30	81 14 30	...do....	82	82	83	1.0226	1.025506
24	6 p. m.	....	0 56 30	81 40 00	...do....	84	83	83	1.0226	1.025506
24	12 p. m.	....	0 47 00	82 06 00	...do....	80	80	83	1.0226	1.025506
25	6 a. m.	....	0 41 00	82 32 00	...do....	81	80	83	1.0228	1.025706
25	12 m.	....	0 31 00	82 59 00	...do....	82	81	83	1.0226	1.025506
25	6 p. m.	....	0 19 00	83 20 00	...do....	82	81	83	1.0226	1.025506
25	12 p. m.	....	0 07 00	83 56 00	...do....	82	81	83	1.0224	1.025306
			South.							
26	6 a. m.	....	0 05 00	84 23 00	...do....	81	80	83	1.0224	1.025306
26	12 m.	....	0 18 00	85 03 00	...do....	83	83	83	1.0218	1.024706
26	6 p. m.	....	0 23 00	85 34 00	...do....	83	83	83	1.0216	1.024506
26	12 p. m.	....	0 27 00	86 05 00	...do....	82	81	83	1.0218	1.024706
27	6 a. m.	....	0 35 00	86 36 00	...do....	83	81	83	1.0218	1.024706
27	12 m.	....	0 40 00	87 06 30	...do....	82	82	83	1.0216	1.024506
27	6 p. m.	....	0 45 00	87 40 00	...do....	83	83	83	1.0220	1.024906
27	12 p. m.	....	0 51 00	88 14 00	...do....	82	81	83	1.0220	1.024906
28	6 a. m.	Off Chatham Island			...do....	82	81	83	1.0220	1.024906
28	12 m.	....	1 01 00	89 22 00	...do....	82	83	83	1.0220	1.024906
29	12 m.	Wreck Bay			...do....	81	82	83	1.0222	1.025106
Apr. 1	12 m.	Charles Island			...do....	80	83	83	1.0224	1.025306
2	12 m.	Duncan Island			...do....	81	83	83	1.0224	1.025306
2	6 p. m.	Indefatigable Island			...do....	82	82	83	1.0222	1.025106
3	12 m.	....	0 01 00	90 23 00	...do....	81	80	83	1.0220	1.524906
			North.							
4	12 m.	....	1 05 00	91 17 00	...do....	82	81	83	1.0222	1.025106
4	6 p. m.	....	1 23 00	91 30 00	...do....	82	81	83	1.0222	1.025106
4	12 p. m.	....	1 51 00	91 43 00	...do....	81	79	84	1.0222	1.025292
5	6 a. m.	....	2 14 00	91 56 00	...do....	82	78	84	1.0221	1.025192
5	12 m.	....	2 39 00	92 09 00	...do....	83	84	84	1.0222	1.025292
5	6 p. m.	....	3 17 00	92 31 00	...do....	84	83	84	1.0224	1.025492
5	12 p. m.	....	3 55 00	92 51 00	...do....	83	81	84	1.0226	1.025692
6	6 a. m.	....	4 34 00	93 14 00	...do....	82	81	84	1.0226	1.025692
6	12 m.	....	5 13 00	93 35 00	...do....	83	82	84	1.0230	1.026092
6	6 p. m.	....	5 53 00	94 03 00	...do....	82	82	84	1.0230	1.026092
7	6 a. m.	....	7 10 00	94 59 00	...do....	81	81	84	1.0230	1.026092
7	12 m.	....	7 54 00	95 27 00	...do....	82	83	84	1.0226	1.025692
7	6 p. m.	....	8 31 00	95 43 00	...do....	81	82	84	1.0224	1.025492
7	12 p. m.	....	9 08 00	95 59 00	...do....	82	82	84	1.0224	1.025492
8	6 a. m.	....	9 45 00	96 15 00	...do....	82	81	84	1.0224	1.025492
8	12 m.	....	10 23 00	96 30 30	...do....	83	83	84	1.0222	1.025292
8	6 p. m.	....	10 58 00	96 44 00	...do....	83	83	84	1.0222	1.025292
8	12 p. m.	....	11 33 00	96 58 00	...do....	82	81	84	1.0222	1.025292
9	6 a. m.	....	12 08 00	97 12 00	...do....	81	80	84	1.0222	1.025292
9	12 m.	....	12 45 00	97 26 00	...do....	83	84	84	1.0224	1.025492
9	6 p. m.	....	13 33 30	97 57 30	...do....	83	83	84	1.0224	1.025492
9	12 p. m.	....	14 09 00	98 18 00	...do....	83	82	84	1.0224	1.025492
10	8 a. m.	....	14 46 00	98 40 00	...do....	82	83	84	1.0226	1.025692
10	6 p. m.	....	15 28 00	98 19 00	...do....	84	83	84	1.0226	1.025692
10	12 p. m.	....	15 49 00	98 09 00	...do....	82	81	84	1.0228	1.025892
11	6 a. m.	....	16 10 00	97 58 00	...do....	80	79	84	1.0228	1.025892
11	12 m.	....	16 32 00	97 48 40	...do....	82	83	84	1.0228	1.025892
15	6 p. m.	....	16 50 00	100 20 00	...do....	80	79	67	1.0256	1.025767
15	12 p. m.	....	17 05 00	100 58 00	...do....	80	78	66	1.0258	1.025820

Record of ocean temperatures and specific gravities by the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1889—Continued.

Date.	Time of day.	Station.	Lat. N.	Long. W.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temp. of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 15° C., with pure water at 4° C. as standard.
1891.			° ′ ″	° ′ ″	*Fms.*	°	°	°		
Apr. 15	6 a. m		17 20 00	101 34 00	Surface	78	76	66	1.0258	1.025820
16	12 m		17 43 00	102 19 30	...do	80	79	66	1.0256	1.025620
16	6 p. m		18 12 00	102 58 00	...do	80	77	66	1.0256	1.025620
16	12 p. m		18 41 00	103 37 00	...do	76	76	66	1.0256	1.025620
17	6 a. m		19 10 00	104 16 00	...do	77	74	66	1.0256	1.025620
17	12 m		19 44 40	104 56 30	...do	74	75	66	1.0256	1.025620
17	6 p. m		20 02 00	105 17 00	...do	72	74	66	1.0256	1.025620
18	6 a. m		20 46 00	105 59 00	...do	74	72	66	1.0256	1.025620
18	12 m		21 07 30	106 21 30	...do	75	77	66	1.0260	1.026020
19	12 m		22 58 00	107 20 00	...do	73	75	66	1.0258	1.025820
20	12 m		24 20 30	108 34 30	...do	71	70	66	1.0254	1.025420
21	12 m		25 33 00	109 50 00	...do	71	73	66	1.0256	1.025620
22	12 m		26 58 00	110 49 30	...do	71	74	66	1.0260	1.026020
23	12 m	Guaymas, Mexico			...do	71	72	66	1.0262	1.026220
24	12 m		27 33 00	110 02 00	...do	71	73	66	1.0262	1.026220
25	12 m		25 06 00	109 51 00	...do	72	72	66	1.0256	1.025620
26	12 m		23 07 00	110 08 00	...do	65	75	66	1.0254	1.025420
27	12 m		24 41 30	112 16 30	...do	62	67	66	1.0250	1.025020
28	12 m		26 40 00	114 06 30	...do	64	66	66	1.0250	1.025020
29	12 m		28 51 30	115 06 30	...do	57	57	66	1.0248	1.024820
30	12 m		30 44 30	116 13 45	...do	57	57	66	1.0250	1.025020
May 2	12 m	San Diego, Cal			...do	65	65	66	1.0248	1.024820
3	12 m		33 55 40	118 54 20	...do	60	60	66	1.0250	1.025020
4	12 m		35 49 30	121 36 00	...do	58	62	66	1.0250	1.025020

Record of serial temperatures by the U. S. Fish Commission steamer Albatross, February, March, and April, 1891.

Date.	Serial number.	Position. Lat. N.	Position. Long. W.	Air.	Surf.	25 faths.	50 faths.	100 faths.	200 faths.	300 faths.	400 faths.	500 faths.	600 faths.	700 faths.	800 faths.	900 faths.	1,000 faths.	Bottom.	Depth.
1891.		° ′ ″	° ′ ″	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	*Fms.*
Feb. 23	Hy. 2609	7 12 30	80 56 00	79	81	67.2	63.2	......	......	......	......	......	......	......	......	......	......	57.7	127
23	Dr. 3356	7 09 30	81 08 00	80	83	68.4	65.9	58.5	52.9	44.9	48.7	......	......	......	......	......	......	40.1	546
24	Dr. 3357	6 35 00	81 44 00	80	83	74.4	76.0	......	51.8	46.1	43.0	41.0	......	......	......	......	......	38.5	782
25	Dr. 3361	6 10 00	83 06 00	81	82	76.9	59.0	55.7	50.5	46.8	43.6	41.9	40.2	38.3	38.9	37.5	36.5	36.6	1,471
26	Dr. 3362	5 56 00	85 10 30	80	84	71.8	......	55.8	51.3	46.7	......	59.3		39.1	......	37.3	36.8	36.8	1,175
27	Dr. 3364	5 30 00	86 08 30	79	81	68.9	71.4	54.4	48.8	44.9	42.8	41.0	......	......	......	......	......	38	902
27	Dr. 3366	5 30 00	86 45 00	83	84	73.7	58.9	55.8	50.9	45.9	44.7	41.5	40.4	38.8	......	......	......	37	1,067
28	Dr. 3367	5 31 30	86 52 30	81	82	72.4	69.0	......	......	......	......	......	......	......	......	......	......	57.1	100
Mar. 1	Dr. 3372	4 49 00	86 11 20	85	84	74.4	58.8	55.0	49.1	44.9	42.5	41.0	......	......	......	......	......	38.8	761
2	Dr. 3373	4 02 00	84 58 00	83	82	77.7	60.9	55.9	49.7	44.4	41.9	......	38.9	38.0	37.5	37.1	37.0	36.6	1,877
3	Dr. 3374	2 35 00	83 53 00	81	80	74.8	61.1	56.6	51.3	45.8	42.3	40.9	39.4	......	......	......	......	36.4	1,823
4	Dr. 3375	2 34 00	82 29 00	76	77	66.7	......	58.0	54.2	46.6	43.8	40.9	39.9	38.9	38.0	37.6	37.2	36.6	1,201
5	Hy. 2613	3 50 00	81 44 20	77	77	69.9	59.9	57.7	50.8	45.6	43.3	40.9	39.7	38.8	......	37.3	......	36.5	1,181
6	Dr. 3381	4 56 00	80 52 30	78	77	70.9	59.3	55.4	51.5	46.7	42.8	40.5	39.4	38.6	37.7	37.4	36.6	35.8	1,772
7	Dr. 3382	6 21 00	81 41 00	77	75	67.7	61.1	55.3	49.9	45.8	42.8	41.1	39.4	38.8	38.1	36.7	36.3	35.8	1,793
8	Dr. 3383	7 21 00	79 02 00	75	74	63.2	63.4	56.4	49.1	45.0	43.3	41.3	39.6	39.4	39.0	37.4	37.0	36	1,832
8	Dr. 3387	7 40 00	79 17 50	77	74	65.8	64.0	......	......	......	......	......	......	......	......	......	......	56	127
9	Dr. 3388	7 06 00	79 48 00	75	73	64.0	60.9	56.1	49.0	45.5	43.4	43.1	39.8	39.2	38.1	37.7	37.2	36.2	1,168
10	Dr. 3392	7 05 30	79 40 00	76	73	63.0	......	55.9	49.8	45.0	43.2	40.5	39.7	38.6	39.5	37.3	36.8	36.4	1,270
11	Hy. 2619	7 31 00	78 42 30	72	68	65.0	61.8	61.3	48.9	45.5	42.6	41.1	40.2	38.7	37.8	......	......	36.5	1,100
11	Dr. 3396	7 32 00	78 36 30	77	70	64.5	62.4	55.9	......	......	......	......	......	......	......	......	......	47.4	259
23	Hy. 2624	1 18 00	80 01 00	77	80		59.1	58.1	56.4	45.6	43.1	41.9	41.0	......	......	......	......	39	724
23	Hy. 2626	1 07 00	79 59 00	79	80	68.9	60.7	......	......	......	......	......	......	......	......	......	......	57.3	90
23	Dr. 3398	1 07 00	80 21 00	84	84	68.8	64.4	59.0	53.8	45.1	42.9	42.0	40.3	39.5	38.4	38.0	37.0	36	1,573
24	Dr. 3399	1 07 00	81 04 00	79	80	72.7	65.7	56.1	50.0	44.9	43.0	41.4	40.1	38.9	38.0	37.6	36.7	36	1,740
25	Hy. 2627	0 36 00	82 45 00	80	81	71.4	64.3	56.8	49.2	44.8	42.5	41.9	40.2	38.7	38.2	37.7	37.1	36	1.832
		South.																	
26	Hy. 2629	0 20 00	85 08 00	85	83	69.9	63.7	56.2	50.1	45.0	42.4	41.8	40.3	39.2	38.6	37.8	36.8	36	1,488
28	Dr. 3401	0 59 00	88 58 30	81	82	70.1	63.7	56.6	50.0	46.1	......	......	......	......	......	......	......	43.8	395
Apr. 3	Dr. 3406	0 16 00	90 21 30	79	81	73.5	59.9	57.9	53.9	45.0	42.3	......	......	......	......	......	......	41.3	551
		North.																	
4	Dr. 3411	0 54 00	91 09 00	79	82	71.8	67.8	61.5	54.0	46.8	43.0	41.3	40.8	39.8	38.9	38.1	37.5	36.2	1.189
8	Dr. 3414	10 14 00	96 28 00	81	82	81.9	72.1	59.5	51.8	47.8	44.4	42.0	40.8	39.6	38.8	38.1	37.3	35.8	2,232

Record of meteorological observations by the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891.

Date.	Position at meridian.		Barometer.		Temperature.						Weather.	Direction and force of winds.	Rainfall.
					Air: Dry bulb.		Air: Wet bulb.		Water at surface.				
	Lat. N.	Long. W.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.			
1889.	° ′ ″	° ′ ″	°	°	°	°	°	°	°	°			
July 1	Departure Bay, B. C.		30.44	30.26	74	51	69	50	68	52	Clear and pleasant	Calm, W. 1, N. 1, NNW. 1, calm	None.
2	......do		30.48	30.12	75	53	67	52	69	56	......do	Calm, NE. 2, W. 1, calm	Do.
3	48 34 00	123 14 00	30.12	30.04	68	55	64	53	59	52	......do	Calm, WNW. 1–2, S. 2, SSW. 4–5	Do.
4	48 23 30	123 20 00	30.20	30.10	58	53	55	52	56	51	Clear and pleasant; squally; pleasant.	SSW. 4, SW. 4–5, WSW. 4	Do.
5	Port Townsend, Wash.		30.14	30.08	74	55	64	52	63	51	Cloudy and squally to clear and pleasant.	WSW. 4–3. calm, E. 1, calm	Do.
6	Tacoma, Wash		30.20	30.08	70	53	65	52	68	54	Misty to clear and pleasant	SE. 1 to SW. 1, W. 1, calm	Light mist.
7	47 30 00	122 25 00	30.16	30.04	68	55	63	54	62	56	Clear and pleasant	Calm, NW. 1–2, W. 2, calm	None.
8	49 38 00	124 40 50	30.16	30.00	73	56	68	55	68	53	......do	WNW. 0–1, calm, WSW. 2	Do.
9	51 32 45	128 53 00	30.10	29.92	65	52	63	51	61	51	Foggy and misty weather	Variable winds, 2–1	Light mist.
10	53 24 00	129 23 00	30.06	29.98	61	57	65	56	66	54	Overcast, foggy and misty	Calm and variable winds, 1	Do.
11	54 46 15	130 54 00	30.12	30.04	75	54	67	53	67	53	Overcast and foggy to clear and fair.	......do	None.
12	Port Chester, Alaska		30.14	29.96	76	59	70	58	68	58	......do	Calm and light W'ly airs	Do.
13	Fort Wrangel, Alaska		30.10	29.94	68	56	63	56	62	52	Clear and pleasant	Light W'ly airs, calm light S'ly airs.	Do.
14	57 31 00	135 27 00	30.14	30.00	69	56	65	54	62	54	......do	Gentle W'ly breezes	Do.
15	Sitka, Alaska		30.14	30.04	57	54	55	52	58	55	Overcast and drizzly	Light W'ly airs and calm	Light drizzle.
16	......do		30.22	30.04	58	53	56	52	58	51	Overcast and rainy	Light W'ly airs	Light.
17	Freshwater Bay, Alaska.		30.22	30.10	57	52	55	51	57	51	Overcast, squally and drizzly	Moderate SE'ly breezes	Do.
18	58 40 30	136 06 00	30.34	30.22	55	43	54	42	54	35	Clear and pleasant	Light W'ly airs	None.
19	58 39 00	135 17 00	30.34	30.26	63	49	61	48	58	50	......do	Calm, NE. 1, ENE. 1, calm	Do.
20	59 01 00	135 19 00	30.36	30.30	61	55	57	53	58	52	......do	Calm, light variable breezes	Do.
21	Juneau, Alaska		30.34	30.30	60	55	59	53	54	52	Overcast and fair	W. 1, WSW. 3, W. 1	Do.
22	......do		30.32	30.20	60	55	58	53	54	51	......do	WSW. 1, and variable, 1	Do.
23	56 14 00	132 56 00	30.20	30.12	65	51	63	50	63	50	Fair and pleasant	Light, variable airs	Do.
24	53 52 00	130 03 00	30.18	30.06	70	58	67	57	64	56	Cloudy to fair and pleasant	......do	Do.
25	51 21 00	127 52 00	30.20	30.12	64	56	63	55	62	52	Foggy to fair	Gentle breezes from S'd. and W'd	Do.
26	49 18 00	123 55 00	30.18	30.10	74	58	71	56	68	54	Clear and pleasant	Gentle breezes from W'd	Do.
27	Victoria, B. C		30.24	30.16	64	56	64	55	60	55	Fair to hazy	Calm, S. 1, SSW. 2, W. 3, NE. 1	Do.
28	Port Townsend, Wash.		30.26	30.10	73	54	71	52	65	52	Foggy and hazy	Calm, variable 1	Do.
29	......do		30.22	30.04	65	53	62	52	58	52	Foggy and misty	Calm, NW. 1, calm	Do.
30	......do		30.26	30.04	67	55	64	53	57	52	......do	Calm, SSE. 1, W. 1, calm	Do.
31	......do		30.30	30.16	66	53	65	52	61	52	......do	Calm, N. 1, W. 2, calm	Do.
Aug. 1	......do		30.22	30.10	64	53	60	52	64	54	......do	Calm, variable 1	Do.
2	Departure Bay, B. C.		30.22	30.12	69	61	68	59	68	59	Foggy, clear and pleasant, and misty.	ENE. 1, NE. 1, calm	Do.

Record of meteorological observations by the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Date.	Position at meridian.		Barometer.		Temperature.						Weather.	Direction and force of winds.	Rainfall.
					Air: Dry bulb.		Air: Wet bulb.		Water at surface.				
	Lat. N.	Long. W.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.			
1889.	° ′ ″	° ′ ″	°	°	°	°	°	°	°	°			
Aug. 3	Departure Bay, B. C.		30.26	30.12	68	57	67	56	65	62	Fair and foggy	Calm, E. 1, calm	None.
4	do		30.28	30.20	65	58	62	54	64	57	Fair and pleasant	Calm, W. 1, W'ly 2–4	Do.
5	50 30 00	126 29 00	30.40	30.30	58	55	55	52	58	53	Clear and pleasant	WNW. 3–4, W. 3, WSW. 3	Do.
6	51 34 00	131 16 00	30.40	30.18	59	56	58	54	58	54	Drizzly and foggy	S'ly 2–3	Light drizzle.
7	52 34 24	136 20 36	30.18	30.04	58	56	57	55	58	56	do	S'ly 3	Do.
8	51 23 00	133 27 30	30.12	30.04	60	58	60	58	60	58	do	S'ly 4–2	Do.
9	50 04 45	129 02 00	30.18	30.12	68	59	65	57	63	59	Foggy to clear and pleasant	SW'ly 2 to SW'ly 3	None.
10	48 24 00	124 55 00	30.18	30.10	61	53	59	52	58	52	Thick and foggy	WNW. 4 to SW. 3	Do.
11	Port Townsend, Wash.		30.18	30.02	67	54	61	53	58	52	Overcast and foggy	Calm, WSW. 2, calm	Do.
12	do		30.18	30.10	62	55	61	54	56	53	do	Calm, variable 1	Do.
13	do		30.18	30.00	69	52	65	53	59	51	do	do	Do.
14	do		30.12	30.06	66	54	61	52	57	52	do	Calm, W. 1, WSW. 2, W. 2	Do.
15	do		30.20	30.06	64	57	61	56	55	52	do	W'ly 1	Do.
16	do		30.10	30.04	63	57	60	56	56	52	do	Calm, SE. 2, WNW. 2, calm	Do.
17	do		30.02	29.90	62	55	60	55	54	53	Overcast and foggy and rainy	Calm, variable 1, calm	Light.
18	do		30.20	30.02	64	55	62	55	56	53	Overcast and foggy	Calm, ENE. 1, calm, SW. 1	None.
19	do		30.30	30.20	62	56	60	55	57	53	Foggy and misty to clear and pleasant.	Variable 1	Do.
20	do		30.24	30.08	66	54	63	53	59	53	Foggy and misty	Calm, W. 1, calm	Do.
21	do		30.20	30.06	70	54	64	53	56	53	Foggy, overcast, and squally	Calm, W. 1	Do.
22	do		30.26	29.94	62	58	60	56	55	53	Fair and smoky	Calm, SE. 1, calm, variable 1	Do.
23	Departure Bay, B. C		30.12	29.94	67	57	65	57	62	53	Squally and rainy to clear and pleasant.	Calm, SW. by W. 3, NE'ly 1, calm	Light.
24	49 13 00	123 49 00	30.16	30.00	60	56	58	55	59	53	Clear and pleasant to overcast and cloudy.	Calm, ESE. 2, NE. 1	None.
25	Victoria, B. C.		30.00	29.84	61	56	59	54	54	52	Misty, squally, and rainy	S. E'ly 1 to SW. 3	Light.
26	do		29.90	29.60	59	54	57	52	55	52	Cloudy, foggy, and rainy	Calm, SE'ly 1, calm	Do.
27	48 21 00	123 26 00	30.02	29.60	56	53	55	51	54	51	Clear and pleasant to squally and rainy.	SW. 3, S. 2	Do.
28	46 51 00	124 20 00	30.14	30.02	69	56	63	55	65	52	Fair; overcast and misty to clear and pleasant.	SE. 2, S. 2, SSW. 2, NW. 1, N. 2	None.
29	45 20 00	124 11 00	30.04	29.96	68	59	64	58	66	59	do	Variable 1	Do.
30	44 50 00	124 51 00	29.96	29.90	62	55	60	54	62	56	Cloudy, squally and rainy	SE'ly 2, N. by E. 3, N. 4, NNW. 3	Light.
31	44 08 00	124 32 00	30.28	29.98	71	56	66	54	63	56	Rainy to fair and pleasant	N'ly 4–2	Do.
Sept. 1	44 00 30	124 55 30	30.28	30.02	64	55	62	53	62	55	Clear and pleasant	NW'ly 2	None.
2	44 12 00	124 19 00	30.24	30.06	62	57	59	55	59	54	Drizzly and thick to fair and pleasant.	NW'ly 3–4	Light drizzle.
3	44 29 00	124 25 00	30.32	30.24	59	55	57	53	58	52	Clear and pleasant	N. 3, NW'ly 3–4	None.
4	46 06 00	124 03 30	30.26	30.10	67	54	63	52	62	52	do	NW'ly. 2–3, SE. 2	Do.

	5	Astoria, Oregon		30.12	30.00	75	58	69	57	66	57	......do	Variable 1	Do.
	6	......do		30.20	30.10	68	56	67	55	66	58	Foggy, to clear and pleasant	SW. 2, SE. 1, W. 1, WSW. 3, W. 3	Do.
	7	46 16 00	124 02 00	30.26	30.20	63	57	61	55	63	54	Cloudy to fair to misty and rainy	NNW. 3, W. 1, NW. 2	Light.
	8	45 30 00	124 00 00	30.28	30.20	57	54	56	51	57	50	Fair and pleasant	NW'ly 2–4	None.
	9	45 07 00	124 03 15	30.30	30.18	55	50	53	47	57	48	Fair, to drizzly and rainy	SE'ly 2, and calm	Light.
	10	43 38 00	124 15 30	30.46	30.30	60	48	59	47	57	48	Fair and pleasant	SE. 1, WSW. 1–3, NW. 5–7, N. 6	None.
	11	43 07 00	124 41 00	30.36	30.26	60	50	58	49	59	48	Clear and pleasant	N'ly 5	Do.
	12	42 53 00	124 34 00	30.38	30.30	55	50	52	47	49	46	Foggy to fair and pleasant	N. 2, NNW. 1–4, N. 7–2	Do.
	13	42 36 00	124 41 00	30.30	30.16	58	49	57	47	51	47	Fair, and smoky and pleasant	N. 2–5, NW'ly 5–8–5	Do.
	14	43 38 00	124 41 00	30.30	30.20	58	50	56	49	57	48	......do	NW'ly 4–3, N. 3	Do.
	15	46 10 00	124 06 00	30.38	30.30	67	58	64	53	63	56	Fair to foggy, then clear and pleasant.	NNW. 3, W. 3, SW. by W. 2, WSW. 1.	Do.
	16	Astoria, Oregon		30.30	30.00	70	59	68	58	65	59	Clear and pleasant	NE'ly 1–2	Do.
	17	......do		30.02	29.80	84	65	74	61	64	61	......do	NE. 3, NNE. 4–2, N. 1	Do.
	18	......do		30.00	29.92	73	63	68	61	63	59	Foggy and smoky	Calm, variable 1, calm	Do.
	19	......do		30.06	30.00	61	58	60	56	61	57	......do	Calm, W. 1, SW. 1	Do.
	20	......do		30.10	30.04	68	53	64	52	61	56	Drizzly and overcast, to fair and pleasant.	Calm, S. 1, SW. 2	Light drizzle.
	21	......do		30.02	29.80	59	52	56	51	59	56	Fair and cloudy, to rainy	Calm, variable, 1–4	Light.
	22	......do		30.20	29.88	58	50	56	50	58	56	Rainy	SW'ly 1–3, SE'ly 3, S. 2	Moderate.
	23	......do		30.52	30.24	70	56	63	54	60	57	Rainy to fair and pleasant	SW. 2, SSW. 2, N. 1, W. 1, calm	Light.
	24	......do		30.54	30.36	73	54	70	54	61	56	Thick to clear and pleasant	NE. 2, NNE. 2, ENE. 3, N. 4	None.
	25	......do		30.34	30.12	75	57	67	57	67	58	Clear and pleasant	N. 3, NNE. 3–1, calm	Do.
	26	......do		30.20	30.04	75	57	70	56	64	59	......do	NNE. 1, NE. 2, calm	Do.
	27	Portland, Oregon		30.14	29.94	63	54	63	53	62	58	Thick and smoky	Calm, W. 1, calm	Do.
	28	......do		30.02	29.88	66	60	65	60	63	60	Thick and drizzly to fair to rainy.	Calm, SSE. 1	Light.
	29	......do		30.10	29.90	63	59	62	58	63	61	Rainy	SSE. 2, SE. 3, S. 1, calm, SE. 1	Moderate.
	30	......do		30.06	29.82	70	59	68	58	63	61	......do	SE. 1–2, SSE. 3–1, calm	Light.
Oct.	1	......do		30.22	29.88	64	57	63	56	63	58	Rainy to clearing and fair	SSE. 2, S. 1, SSE. 1, calm	Do.
	2	......do		30.30	30.20	65	53	61	51	61	58	Fair and pleasant	Calm	None.
	3	......do		30.30	30.02	65	53	65	52	63	58	Foggy to clear and pleasant	......do	Do.
	4	......do		30.10	29.98	68	55	64	53	63	59	Fair and pleasant	......do	Do.
	5	......do		30.10	29.94	68	52	66	51	63	58	Foggy to fair and pleasant to overcast.	......do	Do.
	6	......do		29.96	29.70	67	58	65	57	63	58	Misty and rainy	......do	Light.
	7	......do		29.78	29.70	62	57	61	56	62	59	Rainy	......do	Moderate.
	8	......do		30.04	29.76	59	55	58	55	60	59	......do	Calm, SSE. 1	Do.
	9	......do		30.22	30.06	57	53	56	51	60	57	......do	S. E. 1, 2, calm	Light.
	10	......do		30.26	30.14	60	51	58	51	59	55	Rainy to clearing	Calm, SE. 1, NE. 1, WSW. 2. SW. 1	Do.
	11	46 04 00	124 04 00	30.28	30.20	62	53	60	52	59	55	Fair and pleasant	Calm, variable 1, 2	None.
	12	42 21 00	124 31 00	30.20	30.04	69	54	66	54	62	57	Clear and pleasant	N. 2, NW. 1	Do.
	13	41 15 00	124 31 00	30.14	30.02	58	56	58	54	58	55	Thick and drizzly to fair and clearing.	NNW. 2, NW. 2–5	Do.
	14	39 05 00	124 02 00	30.22	30.10	65	56	64	55	57	56	Clear and pleasant	NNW. 6–5, NW. 3–1, S. 1	Do.
	15	San Francisco, Cal		30.26	30.12	62	55	60	55	61	56	Foggy to fair and pleasant	S'ly 1–2, calm	Do.
	16	......do		30.16	30.00	65	56	61	55	61	58	Fair and pleasant	Calm, ESE. 1, SW. 2	Do.
	17	......do		30.00	29.92	60	57	59	56	61	58	Fair to rainy	ESE. 3, SE. 4, SSE. 5	Light.
	18	......do		30.12	29.98	63	58	60	57	61	59	Rainy to fair	SSE. 3, SSW. 2, SW. 1, calm	Do.
	19	......do		30.08	29.74	63	58	61	57	61	59	Clear and pleasant to overcast and rainy.	Calm, ENE. 1, E. 2, SE. 1	Do.
	20	......do		29.76	29.54	60	58	59	57	61	59	Rainy and squally	SE. 1, E. 3, ESE. 4, 6	Do.

Record of meteorological observations by the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Date.	Position at meridian.		Barometer.		Temperature.						Weather.	Direction and force of winds.	Rainfall.
					Air: Dry bulb.		Air: Wet bulb.		Water at surface.				
	Lat. N.	Long., W.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.			
1889.	° ′ ″	° ′ ″	°	°	°	°	°	°	°	°			
Oct. 21	San Francisco, Cal		29 84	29.74	62	58	60	58	60	58	Squally and rainy	SE. 3-6, S. 4, SE'ly 3	Light.
22	do		29.94	29.84	63	59	61	58	61	59	do	SE. 4, veering to S. 2	Do.
23	do		30.20	29.94	67	59	65	59	62	59	Clear and pleasant	S. 2, SSE. 3, S. 2-1	None.
24	do		30.20	30.06	66	60	63	59	61	59	do	Calm, E. 1, calm, W. 1-2	Do.
25	do		30.10	30.04	64	62	63	61	62	60	Rainy	Variable, 2 and 1	Light.
26	Navy-yard, Mare Island, California.		30.08	29.90	62	60	62	60	61	60	do	ENE. 2, ESE. 1, SSE. 2, SE. 1	Do.
27	do		30.26	30.08	69	57	67	56	62	59	Fair and pleasant	SE. 1, calm, S. 1, WSW. 1	None.
28	do		30.34	30.20	67	52	65	49	61	54	Clear and pleasant	WSW. 1, NW. 1, calm	Do.
29	do		30.30	30.20	62	49	61	48	60	56	do	Calm, SW. 1, SSW. 1, S. 2	Do.
30	do		30.30	30.18	65	51	62	51	61	55	do	WSW. 1, W. 1, calm	Do.
31	do		30.30	30.22	69	57	65	57	61	56	do	WSW. 2, NW. 3-4, calm	Do.
Nov. 1	do		30.40	30.28	67	54	65	53	61	55	do	Calm, E. 1, ENE. 2, calm	Do.
2	do		30.40	30.20	66	57	64	51	61	55	do	Calm, ENE. 1, E. 2, SE. 1, calm	Do.
3	do		30.22	30.10	73	56	69	55	64	57	do	Calm, NW. 4-3	Do.
4	do		30.12	29.92	73	60	70	58	63	56	do	NW. 1-2, WNW. 2	Do.
5	do		30.34	30.12	66	53	64	52	60	55	do	NE. 2, ESE. 1, ENE. 2, calm	Do.
6	do		30.48	30.28	62	46	61	45	59	52	do	Calm, E. 1, S. 1, SW. 1	Do.
7	do		30.36	30.14	62	48	60	48	59	55	do	Calm, ENE. 1, calm	Do.
8	do		30.36	30.24	65	50	64	49	61	53	do	Calm, E. 2, ENE. 1, calm	Do.
9	do		30.46	30.30	63	49	61	49	59	51	do	Calm, ENE. 1, WSW. 1, calm	Do.
10	do		30.32	30.08	63	50	62	50	59	54	do	Calm	Do.
11	do		30.14	29.98	69	57	67	56	61	55	do	NW'ly 3-1, calm	Do.
12	do		30.16	30.08	63	51	62	50	58	51	do	Calm, SSW. 1, calm	Do.
13	do		30,20	30.04	61	48	58	47	58	52	do	Calm, W. 1, calm	Do.
14	do		30.28	30.16	61	43	60	42	57	51	do	Calm, ENE. 2, calm	Do.
15	do		30.28	30.16	63	48	62	47	58	51	do	Calm, E. 2, ENE. 2	Do.
16	do		30.28	30,12	60	49	59	48	57	51	Fair and pleasant	Calm, ENE. 1, calm	Do.
17	do		30.12	30.06	60	55	60	55	58	53	Fair to overcast and rainy	Calm, E. 2, SE'ly 3, calm, SSE. 2	Light.
18	do		30.08	29.98	61	53	61	53	58	54	Rainy and squally	E. 1, SE. 2, S. 3-5	Heavy.
19	do		30.18	30.06	60	55	60	55	57	54	Rainy	S. 2-3, SSW. 3-5, W. 3-2	Do.
20	do		30.28	30.18	60	57	60	57	58	55	do	W. 1, calm	Moderate.
21	do		30.30	30.14	61	57	61	57	58	55	Overcast to clearing and fair	Calm	None.
22	do		30.18	30.00	59	49	58	49	57	50	Overcast and rainy to clear and pleasant.	Calm, S. 2, WSW. 2	Light.
23	do		30.26	30.18	57	47	56	46	56	50	Fair and pleasant	WSW. 1, calm, W. 1, calm	None.
24	do		30.36	30.26	55	46	54	45	55	50	do	Calm, SW. 1	Do.
25	do		30.44	30.26	59	48	59	47	56	49	Clear and pleasant	Calm, W'ly 1, calm	Do.
26	do		30.40	30.14	57	50	56	49	55	51	do	E 2	Do.

	27	......do	30.12	30.00	54	50	54	50	54	51	Fair and overcast	E 3	Do.
	28	......do	30.00	29.92	57	52	56	51	58	52	Fair to rainy	......do	Light.
	29	......do	30.06	30.00	56	53	56	52	54	51	......do	E. 1, ENE. 2-4	Do.
	30	......do	30.10	29.94	59	52	59	52	56	53	Fair to clear and pleasant	Calm, NE. 2, E. 1	None.
Dec.	1	......do	30.08	29.88	59	53	59	53	57	53	Drizzly and rainy to fair and pleasant.	Calm, E. 1, WSW. 2	Light.
	2	......do	30.20	30.06	61	51	59	51	55	52	Clear and pleasant to rainy	Calm, SE. 2	Do.
	3	......do	30.10	30.02	60	53	59	53	55	52	Rainy to fair to rainy	SE. 2, SSE. 2	Do.
	4	......do	30.02	29.90	56	51	55	51	55	52	Rainy and squally	SSW. 1, S. 3, SE. 2	Moderate.
	5	......do	29.96	29.92	52	50	53	50	54	50	Rainy	SE. 3, ESE. 2, ENE. 3	Do.
	6	......do	29.94	29.88	54	50	54	49	52	51	......do	ESE. 3, E. 2	Do.
	7	......do	30.14	29.92	59	51	58	51	52	50	Rainy to fair and clearing to rainy	E. 1, SE. 1, S. 2, SE'ly 3	Light.
	8	......do	30.14	29.92	56	53	56	53	53	51	Rainy to fair and clearing	SE. 3, SW'ly 3-2	Do.
	9	......do	30.26	30.14	58	53	57	53	54	52	Overcast, misty and rainy	SE'ly. 1, S. 1, SE. 1	Do.
	10	......do	30.18	29.82	58	51	57	50	54	51	Rainy	SSE. 2, S. 2-4	Moderate.
	11	......do	29.96	29.88	55	49	54	49	53	49	Fair to drizzly and rainy	Calm, variable 1	Light.
	12	......do	30.14	29.86	54	47	54	47	52	48	Rainy to clear	NE. 3-1, SE. 1 calm	Do.
	13	......do	30.28	30.14	52	45	50	45	51	48	Clear and pleasant	Calm, E. 1, calm	None.
	14	......do	30.30	30.18	52	43	51	43	51	48	......do	Calm, NE. 1-2, calm	Do.
	15	......do	30.34	30.20	52	43	52	42	51	47	Foggy to clear and pleasant	Calm, SW. 2, calm	Do.
	16	......do	30.34	30.10	51	42	50	42	50	45	Clear and pleasant to rainy	Calm, E. 3-1	Light.
	17	......do	30.22	30.10	54	47	54	47	51	46	Rainy to clear and pleasant	S'ly 3-1, SW. 1, calm	Do.
	18	......do	30.30	30.02	53	47	53	47	50	47	Rainy	E. 3, S. 1, ESE. 1	Do.
	19	......do	30.30	30.18	56	49	56	49	51	47	......do	ESE. 2, SE. 2, S. 2, SW. 4	Do.
	20	......do	30.32	30.20	57	47	56	47	50	47	Drizzly to clear and pleasant	S. 2, SW. 1, calm	None.
	21	......do	30.24	29.84	52	45	52	45	50	45	Fair to rainy and squally	SE. 2-6, SW. 5-3, calm	Moderate.
	22	......do	29.96	29.82	47	44	47	44	48	44	Rainy to fair	E. 2, calm	Light.
	23	......do	29.84	29.68	53	43	49	42	49	44	Rainy to fair to rainy	Calm, ENE. 2, SSE. 2-4	Do.
	24	......do	29.86	29.72	50	45	50	45	48	45	Rainy	NE. 2, ENE. 4, E. 2-1	Do.
	25	......do	30.20	29.86	54	47	53	47	49	46	Rainy to clearing and fair	SE. 2, NNW. 2	Do.
	26	......do	30.28	30.20	48	46	48	45	47	45	Drizzly to clear and pleasant	Calm, ENE. 1-2	Light drizzle.
	27	......do	30.30	30.20	49	42	49	42	48	43	Foggy to fair and pleasant	Calm, SSW. 1-2	None.
	28	......do	30.44	30.24	52	43	51	42	48	42	Drizzly and rainy to fair	Calm, NW. 1, calm	Light.
	29	......do	30.52	30.44	50	39	49	39	46	42	Clear and pleasant	Calm, E. 1, calm	None.
	30	......do	30.42	30.18	54	45	53	45	48	44	Rainy to fair and pleasant	Calm, WSW. 2	Light.
	31	......do	30.26	30.10	52	42	51	41	48	42	Clear and pleasant to drizzly	WSW. 1, W. 1	Light drizzle.
1890.													
Jan.	1	......do	30.14	30.06	59	46	54	46	48	46	Fair	Calm, SSW. 1, WSW. 1, calm	None.
	2	......do	30.14	29.88	51	46	51	46	47	45	Rainy and overcast	Calm, S. 1-2	Moderate.
	3	......do	29.90	29.78	47	41	47	40	46	42	Rainy	SW. 3, variable 2, SSW. 1, calm	Do.
	4	......do	29.96	29.84	45	39	44	39	45	38	......do	Calm, E'ly 1-3	Light.
	5	......do	30.18	29.96	47	37	46	37	45	38	Overcast and rainy to clear and pleasant.	Variable 0-1, calm	Do.
	6	......do	30.30	30.20	46	36	45	36	44	38	Clear to rainy to clear and pleasant.	Calm, NNE. 1-2	Do.
	7	......do	30.46	30.38	45	36	43	35	44	40	Clear and pleasant	Calm, E'ly 1, calm	None.
	8	......do	30.46	30.30	45	36	45	35	43	38	Clear and pleasant to overcast and rainy.	Calm, E. 1, calm	Light.
	9	......do	30.42	30.08	44	34	44	34	42	36	......do	......do	Do.
	10	......do	30.20	30.10	48	38	49	37	43	39	Clear and pleasant	Calm, W. 1, calm	None.
	11	......do	30.44	30.24	49	36	48	36	43	38	Clear and pleasant to overcast and drizzly.	Calm, NNW. 2-1, calm	Light drizzle.

Record of meteorological observations by the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Date.	Position at meridian.		Barometer.		Temperature.						Weather.	Direction and force of winds.	Rainfall.
					Air: Dry bulb.		Air: Wet bulb.		Water at surface.				
	Lat. N.	Long. W.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.			
1890.	° ′ ″	° ′ ″	°	°	°	°	°	°	°	°			
Jan. 12	Navy-yard, Mare Island, California.		30. 46	30. 16	51	41	51	41	47	40	Drizzly and rainy to fair	Calm, E. 1-2, S. 2	Moderate.
							51						
13	do		30. 42	30. 26	54	42		42	45	40	Clear and pleasant	N. 4, NW. 1, W. 2	None.
14	do		30. 44	30. 32	49	38	49	37	43	40	do	Calm, E. 1	Do.
15	do		30. 32	29. 90	52	41	51	42	45	41	Fair and pleasant to overcast and rainy.	Calm, SE. 1-5, calm	Light.
16	do		30. 02	29. 88	54	46	53	46	45	42	Overcast and rainy	Variable 1, S. 2-1	Do.
17	do		29. 96	29. 90	53	46	53	46	46	43	do	Calm, S'ly 1-3, calm	Do.
18	do		30. 30	29. 96	50	42	49	42	46	40	Overcast and rainy to clear and pleasant.	SW'ly 1, calm	Do.
19	do		30. 40	30. 26	50	37	48	37	45	40	Clear and pleasant to rainy and overcast.	Calm, E. 1	Do.
20	do		30. 46	30. 20	45	38	44	37	44	40	Rainy to fair and pleasant	Variable 1, calm	Do.
21	do		30. 20	30. 10	45	39	44	39	44	40	Overcast and rainy	SE'ly 3	Do.
22	do		30. 20	30. 12	51	44	50	43	46	42	do	SE'ly 3-2	Do.
23	do		30. 18	30. 08	55	49	53	48	46	44	do	do	Moderate.
24	do		30. 06	29. 84	58	50	57	49	50	45	do	SE'ly 3-5	Do.
25	do		30. 20	29. 84	50	44	50	43	48	40	Overcast and rainy to clear and	Calm, WSW. 1, calm	Do.
											pleasant.		Light.
26	do		30. 32	30. 18	51	40	50	39	48	45	Clear and pleasant	Calm, E. 1	None.
27	do		30. 38	30. 28	49	40	46	39	46	42	do	Calm, E. 1, calm	Do.
28	do		30. 40	30. 30	56	43	53	42	49	43	do	Calm, E. 1, ESE. 1, calm	Do.
29	do		30. 34	30. 18	60	51	58	50	51	47	Overcast and drizzly	Calm, SE. 1-2, SW. 1	Light drizzle.
30	do		30. 38	30. 30	57	48	55	46	50	44	Fair to clearing	SW. 1, calm, SW. 1, calm	None.
31	do		30. 40	30. 32	55	41	54	40	50	44	Clear to fair and pleasant	Calm	Do.
Feb. 1	do		30. 42	30. 30	55	48	54	47	50	46	Fair to cloudy	Calm. SW. 1, calm	Do.
2	do		30. 34	30. 20	60	48	59	47	51	45	Foggy and cloudy	Calm. SE. 1, calm	Do.
3	do		30. 30	30, 20	62	53	60	52	52	45	Fair to overcast and drizzly	Calm, S'ly 1, calm	Light drizzle.
4	do		30. 40	30. 30	61	53	59	52	52	49	Overcast and drizzly	SW. 1, SSW. 1, calm	Do.
5	do		30. 42	30. 32	58	50	57	49	52	49	Overcast and drizzly to clear and pleasant.	Calm, S. 1, SW. 1	Do.
6	do		30. 42	30. 26	59	46	56	45	54	49	Clear and pleasant	Calm	None.
7	do		30. 34	30. 24	58	47	56	47	53	49	do	E. 2, NE. 2, calm	Do.
8	do		30. 30	40. 16	59	46	58	46	53	49	Foggy to clear and pleasant	Calm	Do.
9	do		30. 38	30. 22	56	48	55	47	52	50	do	SW. 1, S. 1, E. 1	Do.
10	do		30. 44	30. 34	62	48	55	44	53	49	Clear and pleasant	N. 2, NW. 1, calm	Do.
11	do		30. 56	30. 46	58	45	53	42	52	49	do	E. 1-3, NE. 2, calm	Do.
12	do		30. 54	30. 20	59	45	57	44	52	48	Clear and pleasant to fair and cloudy.	Calm, SW. 1-4, NW. 3	Do.

	13	......do	30.28	30.12	54	42	53	40	50	40	Clear and pleasant	NW. 3, N. 3-2, calm	Do.
	14	......do	30.26	30.16	56	40	54	39	50	48	......do	Calm	Do.
	15	......do	30.16	29.80	55	48	53	47	49	47	Overcast, drizzly, and squally	Calm, SE. 1, ESE. 2-5	Light drizzle, rain.
	16	......do	29.94	29.64	52	46	51	44	49	47	Overcast and rainy	SE. 4-6, S. 5, W. 3, SW. 1	Moderate.
	17	......do	29.98	29.78	53	42	52	41	49	45	......do	S'ly 1	Do.
	18	......do	30.00	29.76	47	42	46	42	47	44	......do	S. 1, SW'ly 2-4-2	Do.
	19	......do	30.04	29.90	45	41	44	40	47	44	......do	SE'ly 2-1, E. 1	Do.
	20	......do	30.00	29.86	51	43	51	42	47	44	Clearing to overcast and rainy	E. SE. 2-3, S. 3, SW. 2, calm	Light.
	21	......do	30.12	29.96	47	40	46	39	46	44	Cloudy and rainy	Calm, variable 1, calm	Do.
	22	......do	30.32	30.16	50	40	49	39	47	45	Rainy to clear and pleasant	Calm, SW'ly 1, calm	Do.
	23	......do	30.32	30.16	50	38	49	38	47	44	Clear and pleasant	Calm, S. 1, SW'ly 1	None.
	24	......do	30.16	30.02	54	42	52	41	47	45	Clear to drizzly and overcast	Calm, SW. 1, W. 1	Light drizzle.
	25	......do	30.02	29.92	51	40	50	38	47	40	Fair and pleasant	SW. 1, WSW. 2, W. 2-3	Light mist.
	26	......do	30.26	30.04	49	38	46	36	46	44	Clear and pleasant	W. 3, variable 1, calm	None.
	27	......do	30.42	30.28	51	36	46	36	47	42	......do	Calm, variable 1, calm	Do.
	28	......do	30.50	30.40	50	38	47	37	47	40	Clear and pleasant to overcast and misty.	Calm, easterly 1-4-1, calm	Light mist.
Mar.	1	......do	30.46	30.30	55	45	51	43	49	45	Overcast and misty to fair and pleasant.	Easterly 1-2, calm	Do.
	2	......do	30.32	30.16	59	46	57	45	58	45	Clear and pleasant to overcast and drizzly.	Easterly 1-2	Light drizzle.
	3	......do	30.30	30.22	59	50	56	50	50	47	Fair and cloudy	Calm, easterly 1	Do.
	4	......do	30.26	30.16	58	53	58	52	50	49	Overcast, drizzly, and rainy	E. 1, variable 1	Rain, light.
	5	37 58 30 | 122 26 00	30.18	30.08	60	51	59	50	52	48	Overcast and rainy, fair and pleasant, and overcast.	Southerly 1	Do.
	6	Navy-yard, Mare Island, California.	30.08	29.82	55	50	55	50	52	49	Foggy and rainy	Calm, S. 1-4	Do.
	7	......do	30.08	29.86	58	52	57	50	54	50	Overcast and rainy	S. 5-2, SW. 2-1	Do.
	8	......do	30.10	29.76	52	44	52	43	51	46	......do	Variable 1-6, SE. hauling to NW.	Moderate.
	9	......do	30.30	30.10	52	44	50	43	51	46	Fair and cloudy	Variable 5-2, S. 4-1	None.
	10	San Francisco Bay, California.	30.50	30.30	71	43	62	42	54	45	Clear and pleasant	WNW. 1-4	Do.
	11	37 27 20 | 122 44 00	30.56	30.44	60	48	55	45	53	49	......do	WNW. 4, NNE. 2, NW. 3	Do.
	12	37 03 30 | 122 18 00	30.56	30.48	58	47	57	45	55	50	......do	NNW. 1-2, NW. 1	Do.
	13	36 44 26 | 122 11 00	30.60	30.52	65	43	65	43	59	49	......do	NW. 1, E. 2-3, variable 1	Do.
	14	Monterey Harbor, California.	30.50	30.30	67	47	65	47	58	53	......do	Calm, northerly 2, E. 1	Do.
	15	36 55 00 | 122 12 00	30.32	30.18	58	49	57	49	55	52	......do	NNW. 2, NW'ly 1-2	Do.
	16	Navy-yard, Mare Island, California.	30.18	30.02	64	53	62	53	56	52	Foggy and cloudy, fair	Calm, E. 1, calm, SSW. 1	Do.
	17	......do	30.08	30.00	59	53	59	52	55	52	Fair to overcast and rainy	SW. 1, SSE. 1-2	Light.
	18	......do	30.00	29.92	56	50	55	49	54	52	Overcast and rainy	SE. 3-4, calm, NW. 1	Moderate.
	19	......do	30.10	29.96	51	46	50	45	54	51	Rainy to clear and pleasant	NW. 1, W. 2-5	Light.
	20	San Francisco, Harbor, California.	30.20	30.10	58	48	56	47	54	51	Clear and pleasant	NW. 2, W. 1-3	None.
	21	37 42 30 | 125 41 00	30.24	30.12	54	49	53	49	55	51	Foggy to fair and pleasant	Calm, variable 1, W. 1, calm	Do.
	22	37 48 35 | 123 12 40	30.18	30.08	53	51	53	51	53	52	Overcast, drizzly and rainy	SE. 1, hauling to NW. 3	Light.
	23	Drake Bay, California	30.26	30.18	52	49	52	48	53	50	Fair and pleasant to clear	NNW'ly 4-1	None.
	24	38 01 00 | 123 28 00	30.20	30.12	57	48	55	48	55	51	Clear and pleasant to cloudy and misty.	NNW. 1, W. 2-1, calm	Light mist, rain.
	25	38 32 30 | 123 25 00	30.18	30.06	52	49	50	48	53	50	Overcast, rainy, and squally	S. 2, SSW. 4-5	Light.

Record of meteorological observations by the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Date.	Position at meridian.		Barometer.		Temperature.						Weather.	Direction and force of winds.	Rainfall.
					Air: Dry bulb.		Air: Wet bulb.		Water at surface.				
	Lat. N.	Long. W.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.			
1890.	° ′ ″	° ′ ″	°	°	°	°	°	°	°	°			
Mar. 26	San Francisco Harbor..		30.42	30.20	52	49	50	48	53	50	Rainy and squally to fair	SW. 3-5, NW. 2, W. 2	Light.
27	do		30.42	30.22	58	49	56	48	55	53	Clear and pleasant	W. 2, NW. 2-1, WSW. 4, W. 4	None.
28	38 24 00	123 26 30	30.22	30.06	53	48	51	47	53	50	Clear and pleasant to overcast and rainy.	WNW'ly 2-3	Light.
29	37 50 00	122 41 30	30.22	30.04	55	49	54	47	55	49	Overcast and rainy to fair	WNW. 2, NW. 1, SW. 1-3	Do.
30	San Francisco Harbor..		30.28	30.14	52	49	52	47	54	53	Overcast and rainy to fair and pleasant.	WSW. 2, W. 4-3	Do.
31	do		30.22	30.08	64	48	58	46	56	52	Clear and pleasant	NW. 3, W. 3	None.
Apr. 1	do		30.12	30.00	66	53	59	52	57	54	do	Calm, SW. 2	Do.
2	do		30.28	30.12	53	50	52	49	54	42	Overcast, drizzly, and cloudy	S. 2-1, SW. 2-3, WNW. 1	Light drizzle.
3	36 19 00	122 00 30	30.30	30.22	56	51	54	50	54	51	Clear and pleasant	NW. 2, NNW. 3, NW. 3	None.
4	35 37 00	121 13 30	30.22	30.12	56	50	55	49	54	52	Fair and pleasant	NW. 4-5-2	Do.
5	35 14 00	121 07 00	30.26	30.18	57	50	56	50	54	51	do	NW'ly 2-5	Do.
6	34 15 30	119 52 30	30.26	30.16	61	53	59	53	58	52	do	NW. 4, WNW. 2, W. 4-1	Do.
7	Santa Barbara Harbor..		30.30	30.18	58	52	57	52	57	52	do	Calm, WSW. 1-6, W. 7-8	Do.
8	34 11 15	120 10 30	30.20	30.08	60	53	59	53	55	52	Clear and pleasant	WSW. 5-2, W. 2, N'ly 1	Do.
9	36 13 50	121 14 00	30.20	30.10	73	54	67	54	62	51	do	NW'ly 1, calm	Do.
10	Monterey Harbor		30.14	29.96	66	54	65	54	60	54	do	Calm, NW. 2, W. 1	Do.
11	36 46 10	121 59 40	30.12	30.00	55	49	55	48	58	52	Foggy and misty to fair and pleasant.	Calm, NW. 2, W. by N. 4, NE. 1	Do.
12	36 59 00	122 27 00	30.28	30.16	50	47	49	46	55	59	Fair and pleasant	NW. 1-4	Do.
13	Navy-yard, Mare Island, California.		30.32	30.20	62	47	60	47	60	48	Clear and pleasant	Calm, SW'ly 1-2	Do.
14	do		30.26	30.12	66	51	63	50	62	59	do	Calm, W. 1	Do.
15	do		30.26	30.20	65	52	63	52	64	58	do	W. 1, SW'ly 1, W. 2	Do.
16	do		30.22	30.22	63	52	61	51	61	59	Fair and cloudy	Calm, SSW. 1-2	Do.
17	do		30.22	29.86	64	53	63	52	In dry dock		Fair to overcast, drizzly, and rainy	S. 1, SW'ly 1, S. 1, SE. 1	Light.
18	do		30.02	29.86	57	51	56	51	do		Overcast and rainy	S'ly and W'ly 1-2, varying	Do.
19	do		30.16	30.02	62	50	60	50	do		Cloudy to fair	Calm, SW'ly 1	None.
20	do		30.20	30.14	64	51	61	50	do		do	Calm, W. 1, S. 1, W. 1	Do.
21	do		30.22	30.10	67	51	65	50	do		Fair and pleasant	Calm, SW'ly 1-2	Do.
22	do		30.18	30.06	67	50	64	49	do		do	SW. 2, SSW. 1	Do.
23	do		30.20	30.12	65	52	63	51	do		Fair to clear and pleasant	SSW. 1, SW. 1, S	Do.
24	do		30.22	30.10	72	50	69	49	do		Clear and pleasant	Calm, S'ly 0-1	Do.
25	do		30.20	30.10	69	54	65	52	do		do	S. 1, SW. 2, W. 1	Do.
26	do		30.18	30.04	70	51	69	51	do		do	SSW. 1, S. 1	Do.
27	do		30.18	30.00	69	52	65	51	do		do	S. 1, SSW. 1	Do.
28	do		30.10	30.02	60	51	59	51	61	57	Fair and pleasant	SSW. 1-2, SW'ly 3-1	Do.
29	do		30.12	30.02	62	52	60	50	62	55	Cloudy and pleasant to drizzly	SW. 1-2, SSW. 1	Light drizzle.

	30	......do		30.18	30.12	64	52	62	51	62	59	Cloudy to fair	SW'ly 1	None.
May	1	......do		30.20	30.04	63	52	60	52	62	55	Clear and pleasant	W'ly 1, W. 2	Do
	2	San Francisco Harbor, California.		30.18	30.10	65	54	63	52	62	56	Fair and pleasant	SE. 0-1, SW. 3	Do
	3	......do		30.22	30.10	68	58	68	58	62	58	......do	E'ly 1, W. 3	Do.
	4	......do		30.12	30.04	67	57	65	56	60	52	......do	Calm, W. 1-4	Do.
	5	......do		30.14	30.10	64	51	61	51	60	52	......do	W'ly 3-4	Do.
	6	40 07 00	124 38 00	30.12	30.06	54	51	54	51	54	51	Cloudy and misty	WNW'ly 2-4	Do.
	7	43 17 00	124 51 00	30.12	30.04	55	53	55	53	54	52	Overcast with passing showers	NW. 4, WNW. 2-3	Light.
	8	46 20 30	124 09 00	30.12	30.04	53	49	53	49	55	50	......do	W'ly 3-2	Do.
	9	48 24 20	123 13 00	30.12	30.00	54	46	53	46	55	48	Fair and pleasant	Variable 0-1, calm	None.
	10	Departure Bay, British Columbia.		29.98	29.76	53	49	55	49	56	52	Overcast and rainy	Calm	Moderate.
	11	......do		30.42	29.86	54	50	54	50	57	55	......do	......do	Do.
	12	......do		30.58	30.42	58	48	58	47	60	53	Cloudy to fair and pleasant	Calm, E. 1-2, calm	None.
	13	......do		30.58	30.30	60	52	59	50	63	53	Fair and pleasant	Variable 0-2	Do.
	14	50 33 50	126 52 40	30.32	30.18	58	51	58	52	56	51	......do	Calm, SW'ly 2-1	Do.
	15	51 09 00	132 35 00	30.18	29.86	52	45	52	45	53	47	Overcast and misty	SE'ly 2-4, S. 2	Light.
	16	51 52 00	137 27 00	30.10	29.94	47	45	46	45	54	42	Overcast, squally, and rainy	S. 5-3, SSE. 5-6	Do.
	17	52 25 30	142 41 30	29.96	29.80	45	40	45	40	47	44	Rainy to misty and cloudy	S. 4, SSE. 3	Do.
	18	52 43 30	147 44 00	29.78	29.68	41	38	41	38	45	43	Overcast, rainy, and misty	S. 2, SW. by W. 3, SW. 3	Do.
	19	53 13 00	152 48 17	29.76	29.48	42	39	42	39	44	43	......do	SW'ly 2, S. 3, SE'ly 2	Do.
	20	53 55 00	158 04 40	29.46	29.32	44	41	44	41	46	43	......do	SE'ly 1-3, variable 0-1	Do.
	21	54 00 40	162 57 00	29.42	29.14	44	39	44	39	44	40	......do	NE'ly 1-5	Do.
	22	54 16 00	165 13 00	29.74	29.24	42	38	42	38	43	40	Clearing to fair, then squally	NW. 1 to SW. 5	None.
	23	54 36 30	166 53 00	30.22	29.76	39	36	39	36	45	40	Squally, with rain, snow, sleet; overcast.	W. 4-5, NW. 3	Moderate.
	24	Iliuliuk Harbor, Unalaska Island.		30.34	30.16	45	38	43	37	46	42	Overcast and cloudy	Variable 0-1	None.
	25	......do		30.12	29.75	51	39	49	39	54	42	Overcast and rainy	Variable 2-1	Light.
	26	......do		30.14	29.72	44	42	44	42	46	43	......do	SSW. 4, SW. 4-2	Do.
	27	......do		30.22	30.14	55	42	50	42	50	45	Clearing to fair	SE'ly 2-1	None.
	28	54 29 00	165 10 20	30.36	30.18	45	41	45	41	46	42	Squally, overcast, and rainy	ESE. 4, SE. 3, S. 7	Light.
	29	55 11 30	163 17 00	30.36	30.28	45	42	44	42	46	44	Rainy to overcast and cloudy	S. 7, SE'ly 4-6	Do.
	30	56 10 00	160 31 30	30.20	30.08	48	41	47	41	46	41	Overcast, squally, and rainy	E'ly 3-5, S'ly 4	Do.
	31	58 03 30	157 46 00	30.14	29.90	50	42	50	42	50	41	......do	E'ly 5-2	Do.
June	1	58 41 00	157 12 00	29.92	29.82	52	43	50	42	51	46	Overcast to fair	E. by S. 3, SE. 5	None.
	2	58 28 10	157 36 00	30.02	29.92	64	41	59	41	59	45	Fair and pleasant	ESE. 3 to WNW. 1	Do.
	3	58 50 00	158 31 40	30.10	30.02	53	46	52	46	52	47	Cloudy and pleasant	N. by W. 1 to S. 1	Do.
	4	Clark Point, Nushagak River, Alaska.		30.30	30.12	53	46	53	46	52	48	Cloudy and thick	NE'ly 1-2	Do.
	5	......do		30.32	30.24	63	45	60	44	58	48	Fair weather	WSW. 1-2	Do.
	6	......do		30.32	30.08	62	44	61	44	55	49	Foggy to clear and pleasant	SW. 1, S. 2	Do.
	7	58 31 00	158 35 00	30.06	29.92	55	35	54	35	53	39	Clear and pleasant to thick and foggy.	SSW. 1-3	Do.
	8	58 37 00	159 56 00	29.90	29.80	50	36	45	36	49	41	Fair and pleasant	SW. 2, S. 2	Do.
	9	58 43 00	161 02 20	29.86	29.60	47	39	47	38	49	38	Overcast and misty	S. 3-1, SE. 2	Do.
	10	58 40 00	162 06 00	29.58	29.40	44	40	43	39	44	40	Thick, rainy, and squally	ESE. 7-4	Light.
	11	58 57 00	162 05 00	29.52	29.40	47	40	46	39	48	41	Squally and rainy to fair	SE. 4 to E. and S. 1	Do.
	12	59 06 00	161 59 00	29.66	29.52	44	42	45	40	46	43	Misty and rainy	ESE. 2-4	Do.
	13	58 40 30	162 06 00	29.88	29.66	43	38	42	38	44	39	......do	ESE. 4, SE. 3	Do.
	14	56 55 30	164 30 00	30.16	29.90	46	38	45	38	47	39	Overcast and cloudy	SE. 2, E. and N. 2	None.

Record of meteorological observations by the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Date.	Position at meridian.		Barometer.		Temperature.						Weather.	Direction and force of winds.	Rainfall.
					Air: Dry bulb.		Air: Wet bulb.		Water at surface.				
	Lat. N.	Long. W.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.			
1890.	° ′ ″	° ′ ″	°	°	°	°	°	°	°	°			
June 15	54 43 00	166 01 00	30.12	29.56	45	41	44	41	45	44	Squally, rainy, and misty	E'ly 4-7	Light.
16	Iliuliuk Harbor, Unalaska Island.		30.06	29.82	47	42	45	41	50	46	Misty and rainy	SE. 2	Do.
17	do		30.06	29.50	48	39	46	39	49	44	do	S. 1 to E. 4	Do.
18	do		29.58	29.22	45	39	44	39	47	43	Squally and rainy	SE. 4, S. 4, SW. 7	Do.
19	do		30.00	29.60	44	41	43	40	45	44	do	SW. 4-8, WSW. 6-1	Do.
20	do		30.06	29.98	50	41	49	41	52	44	Overcast and rainy	Calm, NE'ly airs 1	Do.
21	do		30.14	30.04	51	44	50	43	52	44	Overcast and cloudy	Calm, variable 1	None.
22	do		30.18	29.94	50	43	49	42	50	46	Overcast and rainy	SW. 1, NNE. 1, E. 2	Light.
23	do		29.88	29.36	48	42	47	42	49	45	do	E. 3, SE. 4	Do.
24	54 41 30	164 51 00	29.40	29.34	45	42	44	41	45	44	Misty and foggy	SSW. 1 to W. 2	None.
25	55 23 10	163 20 00	29.70	29.38	49	42	49	41	48	44	Thick, drizzly, and misty	W. 2, SW. 3	Light.
26	55 16 30	163 02 00	29.78	29.68	44	42	44	42	47	44	do	SW. 2	Do.
27	55 25 50	163 08 00	30.10	29.80	44	42	44	41	46	44	Misty and foggy	W'ly 2-3	None.
28	56 29 50	162 26 00	30.24	30.10	45	41	45	40	46	44	Overcast and cloudy	SW. by S. 3, SW. 3	Do.
29	56 18 30	160 53 00	30.22	29.70	46	41	44	41	50	44	Cloudy and misty	SW. by S. 3, S. 4, SE. 6-8	Do.
30	55 53 10	160 46 20	29.66	29.46	49	43	48	42	51	46	Thick, rainy, and misty	ESE. 4-6, SSE. 1	Light.
July 1	55 53 10	160 46 18	29.92	29.66	54	45	54	45	54	50	Overcast and showery	SE. 1 to WNW. 2	Do.
2	55 53 10	160 48 58	29.88	29.62	51	45	51	44	52	45	Overcast, occasionally clearing	NE. 1 to NW. 1, calms	None.
3	55 46 40	160 47 45	29.82	29.64	53	46	52	46	53	48	Overcast to fair and pleasant	Variable 2, calms	Do.
4	55 46 40	160 47 45	30.02	29.86	50	46	50	46	52	50	Misty and squally, occasionally clearing.	WSW. 2 to NW. 3	Do.
5	55 46 40	160 47 45	30.20	30.02	46	44	46	44	51	49	Foggy and misty to rainy	W. 2-4	Light.
6	55 45 20	160 42 10	30.34	30.22	46	41	45	41	51	48	Overcast and misty	W. 4, NW. 3, calms	None.
7	55 45 20	160 42 10	30.26	29.54	51	41	50	41	52	48	Misty, squally, and rainy	Calms, W'ly 6-9	Light.
8	55 45 20	160 42 10	29.80	29.46	52	45	51	45	53	49	Rainy and foggy	SE. 4, W. 6	Do.
9	55 45 20	160 42 10	30.06	29.80	45	41	45	41	50	45	Overcast and rainy	W'ly 3-4	Do.
10	55 45 20	160 42 10	30.32	30.06	47	44	47	44	51	48	Overcast, misty, and rainy	W. 3-4	Do.
11	55 45 20	160 42 10	30.47	30.32	49	43	48	43	51	48	Overcast, foggy, and misty	WNW. 1, W. 3	None.
12	55 45 20	160 42 10	30.50	30.44	52	45	51	44	53	49	Overcast to clear to foggy and misty.	SW. 1-3	Do.
13	55 45 20	160 42 10	30.46	30.40	59	45	59	44	58	52	Foggy to fair and pleasant	Variable 1, calms	Do.
14	55 45 20	160 42 10	30.40	30.22	54	46	51	45	56	50	Fair and pleasant to rainy	SE. 3-8	Light.
15	55 45 20	160 42 10	30.20	30.10	56	46	55	45	55	50	Squally, misty, and rainy	SE. 6-8	Do.
16	55 53 15	160 46 25	30.16	30.10	52	44	50	44	54	46	Overcast, misty, and rainy	SE. 4-7, SW. 6, S. 6	Do.
17	56 22 00	160 13 00	30.16	30.12	47	41	47	41	49	42	Foggy, misty, and rainy	SSW. 4 to WSW. 6	Do.
18	57 08 45	159 23 00	30.18	30.08	45	40	45	40	48	41	Overcast, misty, and foggy	SW. 2, W. 3	None.
19	57 25 00	158 44 00	30.34	30.14	49	42	49	42	52	46	Foggy to fair and pleasant	S. 2, W. 3	Do.
20	58 00 10	159 01 00	30.44	30.34	51	45	50	45	55	49	Fair and pleasant	S. 2, SSW. 3	Do.

	21	57	30	00	160	12	00	30.48	30.40	50	45	49	45	52	45	Overcast and foggy, occasionally clearing.	SSW. 2, SW. by W. 3	Do.
	22	57	34	00	161	25	30	30.46	30.44	47	45	47	45	52	48	Foggy and misty, clearing at intervals.	SSW. 2 to W. by S. 6	Do.
	23	56	01	20	160	37	20	30.46	30.40	49	46	49	46	52	48	Overcast, misty, and rainy	SSW. 2 to WNW. 3	Light.
	24	55	45	15	162	42	10	30.42	30.38	50	47	50	46	54	49	......do	W. 2–3	Do.
	25	55	45	15	162	42	10	30.50	30.44	51	47	51	47	55	50	......do	W. 3–4	Do.
	26	55	45	15	162	42	10	30.50	30.44	50	46	50	46	54	52	......do	......do	Do.
	27	55	45	15	162	42	10	30.44	30.24	57	50	56	50	58	53	......do	WNW. 2, NW. 4	Do.
	28	55	45	15	162	42	10	30.34	30.24	50	46	50	45	54	52	......do	W. 2–6	Do.
	29	56	05	45	161	02	30	30.44	30.36	49	45	48	45	53	50	Cloudy and misty	W. 3, S. by W. 4	None.
	30	55	03	30	164	00	10	30.52	30.44	50	40	49	46	54	47	Overcast, foggy, and rainy	W. by S. 2 to SSW. 4	Light.
	31	Iliuliuk Harbor, Unalaska Island, Alaska.						30.52	30.38	66	46	63	46	64	50	Foggy to fair and pleasant	SE. 2 to W. 4	None.
Aug.	1	......do						30.44	30.32	64	50	62	50	61	53	Fair to rainy, misty and squally	S. 1, SSW., squalls 5	Light.
	2	54	02	00	167	14	00	30.56	30.40	51	47	50	46	54	48	Fair and pleasant to overcast	SW. 1, S. 2	None.
	3	54	20	00	171	03	15	30.34	30.10	50	47	50	47	51	50	Rainy, with lightning and overcast.	SE. by S. 4, veering to NW. 6	Heavy.
	4	56	27	30	172	14	30	30.28	29.92	47	45	47	44	51	49	Rainy and squally, sun appearing at intervals.	NNE. 2, calm, SSE. 7	Light.
	5	58	43	00	174	43	00	29.86	29.74	47	45	47	45	50	47	Rainy and overcast	SE. 5, WSW. 8	Moderate.
	6	56	25	30	175	27	10	30.18	29.88	52	45	49	45	51	48	Overcast and misty	WSW. 6 to NNE. 2	None.
	7	54	06	00	175	32	00	30.36	30.18	49	46	49	45	51	49	Fair and pleasant	NW. 1, NE. by N. 2	Do.
	8	54	08	00	171	55	00	30.36	30.26	52	46	50	45	52	50	......do	NE. by N. 2 to SW. 2	Do.
	9	53	57	00	167	05	00	30.24	30.20	49	46	48	46	52	50	Overcast and rainy to fair	WSW. 4, W. 3, variable 1, calms.	Light.
	10	Iliuliuk Harbor, Unalaska Island, Alaska.						30.20	30.18	52	47	50	46	53	50	Overcast, with occasional mist, squally.	SE. 1 to SW. 3, calms	None.
	11	......do						30.40	30.20	52	49	50	48	53	51	Foggy to clear and pleasant	Variable airs and calms	Do.
	12	......do						30.42	30.34	65	46	65	46	57	52	Fair to overcast and misty	SE. 2, ENE. 3	Do.
	13	......do						30.36	30.10	59	48	58	46	56	52	Overcast and misty to fair and pleasant.	Variable airs and calms	Do.
	14	......do						30.08	29.96	57	52	55	50	57	52	Fair weather to rainy to fair	Variable airs and calms to S. 4	Light.
	15	54	01	23	166	23	37	29.98	29.94	64	50	61	50	56	53	Cloudy and squally	S. 4, ESE. 6	None.
	16	53	56	00	167	00	00	30.02	29.94	61	54	59	52	54	52	Foggy and rainy to cloudy and pleasant.	ESE. 4–6, SW. 3–2	Light.
	17	53	46	00	166	53	00	30.12	29.98	61	57	59	56	57	53	Overcast and foggy to fair and pleasant.	Variable 2	None.
	18	53	41	23	167	16	00	30.48	30.12	56	46	55	46	55	47	Foggy and misty to fair and pleasant.	Variable 2–1	Do.
	19	53	23	30	167	30	00	30.48	30.36	50	45	50	44	50	45	Fair and pleasant	Variable 2–3	Do.
	20	53	31	30	167	35	00	30.42	30.02	50	46	50	45	49	45	Foggy and misty, occasionally clearing.	Variable 1, calms	Do.
	21	54	01	00	166	52	30	30.06	29.98	52	46	52	45	52	45	Overcast and foggy to fair	S. 2, NW. 4	Do.
	22	53	54	00	166	35	35	30.06	29.82	54	46	53	45	54	47	Overcast and pleasant	Variable 1, calms	Do.
	23	53	52	40	166	32	00	30.00	29.80	52	48	51	46	52	50	Overcast, misty, and squally	Calms, NNW. 4	Do.
	24	Iliuliuk Harbor, Unalaska Island, Alaska.						30.10	29.96	65	47	65	46	60	50	Cloudy, but pleasant	NW. 4, NE. 3	Do.
	25	......do						29.96	29.88	52	47	50	46	51	54	Cloudy and pleasant to rainy	Northerly 2–3, calms	Light.
	26	......do						29.98	29.92	56	47	53	46	50	45	Rainy to fair and pleasant	NWly 1–3, calms	Do.
	27	53	58	00	162	37	00	30.02	29.94	60	49	59	48	55	50	Fair and pleasant	WNW. 3, veering to S. 3	None.

Record of meteorological observations by the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Date.	Position at meridian.		Barometer.		Temperature.						Weather.	Direction and force of winds.	Rainfall.
					Air: Dry bulb.		Air: Wet bulb.		Water at surface.				
	Lat. N.	Long. W.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.			
1890.	° ′ ″	° ′ ″	°	°	°	°	°	°	°	°			
Aug. 28	54 34 00	158 47 40	30.10	30.02	53	52	53	51	53	51	Fair and pleasant to overcast and misty	SE'ly 3-4	None.
29	55 41 00	154 48 00	30.18	30.10	55	53	55	53	55	51	Overcast, misty, and foggy	SE'ly 4-6	Do.
30	56 01 00	150 52 00	30.14	30.08	55	54	55	54	55	53	Overcast, foggy, and rainy	SE. 4, S. 6	Light.
31	55 49 00	146 33 00	30.08	29.84	55	53	54	52	55	52	Foggy, misty, and rainy	SE. 2, S. by W. 5	Heavy.
Sept. 1	55 49 00	141 58 00	30.20	29.92	58	54	56	53	56	54	Misty and rainy to fair and pleasant	S. 6 to SW. by W. 3	Light.
2	54 27 00	137 37 00	30.28	30.20	57	55	57	53	56	55	Fair to misty and rainy	S. 3, SE. 4, S. by W. 4	Do.
3	52 55 30	132 25 30	30.42	30.30	65	57	61	55	59	55	Rainy to fair and pleasant	SW. 3-4, veering to NW. 4	Do.
4	51 09 30	130 12 45	30.42	30.30	76	56	67	55	60	55	Fair and pleasant	NW. 4-5	None.
5	49 05 00	126 24 00	30.28	30.20	82	54	71	52	58	51	......do	NW'ly 5-2	Do.
6	Port Townsend, Wash		30.32	30.18	65	52	60	51	55	50	Clear and pleasant	Variable 1	Do.
7	......do		30.18	29.96	70	51	66	50	57	50	......do	Variable 2, calms	Do.
8	......do		30.08	29.98	68	57	65	56	55	52	Fair and pleasant	......do	Do.
9	......do		30.10	29.92	70	56	66	54	56	52	Clear and pleasant	W'ly 1, calms	Do.
10	......do		30.10	29.94	59	52	57	51	56	50	Clear and pleasant, smoky horizon	......do	Do.
11	......do		30.30	30.16	61	52	55	50	54	50	Fair, smoky, and pleasant	W'ly 3, calms	Do.
12	......do		30.32	30.18	70	50	65	49	55	49	Fair, pleasant, and smoky	W'ly 1, calms	Do.
13	......do		30.30	30.26	62	50	60	49	55	50	Thick smoke and fog; pleasant	Variable 1, calms	Do.
14	......do		30.34	30.24	61	52	59	51	54	50	......do	Variable 2-3	Do.
15	......do		30.20	30.04	65	50	64	49	53	50	......do	Variable 2-3, calms	Do.
16	48 22 15	122 49 00	30.10	30.04	59	53	58	53	53	50	......do	S'ly 1, calms	Do.
17	49 11 00	123 52 00	30.28	30.10	62	56	59	51	57	52	Rainy to fair and pleasant	SW. 2, NW. 4	Light.
18	Departure Bay, B. C.		30.30	30.10	60	52	59	51	57	51	Pleasant weather	Variable 1, calms	None.
19	49 13 10	123 57 00	30.28	30.10	76	52	72	50	60	51	Fair and pleasant	SE'ly 2, calms	Do.
20	48 13 00	122 52 00	30.36	30.28	58	48	57	48	53	49	Clear and pleasant, smoky, hazy horizon	W'ly 1, calms	Do.
21	47 27 20	125 17 00	30.32	30.04	60	49	60	49	55	49	Foggy to fair and pleasant	NW'ly 2-4	Do.
22	45 22 00	125 05 00	30.12	30.02	57	50	56	49	57	49	Foggy	N. 2-3 to SE'd 3	Do.
23	43 00 00	124 36 00	30.16	30.10	57	50	56	50	52	50	Foggy to clear, with hazy horizon	Variable 2, calms	Do.
24	40 24 20	124 33 30	30.14	30.06	58	52	57	52	54	52	Fair and pleasant, thick, smoky horizon	NW'ly 2-3, E'ly 3, calms	Do.
25	38 58 00	124 01 20	30.16	30.06	55	53	55	53	54	53	Overcast and foggy	NW'ly 2-3	Do.
26	San Francisco Harbor		30.10	29.98	67	54	66	53	64	53	Clear overhead, thick, foggy horizon	Variable 1, calms	Do.
27	......do		30.22	30.14	70	60	66	59	62	59	Overcast, with drizzling rain	W'ly 2-4	Light.
28	......do		30.16	30.06	71	60	68	60	64	59	Cloudy to drizzly and rainy	Variable 1, calms	Do.
29	......do		30.12	30.04	63	59	62	59	62	60	Overcast, foggy, and rainy	......do	Do.
30	......do		30.18	30.10	64	59	64	58	63	60	Overcast and misty to clearing	SW'ly 1	None.
Oct. 1	Navy yard, Mare Island		30.16	30.04	67	58	66	57	64	61	Foggy to fair and pleasant	SW. 1	Do.
2	......do		30.12	30.00	77	57	68	57	60	55	Fair and pleasant	SW. 1 to NW. 3	Do.
3	......do		30.12	30.02	82	55	70	54	65	56	Fair weather	SW'ly 1, calm	Do.
4	......do		30.16	30.02	75	55	72	54	65	60	......do	SW. 2 to SE. 4	Do.
5	......do		30.16	30.00	83	59	75	58	66	53	......do	SE. 2-3	Do.

6	......do	30.14	30.00	78	60	75	60	66	62	......do	NW. 2, SW. 3	Do.
7	......do	30.06	29.88	75	61	70	60	67	63	Clear and pleasant	S'ly 1, calm	Do.
8	......do	29.90	29.68	69	56	68	52	66	60	Fair and pleasant	SW. 4-6, calm	Do.
9	......do	30.00	29.72	66	56	64	52	63	60	......do	NW. 8, NW. 2, SE. 3	Do.
10	......do	30.12	30.02	70	52	65	50	62	58	Clear and pleasant	Variable, 1	Do.
11	......do	30.24	30.08	58	50	57	49	62	57	......do	SW'd. 1-3	Do.
12	......do	30.34	30.20	62	49	60	49	62	57	......do	WSW. 1 to SSW. 1	Do.
13	......do	30.26	30.10	64	49	61	48	62	55	......do	Calm, SW'd 1	Do.
14	......do	30.18	29.96	67	51	64	50	63	56	......do	Calm, S'd 1	Do.
15	......do	30.04	29.88	68	49	63	49	62	56	......do	Calm, SW. 1	Do.
16	......do	30.02	29.88	68	50	63	49	62	58	......do	SW. 1, south 1	Do.
17	......do	30.10	29.96	69	51	65	50	62	57	......do	Calm, SE. 1	Do.
18	......do	30.20	30.10	68	53	62	52	61	54	......do	Calm, SW'd 1	Do.
19	......do	30.24	30.14	74	54	71	52	62	56	Fair and pleasant	SE. 2 to S. 1	Do.
20	......do	30.16	29.94	72	53	67	52	62	58	Clear and pleaant	Calm, SW'd 1	Do.
21	......do	30.04	29.84	75	55	68	54	65	55	......do	Calm, East 1	Do.
22	......do	30.00	29.88	72	56	68	55	64	57	Fair and pleasant	Calm, W'ly, 1	Do.
23	......do	30.10	30.00	72	54	68	53	64	58	Clear and pleasant	SW. 1, SSW. 1	Do.
24	......do	30.20	30.00	71	56	69	55	64	60	......do	Calm, W'd 1	Do.
25	......do	30.14	29.96	76	55	71	55	63	56	......do	E'ly 1	Do.
26	......do	30.12	29.98	77	59	68	57	65	58	Fair and pleasant	Calm, east 2	Do.
27	......do	30.20	30.02	76	56	70	55	63	56	Clear and pleasant	Calm, east 1	Do.
28	......do	30.20	29.98	78	56	70	54	65	60	......do	Calm, NW. 1, E. 1	Do.
29	......do	30.14	29.96	75	57	68	54	64	55	......do	Calm, E. 1	Do.
30	......do	30.20	30.08	68	57	68	56	63	57	......do	Calm, S'ly 1	Do.
31	......do	30.26	30.14	62	54	61	53	61	54	Fair and pleasant	W. 1 to SSW. 1	Do.
Nov. 1	......do	30.28	30.18	59	52	58	51	61	57	Foggy to fair and pleasant	W. 1, SSW. 1	Do.
2	......do	30.28	30.18	61	50	60	49	59	55	Clear and pleasant	NW. 1, veering to S. 1	Do.
3	......do	30.34	30.14	70	49	65	49	64	55	Calm, clear, and pleasant	Calm, E. 1	Do.
4	......do	30.20	30.00	61	51	60	50	60	56	Clear and pleasant	Calm, S. 1	Do.
5	......do	30.00	29.78	61	52	59	49	60	56	Fair and pleasant	W. 1-3	Do.
6	......do	29.90	29.80	57	48	54	48	58	50	......do	W. 2, NNE. 2, calm	Do.
7	......do	29.96	29.84	65	46	63	45	59	50	Clear and pleasant	Calm, SSW. 1, SW. 1	Do.
8	......do	30.16	30.00	59	46	57	45	58	55	......do	E. 1	Do.
9	......do	30.28	30.16	61	46	59	45	57	54	......do	Calm, NE. 1	Do.
10	......do	30.40	30.24	62	46	62	45	59	50	......do	Calm	Do.
11	......do	30.44	30.28	64	46	61	46	59	54	......do	ESE. 1, SW. 1, NW. 1	Do.
12	......do	30.32	30.22	73	56	72	55	20	55	......do	Variable 1, calms	Do.
13	......do	30.24	30.08	65	47	63	46	58	53	......do	Variable 1, calms	Do.
14	......do	30.20	30.10	69	49	65	48	57	53	......do	NE. 1 to SE. 4	Do.
15	......do	30.28	30.20	65	48	63	48	59	50	Fair and pleasant	E. 1, calms	Do.
16	......do	30.24	30.18	61	46	60	45	57	51	Clear and pleasant	Calm, SW. 1	Do.
17	......do	30.24	30.14	61	46	60	46	56	52	......do	Calm, E. 1	Do.
18	......do	30.18	30.10	65	45	61	45	56	49	......do	E. 1	Do.
19	......do	30.30	30.10	64	47	60	47	56	48	......do	E. 1	Do.
20	......do	30.36	30.18	64	49	61	47	56	50	......do	E. 1	Do.
21	......do	30.30	30.22	63	49	60	48	56	52	Fair and pleasant	E. 1 to NE. 2	Do.
22	......do	30.40	30.24	64	51	61	50	59	51	Clear and pleasant	NE. 1 to E. 1, calm	Do.
23	......do	30.30	30.12	64	50	61	48	56	50	......do	E. 1	Do.
24	......do	30.18	30.08	61	52	59	51	56	52	Fair and pleasant	E. 1 to SW. 1	Do.
25	......do	30.26	30.14	62	53	61	52	58	53	......do	Calm	Do.
26	......do	30.32	30.22	60	50	59	50	58	52	......do	Calm	Do.

Record of meteorological observations by the U. S. Fish Commission steamer Albatross, July 1, 1889, to June 30, 1891—Continued.

Date.	Position at meridian.		Barometer.		Temperature.						Weather.	Direction and force of winds.	Rainfall.
					Air: Dry bulb.		Air: Wet bulb.		Water at surface.				
	Lat. N.	Long. W.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.			
1890.	° ′ ″	° ′ ″	°	°	°	°	°	°	°	°			
Nov. 27	Navy-yard, Mare Island.		30.34	30.16	64	48	61	47	54	49	Clear and pleasant	NE. 1	None.
28	......do		30.30	30.18	65	47	61	46	57	52	......do	Calm, E. 1	Do.
29	......do		30.34	30.18	63	49	60	48	55	51	......do	ENE. 1, E. 1	Do.
30	......do		30.30	30.16	60	48	57	47	55	49	......do	ENE. 1, calms	Do.
Dec. 1	......do		30.24	30.16	57	45	56	45	54	50	Fair and pleasant	Calm, SSW. 1	Do.
2	......do		30.18	29.80	59	50	58	50	56	51	Overcast and cloudy to rainy	SSW. 1 to SW. and S. 4	Light.
3	......do		29.70	29.50	57	54	57	53	58	53	Squally and rainy	SSE. 2–5; S. 3–6	Moderate.
4	......do		29.98	29.58	57	49	56	48	53	50	Squally and rainy to clearing	S. 4, to SW. 1	Light.
5	......do		30.26	29.98	56	45	55	44	54	46	Clear and pleasant	SW. 1, S. 1	Do.
6	......do		30.38	30.26	53	46	52	46	52	50	Fair and pleasant	NW. 1, E. 1	Do.
7	......do		30.46	30.34	55	45	54	44	53	47	......do	Calm, SW. 1, calm	Do.
8	......do		30.50	30.38	49	43	48	42	50	45	Clear and pleasant	E. 1	Do.
9	......do		30.40	30.28	47	42	46	41	51	45	Fair and pleasant	NE. 2	Do.
10	......do		30.32	30.16	48	37	47	38	49	47	......do	NE. 2–1	Do.
11	......do		30.46	30.22	44	37	43	37	48	43	Clear and pleasant	NE. 2–3	Do.
12	......do		30.52	30.40	41	37	41	37	47	42	Cloudy and disagreeable	NE. 3–2	Do.
13	......do		30.40	30.28	49	40	48	39	49	45	Fair and chilly	NE. 1	Do.
14	......do		30.44	30.34	46	42	45	42	47	40	Clear and cool	Calm, NE. 1	Do.
15	......do		30.48	30.34	46	40	46	39	47	43	Cloudy and chilly	NE. 1–2	Do.
16	......do		30.38	30.24	43	40	43	40	47	40	Raw, chilly, and cloudy	ENE. 4	Do.
17	......do		30.36	30.22	43	39	42	39	46	42	Raw and cloudy	NE. 3 to E. 2	Do.
18	......do		30.26	30.14	49	43	49	42	50	44	Overcast; passing rain showers	E. 2–1	Light.
19	......do		30.42	30.22	54	47	54	46	52	46	Fair and pleasant	Calm, SW. 1	None.
20	......do		30.52	30.42	51	42	51	41	50	44	Clear and pleasant	Calm	Do.
21	......do		30.54	30.42	47	41	46	41	47	43	......do	Calm, E. 1	Do.
22	......do		30.42	30.30	44	41	43	41	46	43	Cloudy and pleasant	E. 3, NE. 3	Do.
23	......do		30.30	30.18	49	41	48	40	48	41	Fair and pleasant	E. 3, ENE. 3	Do.
24	......do		30.18	30.14	47	41	46	40	47	45	......do	E. 1 to NE. 1	Do.
25	......do		30.32	30.14	45	41	44	41	46	44	Overcast and hazy	ENE. 2, E. 1	Do.
26	......do		30.32	30.22	45	41	44	40	46	44	Overcast and cloudy	Calm, E. 2	Do.
27	......do		30.36	30.24	45	39	45	39	47	45	Cloudy, but pleasant	E. 3, ENE. 3	Do.
28	......do		30.30	30.14	45	41	44	40	46	44	......do	E. 1–2, ENE. 1–2	Do.
29	......do		30.16	30.02	51	40	50	40	48	45	Rainy to overcast and cloudy	ENE. 1, calms	Light.
30	......do		30.36	30.00	54	45	53	44	50	46	......do	S. 1, veering to NW. 1	Do.
31	......do		30.54	30.38	51	41	49	40	47	45	Clear and pleasant to overcast and rainy.	Calms, W'ly. 1	Do.


U.S. Commission of Fish and Fisheries
M. McDonald Commissioner.
CHART OF
SAN FRANCISCO AND SAN PABLO BAYS
SHOWING THE LOCATION OF
OYSTER GROUNDS
SEASON OF 1890, 1891.
SCALE OF STATUTE MILES
LEGEND
ABANDONED OYSTER BEDS
EXISTING " "
SAN PABLO BAY
SAN FRANCISCO BAY
PACIFIC OCEAN
NAVY YARD
VALLEJO
STRAITS OF CARQUINES
McNear's Landg
Pt. San Pedro
Pt. San Pablo
Marin Ids
Pt. San Quentin
Red Rock
Ellis Landing
California Cy. Pt.
Sheep I.
Saucelito
Alcatraz I.
Yerba Buena
GOLDEN GATE
Mile Rocks
OAKLAND
SAN FRANCISCO
ALAMEDA
Bay Farm Island
Hunter Pt.
Thompson's Landg
Pt. San Bruno
MILBRAE
MILBRAE BEDS
Pt. San Mateo
SAN MATEO BEDS
SAN MATEO
N. BELMONT BEDS
S. BELMONT
ALVARADO BEDS
UNION CY.
BELMONT
REDWOOD CITY
RAVENSWOOD
DUMBARTON BEDS
122° 40'
122° 30'
122° 20'
122° 10'
122° 00
38° 10
38° 00
37° 50
37° 40
37° 30

2.—REPORT OF OBSERVATIONS RESPECTING THE OYSTER RESOURCES AND OYSTER FISHERY OF THE PACIFIC COAST OF THE UNITED STATES.

By CHARLES H. TOWNSEND.

CALIFORNIA.

SAN FRANCISCO BAY.

The oyster industry of the Pacific coast, exclusive of the trade in the small indigenous species, has never extended beyond the limits of the bay of San Francisco, where it has been restricted to the growing or fattening of seed or yearling oysters, brought annually in large quantities from the Atlantic coast and kept in the waters of the bay until they attain a marketable size. Although this method of supplying the market has been practiced by the oyster-dealers of San Francisco for many years, so that since the completion of the first overland railroad there has constantly been a supply of eastern oysters in the bay, it has generally been understood that there was no natural increase of the species, its alleged failure to propagate being usually attributed to the low temperature of the water. Some recent studies of the oyster beds and of the physical conditions of the bay of San Francisco by myself, under the direction of the United States Commissioner of Fish and Fisheries, have yielded data sufficient to warrant a review of the entire subject in a new light.

The interesting fact that oysters do propagate in San Francisco Bay, in certain favorable localities at least, calls for some explanation as to the long acceptance by the public of the statement that there has been no natural increase. This state of things may have resulted from one or more of the following conditions, perhaps in part from all of them, namely: The popular knowledge of the low temperature of the water as compared with the same latitude on the Atlantic coast; the peculiar situation of the localities where the imported oysters were laid out; the enemies they were known to have in Pacific waters; and the lack of sufficient public interest to demand the study and outlay necessary to discover the real truth respecting the life of the eastern oyster in

California waters. Doubtless one reason for the lack of information necessary to effect a change in the method of handling oysters is the fact that all the minor firms engaged in the business were early merged into one or more important companies, which, having practically the control of the entire oyster industry of the Pacific coast, had no need to change the methods of a business already profitable. Importations of seed oysters from Atlantic waters have therefore been made annually almost to the present time, while it is by no means proven that seed oysters can not be raised in that region. The methods of nearly twenty years ago are still in vogue, the only advancement made being the larger scale on which the business is now conducted.

The subject of oyster-culture does not appear to have engaged the attention of the State fish commission at any time, or at least it is not mentioned in such of the published reports as are accessible, and nothing has ever been done in California in this direction beyond the enactment of the usual laws relating to such fisheries.

During occasional visits to the oyster beds in 1889 I found proof of considerable natural propagation of the eastern oyster in the southern part of San Francisco Bay, and transmitted evidence of the same to the United States Commissioner of Fish and Fisheries, who directed that an examination be made in order to determine to what extent this had taken place.

My studies on this subject were limited to such times as the U. S. Fish Commission steamer *Albatross* was detained at the port of San Francisco, and even then they were secondary to my regular duties as naturalist of the vessel.

The investigations were, therefore, made very irregularly, and at different seasons of the year, as follows: February and October, 1890, and May, June, September, and October, 1891. A few days in June, 1891, were devoted to an examination of Tomales Bay, and two weeks in September, 1891, were spent in visiting the native oyster beds of Olympia and Willapa Bay. In this work I frequently had the use of one of the steam launches belonging to the steamer *Albatross*, which enabled me to examine every portion of San Francisco Bay, employing baymen as pilots for the narrower channels when necessary.

In view of the great success that attended the introduction of certain Atlantic species of mollusks and fishes into the waters of California, such as the soft-shelled clam, shad, striped bass, carp, catfish, etc., there was reason for expecting similar results from the introduction of the oyster. The investigations of this subject have simply disclosed the facts that the oyster has to some extent adapted itself to the new habitat in common with the other introduced species and that in spite of many unfavorable conditions it is slowly increasing. Future study with reference to oyster-culture on the Pacific coast should be made in the light of these facts.

Temperature.—The popular belief that the low temperature of the water of San Francisco Bay has prevented the increase of the oyster is not based on any exact information on the subject. The temperature of the bay in the vicinity of the city of San Francisco, usually not much higher in summer than in winter, was early assumed to be too low for oyster propagation; and, from the lack of special evidence of oyster increase, this gradually became the common explanation to casual inquirers about the matter, no one making any attempt to disprove it, although the spat from imported oysters has, it seems, been developing and growing in secluded places, doubtless from the very start. The oyster-growers apparently keep no record of temperatures, or of other observations that would throw light upon the physical conditions of the bay during the different seasons of the year.

Mr. M. B. Moraghan, an oyster-dealer of San Francisco, says that the temperature at his oyster beds at Millbrae ranges from 58° to 65° F. At the extreme southern end of the bay the summer temperature has recently been found to be much higher, ranging from 67° to 74° F. for July and August. My personal observations on the temperature were of course limited to times when the *Albatross* happened to be in port, and as this never occurred in summer the most important season is as yet but little understood. The importance of studying this subject is evident when the influence of the marked rainy and dry seasons of California upon the waters of the bay is considered. Although the water never reaches the summer warmth of corresponding latitudes on the Atlantic coast, the temperature is more equable than that of most places upon the Atlantic coast where oysters grow, and the extremes of temperature are within those of such regions. It may be that the temperature during the spawning season of the oyster, which is of course the critical period, is low enough to seriously limit the quantity of spat developed, but this can readily be determined by a careful study of the beds at the proper season, which has not yet been done.

Experiments in the artificial propagation of the oyster indicate that the nearer the temperature to 70° the more likely is success. During the latter part of October, 1890, I found the temperature of the southern part of the bay, near Belmont, to be usually 61° F. On the same dates, in the region of San Mateo, a few miles nearer the sea, it was 1° lower; while at California City, still nearer, it was 57°. Recent observations have shown, however, that the water temperature is much lower in October than in the midsummer season. It is altogether probable that the extreme southern portions of the bay, 20 or 30 miles back from the sea, are several degrees warmer at all seasons than those farther north, since the region is more sheltered from sea winds and the strong breezes of San Francisco are less noticeable there. The French system of *claires* would furnish still warmer water than any of the bays of California.

The following table and diagram of observations upon the temperatures of water and air in the Golden Gate, at 7 a. m., for ten years, 1874 to 1883, are taken from Davidson's "Pacific Coast Pilot."

Table showing the temperature of the water and air in the Golden Gate for 10 years, from 1874 to 1883, inclusive.

[Observations taken daily at 7 a. m., and reduced to monthly means.]

Months.	Water.	Air.	Water—Air.
January	50. 49	46. 89	+3. 60
February	50. 99	49. 21	+1. 78
March	52. 49	51. 98	+0. 51
April	54. 28	54. 72	—0. 44
May	56. 46	58. 33	—1. 87
June	58. 35	60. 27	—1. 92
July	58. 88	58. 78	+0. 10
August	59. 23	58. 00	+1. 23
September	59. 68	58. 86	+0. 82
October	57. 83	57. 30	+0. 53
November	54. 66	52. 40	+2. 26
December	51. 94	48. 58	+3. 35

The data contained in the above table are represented graphically in the following diagram:

Prof. Davidson says: "The lowest temperature of the water is for the month of January, 50.49°; and the highest for the month of September, 59.68° F.," and he adds that "the temperature of the air follows very closely that of the water."

Hourly water temperatures taken by the *Albatross* at the foot of Market street and at the Union Iron Works, San Francisco, for limited periods, indicate a slightly higher temperature than in the Golden Gate, as may be seen from a study of the accompanying table. Temperatures taken by the same vessel at Mare Island, where the water is more subject to the influence of the Sacramento River, show a much lower temperature.

Table of hourly changes of surface-water temperature in parts of San Francisco Bay.

[Reduced to monthly means.]

Time of day.	Off Market street and Union Iron Works, San Francisco.									Mare Island navy-yard.				
	May 11 to 31, 1888.	June 1 to 25, 28 to 30, 1888.	July 1 to 4, 1888.	Oct. 22 to 31, 1888.	Nov. 1 to 30, 1888.	Dec. 1 to 25, 29 to 31, 1888.	Jan. 1 and 2, 1889.	Oct. 15 to 24, 1889.	Mar. 29 to Apr. 2, 1890.	Oct. 27 to 31, 1889.	Nov. 1 to 30, 1889.	Dec. 1 to 31, 1889.	Jan. 1 to 31, 1890.	Feb. 1 to 28, 1890.
	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.
1 a. m.	56.3	58.8	59.2	58.5	56.1	53.5	52.5	59.1	53.5	57.0	54.3	48.9	42.5	47.3
2 a. m.	56.2	58.5	59.0	58.4	55.9	53.5	52.5	59.2	53.5	56.8	54.0	48.9	42.5	47.3
3 a. m.	56.0	58.5	58.7	58.6	55.8	53.3	52.0	59.1	53.5	56.6	53.9	48.9	42.6	74.1
4 a. m.	56.0	58.7	58.5	58.6	55.7	53.3	51.5	59.2	53.5	56.6	53.9	48.8	42.5	46.9
5 a. m.	56.1	59.0	60.7	58.7	55.7	53.4	50.5	59.7	53.2	56.6	53.8	48.6	42.3	47.1
6 a. m.	56.3	59.5	60.2	58.4	55.4	53.5	50.5	59.9	53.7	56.4	53.9	48.4	42.2	47.0
7 a. m.	56.6	59.9	61.0	58.5	55.7	53.5	50.0	60.2	53.5	57.4	54.3	48.5	42.2	46.9
8 a. m.	56.9	60.3	61.2	59.0	55.9	53.8	52.0	59.9	53.7	59.2	54.9	48.9	42.8	47.3
9 a. m.	57.3	61.2	61.2	59.4	56.6	54.0	53.0	60.1	53.7	59.4	55.3	49.1	43.1	47.9
10 a. m.	57.8	61.4	61.5	59.3	56.1	54.0	53.5	60.3	53.7	59.4	55.7	49.6	43.4	48.0
11 a. m.	58.5	61.6	61.5	59.4	56.5	54.2	53.5	60.1	54.0	59.6	56.5	49.8	43.7	48.2
M	58.6	61.8	61.0	59.6	56.6	54.4	53.5	60.0	54.2	60.6	56.8	50.2	44.2	48.5
1 p. m.	58.9	61.9	62.0	59.6	57.1	54.7	55.0	60.3	55.2	60.4	57.5	50.3	44.8	48.7
2 p. m.	59.3	62.3	63.0	59.8	57.2	54.8	55.0	60.4	55.5	60.8	57.6	50.3	45.2	48.8
3 p. m.	59.4	62.2	62.7	59.7	57.2	54.8	54.5	60.3	55.2	60.6	57.7	50.2	45.4	49.1
4 p. m.	59.3	62.1	63.0	59.7	57.2	54.9	54.0	60.4	55.5	60.6	57.6	50.1	45.1	49.3
5 p. m.	58.9	61.9	62.3	59.5	57.2	54.6	53.5	60.5	55.5	60.0	57.2	50.1	45.0	49.2
6 p. m.	58.6	61.5	62.0	59.1	56.8	54.3	52.5	60.0	55.0	60.0	56.5	49.8	44.9	48.9
7 p. m.	58.2	60.9	61.3	58.9	56.8	53.9	52.0	60.0	54.0	59.4	56.0	49.7	44.6	48.5
8 p. m.	57.9	60.3	60.0	58.7	56.6	53.7	52.0	59.9	54.0	59.4	55.7	49.5	44.3	48.2
9 p. m.	57.3	59.7	60.0	58.8	56.5	53.7	51.0	59.9	53.7	59.2	55.5	49.3	43.9	48.2
10 p. m.	57.0	59.3	60.0	58.8	56.3	53.8	51.5	59.8	53.5	58.6	54.9	49.1	43.6	48.1
11 p. m.	56.9	59.3	59.7	58.7	56.1	53.6	52.0	59.7	53.5	57.4	54.8	49.0	43.3	47.6
Mid ...	56.7	59.0	59.3	58.5	56.1	53.5	52.0	59.5	53.7	57.4	54.4	48.8	42.9	47.3
Range.	55–72	55-68	57–66	56–61	52–61	50–59	49–55	56–62	52–57	54–62	49–64	42–57	38–51	40–45

A series of temperatures taken in Oakland Creek from September 7, 1890, to May 20, 1891, at 4 a. m. daily, range from 49.8° for December to 64.9° for September. The temperatures are here reduced to means of ten days.

Temperature of the water at the surface in Oakland Creek, San Francisco Bay, from September 1, 1890, to May 20, 1891.

[Taken by Coast Survey steamer *McArthur*, Lieut. W. P. Ray, U. S. N., commanding.]

1890.	° F.	1891.	° F.
Aug. 28 to Sept. 7	64.9	Jan. 1 to 10	50.0
Sept. 8 to 17	63.4	Jan. 11 to 20	50.6
Sept. 18 to 27	55.0	Jan. 21 to 30	51.4
Sept. 28 to Oct. 7	51.9	Jan. 31 to Feb. 9	51.2
Oct. 8 to 17	49.2	Feb. 10 to 19	50.1
Oct. 18 to 27	49.9	Feb. 20 to Mar. 1	51.0
Oct. 28 to Nov. 6	51.0	Mar. 2 to 11	53.8
Nov. 7 to 16	55.2	Mar. 12 to 21	56.4
Nov. 17 to 26	54.3	Mar. 22 to 31	56.2
Nov. 27 to Dec. 6	53.7	Apr. 1 to Apr. 10	57.1
Dec. 7 to 16	49.8	Apr. 11 to 20	57.0
Dec. 17 to 31	49.8	Apr. 21 to 30	58.6
		May 1 to 10	61.4
		May 11 to 20	61.4

Recent summer temperatures taken by authority of the United States Fish Commissioner at the extreme southern end of the bay, through the coöperation of the Morgan Oyster Company, have yielded valuable information, the water of that part of the bay having been found to have a summer warmth amply sufficient for the propagation of the oyster. The important table of temperatures from this locality is condensed to means of ten days from a lengthy series of daily observations at both high and low tide.

Temperature at the oyster beds, 1 mile from Dumbarton Point, San Francisco Bay, July 12 to October 12, 1891.

Date.	Air temperature.	Surface-water temperature.		Range of water temperature.
		High tide.	Low tide.	
	°F.	°F.	°F.	°F.
July 12 to 19	68.	69.6	71.9	67 to 73
July 20 to 29	68.9	70.9	71.9	69 to 74
July 30 to Aug. 8	67.3	69.5	69.7	68 to 72
Aug. 9 to 18	68.4	70.3	70.7	68 to 72
Aug. 19 to 28	72.3	71.4	72.0	69 to 74
Aug. 29 to Sept. 7	66.8	70.7	69.1	67 to 72
Sept. 8 to 17	66.4	67.8	68.0	64 to 71
Sept. 18 to 27	65.7	66.1	67.3	64 to 70
Sept. 28 to Oct. 7	64.2	65.6	62.9	58 to 70
Oct. 8 to 12	61.9	63.2	64.0	62 to 65

Peculiar situation of the oyster beds.—There are at present no eastern oysters in San Francisco Bay that are not laid upon tide lands, or so-called mudflats, completely exposed at the time of low tide. The principal reason for the selection of such situations is that the beds may be readily fenced in by closely set stakes to protect them from the depredations of the stingray (*Myliobatis californicus*), which enters the bay every spring and is the principal enemy of the oyster in these waters. In this complete dependence for oyster-growing upon tide lands, frequently left dry, is doubtless to be found one explanation of the slow increase of the species. The California summer is absolutely dry and rainless. It is a season of cloudless skies and regularly recurring heat in the daytime; therefore an oyster bed at this season, when the tide is out, is exposed not merely to the air, but to a heat sufficient to dry the moisture off from all the oysters in sight, and perhaps injure the majority of the spat that might have been attached to their shells. If embryo oysters, set free on the beds, drift with the receding tides to deeper waters outside the stake-protected area of the flats, they are exposed to the stingrays when they have attained sufficient size.

Stingrays, and the stake protection employed against them.—The California stingray (*Myliobatis californicus*) enters San Francisco Bay in large numbers in the spring and remains until late in the fall. It is said to be as destructive to oysters in these waters as the starfish is on certain parts of the Atlantic coast. It has heavy flat teeth, arranged in a sort of pavement in each jaw, and is essentially a feeder on shellfish. Its presence requires the fencing in of all the oyster beds in the bay with closely set stakes about 12 feet long, which are driven about 4 feet into the ground. Plates 8 and 9 show the nature of these fences. When a broken stake allows a school of stingrays to raid an oyster bed, the surface, after the tide has gone out, presents much the appearance of a field that has been rooted by hogs. Sometimes the oystermen, discovering their presence, manage to entrap them inside the line of stakes, and thus destroy many of them during one low tide.

Fencing oyster beds against stingrays constitutes another heavy expense to the California oystermen, in addition to the annual outlay for seed oysters from the Atlantic coast. The fences must be looked after constantly and kept in repair. The heavy winds that sometimes during the winter season cause vessels in San Francisco Bay to drag their anchors do great damage to the fences of the oystermen, which they must manage to have in good condition by the time the stingrays reappear in the bay.

I do not know how late in the fall stingrays continue to menace the oysters, but I netted a few small specimens in San Pablo Bay as late as November 7, 1890. They first appear in April.

The danger from stingrays is probably overestimated, in view of the natural increase of oysters upon wide tracts unprotected by stakes.

Other enemies of the oyster.—The drill (*Urosalpinx cinerea*) has not become troublesome upon the oyster beds of San Francisco Bay until very recently, and even now is abundant only in the southern part of the bay. The oystermen showed me heaps of shells, all more or less drilled with small holes, in evidence of its ravages. At the Belmont beds I had no difficulty in gathering a quart of these mollusks in less than ten minutes by merely turning over the large oysters when the water had receded from the beds. Sometimes half a dozen were to be found on a single oyster. With its minute "tongue-file" this creature drills a hole through the oyster's shell, and inserting its proboscis into the opening, barely large enough to admit a pin, it feeds directly upon the soft parts.

This destructive animal may have been introduced much earlier than the oystermen suppose, as a few individuals accidentally imported among the original oysters would require several years to increase to the present numbers. Mr. Moraghan informed me that there were no drills upon his beds at Millbr ae, which, as stated above, are much nearer the sea than the Belmont beds. If they are restricted to the Belmont beds, as seems to be the case, it would pay the oyster-growers to pick them off as far as possible. Any gathering of drills that would keep them in check is important, as their increase will cause great loss in the future.

Two species of crabs are found upon the San Francisco oyster beds, one of which is exceedingly abundant, but their presence has probably no effect upon the oysters.

Large numbers of shells were found honeycombed by the boring sponge.

The starfish has never proved troublesome to the oyster beds of the bay, and, in fact, is seldom found upon them. It is doubtful if it occurs, except as a straggler, farther south in the bay than the wharves of San Francisco and Oakland, and requires no special mention in this connection, as its presence upon a bed would be readily detected at low water, when stray specimens would be picked off by hand and disposed of effectually. The original bedding-grounds for oysters at Sausalito, being so close to the sea, were sometimes visited by starfish, but they were not considered troublesome.

Preparation of ground for laying out the oysters.—The mudflats are always more or less prepared for oyster-ground by gangs of workmen, who level the surface by removing the elevations and filling in the depressions. This is done, of course, when the proposed oyster bed is laid bare at low tide. There seems to be very little improvement of the ground by the use of old shells of the eastern species. Mr. Moraghan returns the shells from his restaurant stands in the California market in San Francisco to his beds at Millbrae, but he uses them for filling depressions, and does not distribute them over the beds as spat-collectors.

Fixation of spat.—Not only are the chances for the fixing of spat diminished by the use of ground in some places where there are very few old shells upon the bottom, but almost all of the shells of *Ostrea virginica* are returned from the marketmen to the principal oyster company, who sell them for the manufacture of lime, instead of using them for the improvement of the beds. These shells of eastern oysters, if returned to the beds where they were grown, or to other portions of the bay, would certainly increase the chances for the fixation of spat set free from the beds where adult oysters are growing. It is probable that careful attention to this matter of increasing the fixing surface required by the young oyster might make just the difference between rapid self-propagation and the present slow increase.

So far as has been ascertained, no recent attempt has been made by anyone to collect the spat of *Ostrea virginica* in San Francisco Bay, and it is evident that the prevailing impression that there is no propagation of the species here is not founded upon conclusions based upon actual investigations. Previous to my first examination of the oyster beds, a gentleman as keenly alive to matters of public interest as anyone in California, and a member of the original Tide Lands Commission, said to me, "You will find that the oyster does not propagate here." A general impression had simply grown into a widespread belief. With the exception of a few persons connected with the management of the oyster business, the men employed in the industry know little of the subject outside of the peculiar methods practiced in California.

Hundreds of thousands of bushels of oyster shells have been distributed over the bottom of Long Island Sound in deep water, as cultch to which the oyster spat could attach itself, with the very best results. Strewing the shells of eastern oysters in the slightly deeper waters just outside the existing beds upon the tide lands, and in other parts of the bay, might furnish the lacking element in these waters—viz, fixing-surfaces for spat. Young oysters found in such situations could be taken up before the next annual appearance of the stingray and used as seed oysters in the customary way. It would seem that there are possibilities for oyster-culture in San Francisco Bay by methods entirely distinct from those now practiced there.

Evidences of natural propagation.—One of the first indications I had of the natural propagation of the oyster was the finding of young oysters six months or a year old upon beds where those three or four years old were kept. They were in most instances attached to clusters of dead shells of the small native oyster. Very few were to be found attached to adult specimens of *Ostrea virginica*, but this may be explained by the fact that such oysters are frequently handled and "laid out" to keep them well upon the surface and prevent any settling in the mud. The handling is done in order to select and clean the largest for market, the others being also cleaned of the ever-accumulating native oysters, which would involve the destruction of such small eastern oysters as might be among them upon the shells of the large oysters.

The fact of young eastern oysters being attached to anything is proof that they grew in the bay where they were found, for oysters do not have the power of fixing themselves a second time. All these small oysters are knocked off the large shells with a small cleaning hatchet, and the operation is a necessary one, as the extremely productive natives cluster upon the large species in such numbers as to greatly interfere with their growth.

In October, 1891, I discovered some oysters of large size in certain sloughs of the south bay, where they had long escaped the stingrays in consequence of bars which shut off the sloughs from all but the highest tide. These were the largest oysters seen at San Francisco, and had evidently lain there for several years. More recently I obtained a quantity of oysters, apparently two years old, in Oakland Creek. As the oyster beds maintained there several years ago by Mr. Doane, now of the Morgan Oyster Company, have long since been abandoned and the stakes removed, it is evident that a limited number of oysters have found conditions suitable for their development and growth, even in this muddy place. They are no longer found on the mudflats, where they were originally kept, but live in the mud of the channel, from which I obtained them with tongs.

Mr. Cleaveland Forbes, of the Spring Valley Water Company, informed me that several years ago he found full-grown eastern oysters upon the piles of an old narrow-gauge railroad trestle, across a slough, near Dumbarton Point, and that the men of his party frequently found many upon banks composed of shells of the native species, near where the pipes of the company cross the bay.

Mr. H. D. Dunn has recently reported, through the press, the discovery of a full-grown eastern oyster near Mile Rock, in the Golden Gate.

It is possible that during the long time eastern oysters have been kept in the bay they have become in a measure acclimated, and that there is a constantly increasing tendency to propagate—that is, the progeny of oysters grown here become hardier with each generation and better adapted to the colder but more equable waters.

During my latest examinations of the bay (May and June, 1891) eastern oysters, very large and old, were found in the following places near the sites of former oyster beds: Several adhering to the piles of the narrow-gauge railroad trestle across San Leandro Bay; a few upon the rocks at the extreme north point of Sheep or Brooks Island, near low-water mark; a few upon the rocks at Point San Pedro (at entrance to San Pablo Bay). Those from San Leandro Bay doubtless originated as spat from the oyster bed near the entrance to that bay, at the end of the bay northwest from the island. Those from Sheep Island had merely drifted as young across the half mile of distance from the old beds near Ellis Landing, while the San Pedro oysters originated upon the beds between Marin Island and Point San Quentin, a couple of miles distant.

Mr. H. D. Dunn informed me that wild eastern oysters had been reported to him from some other place near Point San Pedro, but I did not discover them, being without a pilot. These finds are very interesting, as showing not only the breeding of the oyster in various parts of the bay, but that the species began breeding several years ago when oysters were laid out in those northern parts of the bay. At Point San Pedro oysters are directly exposed to the influences of the Sacramento River. But the largest and most important tract of oyster propagation is in the region of the natural shellbanks of native oysters along the east side of the bay, beginning at Bay Farm Island and extending well southward and off into deep water. Here wild eastern oysters may be found during the low tides that expose the outer portions of the shellbanks. At this place they are numerous, and when the tides are sufficiently low it is possible to gather them by the score, ranging in size from yearlings to those several years old. This deposit is at least 4 miles removed from the nearest site of a former oyster bedding-ground, and there is no doubt about the oysters upon the whole tract being of volunteer growth. A channel several feet wide separates this tract from the old bed on the north, while it is nearly 10 miles to the nearest beds on the south.

Examination of two or three hundred oysters gathered in this region shows the fixing surface for the spat to have been the shells of the native oyster (*Ostrea lurida*). Indeed, there is nothing on this whole bank but clean shells of the native species. The bank is exposed to heavy seas during the season of strong winds, and many eastern oysters doubtless become buried beneath the easily drifted shells of the small natives. It is probable that there is a very great production of eastern oysters here that we know nothing of, as the whole tract is accessible to stingrays, which prey upon every kind of shellfish outside of the stake-protected beds. It is also probable that the heavy seas which at times sweep across this shallow section of the bay and actually break up the clusters of native oysters by rolling them toward the beaches, have an injurious effect upon newly fixed eastern spat by burying them beneath the drifting shells.

Considerable quantities of wild eastern oysters are annually gathered upon this and other shellbanks in the bay. They are retailed in Oakland and Alameda at $1.50 per 100, or sold to the oyster companies who lay them out on their fenced beds for further growth. They are obtained when unusually low tides happen to expose them. No tonging or dredging is done, the oysters being gathered by hand. The work is performed chiefly by boys. I have no means of knowing the quantity of oysters derived from this source.

It appears, therefore, that there are other parts of San Francisco Bay as good for oyster-culture as those now inclosed, and that the increase of wild oysters now growing there would be more rapid if they were inclosed and afforded similar protection from heavy seas, stingrays, etc.

Spawning season.—It is not unlikely that the oyster spawns here as early as on the north Atlantic coast, as the warming to which adult oysters are often exposed early in the spring during low tides must have a tendency to hasten the process. I have not examined them earlier than the 1st of May, but from that time until July 15 plenty of them are to be found ripe with eggs. Of other months I can not speak personally. Dr. H. W. Harkness, president of the California Academy of Sciences, informed me that during one year he examined many oysters from the market stalls with the microscope, and he expressed the belief that oysters could be found with eggs during most months of the year. Opinions of oystermen differ as to the duration of the spawning season, but from April to August seems to be the decision of the majority.

Notes on the general history of the oyster industry of San Francisco Bay.—Live oysters were first brought here by A. Booth, of Chicago, about the year 1870, when the first overland railroad was completed. Afterwards, from time to time, others engaged in the introduction of eastern oysters, and they eventually brought only supplies of seed oysters, which were bedded until they became marketable.

Corville & Co. established an oyster bed a short distance south of Point San Bruno about 1872. This place was subsequently owned by Swanberg & West, who had both eastern and Willapa Bay oysters at Pinole Point at one time.

Doane & Co. once had Shoalwater Bay oysters a short distance north of Point San Bruno, but they were lost during a "northeaster," and the locality was abandoned. The same firm kept both species of oysters in Oakland and Alameda creeks, but these localities were abandoned with the increase of traffic and on account of sewers.

Before the introduction of the eastern species, oyster-dealers in San Francisco maintained a trade in Willapa Bay oysters, which is continued up to the present time. As these oysters are obtained readily from their natural beds, no attempt is made to propagate them here; they are simply freshened before they are marketed. The localities originally used for bedding oysters by Morgan & Co., Doane & Co., Swanberg & West, and other firms now consolidated with the Morgan Oyster Company, viz, Sausalito, Point San Quentin, Sheep Island, and Oakland and Alameda creeks, have all been abandoned in favor of localities south of San Francisco, where the nearest are from 10 to 15 miles removed from the influence of the Sacramento River, and where they are almost free from deposits of sediment. There was always a large percentage of loss from oysters settling in the mud at the old localities. I examined all these old beds, but found no oysters on any of them.

When oysters are removed from certain localities to others better suited to their fattening, the shells of the native oysters are knocked off them with a light, long-bladed, adz-shaped instrument adapted to the purpose.

In the frequent transplanting of oysters may be found another feature of their treatment tending to reduce propagation; many eastern oystermen consider "plants" (transplanted oysters) infertile for a year or two. If there is truth in this the extent to which oysters are moved at San Francisco must certainly have its influence.

Seed oysters are brought to San Francisco in the fall by fast freight. Not more than 10 per cent loss is expected under ordinarily favorable circumstances. The mere freezing of the liquid about the oyster is not considered injurious. In illustration of the length of time cold or frozen oysters may remain out of water without losing their vitality, Mr. Morgan told me that from a number of carloads of oysters consigned to his company one car was lost through some mistake and turned up in St. Louis. When it finally arrived at San Francisco, after being two months on the way, and the frozen oysters were bedded, it was found that there was but little more loss than in shipments of ordinary duration.

A new company, the Chesapeake Oyster Company, a branch of the International Oyster Company of New York, has lately begun the shipment of fresh marketable oysters to San Francisco, and at present has a quantity of them deposited at Sausalito.

Quantity of oysters put upon the market.—Statements on this subject were conflicting. Certain oyster-dealers said that there were from 350 to 400 boxes of oysters (containing 200 full-grown oysters to each box) put upon the San Francisco market daily; while from the statements of certain outsiders, it appeared that the quantity was much greater. Neither did I learn what proportion to this amount the shipments to outside towns bear. From certain sources I heard that there were about 100 carloads of seed brought west annually, while others discredited this statement and placed the amount at half that number.

The consumption of eastern oysters on the Pacific coast has greatly increased of late years, while the rate of importation of seed oysters has not; in fact, after considerable inquiry, the conclusion is that it has decreased; so we may infer that the beds, although not self-sustaining, are nevertheless contributing something in the way of natural increase to meet the demand.

The market for oysters in San Francisco is good, and all that are produced sell readily. They are ordinarily packed in boxes containing 200, worth $4 per box. It will be seen that they cost twice as much as on the Atlantic coast, where choice oysters are worth $1 per 100, and good oysters, not specially selected, can usually be bought for 75 cents per bushel. Californians will undoubtedly consume more oysters when they can get them at eastern prices.

Oysters are always in season in California, the sales and prices being the same in summer as in winter.

The Pacific coast native oyster (*Ostrea lurida*).—This small oyster abounds in San Francisco Bay, where it is utterly worthless as compared with the oyster from Washington. It is present upon all the bedding-grounds of the eastern species. When the latter are permitted to lie too long undisturbed they become coated with the small shells of *O. lurida.* There are extensive deposits of this species in the shallow waters all along the western part of the bay, and their dead shells washed ashore by the high seas that accompany the strong winds of the winter season have formed a white glistening beach that extends from San Mateo for a dozen or more miles southward. So abundant are they that this constantly increasing deposit of shells covers everything alongshore and forms bars extending into the bay.

Schooners frequently carry away loads of them for the making of garden walks and for other purposes to which old oyster shells are adapted. Quantities are ground up and scattered about poultry ranches. The supply is unfailing. Their small size and thin, light shells permit them to be readily drifted about the bay, and thus render them unsuitable as collectors of the spat of eastern oysters. They break apart and disintegrate, and shift so freely when exposed to heavy waves that they can not be considered good fixing-surfaces for the large species when in exposed places. If the banks formed of these little shells could be protected from the heavy waves by some firm outside barrier, and be covered with an abundance of large shells not so likely to drift, a permanent bed might readily be formed. The eastern oysters laid out on the natural shellbanks in some places are frequently rolled along the bed and washed high and dry upon the beaches. The original bedding-grounds along the east side of the bay have been abandoned mainly on this account.

It is possible that I have not attached sufficient importance to the evil of overcrowding by the remarkably fertile native species. This little oyster, naturally adapted to these places, finds the large shell of the eastern oyster a fixing-surface specially adapted to its needs. It is thus protected from the bad results attendant upon the changing surface of its natural shellbanks; it has the advantage of the protection of the fences; it is nearer to the muddy bottom, from which much of its food is derived, and yet is lifted by the shell of the large oyster to a safe height above that bottom, where the under shells of a cluster of any species of oyster would be smothered in the mud. So closely do these indigenous oysters crowd upon the shells of the large species that when a heap of the latter have been cleaned for market the accumulated parasites almost equal in bulk the edible species. Doubtless they are responsible for crowding many of the young of the less adaptive eastern species completely out of existence.

The native oyster (*O. lurida*) grows twice as large at Willapa Bay, Washington, as it does at San Francisco, and is constantly misnamed the "California oyster." But no use is made of the small California coast oyster, except as its shells are utilized in the ways previously mentioned.

The Morgan Oyster Company.—This company now maintains six important stations or groups of oyster beds in San Francisco Bay, where oysters imported from the Atlantic coast are kept until they reach a marketable size. All are situated in the southern part of the bay, and are from 15 to 35 miles back from the Golden Gate. At each of these localities there is a comfortable building for housing the employés. Each station is supplied with fresh water by an artesian well, which usually elevates the water a few feet above high tide, windmills being added at three of the stations to raise the water to tanks. At four stations (Dumbarton, San Bruno, Millbrae, and Alvarado, the last now abandoned) the houses are built upon piles, and are 1 or 2 miles from the nearest land. At the other stations they are upon islands or the shores of the bay. There are several inclosed oyster beds near each of the houses, varying in extent from 50 to 100 acres each. I had no means of knowing the actual extent of the oyster beds of this company, but will roughly estimate the territory fenced in by stakes at 1,500 or 2,000 acres. This should, perhaps, be regarded as a guess rather than as an estimate.

The station known as San Bruno was established by Corville & Co. about 1872. It was subsequently owned by Swanberg & West, and finally passed into the hands of the Morgan Oyster Company.

The establishment at Millbrae dates from 1874, and is one of the most valuable. The house is nearly 2 miles off shore, and is connected by telephone with the city office.

Dumbarton was begun in 1877 and may be considered the most important station of all. The oyster beds here are the most remote from the sea. There is probably sufficient warmth of water here in summer to admit of more extensive oyster-spawning than elsewhere. South of this point the tide water backs up many sloughs and creeks far inland, where it can become warm, and there is little doubt that future tests will show this to be decidedly the warmest part of the bay and the best adapted for raising seed oysters.

The Alvarado place, about 8 miles north of this and in a very exposed situation, has been abandoned on account of the heavy seas, caused by winter winds, to which it was subjected. The South Belmont place was started in 1877 and North Belmont in 1884. The last, founded by Doane & Co., was later consolidated with the Morgan Oyster Company, of which Mr. Doane is now the field superintendent. The San Mateo oyster station has been in operation for five or six years. The employés are moved from station to station as the beds at different places require attention.

Seed oysters are usually laid out at the Dumbarton beds or the Belmont beds (all of which are near the head of the bay) for a couple of years, and are then transferred to the beds at Millbrae and San Bruno for the final year before being put on the market, as the latter localities are supposed to be better adapted to fattening them.

This company employs a schooner, quite a fleet of sloops or "plungers," many scows or barges, and some floats. No retail stands or restaurants are operated. They have considerable territory in Willapa Bay, Washington, devoted to the cultivation of the Washington coast oyster (*Ostrea lurida*). Large regular shipments of this species are made to San Francisco. The wholesale oyster business of the company is transacted at a commodious building on Third street, San Francisco, from which oysters, opened or in the shell, are supplied to the hotels and restaurants of the city, and, boxed or canned, are shipped to all the large towns of the Pacific region, from Victoria to San Diego, and from Salt Lake to Honolulu.

Oyster establishment of M. B. Moraghan.—Mr. M. B. Moraghan, an importer, planter, and wholesale and retail dealer in oysters in the California Market, San Francisco, established his oyster bedding-ground at Millbrae about 1882, where he owns 200 acres and leases 900 acres of tide lands. Much of the product of these beds is used at his restaurant stalls in the California Market. The methods of the Morgan Oyster Company, previously described, apply also to this place.

Vessels.—The vessels employed are schooners, sloops, scows, floats, and a few small rowboats.

The floats are large barges with the bottom planks sufficiently separated to admit the water freely. They are used as temporary receptacles for oysters that have been culled and cleaned, and to keep them fresh while awaiting transfer to market. They are kept afloat by "air boxes," *i. e.*, air-tight compartments along the sides and ends, and, in extra large floats, lengthwise through the middle. The bottom is made of 3-inch square timbers separated by half-inch spaces. The float thus constructed has a free circulation of water among the oysters stored in it, and will hold great quantities of them in a fresh and healthy condition. Floats are constructed in varying sizes adapted to the requirements of each station, the large double floats with central air box being usually 40 feet long by 20 wide. The single compartment floats are about half this size.

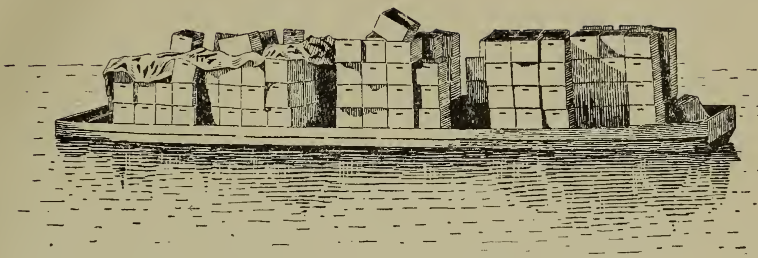
The scows are used in tonging up oysters and for sorting and otherwise handling them. They are shallow and flat-bottomed, with sides very slightly tapering from the middle to the square ends. The flush decks slope a little toward the low rail strip at the sides. Each end is fitted with a large iron ring, through which the heavy propelling poles are passed and driven by hand into the mud to steady it in tonging. In this operation the scow is gradually moved broadside across the oyster bed, permitting a thorough taking-up of all oysters in its course, which is previously laid out by occasional light poles set up on the bed at low tide. When loaded, the scow is pushed alongside the float and moored to it until its oysters are culled. Scows are made in different sizes, with decks averaging 8 feet by 24 feet.

The sloops or "plungers" in use are built upon several models, some of them with flush decks and a large central cockpit divided by a centerboard. A larger size is a keel boat with low deckhouse. Both forms are commonly cat-rigged. They are employed for general transportation between the oyster stations and to carry oysters to market.

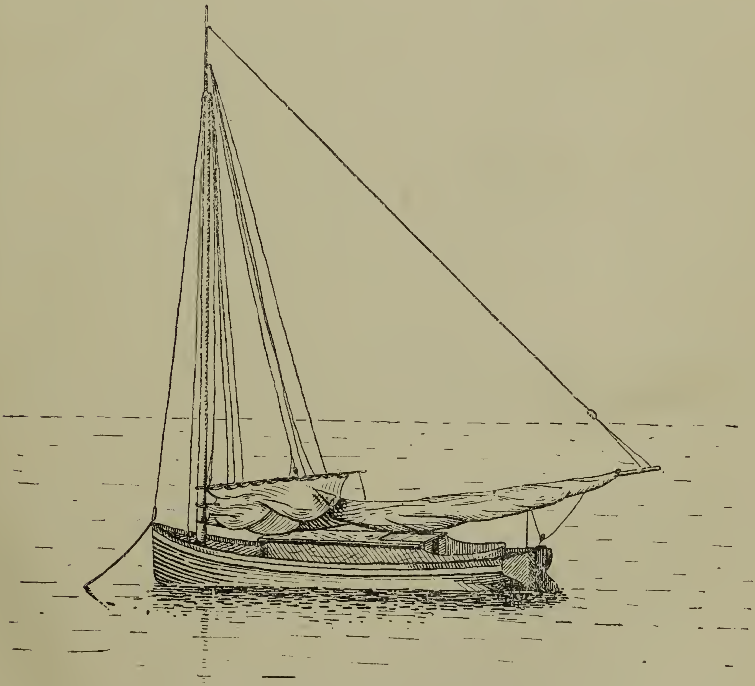
A good-sized schooner of unusually light draft has been built by the Morgan Oyster Company for oyster work in the bay and has been found very efficient.

When the tide goes out and all these craft are left high and dry upon the tide lands, the workmen, putting on leather-soled rubber boots for wading in the mud, are employed in leveling or otherwise improving the surface for oyster bedding.

Employés.—Usually about 100 men are employed upon the oyster beds of San Francisco Bay, this number being considerably increased at certain times. They are recruited from the ranks of the sea-going class, nearly always numerous about the wharves of San Francisco, and are constantly changing, none of them developing into regular oystermen. About 90 per cent of them are of Scandinavian origin.



FLOAT AND PACKING-BOXES, SAN FRANCISCO BAY.



OYSTER SLOOP, SAN FRANCISCO BAY.

San Pablo Bay.—The most diligent dredging from a steam launch failed to reveal any shell life, except clams, upon the bottom of San Pablo Bay. The native oyster, *O. lurida*, so abundant in San Francisco Bay, particularly far south of the city, was not found here at all. It is probable that it formerly lived here, for there are extensive deposits of shells of this species to be seen in the faces of the bluffs along the west side of Mare Island fronting on San Pablo Bay. Nearly all the supply of soft-shelled clams is derived from the mudflats of San Pablo Bay. This species is apparently as abundant here as if it had always existed in these waters.

While San Pablo Bay appears to be devoid of shell life, except clams, it is rich in shrimps and fishes. Many of the Chinese shrimp-fishers' nets are set here constantly and the Italian fishermen take many sturgeon. The shrimp nets also take sculpins, young flounders, and other small fish in abundance.

The muddy character of the bottom is due to its being a favorable place for the waters of the Sacramento River to expand and thereby deposit the sediment carried by its current. The river maintains a deep channel along the south side of the bay on its course to the sea, but when it meets an incoming tide at the entrance to San Francisco Bay its muddy flood is spread all over the broad extent of San Pablo.

Mr. M. Manson, engineer for the Harbor Commission, states that the shoaling of San Pablo Bay dated from the time of hydraulic mining, but that since the cause of débris has been removed the bay has improved and will doubtless continue to do so. He recommended an examination of the west side of San Pablo Bay with reference to the possibility of its being made bedding-ground for oysters, but as far as I was able to examine it there were no indications of firm bottom like that of the west side of San Francisco Bay.

Mr. McNear, proprietor of the wharves at McNear's Landing, on San Pablo Bay, once laid out eastern oysters upon a narrow mudflat near the landing, but lost most of them from continued rough weather, during which they were either washed upon the beach or covered by soft mud. The experiment was not repeated.

Though I have as yet found no oysters in San Pablo beyond McNear's Landing, the discovery of many eastern and Willapa Bay oysters about the narrows at the entrance to the bay is interesting as showing the propagation of oysters exposed to the fresh water of the river, and is an indication that something might be done for oyster-culture in San Pablo Bay if firmer bedding-grounds can be secured.

Tide lands.—The sale of the tide lands of San Francisco Bay has hitherto been considered as exercising a retarding influence upon the development of the oyster industry, as well as of other branches of business. These lands, surveyed and sold by the State at $1.25 per acre, have gradually passed into the hands of the larger oyster companies. This is especially true of the extensive flats in the southern part of the bay most available for the present system of laying out oysters, and the managers of the Morgan Oyster Company informed me that they owned about all that they considered valuable for their method of growing oysters. Many consider the sale of the tide lands an injustice to the people. It is said that the railroad companies are proprietors in tide lands to such an extent that the city of Oakland is greatly handicapped for water frontage and wharf facilities.

The law permitting the sale of the tide lands is not, however, an unmixed evil, for while it might lead to monopoly it would allow oyster-planters to reap the harvests they sow. It is now conceded by many who have long upheld the system of public dredging in the Chesapeake region, that private cultivation must be provided for before there can be any marked increase in the oyster supply.

The Tide Land and Water Front Company of San Francisco are proprietors of the tide lands to a considerable extent, and offer them for sale at the uniform price of $25 per acre. Notwithstanding the fact that much desirable oyster-bedding ground is already fenced in, there is still much good oyster-ground unoccupied in the southern part of the bay. In the Long Island Sound region, where the oyster-ground can be bought or leased from the States, the system of private ownership of the beds has been found perfectly practicable and very advantageous.

In reply to inquiries respecting the value of the tide lands now inclosed and used by the oyster-growers of San Francisco, Mr. Moraghan writes me:

> The price depends upon the location, the kind of bottom, whether mud, shell, or sand, etc., and more than all, upon the improvement or amount of labor bestowed on the land. We have some beds that are worth fully $1,000 per acre to us, as we have been improving and working upon them for the past ten years in bringing them to their present condition.

Mr. Moraghan adds that unimproved tide land, such as is used in the Californian method of bedding oysters, is very cheap, being worth $10 per acre, and that such lands can be had adjacent to the best inclosed beds for $20 per acre.

Suggested introduction of other species of oysters.—With evidence at hand of the propagation of our own oyster (*O. virginica*) in California, the introduction of foreign species seems superfluous; but Prof. George Davidson and Mr. H. D. Dunn, of San Francisco, both of whom have resided in Japan, have frequently spoken to me of the large oyster of Japan in connection with the subject of oyster-growing in California. Prof. Davidson sends the following note on this subject:

> The oyster I knew in Japan was found in the vicinity of Nagasaki, where I was stationed during the three months October, November, and December, 1874, and part of January, 1875. The oyster is there very large, full, and well flavored. I obtained some shells that were fully 12 inches long. I tried to interest some of our steamship captains to bring them to San Francisco, but at that time the trip frequently consumed a full month, with a change of steamer at Yokohama, and they

doubted the success of such an experiment. With the present more rapid transportation and a better knowledge of their treatment en route, I think it very advisable to try and introduce them to the Pacific coast.

The introduction of oysters from Japan would probably not be difficult, as a great many species of shellfish from that region are identical with California species.

Attempts have been made by oyster-growers in San Francisco Bay to introduce the large oysters of the Yaqui River lagoons and other parts of western Mexico, which strikingly resemble *O. virginica*, but a large percentage of the oysters died on the voyage. The change from the warm waters of that latitude to the bay of San Francisco was supposed to be too great, even if they survived the voyage. I can testify to the large size, good flavor, and great abundance of the Yaqui River oysters from personal experience. They are so abundant that we frequently loaded the dingey of the *Albatross* by merely gathering them from the borders of the shell heaps exposed everywhere at low tide. The temperature of the water while we were there (March 31 and April 1, 1889) ranged from 69° to 73° F. Now that there is railroad connection between Guaymas, Mexico, and San Francisco, the introduction of these oysters by rail might give better results.

Table showing the temperature of the water in the vicinity of the natural oyster beds near the mouth of the Yaqui River, Mexico, March 31 and April 1, 1889.

Locality and time.	Air.	Water.	Locality and time.	Air.	Water.
Off Algodones Lagoon:			Off Algodones Lagoon—cont'd.		
Mar. 31, 12 m	73	69	Apr. 1, 4 a. m	65	67
Mar. 31, 1 p. m	71	72	Apr. 1, 5 a. m	65	69
Mar. 31, 2 p. m	71	73	Apr. 1, 6 a. m	64	69
Mar. 31, 3 p. m	72	73	Apr. 1, 7 a. m	65	69
Mar. 31, 4 p. m	71	72	Apr. 1, 8 a. m	66	69
Mar. 31, 5 p. m	73	72	Apr. 1, 9 a. m	71	72
Mar. 31, 6 p. m	72	72	Apr. 1, 10 a. m	73	73
Mar. 31, 7 p. m	71	70	Apr. 1, 11 a. m	73	74
Mar. 31, 8 p. m	70	70	Off Yaqui River:		
Mar. 31, 9 p. m	69	70	Apr. 1, 12 m	71	73
Mar. 31, 10 p. m	69	69	Apr. 1, 1 p. m	72	73
Mar. 31, 11 p. m	68	68	Apr. 1, 2 p. m	72	73
Mar. 31, 12 p. m	70	70	Apr. 1, 3 p. m	73	73
Apr. 1, 1 a. m	69	68	Apr. 1, 4 p. m	74	73
Apr. 1, 2 a. m	65	68	Apr. 1, 5 p. m	74	73
Apr. 1, 3 a. m	65	68			

It should be stated that the hourly temperatures taken by the *Albatross* were not in Algodones Lagoon or in the mouth of Yaqui River, but at the ship's anchorage, a mile or two outside, in the Gulf of California.

In December, 1890, a large shipment of oysters was made from Acapulco to San Francisco, but most of them died on the way. The few that reached market were considered good. This species was doubtless the *Ostrea iridescens*, a large oyster common in the vicinity of Acapulco.

The oyster of the Gulf of California has been referred by some conchologists to *Ostrea virginica*. In Carpenter's Shells of Mazatlan it is referred to that species, and in the collection of the U. S. National

Museum are many specimens from the Gulf of California so labeled. Compared with *Ostrea virginica*, it is of similar size and appearance, and to the superficial observer undistinguishable from it. It is found in the lagoons of the eastern shore of the Gulf from Mazatlan to the vicinity of the Rio Colorado, and is said to abound at a point opposite George Island, well up the gulf. It is found also on the western side of the gulf at Angeles Bay, opposite the southern end of Angel Guardia Island, and near Salinas Bay on Carmen Island. The oysters of both of these localities are said to be well flavored, and shipments from the latter have been made to San Francisco.

Dr. Edward Palmer, of the Department of Agriculture, informs me that he first saw the natural oyster deposits of the Yaqui River lagoons twenty years ago, and that there was then more traffic in them than at the present time. He ascribes the origin of the large mounds of oyster shells so conspicuous there to the drying of oysters by Indians, for sale among the mines of Sonora and Sinaloa. These oysters are still gathered by Indians, and are used in the hotels of Guaymas the year round. They are usually stored in the bay awaiting the arrival of the steamers. Many are sent by rail to Hermosillo, and a few are shipped by steamer to La Paz. Considerable quantities are taken from a stream near Altata, at the mouth of the gulf, and sent to Culiacan, in the interior, over the Sinaloa and Durango Railway.

I found a small oyster (*Ostrea palmula*, variety *glomerata*) abundant on the roots of the mangroves in Concepcion Bay, on the west side of the gulf. I obtained another species (*Ostrea palmula*) farther south at San Josef Island, but it was represented only by dry shells, our stay there being too brief to permit any extended search for the original deposits. The large *Ostrea iridescens* was occasionally brought up by the beam trawl of the *Albatross* in dredging along the western shores of the gulf.

The Mexican Oyster Company.—This company was in existence in 1868, 1869, and 1870. Oysters were brought from the natural beds of Altata and Acapulco, and sold readily in San Francisco at 25 cents apiece. Their arrival was announced by placards on steamer day. As many died on the voyage, the business was never profitable, and was finally ruined by the introduction of eastern oysters upon the completion of the overland railway in 1870.

Australian oysters.—A sack of oysters was recently brought to San Francisco by a steward of one of the Australian steamers. These oysters were sold by M. B. Moraghan at his stand in the California market and were considered as good as eastern oysters.

Suggestions.—In view of the fact that there is considerable propagation among the oysters of San Francisco Bay and that no attempt has been made to collect spat, it would be desirable to experiment in the vicinity of the most southerly beds of the bay with a variety of spat-collecting surfaces. There are many suitable channels, creeks, and tracts of deep water close to the beds. Bundles of brush could be anchored outside the lines of stakes about the beds or in the creeks, and floating collectors could be moored anywhere; these could be made scow-shaped, the sides and ends of coarse timbers of any sort, and the bottom of wide-meshed wire netting; such a craft, loaded with all the shells it could conveniently float, could be towed anywhere and might be large or small. In view of the existence of stingrays, this pattern of collector or the brush collectors would be safest, to say nothing of the ease with which they could be inspected for presence of spat.

If there were fixing surface of any description in the creeks or sloughs that extend from the southern part of the bay far back toward San Jose, Redwood, Belmont, Newark, and through the marsh lands generally, it is probable that oysters would attach. When the cold tide flows in across the extensive sun-heated flats in the springtime, it warms rapidly and fills the creeks with water of a much higher temperature than is found elsewhere in the region of the bay. The warm water flowing across the oysters brings them into spawn very suddenly when the weather conditions are favorable. My attention was called to this fact by the oystermen.

The creeks are, without exception, very muddy and absolutely without any firm surfaces upon which drifting oyster spat might settle. These creeks are similar in character. Most of them retain a considerable depth of water at low tide. They are named on the charts of San Francisco Bay as follows: Union City Creek, Cayote Creek, Beard Creek, Mud Creek, Alviso Slough, Redwood City Creek, Steinberger Creek, Angela Creek. Quantities of brush from the drier lands, just back of the marshes through which they flow, could readily be deposited in them as spat-collectors. From the fact that oysters have been taken from the timbers of two or three old trestles that cross them, we might reasonably expect favorable results from a careful experiment with brush collectors.

Should it finally be found advantageous, these creeks could readily be sown with quantities of shells of the native oyster from the shell heaps about the shores of the bay. That the native species has never penetrated into them is no argument against the propagation of the eastern species there. Occasional specimens have already been found growing there, and the creeks may prove as favorable to them as similar creeks are on the Atlantic coast.

The proper time for placing collectors in San Francisco Bay is yet to be determined.

OTHER BAYS OF THE CALIFORNIA COAST.

In Tomales Bay, Messrs. Weinard and Terry laid out about 17 carloads of eastern oysters in 1875. They remained there only two or three years, until all were marketed or removed to more accessible places in San Francisco Bay. The experiment was not repeated. Capt. Lawson, one of the oldest residents upon Tomales Bay, says that these oysters lived and fattened as well apparently as those in San Francisco Bay. They were laid out at Millerton Station, near the southern end of the bay, where some of the stakes used in fencing the bed are still standing. There is perhaps no reason why the extensive mudflats of Tomales Bay should not be used for laying out oysters in the same manner as is done in San Francisco. The bay is nowhere very deep. With two or three good-sized streams flowing into it, the natural conditions ought to prove very similar to those of San Francisco. It is 18 miles long and averages 2 in breadth. There are no signs of the propagation of eastern oysters there, although *Ostrea lurida* is not uncommon.

From correspondents in southern California I have recently learned that eastern oysters are reported as propagating in San Diego Bay. A few years ago a quantity of oysters were placed there, and they still remain in good condition. It is said also that a lot of Mexican oysters, brought in a steamer from Guaymas several years ago, were found to be dying rapidly when the vessel arrived in San Diego Harbor, and were thrown overboard. It is claimed that survivors from this accidental planting are occasionally found. This bay, more than 400 miles south of San Francisco Bay, is much warmer, and it might be that the oyster of the Gulf of California, which failed to live in the cold water of San Francisco Bay, would be a success in San Diego Bay. The greater part of this bay is shallow and there are extensive mudflats. There are no constant streams flowing into it, though False Bay, immediately north of it, receives San Diego River, a stream which disappears in midsummer.

Humboldt Bay, 200 miles north of San Francisco, is a large and shallow bay that may be found available for oyster-growing when the question of temperature has been studied. By far the greater area of this bay consists of tide lands, exposed at low water. My personal recollection of Humboldt mudflats, visited in 1885, is that they are altogether firmer than those of San Francisco, the bottom being more sandy.

Ballona Bay, near Santa Monica, in southern California, is a small bay where, I am informed, oysters have been placed and found to grow well, but it is not known whether they breed there. A report upon the small bays about Wilmington, near Los Angeles, has already been published by the Fish Commission.*

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*Report upon certain investigations relating to the planting of oysters in southern California. By Charles H. Gilbert. Bull. U. S. F. C., 1889, p. 95-98.

LAWS OF CALIFORNIA RELATIVE TO OYSTERS.

CHAPTER XVII.—*An act to encourage the planting and cultivation of oysters.*

[Approved March 30, 1874; Stat. Cal. 1874, p. 940.]

SEC. 1. Any citizen of the United States may lay down and plant oysters in any of the bays, rivers, or public waters of this State, and the ownership of and the exclusive right to take up and carry off the same shall be continued and remain in such person or persons who shall have laid down and planted the same.

SEC. 2. Any person or persons who now have or may hereafter lay down and plant oysters, as hereinbefore provided, shall stake or fence off the land upon which the same is or hereafter may be laid down and planted, and such stakes or fences shall be sufficient marks of the boundaries and limits, and entitle such person or persons to the exclusive use and occupation thereof for the purposes prescribed in this act: *Provided,* That nothing herein contained shall be deemed to authorize any impediment or obstructions to the navigation of any channels.

SEC. 3. Parties planting or laying down such oyster beds shall record a full description of said bed or beds in the county recorder's office in the county where the same is situated. The recorder shall record the description so furnished in a book to be kept by him for that purpose, to be entitled a "Record of oyster beds."

SEC. 4. Any person or persons who shall enter upon any lot of land in which there shall be oysters laid down and planted, and which at the time of such entry shall be fenced or staked off pursuant to the provisions of this act, and who shall take up and carry off therefrom such oysters, without the consent or permission of the occupants and owners thereof, and shall willfully destroy or remove, or cause to be removed or destroyed, any stakes, marks, or fences intended to designate the boundaries and limits of any land claimed and staked or fenced off pursuant to the provisions of this act, shall be guilty of a misdemeanor.

SEC. 5. The penalties of the penal code relative to misdemeanors are hereby made applicable to any violation of the provisions of this act.

SEC. 6. All fines and penalties collected for a violation of any of the provisions of this act over and above the costs of suit shall be paid into the common school fund of the county where the offense was committed.

SEC. 7. All parties availing themselves of the provisions of this act shall erect or cause to be erected, on some conspicuous part of the grounds devoted to the planting of oysters, a sign not less than 6 feet in length and 1 foot in width, on which shall be painted in black letters upon a white ground the words, "oyster beds."

SEC. 8. All acts and parts of acts in conflict with the provisions of this act, and especially an act entitled "An act concerning oysters," passed April 28, 1851 (Cal. Stat., 1851, p. 432), as also the act entitled "An act concerning oyster beds," approved April 2, 1866 (Cal. Stat., 1866, p. 848), are hereby repealed.

SEC. 9. This act shall not apply to any tide lands which the State may have sold to private parties: *Provided further,* That nothing herein shall be construed as to interfere with the right of the State to sell or dispose of any of the tide lands, nor to affect in any manner the rights of purchasers at any sale of the tide lands by the State.

SEC. 10. This act shall take effect and be in force from and after its passage.

NOTE.—The acts mentioned in section 8 were continued in force by Political Code.

CHAPTER XVIII.—*Penal code.*

602. Every person who willfully commits any trespass by either:

7. Entering upon any land owned by any other person or persons, whereon oysters or other shellfish are planted or growing, or injuring, gathering, or carrying away any oysters or other shellfish planted, growing, or being on any such lands, whether covered by water or not, without the license of the owner or legal occupant thereof, or destroying or removing, or causing to be removed or destroyed, any stakes, marks, fences, or signs intended to designate the boundaries and limits of any such land, is guilty of a misdemeanor.

WASHINGTON.

NATIVE OYSTER INDUSTRY OF WILLAPA OR SHOALWATER BAY.

The total annual output of native oysters from Willapa Bay is about 40,000 sacks. Oysters are taken from the natural deposits below low-water mark, the large ones marketed and the small ones transplanted to the adjacent tide lands until they attain a marketable size.

This large but shallow bay is cut by many intricate channels of deeper water where small oysters (*Ostrea lurida*) are obtained by tonging from flat-bottomed boats. They are then culled or sorted, and the bulk of each boat load, not being at once marketable, is scattered broadcast with shovels upon the selected bedding-grounds above low-water mark. This is done when such oyster-grounds are sufficiently covered by the tides to permit the free passage of boats. Two and a half years is the usual time required for the desired growth.

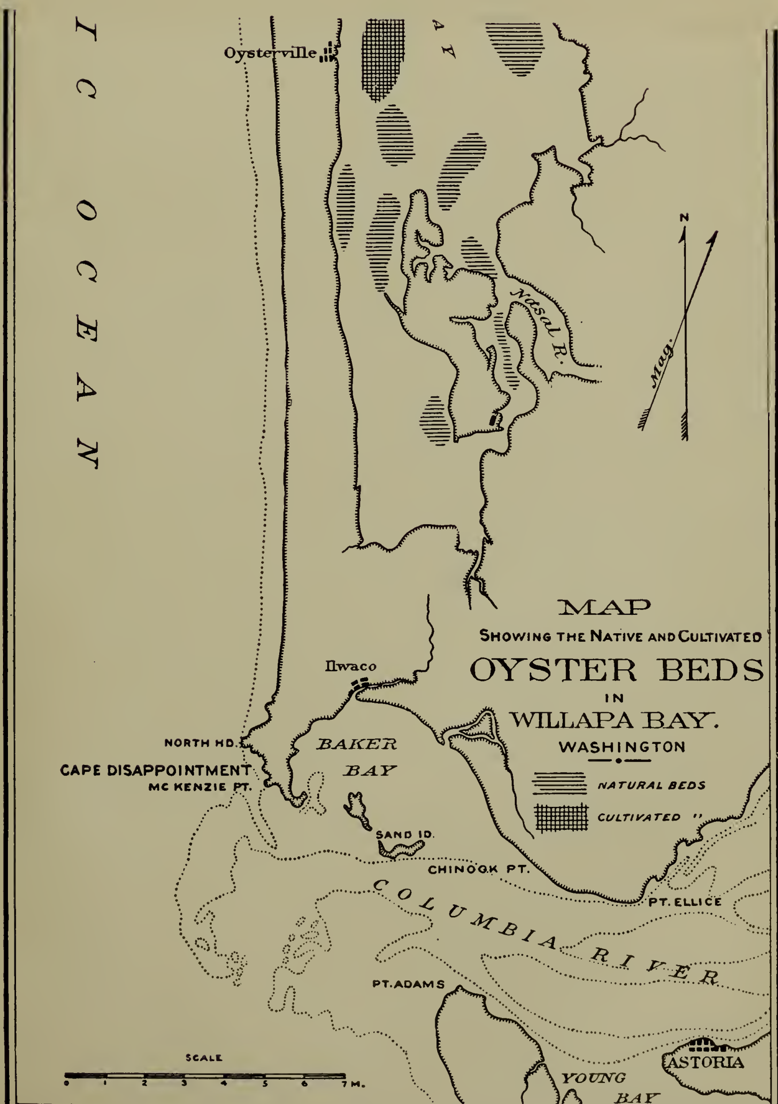
Each oysterman marks the boundaries of his bed of transplanted oysters with young pine saplings from which most of the branches have been trimmed, the tops being left to render such marks more conspicuous. Some planters occupy as much as 100 acres of tide land in this way.

For transplanting, sandy or other smooth bottom is preferred; it should be clean and free from seaweed. It is claimed that in such situations oysters reach their full size much sooner than on muddy bottom. Seaweed or grass grows rankly in many parts of Willapa Bay, and in the vicinity of Oysterville has taken full possession of large tracts that were formerly valuable for oysters. It is frequently mowed, but this is difficult work and can only be favorably done at one stage of the tide when the depth of water is only a few inches, while floating weed is likely to accumulate against boundary stakes and break them down.

Oyster beds here are not inclosed by closely set stakes, there being no destructive stingrays as at San Francisco. Starfish are abundant upon the natural beds along the channels, and are constantly destroyed by the oystermen when tonged up. Occasionally severe winters are ruinous to the transplanted beds, as the oysters freeze by being left exposed at low tide. In 1888 the cold weather killed 60 per cent of all oysters laid out above low-water mark.

After the culling operation, salable oysters are thrown into floats, through which the water passes freely, for safe keeping until sacked for shipment. Sacks holding nearly 2 bushels of oysters sell for $1.75 per sack.

An average of nearly 400 baskets of Willapa Bay oysters go to San Francisco by each steamer. Steamers run every four days, and as the baskets hold nearly a bushel, it is probable that over 35,000 bushels are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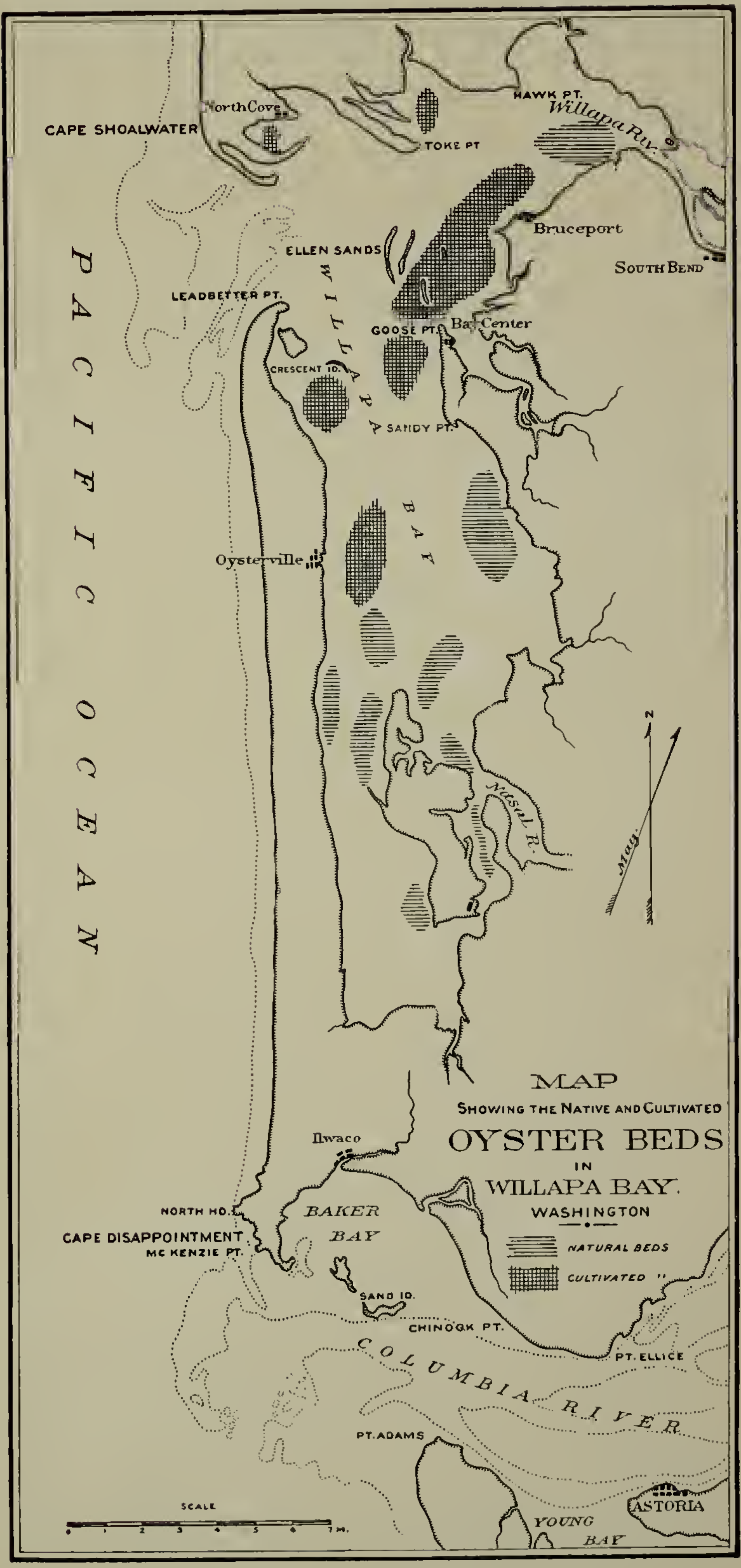
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HAWK PT.
Willapa Riv.
Bruceport
South Bend
ELLEN SANDS
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GOOSE PT.
Bay Center
CRESCENT ID.
SANDY PT.
WILLAPA BAY
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used in San Francisco annually. These, at the Willapa Bay price of $1.75 per sack (of 2 bushels), are worth $30,625. Very nearly as many go to Portland as to San Francisco. The remainder goes to the smaller towns of Washington and Oregon.

Bay Center.—Three or four times as much oystering is carried on here as at any other place in the bay, and during the past two years the business has greatly increased. The total population is about 200, one-third being Indians. The latter class is largely employed in the labor of culling. A few Chinamen are also employed as cullers and render excellent service. There are fifteen proprietors in the business here, employing a fleet of 15 plungers, 35 bateaux, and 18 floats. "The Native Oyster Company" of Bay Center ships chiefly to the Portland market.

Oysterville.—There are over 1,000 acres of transplanted beds here. The village is of about the same size as Bay Center, and like it is supported chiefly by the oyster industry. Oysterville was formerly the chief seat of the fishery, but the beds have become so thickly covered with grass that much of the business has been transferred to Bay Center. There are at present but ten proprietors engaged in the oyster business.

Bruceport and North Cove.—At Bruceport, which occupies the third place in oyster production in Willapa Bay, similar methods and conditions prevail. The oyster business at North Cove is chiefly carried on by the crew of the life-saving station located there, who restrict it to the cultivation of "plants" purchased from other parts of the bay. The area of transplanted beds in the latter place amounts to about 25 acres, yielding nearly 500 sacks per annum.

Temperature.—It is not unlikely that the summer temperature of the extreme southern part of Willapa Bay may be close to that of San Francisco, and that eastern oysters would propagate there. From the shelly nature of the bottom they might be expected to do well, provided the conditions of temperature were similar. It is certain that the native oysters of this bay breed freely at San Francisco. We know nothing as yet about the summer temperature of the water in this bay, except as it is indicated by observations made by the Coast Survey steamer *Gedney* in the northern part. The temperature even there may be higher than the following table indicates, as the observations were all made at 4 a. m., when the temperature is usually lowest, day temperatures being as a rule higher. Ranging, as it does, usually no lower than 60° at 4 a. m., for August and for that part of July covered by the record, it is probable that the temperature would not be lower than 65° for afternoon observations. Assuming a summer temperature of 60° to 65° for that part of the bay nearest the sea, we may reasonably expect to find the water decidedly warmer in those parts of the bay 15 or 20 miles back from the sea. A careful study of the temperature of this locality would no doubt yield important information.

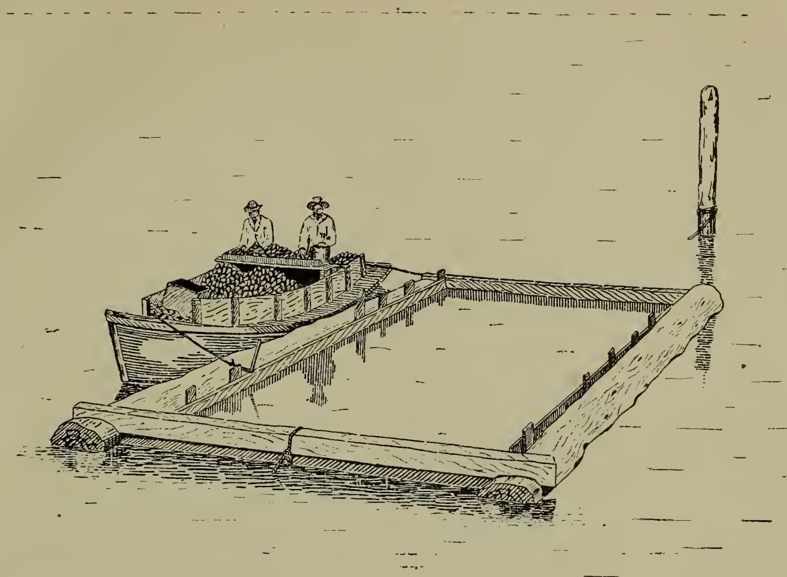
Surface temperatures taken at 4 a. m., daily, by the U. S. Coast Survey steamer Gedney in Willapa Bay, 1890.

Locality.	Date.	Temp.	Locality.	Date.	Temp.
North Cove	July 26	57°	North Cove	Sept. 4	58°
Do	27	62	Do	5	58
Do	28	58	Do	6	59
Do	29	61	Do	8	59
Do	30	60	Do	9	56
Do	31	62	Do	15	58
Toke Point	Aug. 1	61	Do	16	59
South Bend	2	65	Do	17	52
Do	3	65	Do	20	55
Do	4	64	Do	23	54
North Cove	5	60	Willapa Bay	24	55
Do	6	61	Do	27	53
Toke Point	7	61	North Cove	29	60
South Bend	10	61	South Bend	Oct. 5	56
Toke Point	12	62	Do	6	56
Do	13	62	Do	8	54
Do	14	63	Do	9	55
Do	15	63	Do	12	54
Do	16	60	Do	13	54
South Bend	17	64	Do	17	52
Do	18	64	Do	18	52
Willapa Bay	19	60	Do	19	54
Sunshine (Nasal River)	20	60	Do	21	52
Sealand	21	61	Sunshine (Nasal River)	23	53
Do	22	62	Do	25	53
Do	23	62	Do	27	54
Do	24	63	Do	29	53
Do	25	62	Do	Nov. 2	56
North Cove	29	62	Do	4	54
Do	30	62	Do	5	52
Do	31	59	North Cove	8	50
Do	Sept. 3	58			

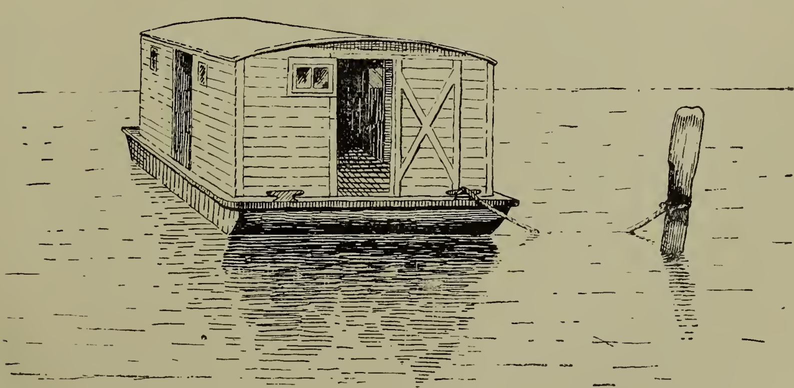
Boats, etc.—The sloops employed in Willapa Bay are usually similar to those in use at San Francisco, where most of them are built. In fact, both the oyster-planting companies of San Francisco have large interests in the oyster industry of Shoalwater Bay, and when possible similar fishery appliances are employed. In both localities the sloop is designated as "plunger."

The "float" in which oysters are stored for market is a simple affair with the floor pieces separated to admit the water freely. It is supported at the sides and ends upon unhewn logs or other solid timbers, sufficient to keep it afloat even when heavily loaded with oysters. Air boxes are not used for that purpose, as in the San Francisco type of float. The usual size is 12 feet by 30 feet.

The "bateau," as the craft for tonging, culling, etc., is locally styled, is quite different from the oyster barge or scow of San Francisco, where a larger and heavier boat is used. It is usually about 30 feet long, with the general plan of the sharpie—the bow sharp, stern square, bottom flat, and sides flaring. The bow and stern are partially decked, and there is a washboard along the sides. Sometimes it is fitted for sailing, being then cat-rigged, with centerboard and outside rudder. A few bateaux are decked entirely over, the oysters taken in tonging being heaped upon the deck, where they are afterward culled. This style is now preferred by many oystermen, because it requires no bailing out, and permits the ready washing of oysters in culling, as the water dashed upon them runs freely over the sides. When the great



OYSTER FLOAT AND BATEAU, WILLAPA BAY.



HOUSE BOAT.

rainfall of this region is taken into consideration, there is an advantage for the boat that requires no bailing out.

This light-draft type of boat is well adapted to the shallow waters of the bay where it has developed. It will float more oysters in slight depths of water than any vessel of its size with which I am acquainted. A couple of them have recently been taken to San Francisco, where they are known as Shoalwater Bay boats. In the form with flush deck the oysters are kept from rolling overboard by light bulwarks, 8 or 10 inches high, at the sides. Another craft in use here is the house boat, which is a simple scow, upon the deck of which a house is constructed for warmth and protection in winter culling of oysters. A stove may be added if desired.

PUGET SOUND.

The following statement of the oyster fishery of Puget Sound is from the report of the State fish commissioner, Mr. James Crawford, for 1890. To this I can add but little, as heavy rains and unfavorable tides did not permit satisfactory investigations during my brief stay at Olympia:

The table below gives the location of the principal transplanted oyster beds on Puget Sound, average number of sacks produced per week, and number of acres in cultivation:

Location.	Acres.	Weekly output, sacks.
Mud Bay	40	45
Oyster Bay	75	100
Big Skookum	45	40
North Bay	70	100
Hood Canal	50	25
Samish Bay	25	25
Scattering	40	15
Total	345	350

The above average is for eight months in the year. During four months of summer not more than one-third of the amount given above is averaged. The number of acres now in cultivation could easily be doubled if the demand required it, and will most probably be, as now perfect title can be secured to the tide lands upon which the oyster beds are located. There are about 125 persons engaged in gathering oysters in the district, 60 of whom are Indians. Oysters are valued at $1.75 per sack of 2 bushels each.

The industry does not appear to be a thriving one. In fact, a dozen years ago, before eastern oysters and the native oysters of Willapa Bay were commonly available on Puget Sound, the local resources were more systematically worked than they are now. Capt. W. J. Doane, of Olympia, informed me that he once had a wholesale oyster business amounting to nearly 1,000 sacks a week. These were supplied to all the towns of the region, from Olympia to Victoria. His trade is at present confined to Olympia.

The best native oyster localities of the region are doubtless in the vicinity of this place. Budd Inlet was formerly good oystering ground, but the growth of the town and the conversion of the inlet into the present harbor of Olympia have been disastrous to the original oyster deposits. Those bays and inlets of the sound which receive rivers are better adapted for oyster cultivation than those with more salty waters. The inlets of the Olympia region are well supplied in this respect. There are extensive natural oyster deposits in the vicinity of Bellingham Bay, Samish Bay, Port Discovery, Port Orford, Hood Canal, and many other places in Puget Sound, but many of them are remote from fresh water. Oyster Bay, near Olympia, is considered the most favorable of the localities for oyster-cultivation.

Puget Sound abounds in starfish, which are considered very destructive to the native oysters.

The close season from May 15 to September 1 is not enforced.

Indians are the natural laborers in this field of industry, and the few whites engaged in it have expended very little money in any branch of oyster-cultivation.

Surface temperatures taken by U. S. Coast Survey steamer McArthur at Olympia, 1891.

Nov. 25	46° (4 a. m.)	52° (4 p. m.)	Dec. 1	46° (4 a. m.)	44° (4 p. m.)
Nov. 26	49° (4 a. m.)	50° (4 p. m.)	Dec. 2	40° (4 a. m.)	43° (4 p. m.)
Nov. 27	48° (4 a. m.)	50° (4 p. m.)	Dec. 3	37° (4 a. m.)	43° (4 p. m.)
Nov. 28	41° (4 a. m.)	51° (4 p. m.)	Dec. 4	32° (4 a. m.)	38° (4 p. m.)
Nov. 29	44° (4 a. m.)	48° (4 p. m.)	Dec. 5	34° (4 a. m.)	36° (4 p. m.)
Nov. 30	47° (4 a. m.)	51° (4 p. m.)			

EASTERN OYSTERS IN PUGET SOUND AND WILLAPA BAY.

Governor E. P. Ferry, of Washington, informed me that he, in company with Col. Laramie and Mr. William P. Wright, made an experiment in planting eastern oysters near Olympia many years ago. The history of the experiment is lost, but Governor Ferry's recollection of it is that two sacks of oysters were put in Budd Inlet, about 2 miles from Olympia. They were perhaps not properly looked after, as they were soon lost sight of. It was observed, however, that they lived for several weeks. The history of eastern oysters in Willapa Bay is similar; a few sacks only were laid out in the vicinity of Oysterville. They lived as well as those at San Francisco, but no signs of propagation were ever discovered. It was conceded by oystermen that there were hardly enough of them to insure fertilization. This experiment was made several years ago and has never been repeated. Many oystermen of Willapa Bay are disposed to try bedding eastern oysters when they can get direct railway communication with the Atlantic coast.

TIDE LANDS OF WASHINGTON.

The following, relative to the sale of tide lands in Washington, is from the report of the State fish commissioner for 1890:

The law passed by the recent legislature (known as the "tide-land bill"), giving the right to purchase tide land from the State, thus securing perfect title to their transplanted beds, will, in the opinion of nearly all the most prominent oystermen, cause a remarkable growth in the oyster industry, as prior to the enactment of such a law many were deterred from embarking in the business because they could not acquire perfect title to the tide lands on which young oysters are planted after being taken from their natural beds. The railways now being built to Willapa Bay will also be an incentive to many, as the lack of transportation facilities and the high tariff charged by the present transportation lines make the margin of profit so small that none but large dealers can successfully carry on the business.

THE OYSTER LAWS OF WASHINGTON.

[Hill's Statutes and Codes of Washington, 1891.]

2585. (*Right to plant oysters may be acquired.*) A person being a citizen of this State, who has planted or who may hereafter plant oysters in any bay or arm of the sea where there are no natural beds of oysters within or bordering upon this State, may acquire, by conforming to the requirements of this chapter, an exclusive right for such a purpose to that portion of such bay or arm of the sea as he shall so occupy, not exceeding for any one person an area of more than 20 acres: *Provided*, That no person or persons shall locate or cause to be located oyster beds in any way interfering with the free use and privilege of any person or persons cutting timbers or logging, or conveying said logs to market.

2586. (*Oyster claims—How initiated—Must be recorded.*) The person desiring the benefits of the preceding section shall cause the place or portion he desires to claim to be marked, so far as is practicable, with stakes or other artificial marks at the corners, with bearings to adjacent natural objects, and shall make, before some officer qualified to administer oaths, an affidavit that he has taken the premises so described for the purpose of planting oysters, and that he has planted or is about to plant oysters thereon; that said premises are not upon and do not include any natural bed of oysters, and that the same are not occupied and claimed, in accordance with law, except by himself; and if said premises shall have heretofore been taken and oysters planted thereon, then within three months after the passage of this act, and if they shall hereafter be taken, then within one month after taking the same, the person having so taken or taking the said premises shall cause his claim, with a description thereof and affidavit as above required, to be recorded by the county auditor of the county in which they may be situated.

2587. (*Extent and number of oyster beds of single claimant.*) The same person may claim and occupy more than one place: *Provided*, The premises so claimed by him do not in all occupy an area greater than 20 acres: *And provided further*, That in those places used and occupied for the purpose of bedding marketable oysters, no one person shall occupy an area greater than 100 by 200 feet, or 20,000 feet of superficial area.

2588. (*Conveyance of right to oyster beds.*) Any person may transfer his right to any other person qualified to hold, by signing the transfer upon record, in the presence of the auditor, or by a written transfer witnessed and acknowledged in the same manner as is or may be required for deeds.

2589. (*Record of oyster claims.*) It shall be the duty of the county auditor of any county, where claims and transfers made under the provisions of this chapter are presented to him for record or entry, to receive and record the same in a separate book provided for this purpose, upon being paid the same fees as are allowed in similar cases.

2590. (*Unlawful for non-residents to take oysters.*) From and after the approval of this act it shall not be lawful for any person who is not at the time an actual inhabitant and resident of this State, and who has not been for six months next preceding an actual inhabitant or resident as aforesaid, to take or gather oysters, either on his own account or on account of others, for sale or transportation, in any of the rivers, bays, or waters of this State; and on conviction shall be fined in any sum not exceeding $500 nor less than $100, or to imprisonment in the county jail for a period not exceeding six months nor less than one month, or both, at the discretion of the court.

2591. (*Dredging for oysters below lowest ebb tide prohibited.*) It shall not be lawful for any person to rake for or gather oysters in any of the rivers, bays, or waters of this State with a dredge, or implement so called, or be employed upon any canal boat, or vessel engaged in the taking of oysters by the process of dredging in any of the waters aforesaid, not above the lowest ebb tide; and on conviction thereof shall be fined in any sum not exceeding the sum of $50, or to imprisonment in the county jail for a period not exceeding twenty days nor less than ten days, or both, in the discretion of the court.

2592. (*Taking of oysters prohibited during certain times.*) It shall not be lawful for any person to rake, scrape, or gather oysters in any of the rivers, bays, or waters of this State, for any purpose whatever, from the 15th day of May until the first day of September of each year; and on conviction thereof shall be fined in any sum not exceeding the sum of $50 for each offense, or to imprisonment in the county jail for a period not exceeding twenty days nor less than ten, or both, at the discretion of the court.

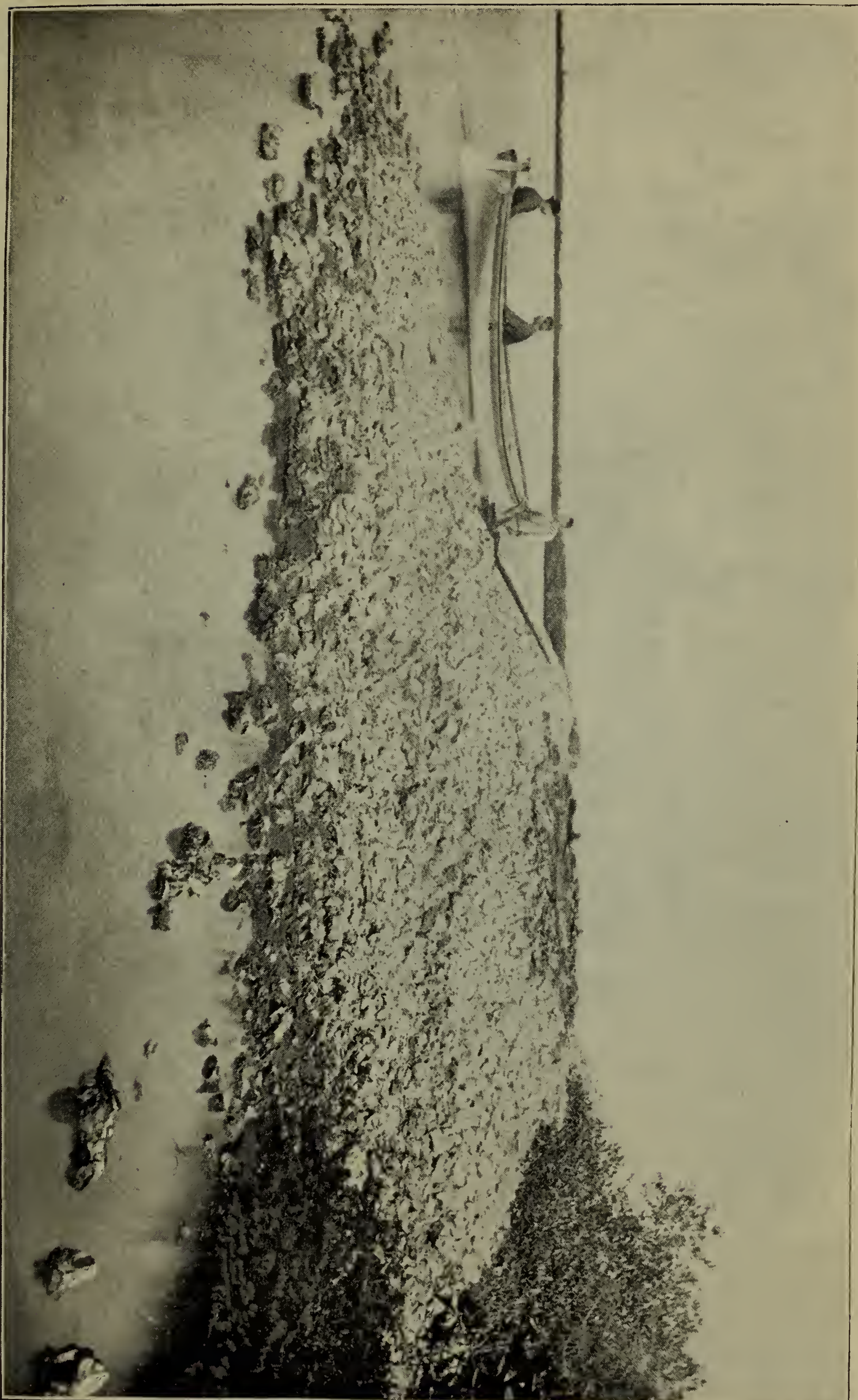
2593. (*Small oysters to be returned to beds.*) It shall not be lawful for any person to destroy oysters taken from the natural beds by assorting or culling them on land or shore and leaving the small oysters that are there to die; but in all cases the small oysters shall be returned to their natural beds, or to private beds for cultivation. And if any person shall offend against the provisions of this section, or in any way wantonly destroy the small oysters, he shall, on conviction thereof, be liable to a fine for each offense, or imprisonment as prescribed in section 2591 of this volume of general statutes.

2594. (*Right acquired by discovery of oyster bed.*) Any person or persons, being a citizen or citizens of the United States, who shall discover any bed or beds of oysters in any bay or arm of the sea bordering upon this State that has not been before discovered, shall, by right of said discovery, be entitled to the exclusive right or privilege of gathering or dredging oysters on said bed or beds for the term of five years. The person or persons making such discovery, who desires to avail himself of the rights and privileges hereby granted, shall be required to designate the place and area of the bed or beds so discovered, with the stakes or other artificial marks, and shall make affidavit before the county auditor of the county in which such discovery has been made that he located the premises so discovered, accompanied by a description and diagram of the same, which shall be filed in the office of said county auditor: *Provided*, That the restriction and protection of the discoveries shall be 10 acres.

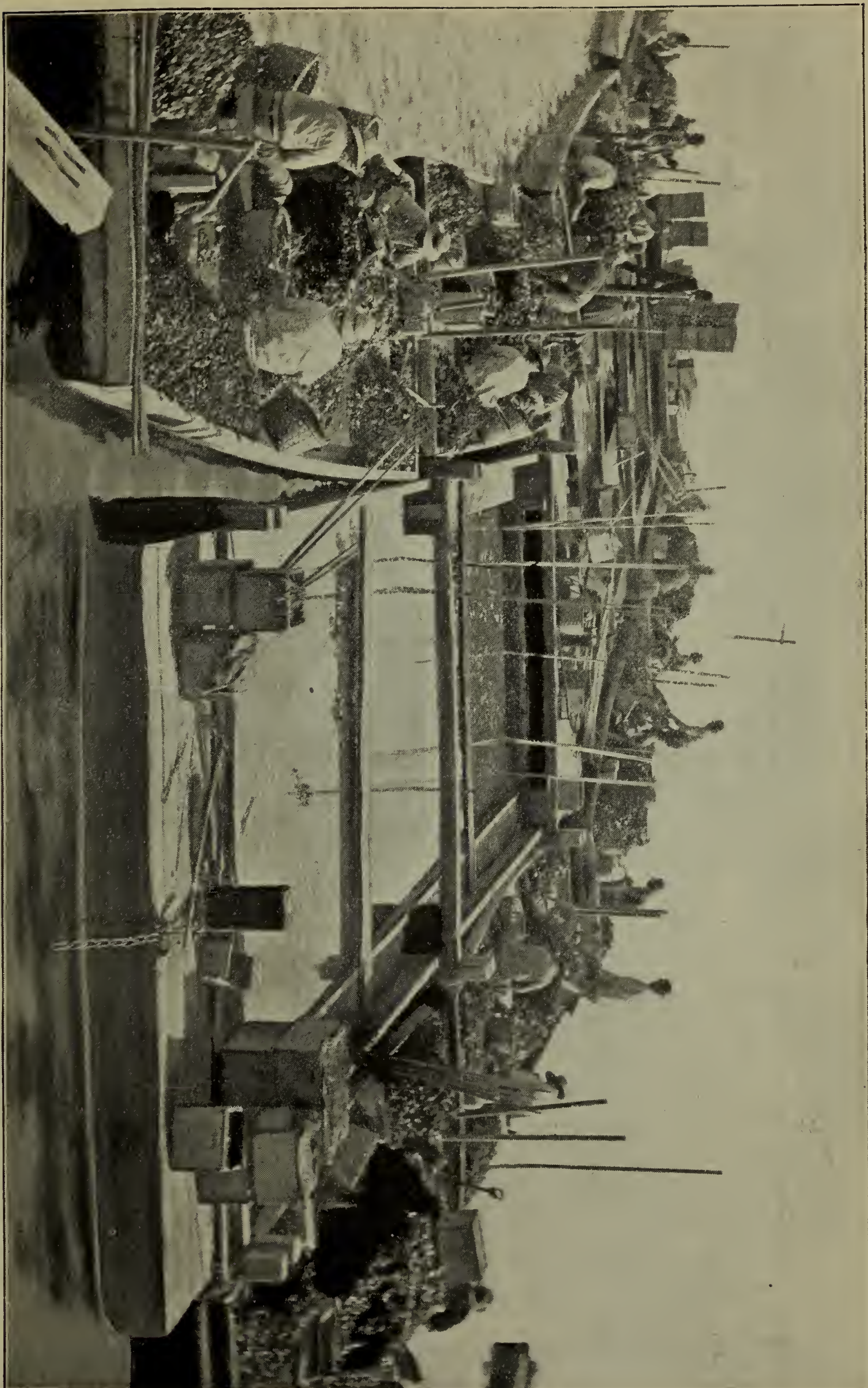
2595. (*Unlawful to gather oysters from beds located by another—Penalty.*) It shall not be lawful for any person to gather by any means on any beds located in accordance with the preceding section, except at the option and by the permission of the party or parties holding the same, under a penalty of $500 fine for so offending, or imprisonment, to be recovered in a civil action, to be brought in the name of the State.

2596. (*Time allowed certain persons in which to remove oyster beds.*) Any person who has, prior to the 26th day of March, A. D. 1890, planted oyster beds upon any of the shore lands of this State, shall be granted a period of not less than six months nor more than three years after said land has been sold by the State to remove the same; the time to be determined by the commissioner of public lands. And any person shall have the exclusive possession of said tide or shore lands during the time that he has to remove said oyster beds under the provisions of this act: *Provided*, That in case any planter of oysters shall fail within the time allotted to remove the said oysters, he shall be deemed to forfeit the same to the purchaser or owner of said lands: *Provided*, That this shall not apply to tide lands within two miles of an incorporated city.

2597. (*Construction of word "person."*) Wherever the word "person" is used in this act, it shall be deemed to mean person, persons, firm, or corporation.

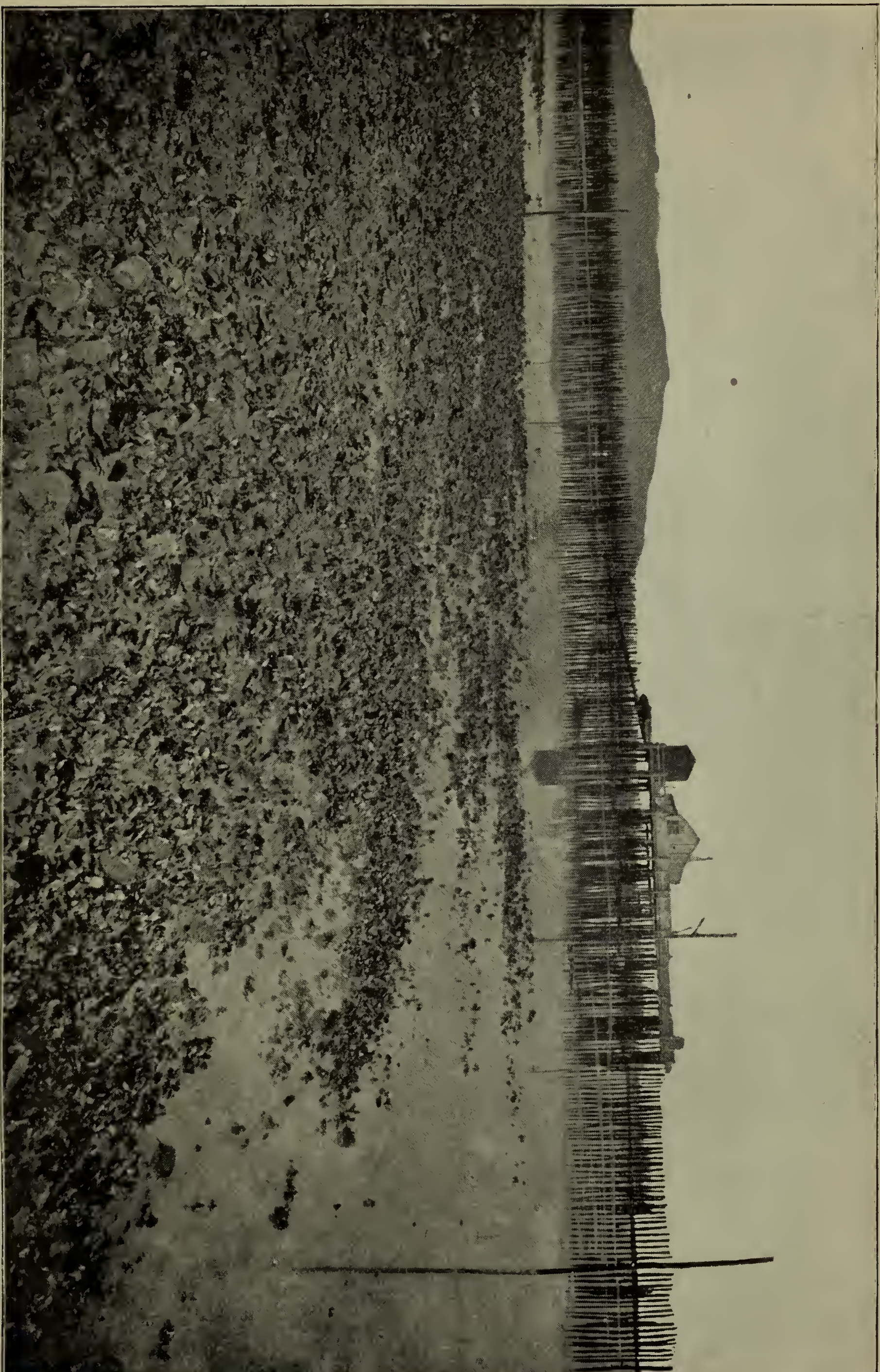


SHELL-HEAP IN ALGODONES LAGOON, GULF OF CALIFORNIA, ACCUMULATED THROUGH THE DRYING OF OYSTERS BY YAQUI INDIANS. LIVE OYSTERS AROUND MARGIN.

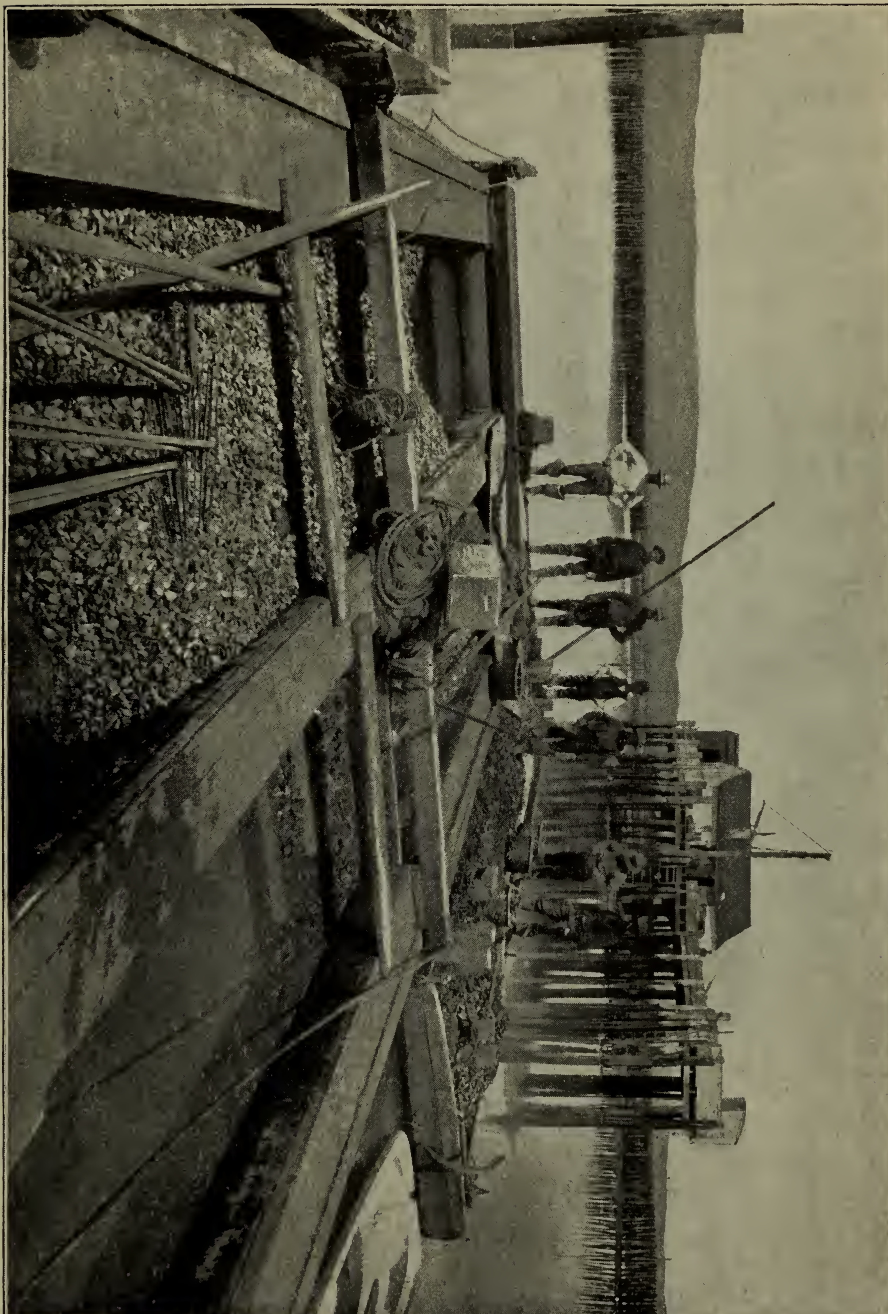


CULLING OYSTERS: SINGLE FLOAT IN FOREGROUND, DOUBLE FLOAT IN BACKGROUND; SCOWS, ETC. THE MORGAN OYSTER COMPANY'S STATION AT MILLBRAE.

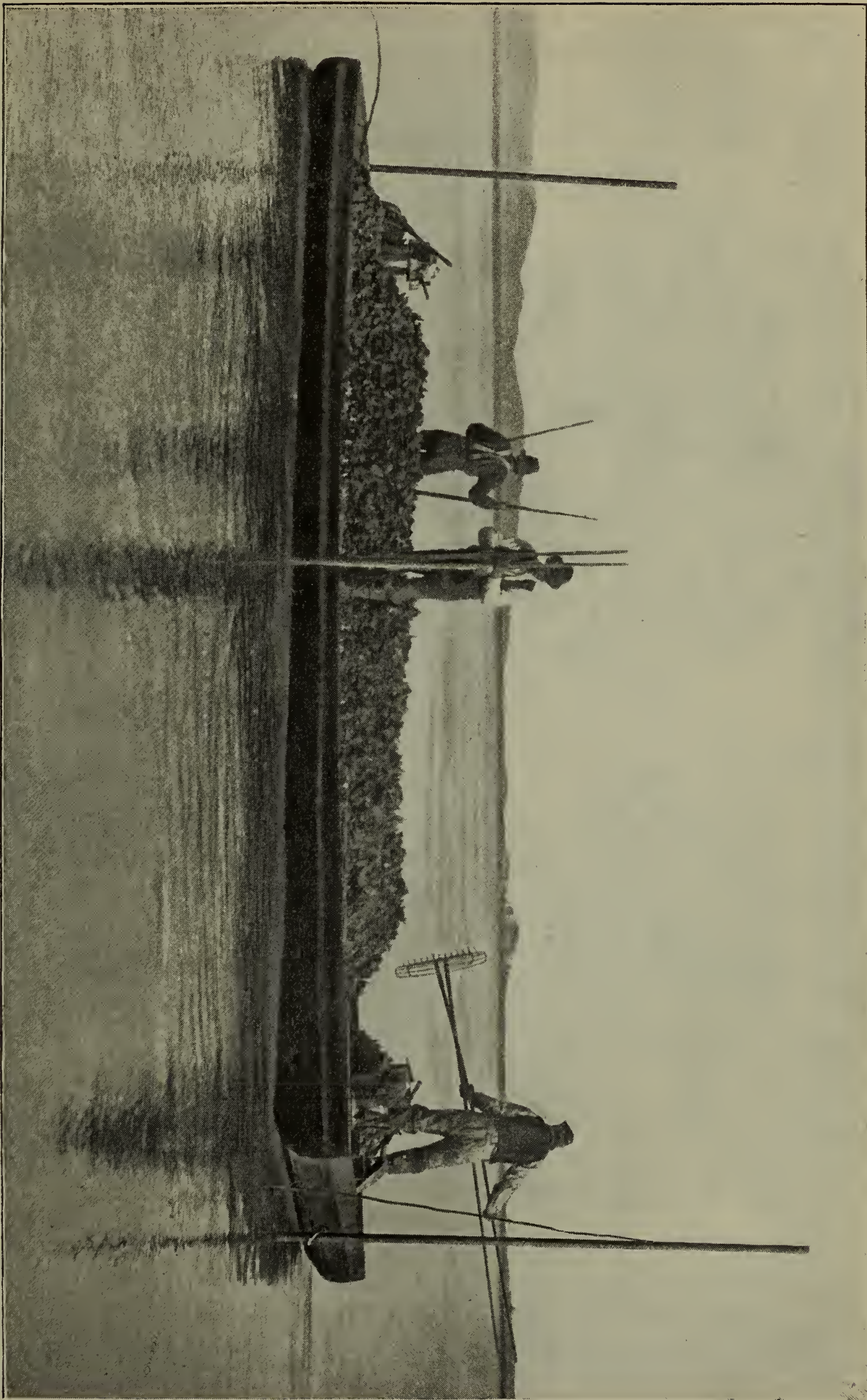
PLATE 8.



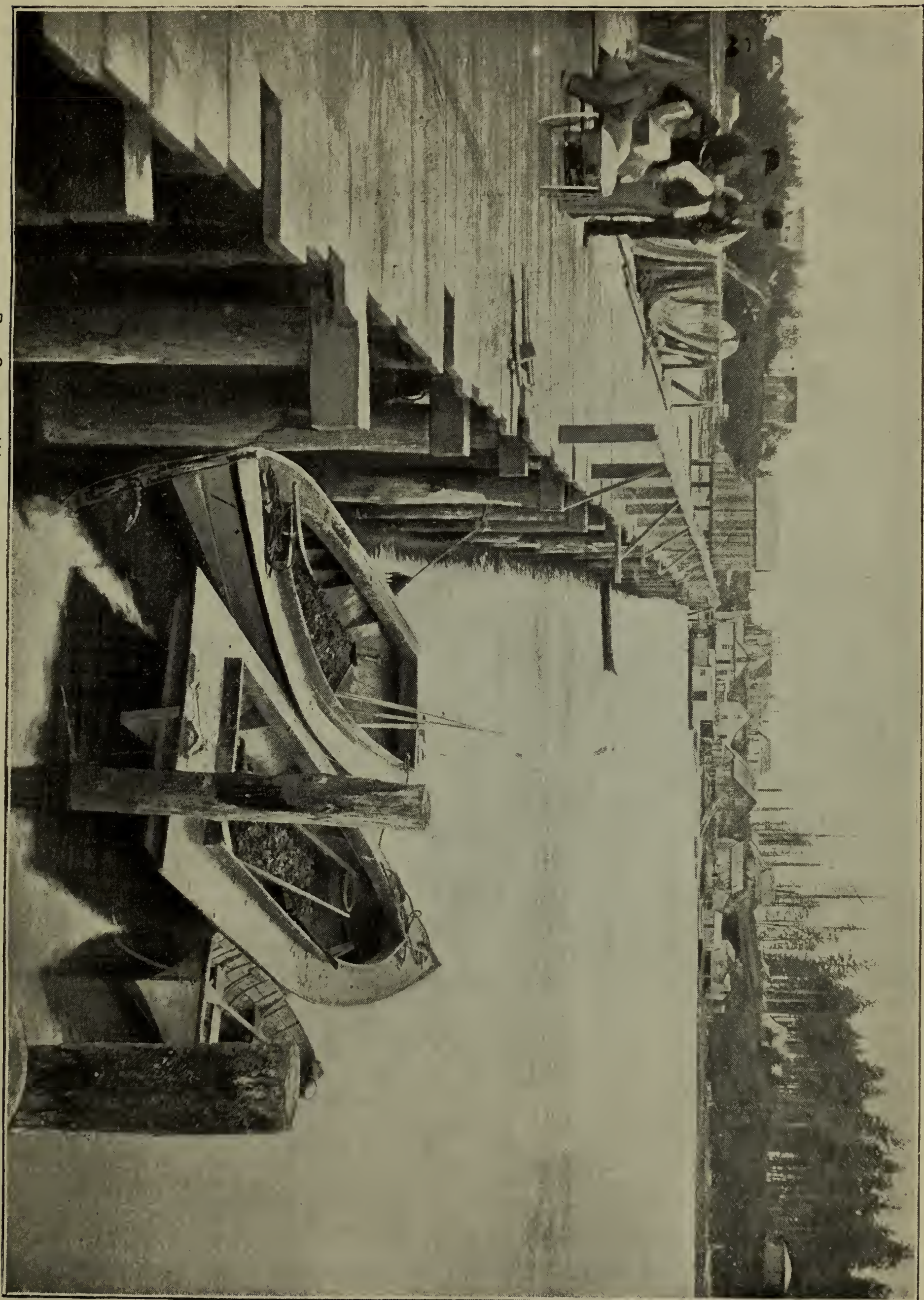
INCLOSED OYSTER BED AT LOW TIDE, SHOWING HOW THICKLY OYSTERS ARE LAID OUT. M. B. MORAGHAN'S ESTABLISHMENT.



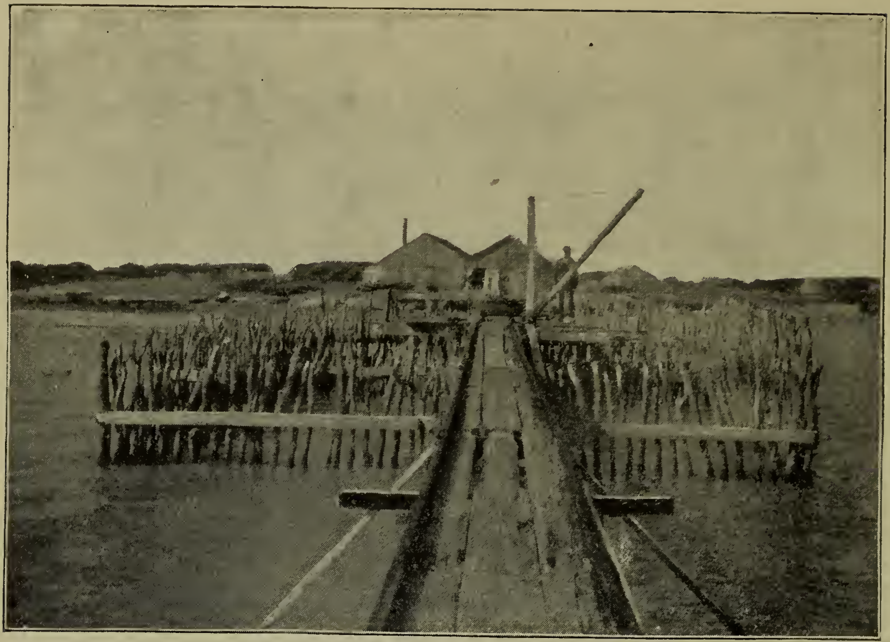
LARGE DOUBLE FLOAT, WITH SCOWS, TONGS, BASKETS, AND OTHER FEATURES OF THE OYSTER FISHERY. M. B. MORAGHAN'S ESTABLISHMENT.



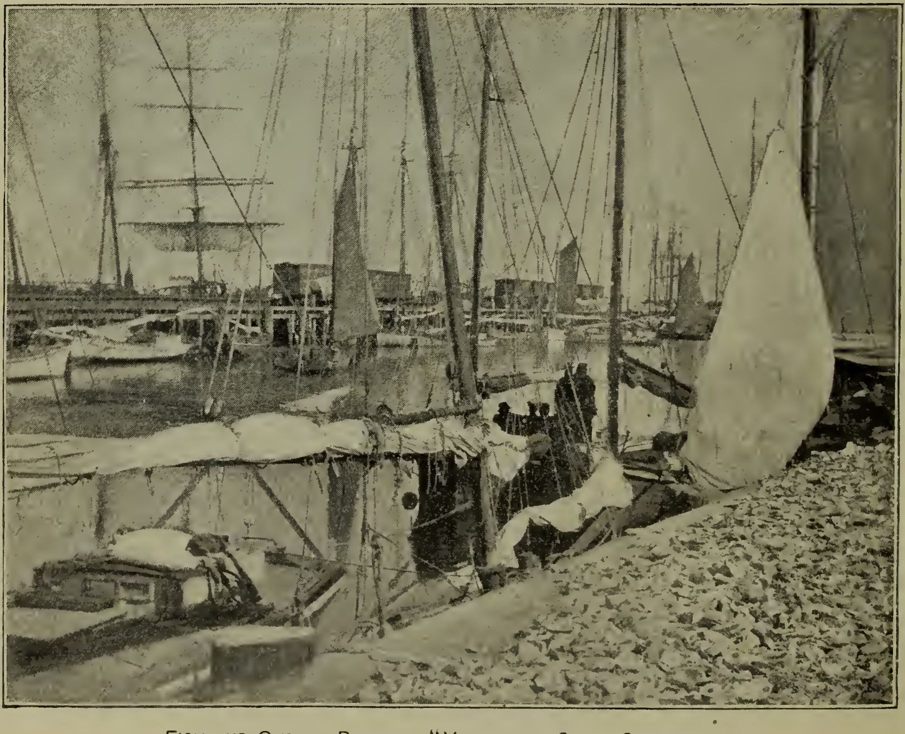
TONGING OYSTERS IN SAN FRANCISCO BAY.



BAY CENTER, WASHINGTON. CENTER OF OYSTER FISHERY OF WILLAPA BAY.



GREEN-TURTLE CANNERY AT FULTON, WITH TURTLE PEN IN THE FOREGROUND.



FISH AND OYSTER BOATS IN "VEGETABLE SLIP," GALVESTON.

3.—REPORT ON THE COAST FISHERIES OF TEXAS.

By Charles H. Stevenson.

INTRODUCTORY.

The published information regarding the fisheries of Texas is very meager, and consists almost entirely of the accounts contained in two reports* of the U. S. Fish Commission, one relating to the year 1880, the other being a condensed statement based on an inquiry made in January and February, 1891. Outside of the localities in which the fisheries are prosecuted little knowledge exists as to their extent, methods, and importance; and in considering the natural resources of the State, the vastness of its other branches is apt to completely overshadow the fisheries. In the investigation of 1891 the coastal regions of Texas were canvassed by the writer, in the capacity of a field agent of the Division of Fisheries, and the present report represents the results of personal observations made at that time. All the important fishing centers were visited, and the principal fishermen, fish-dealers, etc., were interviewed. Owing to the increasing prominence of the oyster industry, special attention was given to a study of its methods and conditions in the different localities.

Some difficulty was experienced in obtaining correct data regarding the quantity of the various species of fish taken. As a rule no books are kept by the fishermen or marketmen in such manner as to be of value in determining the quantity of products handled; and the statements made regarding these data differed greatly, even as to the fisheries of particular localities. Consequently, for information as to the quantity of products, it was necessary to depend largely on the records in the offices of the various transportation companies. This was quite satisfactory as regards the total quantity of fish obtained, but of little value in determining the quantities of the various species taken from the water. Hence the figures given in this report for the different species of fish taken must be accepted as only approximately correct.

*The Fisheries and Fishery Industries of the United States, 4to, 7 volumes, Washington, 1884–87.

A Statistical Report on the Fisheries of the Gulf States. Bulletin U. S. Fish Commission, 1891. Washington, 1892.

IMPORTANCE OF THE FISHERIES.

The investigations by the U. S. Fish Commission in 1880 showed that the number of men employed in the fisheries of Texas was 601; the capital invested, $42,400; and the weight of the fish taken, 3,858,875 pounds, valued at $128,300. In 1890 the number of men engaged in the fishery industries of the State was 1,277; the value of property employed, $315,427, and the weight of the products was 7,961,400 pounds, for which the fishermen received $313,912.

On account of the incomplete transportation facilities, the difficulty of preserving fish in a warm climate for a considerable length of time, and the generally undeveloped condition of affairs on the coast, the fisheries of this State have not heretofore attracted great attention. They have been controlled and prosecuted mainly by Mexicans and natives of Southern Europe, who were usually unfamiliar with the methods in use at other fishing localities in this country. But with the improvement and extension of the railroad system of the Southwest, the cheapening of ice by manufacture, and the extensive immigration which this section of the country is now attracting, the fisheries give promise of being at some time classed among the important industries of the State. The entire State, together with New Mexico, Colorado, Kansas, and a large part of Mexico will be thus benefited by receiving a ready and fresh supply of salt-water fish.

At present "bay seining" is the most important fishery in Texas. The oyster industry is second in extent, but will doubtless rank first within a few years. These two fisheries are prosecuted extensively all along the coast. Each locality also has its own minor fisheries, such as the turtle, the shrimp, the crab, the flounder, the surf-seine, the cast-net, and the hook-and-line.

Aside from the surf seines in use on Galveston Island, some hook-and-line fishing at different places, and an occasional trip of a harbor boat from Galveston to the red-snapper banks, all the fisheries of Texas are confined to the bays and their estuaries along the coast. Of the 7,961,400 pounds of marine products obtained by the fishermen of Texas in 1890, the quantity taken from the Gulf proper is estimated at less than 300,000 pounds.

Since 1880 all the Texas fisheries have increased in extent excepting for shrimps, which are reported as less abundant than they were ten years ago. The catch in 1880 was 637,500 pounds, while in 1890 the quantity taken in both the seines and cast nets amounted to only 179,800 pounds. The oyster and bay-seine fisheries exhibit the greatest actual increase in the value of products.

The growth of the fisheries is due principally to the development of the methods of marketing the catch. The shipping facilities along the coast, except at one or two places, have been greatly increased during the last decade. The building of the Mexican National Railway (narrow gauge) from Corpus Christi to Laredo, in 1880, opened up a Mexican market for the fish and oysters taken in the vicinity of the former place. Then came the construction of the San Antonio and Aransas Pass Railway from San Antonio to Corpus Christi, and its extension a few years later to Aransas Bay, which facilitated the shipping of fish from those two places to the North and West. But the abandonment of those two ports by the Morgan Steamship Line counteracted somewhat the advantages gained by the railroad connections. The shipping facilities of Matagorda Bay have greatly declined since 1880. When this port was abandoned by the Morgan line of steamers the trade with Galveston almost entirely ceased.

The manufacture of ice has also greatly benefited the fisheries. On the shores of Sabine Lake, Galveston Bay, Aransas Bay, and Corpus Christi Bay there are establishments for ice manufacture, and the product can now be obtained in car-load lots at from $3 to $8 per ton, at any railroad station on the coast.

THE FISHERMEN.

The number of men engaged constantly in the fisheries of this State in 1890 was 819, the number who fished for a portion of the time only was 286, and 172 men were employed in the marketing houses and canneries, making a total of 1,277. In 1880 the number of professional fishermen was reported to be 291; the semi-professional, 200; the men on shore, 110; a total of 601.

Only a small portion of the Texas fishermen were born in America; they are chiefly natives of Italy, Sicily, Greece, Austria, and Mexico. Of the native fishermen a large portion were of foreign parentage. A much greater proportion of native Americans is engaged in taking oysters than in the seine fishery. The negroes along the coast do not engage in fishing, except in a small way from the wharves with cast nets, lines, etc.

The fishermen as a rule are not familiar with other occupations. Many of them have inherited their vocations by direct descent for many generations. Prior to their coming to Texas some have fished for the markets of Palermo, Naples, or Athens, or have supplied fish at such Mexican towns as Vera Cruz, Tampico, or Soto la Marina. As a class they are independent in their manners and habits, but are nearly always poor and unthrifty. Their life while on a fishing trip is very rough. The hard, rounding floor of the cabin, with a blanket over it, serves as a bed. The provisions, while usually plentiful, are of the plainest, consisting chiefly of salt meat, bread, hard-tack, onions and garlic, potatoes, and coffee. The cabin floor serves as a table. The cooking is generally done on a small stove or by an open fire in a pot, and one of the crew attends to that work without extra pay.

FISHING VESSELS AND BOATS.

The number of sail craft employed regularly in the fisheries of Texas in 1890 was 311, valued at $106,800. Of this number only 18 measured over 5 tons, the combined tonnage of these being 152.59. The fishermen prefer boats of less than 5 tons measurement in order to escape the inconveniences of having them licensed at the custom-house. Besides the sail craft, 536 skiffs, valued at $5,615, were employed in 1890. Along the Texas coast the expression "boat" is applied to all sail craft, while the word "skiff" is used to designate something propelled by oars; and it is with these meanings that the two words are used in this report. The sloop, cat, and schooner rigged centerboard boats are the prevailing types employed in the oyster, seine, and turtle fisheries. Square or "lugger" rigged boats are not in use at present in the fisheries of this State. The lugger is particularly adapted to winding bayous, where sailing close to the wind is necessary, as in Louisiana; and as few such places occur in the fishing regions of Texas, the safer and more speedy sloop and cat rigged boats are obviously preferable.

The construction and the rig of the sailboats do not materially differ from the styles in general use along the coast of the Middle and New England States. In order to easily pass through the shoal waters of the bays, these boats are built very shallow, having either a flat or "round-knuckle" (one-half flat) bottom. They are usually from 22 to 34 feet long, from 8 to 12 feet wide, and from 1½ to 3 feet deep. The *Cosatinporta*, which was built at Corpus Christi in 1889, may be taken as a type of the best class of sail craft in use. Her dimensions are, length, 30.7; breadth, 10.9; depth, 2.7; net tonnage, 5.37.

The sailboats are built without elaborate or unnecessary finish or equipment. They are decked over fore and aft, and frequently the entire length. All of them have a small cabin, which serves as a cooking and sleeping room. The cost ranges from $150 to $1,800, averaging about $400. They are built mostly in Texas, at Galveston, on the Lavaca River, at St. Marys City, and Corpus Christi. There are, however, no extensive boat-building establishments in the State.

Occasionally, under the influence of a southeast wind, some of the bays become exceedingly rough. Especially is this true of Matagorda Bay, which in threatening weather the fishermen avoid almost as much as they would the open Gulf. More wrecks have probably occurred in this bay during the past six years than in all the remaining bays of the State combined. As the boats are never insured, their loss is a serious matter to the fishermen.

Each sailboat usually carries one or two skiffs or tenders, costing from $5 to $15. These skiffs are roughly constructed, many not being painted. All of them have flat bottoms, so that they may be easily run ashore.

THE FISHERIES.

THE BAY-SEINE FISHERY.

This is at present the most important of the fisheries of Texas. It is prosecuted in the same manner and with the same form of apparatus in all the fishing sections along the coast. In 1890 this fishery gave steady employment to 358 men, using 110 sailboats valued at $38,750; 114 seines valued at $15,200, and other apparatus to the value of $4,643. The total catch amounted to 3,609,100 pounds, for which the fishermen received $150,592. In 1880, according to figures reported by the U. S. Fish Commission, 126 men engaged in fishing 42 seines and the catch amounted to 650,000 pounds, valued at $32,500.

These seines are hauled in all the bays along the Texas coast; they are not used in the Gulf of Mexico nor in the rivers. Ten years ago the greater part of those operated were owned at Galveston; since then the number used in Aransas Bay has shown the greatest increase, as fish have grown scarcer in Galveston Bay and the railroad facilities at Aransas Bay have improved.

Each party of seine fishermen, which usually consists of from two to four men, ordinarily has one sailboat, one seine, one or two skiffs, and two or more live-fish cars. The sailboats and skiffs are of the ordinary type used in all the fisheries on this coast. The sailboats never have "wells" in which the fish may be kept alive, and ice is not used for preserving the catch; but floating cars are used, in which the fish are kept alive while being transported to market; these are roughly constructed, usually of slats in the form of and about the same size as a skiff; in fact, some of the fishermen use an old skiff, cutting or boring holes in it and covering it with an open slat-work top. The live-fish cars are not usually painted; they have capacity for 400 to 2,000 pounds of fish, according to their size and the temperature of the water. The cost ranges from $5 to $15 each. They are carried on board the sailboats when empty of fish, and when the fish are put in them they are towed behind.

The seines vary in length from 80 to 200 fathoms and in depth from 4½ to 6 feet. The small depth is made necessary by the shallowness of the water. Usually no lead or similar weight is attached to the bottom, the sinker consisting of a tarred rope about an inch in diameter; but some of the seines have several lead sinkers on the tarred rope, near the middle. In the center of each seine is a cone-shaped bag from 10 to 15 feet in length and 3 or more feet wide where it joins the bunt, tapering to 6 inches at the smaller end.

The ordinary mesh of the seine is 1½ inches square, but the net used in the bag and for a distance of 12 feet on each side has a mesh about ¾ inch square. This smaller mesh is necessary in order to increase the strength of the seine in those places, to prevent tearing by alligator gars, tarpon, etc. The cost of an ordinary seine is about $1.10 per fathom. One usually lasts about two years, but requires constant mending and repairing.

The fishermen generally work on shares and sell their catch to the marketmen at a price which is usually fixed for the season. In dividing the profits as well as in meeting the expenses all the crew share alike. The captain receives no more than any one of his men, and his duties are equally laborious. The boat and seine, which are generally owned by the captain or some relative or friend of his, count as one share. The seine is kept in good order by the crew, and the owner pays for such expenses as repairing the boat, painting, etc. Formerly at some of the ports, and particularly at Galveston, in order to more easily control the trade of the fishermen, the marketmen owned some of the boats and apparatus and rented them to the fishermen, the marketmen receiving their proportionate share of the catch; but the practice has been discontinued to a considerable extent, as the fishermen fail to take the best care of the boats and seines when they have no property interest in them.

The average annual income of the bay-seine fishermen of Texas, derived from their seining operations, is about $325. This is increased somewhat by hunting and marketing ducks, geese, and other food or plumage-bearing birds with which the bays along the Texas coast abound during certain seasons of the year. The profits are quite regular, not varying much from year to year, although steadily increasing with the development of the fisheries and the constant advance in the market price of the catch.

Occasionally two crews "double up," that is, combine, uniting their seines, and two of the men run the catch to market while the others continue fishing. The proceeds from the catch are then divided equally among the men and boats. At times, when fishing in comparatively deep water, four and even five crews combine for several hauls, fastening the seines end to end.

The men always get in the water to haul the seine without regard to the temperature. They may begin to haul it from the boat when in 8 feet of water, but the fish are landed where the water is from 10 to 36 inches deep. On account of the men having thus to stand in the water, the impracticability of their fishing where the bottom is very muddy will be readily observed, although fish may be found there in abundance, as in Mesquit Bay.

After a haul of the seine the fish are transferred to the live-fish car; the crabs and "poor fish" are thrown away; one of the crew is left to tow the "car," and the others seek another hauling berth in the immediate neighborhood. Or, if the next hauling site be distant 2 or 3 miles, and the wind is favorable, all of the crew return to the boat and sail to the next locality.

The bay-seine fishery is prosecuted during all seasons of the year, but less zealously in the summer on account of the smaller demand for fish. The principal species of fish taken by means of these seines are redfish, sea trout, sand trout, sheepshead, croakers, jackfish, hogfish, drum, mullet, bluefish, Spanish mackerel, pompano, rockfish, jewfish, pigfish, and whiting.

The following species are also reported as being taken in small quantities: Shoemaker, perch, pike, flat croaker, robalo, sawfish, catfish, calico-fish, needle-fish, moonfish, gulf menhaden, crabs, etc. Most of these species are considered of no value and are thrown away as soon as removed from the seines, except occasionally when better fish are scarce.

By far the greater part of the fish brought to market by the bay-seine fishermen consists of redfish, sea trout or squeteague, and sheepshead. Of these, the trout is generally considered the finest for the table, but it does not bear transportation so well as some of the other species. The redfish is preferred for shipping purposes, and is much more popular for the table than the sheepshead, which at times does not meet with a ready sale.

The average weight of a redfish is about 10 pounds and the length 2 feet or over, while some weigh 40 pounds and are 4 feet long or over. The Mexican fishermen in Texas frequently call it the "pez colorado," and in Louisiana the name "poisson rouge" is applied to it. According to the fishermen, the redfish are not usually found in spawn when weighing less than 10 pounds. All fish of this species which weigh over 16 pounds are called "bulls." These are sold at a reduced price, and at so much per fish, usually about 25 cents.

The sea trout (the weakfish or squeteague of the Atlantic coast) average in weight about 3 pounds, and at times attain a weight of 10 pounds and a length of 3 feet. They spawn when weighing about 1½ pounds. They are fine food-fish, but do not keep well, the flesh being very soft. While trout are taken at all times of the year, they are more plentiful in March, April, and May. The sheepshead average in weight about 2½ pounds, with a maximum weight of about 10 pounds. All along the Gulf coast the name of this fish is contracted into "sheephead."

Occasionally the fish taken by a crew during several days consist almost entirely of one of these three most plentiful species. On several occasions the writer has at different ports in Texas seen several thousand pounds of fish of which probably 90 per cent were of one species. One week they may be nearly all sheepshead and the next week trout or redfish. Ordinarily the fishermen and marketmen put the same value on the different species of fish taken, but if an extra large quantity of "poor fish" is taken, or if the catch consists largely of sheepshead, the marketmen may refuse to accept a portion or all of it.

Little difference has been noticed in the quantity of each species of fish taken by the bay seines from year to year. Redfish are reported as having decreased most in plentifulness; bluefish, pompano, and Spanish mackerel are growing more abundant. There is no place along the Texas coast at which the supply of fish is less than the demand, except at Galveston Bay. Occasionally the Galveston fleet is for weeks unable to supply the market demands; but in Matagorda, Aransas, and Corpus Christi bays, and at Point Isabel many of the crews are frequently idle for several days on account of an oversupplied market.

Green turtle (*Chelonia mydas*) and terrapin (*Malaclemmys palustris*) are occasionally taken in the bay seines while being hauled for fish. A small chain is also sometimes attached to the lead line of the seine and a haul is made especially for them. This is done chiefly at Aransas Bay. The terrapin taken weigh about 3 pounds each and are sold by the fishermen at from $4 to $15 per dozen. They do not possess the fine flavor of the Maryland diamond-back. The turtle average from 5 to 20 pounds and sell for about 3 cents per pound. They are the young of the green turtle common on this coast.

Believing that the fish are caught in greater quantities than their natural fecundity can make good, there is a desire on the part of many persons, especially those interested in developing the sporting fisheries of Texas, to restrict in some way the use of seines. While the supply of fish may be decreasing, yet there does not appear to be an urgent necessity for very great restriction. The cessation of the seine fishery in the bays for four months from May to August, which is the plan generally urged, would throw entirely out of employment over 350 men, removing from the coast towns a monthly revenue of more than $12,000, and taking from the market a cheap and wholesome article of food. It would also seriously affect the marketing of fish taken during the winter, since purchasers in the interior would prefer obtaining their supplies from such sources as could provide for them continuously throughout the year. If restriction be deemed expedient and necessary, the prevention of the marketing of large fish, say of redfish weighing over 14 pounds (advocates of a close time contend that redfish, more than any other species, require special protection), would largely answer the purpose without embarrassing persons depending on the bay-seine fishery for a living. These large redfish are the spawning fish. They are difficult to market, being coarse and of poor flavor, and are sometimes even thrown away.

For the purpose of comparison, the total catch by bay seines at the various fishing localities in the State during each of the past four years is herewith appended:

Localities.	1887.		1888.		1889.		1890.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Sabine Lake	42,160	$2,380	45,600	$2,630	45,750	$2,795	47,000	$2,893
Galveston Bay	1,455,500	69,140	1,469,060	70,320	1,489,400	74,668	1,418,500	72,999
Matagorda Bay	74,800	2,860	81,000	2,950	88,800	3,110	102,750	3,593
Aransas Bay	1,089,000	32,890	781,000	23,650	1,076,000	38,050	1,244,100	43,562
Corpus Christi Bay	540,000	18,900	605,000	21,175	685,000	23,801	719,950	24,965
Laguna Madre	91,800	3,400	86,000	3,200	81,050	2,759	76,800	2,580
	3,293,260	129,570	3,067,660	123,925	3,466,000	145,183	3,609,100	150,592

THE CAST-NET FISHERY.

While this is one of the minor fisheries and no one depends on it for a living, yet numbers of cast nets are used at the various settlements along the coast. In 1890 the number used in the State was 315; the quantity of fish taken was 91,500 pounds, the value of which was $3,540.

The cast nets are circular, varying in diameter from 4 to 10 feet. Each net has a small ring in the center, through which pass several small ropes which are attached to the outside rim of the net. After passing through this ring, which is usually made of horn, the ropes are all united and fastened to one larger rope, which is used as a hand-line. Around the edge of the net a number of lead sinkers are arranged at equal distances from each other. The cost of these nets ranges from $1.50 to $8. The average size of the mesh is about 1 inch. Cotton twine is the material usually preferred in their construction.

With the hand line on the ground under one foot, or otherwise secured, the net is held at different places on the rim by the mouth and the two hands; then, with a circular motion, it is thrown so as to fall flat upon the surface of the water Sinking to the bottom it covers such fish as are unable to make their escape from beneath it. Then, by hauling in the main rope or hand line, the net is pursed and the fish are inclosed.

This method of fishing can be practiced only in shallow water. The catch consists mostly of mullet and shrimp. This method of taking mullet is much more successful than by the use of the seines, since so many of these fish escape over the top of the seine while it is being hauled. No boats are used in this fishery, it being carried on from the wharves and docks. The persons using the cast nets are boys and men having no other employment. The catch, which is small, does not pass through the wholesale fish markets, but is usually peddled about the settlements by the fishermen.

POUND NETS, GILL NETS, ETC.

At present there are no pound nets used in Texas. This is due to the fact that they would be destroyed by sharks, alligator gars, and other large predaceous fishes with which these waters abound. About fifteen years ago a pound net of the type used along the coast of the Middle States was set in Galveston Bay, and while it was in working order quantities of fish were taken in it; but large predaceous fish tore the netting so frequently that it required constant mending in order to retain any of the food-fishes. On this account the use of the pound net was soon abandoned. It is possible that pound nets made of galvanized wire or stake and brush weirs could be successfully employed if the sentiment of the people would permit their use.

Except such as are used in the green-turtle fishery, I am not aware that stationary gill nets have ever been used in taking marine products in the coastal waters of Texas. They would be of little service in these waters, not only on account of the damage that would be done to them by predaceous fish, but also because the high temperature of the water would necessitate at too frequent intervals their being raised to remove the fish while in good condition.

THE SHRIMP-SEINE, SURF-SEINE, AND GREEN-TURTLE FISHERIES.

Around Galveston Island, besides the bay-seine fishery, two special forms of seine fishery are found in practice, one for taking shrimp in Galveston Bay, the other used in the surf on the south side of Galveston Island for obtaining sand trout, large redfish, etc. As they were found at no other locality, the discussion of these fisheries will be included in the description of the fisheries of Galveston Bay.

Large green turtle (*Chelonia mydas*) occur more or less abundantly all along the Texas coast; a few are taken by the fishermen of Point Isabel, but as their capture and utilization centers at Aransas Bay a description of this fishery will be found in the notes on that locality.

HOOK-AND-LINE FISHERIES.

While seine fishing continues so successful as at present, it is not probable that an extensive hook-and-line fishery will be developed in the Texas waters; yet, from all the bays along the coast and in the many rivers throughout the State, quantities of fish are taken in this way by sportsmen as well as by those men who engage in the other fisheries.

Catfish are taken on trot lines and by means of hand lines in Sabine Lake, Guadalupe River, Rio Grande, and to a less extent in many other streams. These are the large mud or channel catfish common in the Mississippi River and the Southern States. They sometimes attain a weight of 50 and even 70 pounds. They are quite well liked in this State, in some of the interior towns being preferred to redfish or trout.

Some line fishing in the surf is engaged in on the south side of Galveston Island, and at one or two other places. From all the coast settlements some hand lines are used for taking redfish, trout, sheepshead, tarpon, and other kinds common on the coast. More redfish are taken in this manner than any other single species, mullet and shrimp being the most popular baits used for them. They are very gamy, and a 25-pound redfish will give plenty of sport.

The tarpon, known in Texas also as "grande écaille" or "savanilla," are abundant, but not frequently landed. Jewfish attract much attention in the spring. The Mexican fishermen call this fish the "guasa," and at Pensacola it is known by the name of "warsaw," doubtless a corruption of "guasa." In Texas it is also called the "junefish," because of its being more plentiful in June than at other times. Crabs and mullet are used as bait. Occasionally fish of this species weighing over 500 pounds are taken. In Aransas Bay, in 1890, a jewfish was caught which weighed 597 pounds round weight.

RED-SNAPPER FISHERY.

"Outside fishing" from vessels is also engaged in occasionally, the species sought being the red snapper. All along the coast of Texas from Sabine Pass to the mouth of the Rio Grande there is an irregular series of banks, or reefs, on which these fish may be taken. On account of there being no extensive fishing for them in this part of the Gulf of Mexico, the location of these banks is not generally known, and doubtless but a small number of them have ever been fished on.

Following is given the location of the best-known reefs from which red snappers have been obtained: Due south from Sabine Pass and about 13 miles distant there is a small reef on which a few vessels from Galveston fished several years ago; the depth of water on this reef varies from 7 to 12 fathoms. Off Galveston Island there are two banks, one southeast and distant about 45 miles, in 12 fathoms of water; the other about 85 miles south of the island, with a depth of 30 to 45 fathoms of water. Southeast of Cedar Bayou, in 15 fathoms of water, there is a small bank from which a few fish are taken at times by men living at Aransas Pass and Corpus Christi. A small reef a few miles south of the entrance to Aransas Bay also attracts some attention. Another bank is reported about 6 miles east of Brazos Santiago and Boca Chica.

It is highly probable that all along the coast of Texas and Mexico there are innumerable small patches of sea bottom where red snappers and groupers are to be obtained. Off Sabine Pass and Galveston Island these reefs will probably be found ranging from 5 to 100 miles distant from the shore. Going southwest along the coast, the width of this area becomes gradually smaller, the limits of the reefs being nearer the shore. Off Padre Island there are doubtless no snapper banks at a greater distance from the shore than 55 miles.

Going southward the width of sea bottom on which the red snapper will probably be found continues to contract. The Mexican fishermen report that off Sota la Marina they have never found them at a greater distance from the shore than 15 miles, and similar reports are received from Tampico and Vera Cruz. This width remains about the same all along the coast of the State of Vera Cruz and until in the vicinity of the mouth of the Tobasco River. Here the area begins to enlarge, and rounding Yucatan until Cape Catoche is reached, the grounds on which the red snapper will probably be found extend from 5 to 120 miles from the coast. On account of the great depth of water, there can scarcely be extensive reefs on the Yucatan coast beyond Cape Catoche.

The grounds north and west of Yucatan constitute the well-known Campeche Banks, which have a reputation for being abundantly supplied with fish, and particularly with the red snapper. Aside from one or two trips no attempts have been made to establish a fishery here, on account of the distance from American ports.

In December of 1890, the schooner *Gertrude Summers* (61.19 net tonnage), of Noank, Conn., Benjamin Latham captain, made a trip to these banks, and in two days' fishing, with seven men, took 22,000 pounds of red snapper. On the first day the catch amounted to 14,000 pounds. These fish were rather large, the average weight being about 10 pounds each. In expectation of obtaining smaller fish in shoaler waters, the vessel was sailed nearer the shore. During the second day's fishing Capt. Latham was not much more successful in obtaining small fish, but took 8,000 pounds of mixed size. With this fare he sailed to Galveston. On account of their large size and the fact that the market was not accustomed to so large a quantity of these fish, they were not disposed of at a good price.

In January, 1891, this vessel made another trip to the Campeche Banks, securing 15,000 pounds of fish. In the same month one trip was made to the reefs located about 85 miles south of Galveston Island, from which about 5,000 pounds of fish were obtained.

The attempt to market red snappers from Texas ports has not met with the success expected. This is due to several reasons, among which might be mentioned the large size of the fish and the orders not having been secured from the inland markets before their arrival.

Mr. Heck, who at present has a retail fish market in Corpus Christi, states that he has fished from Vera Cruz in a 52-ton smack, with four men, and obtained 16,000 pounds of red snappers in about five hours. There is every reason to suppose that the development of this fishery offers special inducements both to fishermen and capitalists.

From some of the ports along the Texas coast the entire country west of the Mississippi River may be cheaply reached and supplied with this excellent fish. For this purpose Galveston affords superior facilities, its freight and express accommodations being superior to those of any other port on the Gulf of Mexico west of New Orleans.

At Galveston, under the present conditions and prices, the fish may be taken from the vessel, iced, packed, and delivered in carload lots by fast freight to points within 1,000 miles, and even to Chicago, for 1½ cents per pound.* Neither Pensacola nor Mobile could readily compete with Galveston in supplying the western half of the United States.

THE FLOUNDER FISHERY.

The taking of flounders by means of spears is engaged in during the summer months by a few persons living at Galveston, Aransas Bay, and Corpus Christi. This fishery is prosecuted mostly at night. The men wade out in the shallow water carrying lighted torches and using flounder spears or some similar instruments of capture. Many forms of spears are used. Some of the fishermen employ an ordinary table fork fastened to a stick, while others and probably the most successful

*At Galveston the price of ice ranges from $4 to $8 per ton. Fast-freight rates from Galveston to Chicago are about $120 per carload. Besides ice, etc., one car carries about 18,000 pounds of fish.

ones use a table fork without the extra stick, merely grasping it by the handle. The catch, which is usually sold by the street peddlers, was reported to have been 67,000 pounds in 1890. This was proportioned among the various fishing localities, as follows:

Localities.	Pounds.	Value.
Galveston Bay	27,000	$1,600
Aransas Bay	36,000	1,440
Corpus Christi Bay	4,000	160
Total	67,000	3,200

THE CRAB FISHERY.

The taking of crabs on the coast of Texas scarcely amounts to the importance of a commercial fishery, yet about 32,000 dozen are caught and marketed each year by boys and other persons employed around the wharves. These are taken by means of short hand lines and roughly made trap nets. The catch is usually peddled about the cities, being sold at the rate of 15 to 20 cents per dozen. The quantity of crabs taken in Galveston Bay is about five-sixths of the catch of the entire State. The number taken in the waters of Texas depends entirely on the small local demand, and there seems to be no limit to the quantity that might be obtained if they could be marketed. The seine fishermen take large quantities, but do not save them.

The following table shows the number and value of the crabs reported as taken at the various fishing localities in 1890:

Localities.	Number.	Value.
Galveston Bay	325,000	$4,200
Aransas Bay	26,400	440
Corpus Christi Bay	23,600	400
Laguna Madre	6,600	55
Total	381,600	5,095

ALLIGATORS AND PORPOISES.

While the capture of alligators is not a matter of commercial importance in this State, yet they are somewhat plentiful in the swamps and river bottoms, and a number are killed every year by sportsmen and others. Several years ago, when their hides were not so cheap as at present, the number taken was much greater than has been the case during the past three or four years. The hunting for them has somewhat reduced their abundance.

Porpoises are numerous on the Texas coast, and large schools of them are often seen in the bays as well as outside along the coasts. They are very frequently observed playing in the cutwater of vessels sailing in the Gulf of Mexico. It is reported, however, that they have never yet been taken for commercial purposes.

THE OYSTER INDUSTRY.

EXTENT AND IMPORTANCE.

For many years oysters have been taken in nearly all the estuaries along the Texas coast. At low tide the wharf posts and pilings, the buoy stakes, and the reefs left bare by the receding water, are seen to be covered with small oysters. At times, particularly in the spring, when heavy freshets occur and fill the bays with fresh water, many of the oysters are destroyed; but this rarely happens to all the reefs in any one bay during the same year, and within two or three years they are usually as plentiful as before the occasion of such a disaster.

Until quite recently the taking of oysters was carried on in a very irregular manner, but with the increase in transportation facilities and the influx of capital along the coast the industry is rapidly developing into respectable proportions.

In 1880 only 95,625 bushels of oysters were taken from all the bays in the State. In 1890 the catch amounted to 440,800 bushels, which were sold by the fishermen for $127,990; 369 men were steadily engaged in tonging, and over 100 more in transporting and marketing the catch; 189 sailboats valued at $66,250, 1 steamer valued at $15,000, and other apparatus to the value of $5,451, were constantly used in this industry. A number of general freighting boats were also employed in transporting the catch for a short while during the busy season. The number of oystermen reported in 1880 was 200, and the value of all sailboats, skiffs, tongs, etc., was $17,750.

The oysters found on the Texas coast are the same species as those occurring along the shores of the Middle States, differing only as the oysters of one bay may from those of another in the immediate locality. The oysters of the several bays of Texas differ as much from each other as from those on the Atlantic coast. In general the shells, while not like those of the "coon oysters" of some of the Southern States, are rather long and of very irregular formation. In many places the growth of oysters on a bed is several feet deep, forming ridges rising above the surrounding grounds. In such places, as well as on the muddy bottoms, they have a tendency to grow in clusters, often large enough to fill a bushel basket; this results in great irregularity in the contour of the shell. On account of this and the rank growth of the shell, caused by the abundance of lime brought down by the rivers, the yield of "solid meats" to the bushel is not as great as the average yield of the same grade of oysters on the Atlantic coast. A "barrel" of Texas oysters "opens out" on an average not over 6 quarts, while in the Middle States the same quantity would contain from 8 to 10 quarts of meats. The growth of the oysters is quite rapid, it requiring only about 550 "2½-year olds" to fill a 3-bushel barrel. In the Chesapeake region it requires fully 750 oysters of that age to equal this measurement. Some of the Texas oysters are so large that less than 100 fill a 3-bushel barrel; these are found chiefly in the muddy sections of Matagorda and Mesquit bays.

The quality of Texas oysters compares favorably with that of those found on the Atlantic coast. They are quite similar to the "Western Shores" of the Chesapeake Bay, or those obtained from the "Kettle Bottoms" in the Potomac River. In the spring, on account of the large quantities of fresh water that fill the bays, the oysters are frequently rather fresh, but they are nearly always fat. Except from November to March, the oysters in Texas spawn to a limited extent at all periods in the year, but more particularly during the first half of May.

These oysters are quite free from a number of enemies and adverse agencies common on the middle Atlantic coast. Starfish are not known in Texas, drills are not abundant, and an excellent set of oysters is secured nearly every year. But the Texas oyster industry has its own troubles, the greatest being the destruction caused by heavy freshets in the spring. All the rivers and estuaries of Texas, except the Rio Grande and Brazos, empty their waters into the bays along the coast, and every spring more or less damage is done to the oysters by the fresh water with which some of the bays are filled for several days if the wind be favorable for such a condition. Happily, however, it rarely occurs that the oysters on all the beds in any one bay are destroyed in this manner.

Another trouble which exists here to a considerable extent is the damage done by the drumfish. These are very numerous in all the bays along this coast, and they do much injury, especially where oysters have been taken from the reefs and bedded to await a more favorable market. Occasionally an oysterman builds a picket fence around his bedded oysters to prevent damage from this source, but this practice is not general.

OYSTER BEDS, LOCATION, AREA, ETC.

In all the bays and at the mouths of the rivers along the coast where the water is of suitable density more or less area of oyster reefs may be found. On account of the earlier settlement and the larger population in that vicinity, the reefs in Galveston Bay have been longer known and more extensively fished on than those of any other section. Matagorda Bay undoubtedly has at present the finest supply of oysters on the Texas coast, although the area of natural beds in that bay known to the fishermen is not so great as in Galveston Bay; but owing to poor shipping facilities, the Matagorda grounds are not so extensively fished on as those in other bays. Corpus Christi has recently acquired considerable prominence, and a greater development of the oyster resources of that locality is probable. The inland water route connecting the chain of bays from Matagorda to Corpus Christi will naturally unite the oyster business of the towns on the shores, enabling each market at all times to obtain a supply from any one of these bays.

The bottoms of the Texas bays may be classified generally as shifting sand, muddy, grassy, and hard. The shifting sand offers no support whatever to the oysters, and permits them to sink and be covered; hence none are found on bottoms of this nature. The muddy ground is much better for their growth, and wherever oysters can gain "a footing" on such bottoms they will live and thrive, provided the density of the water be favorable. An excellent example of this is found in the extreme eastern arm of Matagorda Bay and in some parts of Mesquit Bay. However, these grounds are subject to an occasional deposit of mud, which may cover up and destroy the oysters. But where they are able to live, it will be found all along the coast that oysters on muddy bottoms attain a much larger and more rapid growth than those resting on other grounds, and the flavor is generally considered equally fine. But few oysters will be found on sea bottoms abundantly covered with vegetable life, because the grass, etc., covers up and smothers them even more effectually than the mud. Hard grounds form the natural resting-places for oysters, and wherever the water is suitable and the sea bottom is of this nature a generous supply of these mollusks will almost certainly be found.

After inspecting a large part of the oyster reefs and making careful inquiry of the best-informed fishermen, I estimate the area of the sea bottom in this State that has produced oysters during the last ten years as follows:

Localities.	Total area.	Area of oyster-grounds.
	Sq. miles.	*Sq. miles.*
Sabine Lake	94	1
Galveston Bay	565	50
Matagorda Bay	440	45
Espiritu Santo Bay	61	6
San Antonio Bay	129	1
Mesquit Bay	23	3
Aransas Bay	163	15
Corpus Christi Bay	185	13
Laguna Madre	811	3
	2,471	137

It is believed that this area of 87,680 acres represents as nearly the extent of ground in Texas on which oysters have been found as can be obtained without an actual survey of all the reefs in the State.

It is interesting to note in this connection that an official report of the State of Maryland, the greatest oyster-producing region in the world, estimates the area of the natural oyster-grounds of that State, excepting those of the Potomac River, to be about 123,520 acres. The area of the natural oyster beds of Connecticut has by actual survey been determined to be 19,911 acres. The U. S. Fish Commission surveys made in 1891 show 773 acres now producing oysters in South Carolina. In 1888 the U. S. Coast and Geodetic Survey determined the area of natural oyster beds in North Carolina to be 8,237.9 acres, and in Georgia in 1890 to be 1,756.8 acres.

Many of the well-known natural oyster reefs in Texas have not been fished on for several years, and some have never been extensively resorted to, because other grounds are more conveniently situated from which the oystermen have been able to obtain a supply; and it is highly probable that there are large areas of oyster reefs within the bays along this coast of which the fishermen have no knowledge. No search for them has been made; the finding of the beds is in most instances caused by the centerboard of a boat grating on the oysters when the boat is sailing over the bed. The average length of the shafts used in the tongs is only 10 feet, and the fishermen do not ordinarily attempt to obtain oysters at a greater depth than 8 feet; consequently they know little of the animal life on deeper grounds.

VESSELS, APPARATUS, METHODS, ETC.

Making use of a local expression, when "grubbing oysters," or in other words when fishing for oysters, the outfit usually employed consists of one sailboat, one or two skiffs, a pair of tongs for each fisherman, several baskets, one or two small hammers for separating the clusters of oysters or culling, and the necessary outfit for cooking and living on board of the sailboats. The sailboats and skiffs employed do not differ from those in general use along the coast; only four of them measure over 5 tons, the total measurement of these four being 40.01 tons.

The oysters are taken either by means of tongs or are picked up by hand from such reefs as are exposed at low tide. During the season of 1890–91 one schooner, the *C. Highland*, used dredges experimentally for taking oysters at Corpus Christi. Dredges have not been employed in the other bays along the coast on account of the unevenness of the reefs and a lack of knowledge of the methods of handling these implements.

On April 11, 1891, a law was enacted prohibiting the use of any form of oyster dredge in the waters of this State. It is possible that the effect of this enactment may be injurious rather than beneficial. Dredges could undoubtedly be used with excellent results in many places, not only where the water is so deep that tongs are not available, but also where the oysters grow in ridges, which by action of the dredge are torn down and spread over a greater surface, thus furnishing a larger area for growth. An excellent example of this is found in the Choptank River, on the eastern shore of Maryland. In this river, prior to 1874, oysters were taken only by means of tongs. Since that time the use of small dredges in a large portion of that river has been permitted. By their action the reefs have been spread so as to cover the greater part of the river bottom, and the catch of oysters has been many times multiplied. If the taking of small oysters be properly regulated, the only manner in which dredges destroy a reef is by removing so many oysters that the reef is made lower than the surrounding mud and is covered thereby. But this "sinking" of a reef may be caused also by the use of tongs; and for every oyster reef on the Atlantic coast that has been sunk by the use of dredges, grounds of much greater area have been made productive by the same apparatus.

The tongs used by the oystermen cost about $6.50 per pair. The shafts are ordinarily from 8 to 10 feet in length, and the rakes have from 12 to 18 teeth on each side. Usually when taking oysters the sailboats are anchored over the beds and the tongs are used from the decks; but where reefs are exposed at low tide the oysters are picked up by hand and placed in the skiffs, which are dragged up on the reefs.

Generally the oysters are culled on the beds as they are being tonged, but at times this is done while the boat is running to market. Occasionally, particularly in Galveston Bay, oysters are tonged during a dull season and bedded in some suitable place to await a better market, the right of the owner to these being usually respected by his neighbors.

Prior to 1879 no restrictions were placed on this industry, but on March 8 of that year a law was enacted prohibiting the taking of oysters "from the 1st of May to the 1st of September in any year." On April 2, 1887, the "close time" was made "from the 1st of May to the 25th of August." On April 11, 1891, this act was repealed and the prohibited time reëstablished as it was prior to 1887, "from the 1st day of May to the 1st day of September." Since 1887 there has been a law forbidding the taking of oysters in this State "less than 1½ inches in length net," but this law is not generally observed.

No license is required and the State receives no direct revenue from this industry, and is at no especial expense to support or protect it.

There are from two to four oystermen on each sailboat. The members of a crew fish on shares, and the boat and apparatus count as one man both in estimating expenses and profits. The captain does not receive a greater share of the profits than any member of his crew. The average annual income of the oystermen of this coast is about $230.

Table showing the apparatus employed in the oyster industry in 1890.

Localities.	Sailboats.		Skiffs.		Tongs.		Total value.
	No.	Value.	No.	Value.	No.	Value.	
Galveston Bay	127	$42,900	210	$2,140	240	$1,600	$46,640
Matagorda Bay	35	12,400	45	380	84	546	13,326
Aransas Bay	11	4,400	17	170	29	175	4,745
Corpus Christi Bay	13	6,100	13	130	40	260	6,490
Laguna Madre	3	450	3	25	4	25	500
Total	189	66,250	288	2,845	397	2,606	71,701

Table of products of the oyster industry for 1887, 1888, 1889, and 1890.

Localities.	1887.		1888.		1889.		1890.	
	Bushels.	Value.	Bushels.	Value.	Bushels.	Value.	Bushels.	Value.
Galveston Bay	150,049	$57,425	223,825	$78,983	210,000	$70,400	235,300	$72,140
Matagorda Bay	46,000	16,900	53,700	15,450	66,000	19,800	109,350	29,200
Aransas Bay	20,400	4,100	21,000	4,250	26,400	6,600	26,550	6,600
Corpus Christi Bay	36,000	8,400	39,000	9,500	54,000	12,900	65,400	18,350
Laguna Madre	3,750	1,450	3,750	1,450	4,200	1,700	4,200	1,700
Total	256,199	88,275	341,275	109,633	360,600	111,400	440,800	127,990

THE CULTIVATION OF OYSTERS.

With the present abundance and the low prices of oysters in Texas, the necessity and facilities for their cultivation are not fully appreciated. On account of the regularity with which a "set" is obtained on the natural beds every year, there is not that urgent necessity for a system of private oyster-culture that exists in some of the Middle States. However, the policy of increasing the supply of oysters by permitting and encouraging the private ownership of suitable grounds for their growth is very properly being considered. Not only the members of the State legislature but the oystermen have advanced ideas on this subject.

The first oyster law operative in this State was enacted on March 8, 1879, with the following title: "An act for the preservation of oysters and oyster beds, and for protecting the rights of persons to the same, and affixing penalties." This bill provided for public and private grounds. All natural oyster beds in navigable waters were made public. All grounds, whether with or without oysters, in waters not navigable were made the exclusive property of the owners of the adjoining shores; and riparian owners were given control of all within 100 yards of low-water mark. Of the remaining grounds every person was given the right to preëmpt without revenue to the State an area not exceeding 200 yards square (8¼ acres), and no provision was made for return of the ground to the State. The taking of oysters from such preëmpted grounds or other private areas without permission of the owner was made a theft, punishable in accordance with the prevailing law for such crimes.

To persons acquainted with the jealousy with which the States bordering the Atlantic coast preserve their waters suitable for oyster-culture this may seem a very generous policy; but it is on a par with the same liberal spirit which this State has maintained for the settlement of her idle agricultural lands, which has resulted in such great prosperity. While one or two provisions of this law do not seem to be the best possible, the substance of the enactment is excellent; and had it continued operative, with an additional provision for systematic surveys and the return of the preëmpted ground to the State if not used after a certain term of years for the purposes proposed in the act, it would have provided for a steady and satisfactory growth of oyster cultivation. But as the natural beds continued to produce an abundant supply of oysters, few persons took advantage of the liberal provisions of this enactment, although it continued operative until 1887.

In the meantime much information was made public concerning what had been accomplished in oyster-culture in some of the Atlantic coast States, particularly in New York, Connecticut, and Rhode Island; and these reports, together with local factors, were influential in persuading the legislature in 1887 to pass another oyster bill, the provisions of which required the preëmptor to be an "actual bona-fide citizen" of the

State, and permitted him to take for his own use an area not exceeding 538 yards square (nearly 60 acres) and to hold the same for a period of twelve years. It also provided that no preëmption should be permitted "nearer than the extreme low-water mark in front of the shore or water-front of another" without the consent of the owner of such water-front. Within a short time after the passage of this bill many acres of oyster-grounds were preëmpted, and within four years papers had been filed for about 30,000 acres of ground situated in Galveston, Matagorda, Espiritu Santo, Aransas, and Corpus Christi bays.

No mention was made in the act of 1887 as to whether the preëmpted area may not be natural oyster-ground; neither did this enactment expressly repeal the act of 1879, though it seems to embrace much of the subject-matter of that act. Hence the doubt existed as to whether this last enactment permitted the preëmption of natural oyster beds. Many persons thinking that it did permit such preëmption spent time and money in obtaining bottoms of that description, as well as unproductive ground; these were chiefly persons interested in the marketing of oysters. Another class of men, mainly oystermen, while contending that the provisions of the act of 1879 prohibiting the preëmption of natural oyster-grounds was still operative, yet fearing that the courts might decide contrary to their ideas, took up such areas for their own protection. A third class contented themselves with taking up grounds on which oysters do not ordinarily grow, these being obtained partly for planting oysters, partly for speculative purposes, and some (particularly where the preëmptor owned the adjoining water-front) merely to keep out other persons.

This very unsatisfactory order of things existed when the State legislature met in the spring of 1891, and an attempt was made at that session to enact a satisfactory law, and the "oyster question" became of some prominence in Texas. This resulted in the enactment of the law at present in force, which provides for the preservation to the public of all the natural reefs and permits the preëmption by each bona-fide citizen for fifteen years of an area not exceeding 538 yards square (59.8 acres), not productive of oysters at the time of preëmption; the notice of preëmption to be filed for record with the clerk of the county in which the grounds may be situated, and its location to be designated among other things by "four buoys anchored or four stakes firmly and permanently planted, one at each corner of such location. * * * Said stakes shall project at least 4 feet above ordinary tides, and shall be not less than 6 inches in diameter if of wood or 3 inches in diameter if of iron."*

No ground has yet been obtained under this law; all the areas now held by individuals or corporations having been preëmpted under the

*It seems that this would materially interfere with navigation and serious objections would be made to permitting stakes 6 inches square to be "firmly and permanently planted" in navigable waters.

unsatisfactory enactment of 1887. The natural oyster beds preëmpted are fished on by the public without molestation; and of the remaining portion of the ground but a small area has ever been cultivated.

The most elaborate attempts at cultivation have been made in Galveston Bay. In 1889 and 1890 one oyster company secured several thousand acres of sea-bottom located partly in Galveston Bay and partly in Matagorda Bay. During the last week of April in 1890 about 6,000 bushels of oyster shells were planted for the purpose of obtaining a "set" on a part of the grounds in Galveston Bay. This is reported as being the first attempt of the kind made on the Texas coast. On May 10, of the same year, the shells were examined and found to have caught an abundant quantity of "spat." On August 2 following the young oysters were reported to be one inch and over in length. At the time of my visit, in January of 1891, it was found that they had lived well and would then "run" about 1,500 to the barrel.

In the winter of 1890–91 about 20,000 bushels of oyster shells were planted, but with what success is not yet learned. The private grounds in Galveston Bay are also used for planting the small or "cull" oysters obtained from the natural beds, about 45,000 bushels having been planted there in 1890. That was the first year in which this was done on so extensive a scale.

On the whole the cultivation of oysters in Texas waters gives every assurance of success. While the area of natural oyster beds is comparatively large, yet these reefs do not seem to possess as much recuperative power as the majority of beds on the coast of the Middle Atlantic States, and will more readily suffer from extensive fishing. The destructive spring freshets will also probably hasten the cultivation of oysters, by causing the fishermen to remove the young oysters from exposed places and to plant them in sheltered localities.

MARKETING OF FISHERY PRODUCTS.

At nearly all the fishing ports in Texas a number of men give their attention to the wholesale marketing of the products taken by the fishermen. These men have market houses (ranging in value from $500 to $10,000) located on the shores of the bays, from which piers 100 to 400 feet in length usually run out into the water. The products handled in these markets consist almost entirely of oysters and the catch made by the bay-seine fishermen, with at times a few flounders, catfish, turtle, and terrapins. The products of the other fisheries mostly find their way into local consumption without going through the wholesale markets.

Each marketman usually has a verbal agreement with a number of fishermen for the purchase of their catch at a price fixed for the season. He endeavors to so arrange the fleet that a certain number of boats may land their catch on each shipping day. When the fish are accepted by the dealer, the fishermen transfer them from the "live cars" to the market-houses. While doing so the "poor fish," that may have been put in the cars while the seine was being emptied, are thrown away, and the "bulls" are placed to one side. The remaining fish are then weighed and turned over to the marketman at prices varying from 3 to 5 cents per pound, according to the locality and the season. For the "bulls" the marketmen generally give from 20 to 35 cents each, without regard to the weight.

All the fish are sent from the market-houses while fresh. In preparing for shipment, they are either dressed or left "round," to suit the demands of the customer. They are packed in boxes and barrels, and usually with two layers of fish and one layer of ice alternating, the fish being placed backs to backs and bellies to the ice. The prices received by the marketmen for the fish range from 5½ to 8 cents per pound, round weight. They are shipped mostly by express, and are marketed throughout Texas, Mexico, New Mexico, Colorado, Kansas, etc.

Nearly all the marketing is done on a C. O. D. basis, but few open accounts being kept. For expressage the transportation companies charge a fixed rate on the net weight of the fish, and add 25 per cent to that amount for the weight of the box and ice. They also re-ice the fish en route, when necessary, without extra charge.

Oysters are marketed in much the same manner and by the same houses that handle the fish taken by the bay seines. They are sold by the fishermen direct to the wholesale dealers. The price received for the oysters varies, according to the locality, from 50 cents to $1.25 per barrel, which is the unit of measure. There is no very active competition in the business, and but little variation exists in prices throughout the season. Those sold at 50 cents per barrel are not closely culled. At Galveston, Corpus Christi, and Point Isabel the highest prices rule, while the lowest prices prevail in Matagorda Bay. On the reefs in the last-named bay as fine culled oysters as were to be found on the Gulf coast were sold in the season of 1890–91 at 60 cents per barrel; 90 cents is about the average price received by the fishermen throughout the State. In 1890–91 this average price was somewhat less on account of a large quantity of small and unculled oysters being sold for planting on the preëmpted grounds around Galveston.

On account of the cost of transportation but few oysters are shipped from the coast in the shell, and prior to 1891 nothing had been done in the way of canning steamed oysters. The shucking is done by men and boys, who receive 25 cents per gallon, or in some places $1.25 per 1,000, and at other marketing centers they are paid for the time employed. Some of the shuckers come every season from the Atlantic coast to engage in this work. The shucked oysters are shipped in pails holding from 1 to 10 gallons, and in hermetically sealed tin cans containing from 25 to 200 in number. They are sent to all parts of the country west of the Mississippi River, Kansas, Colorado, and Texas receiving the larger part. The trade is rapidly increasing, and the Texas oysters are successfully competing in those States with the product from the Atlantic coast.

The following table exhibits the number of men and the amount of capital employed in the wholesale marketing houses in 1890:

Localities.	No. of houses.	Men employed.	Value of houses.	Cash capital.
Galveston	5	85	$63,500	$30,000
Port Lavaca	2	8	1,000	1,500
Aransas Pass	2	31	18,000	5,000
Corpus Christi	2	25	17,500	12,000
Point Isabel	1	2	500	....
Total	12	151	100,500	48,500

Prior to 1891, the only permanent establishment for canning or otherwise preserving fishery products, was a turtle cannery at Fulton, on the shore of Aransas Bay. About 1879, a factory for canning shrimps was erected at Galveston Bay, and operated for one or two years. While the beef-packeries were in operation at Aransas Bay some green turtle were canned there; and in 1880 a small factory for canning fish was erected at Rockport, now called Aransas Pass, but it was in operation only a short time. In the spring of 1891 factories for canning oysters were established at Galveston and Corpus Christi.

The difficulty in disposing of an oversupply of fish, even at a reduced price, at present militates against the successful prosecution of the fisheries of this coast. As yet, no one in the State makes a business of salting fish. The general opinion along the coast is that on account of the climate it is impracticable to salt the fish so that they will keep for a reasonable length of time. But for many years trout, redfish, sheepshead, mullet, etc., have been successfully preserved in this manner in Florida; indeed, some of the fishing communities of that State depend for support almost entirely on the sale of their salt fish; and it seems that equal care would insure success on the Texas coast.

The drying of fish after the manner practiced in the Barataria region of Louisiana might be resorted to with some success along portions of this coast.

While some of the fish markets have ice manufactories connected with them, by means of which the fish are kept for a few days, yet preserving fish in cold storage for many weeks, as is done particularly along the shores of the Great Lakes, has never been attempted in Texas nor in any of the other States bordering on the Gulf of Mexico. It is a question whether, with the present ruling prices, it will pay to add this feature to the marketing of the more plentiful species of fish occurring here, although it might be done with the higher-priced ones.

Another drawback to the prosperity of the fisheries is the difficulty experienced in marketing many of the varieties of fish taken, which consequently are thrown away as soon as caught. Among these might be mentioned mullet, drum, and other good edible fish which are taken in large quantities, but against which local prejudices exist.

PROTECTION AND CULTIVATION OF FISH.

As in the other States bordering the Gulf of Mexico, little attention has been given to the cultivation and preservation of fish in Texas, and this special branch of legislation seems to have been quite ignored in the State until 1879. On April 17 of that year a bill was enacted "for the preservation of fish and to build fishways and fish-ladders." This act required that all persons who six months after its passage might erect any milldams or other obstructions in the waters of the State should construct fish-ladders and keep them in repair so that at all seasons of the year the fish might ascend above such obstructions to deposit their spawn. Further provision was made in this act for the appointment by the governor of a fish commissioner to serve without compensation, who should see that all individuals and corporations constructed and kept in repair such suitable fishways. As no appropriation went with this enactment, either to encourage fish-culture or to compensate the commissioner, little benefit could be expected.

During the next session of the legislature, which occurred in 1881, another enactment was made providing a salary for the commissioner and appropriating $5,000 annually for the following two years, to be expended in the cultivation and distribution of fish in the rivers and ponds of the State. The amount appropriated for this purpose for the two years following the session of the legislature in 1883 was $10,400.

By act of March 20, 1885, the office of State fish commissioner was abolished, and an appropriation was made during the same session for winding up the affairs of his office. Since that time the State government has made no special effort to stock the waters with fish.

Shortly prior to and during the few years following the enactment of 1881 numbers of young shad, salmon, rainbow trout, carp, etc., were planted, chiefly for experimental purposes, in Texas waters by the U. S. Fish Commission. The shad were placed mostly in the Sabine, Colorado, Brazos, San Antonio, and Trinity rivers. But few instances have been reported of the return of any of the shad here planted. The few California salmon deposited seem to have entirely disappeared. The rainbow trout are reported as having done well. The carp-planting has been a complete success; the rivers, being mainly sluggish and muddy, seem to be fully adapted to this fish.

In the spring of 1890, 745 lobsters, from 7 to 10 inches long, were sent to Galveston by the U. S. Fish Commission to be planted in the Gulf near that city; while it is reported that two or three of these have since been obtained, the experiment can not be considered a success.

The stocking of the streams in Texas with fish is a subject of much importance, of which fact the General Government has recently shown its appreciation by providing for the establishment of a hatchery in the interior of the State. With much of her territory far removed from salt water, and with a length of river course probably greater than that of any other State in the Union, superior inducements are offered for the cultivation of fresh-water fish.

GEOGRAPHICAL REVIEW OF THE FISHERIES.

GENERAL DESCRIPTION OF THE COAST.

The length of the Texas coast line, following its sinuosities, is about 2,000 miles, but in a direct line it is a trifle less than 400 miles. The mainland is for the most part bordered by a chain of low sandy islands and peninsulas, each having the same general trend as the coast, the most important of which are: Bolivar Peninsula, Galveston Island, Matagorda Peninsula, Matagorda Islands, St. Joseph Island, Mustang Island, and Padre Island. On nearly all of these there are a few scattering houses, the homes of men employed in fishing, cattle-raising the Life-Saving Service, etc. There are no important settlements, however, on any of them except Galveston Island, on which the city of Galveston is located.

Between the mainland and the outlying chain of islands and peninsulas are situated a number of bays, viz, Galveston, Matagorda, Espiritu Santo, San Antonio, Mesquit, Aransas, Corpus Christi, and Laguna Madre; also Sabine Lake, in the extreme eastern part of the State; this, however, is an extension of the Sabine River, rather than a bay. The combined area of these bays with their estuaries is 2,471 square miles. In nearly every instance the outlets of the bays are situated at the extreme southwest end.

From Matagorda Bay through Espiritu Santo, San Antonio, Mesquit, and Aransas Bays to Corpus Christi Bay, a distance of 130 miles, there is an inside route permitting the passage of vessels drawing 3 feet of water and connecting advantageously the industries of these six bays. The remaining bays, Galveston Bay, Laguna Madre, and Sabine Lake are isolated and without inland water routes.

SABINE LAKE.

The easternmost fishing locality in Texas is Sabine Lake, which forms a part of the boundary line between this State and Louisiana. This lake is merely an expansion of the Sabine River just before its entrance into the Gulf of Mexico. Its southernmost end is about 4 miles from the Gulf, with which it is connected by a channel known as Sabine Pass. The length of the lake is 19 miles, its greatest width about 9 miles, and the area is 94 square miles.

Sabine River is about 400 miles long and forms about 200 miles of the boundary line between Louisiana and Texas. Three miles below the mouth of the Sabine River the Neches empties into Sabine Lake. The length of this river is about 270 miles. Both of these rivers drain a large area of territory. Hence the water of Sabine Lake is comparatively sweet, especially during the spring freshets.

Little attention is given to fishing, not more than a sufficient supply for local consumption being taken. Seines, cast nets, trot lines, and hand lines are used to a limited extent. Fourteen men depend on the fisheries for a living, and twenty others engage in them at times. The catch of fish in 1890 amounted to 71,700 pounds, for which the fishermen received $4,038.

On Taylor Bayou and at Keath Lake Gully are located two companies of seine fishermen, each company using one small sailboat of about 3 tons. During the winter the catch consists mostly of catfish, buffalo or suckers, and fresh-water drum. In the summer, when the water in the lake is not so fresh, the most abundant species taken are redfish, trout, and sheepshead. The bay-seine fishermen are reported as taking in their seines about 100 dozen terrapins annually.

In the winter and during the spring freshets half a dozen men living at the head of the lake fish for catfish with trot lines. From 150 to 500 hooks (about 4 feet apart) are attached to each line. The length of the snoods is about 18 inches and the cost of such lines ranges from $3 to $10. About 12,000 pounds of fish are annually taken in this manner. The average weight of the catfish is about 20 pounds, while some attain a weight of 75 pounds. The number of trot lines in use at present is not so great as it was seven or eight years ago, but there were no seines used here at that time.

A few cast nets and hand lines are at times used by men living on the shores of Sabine Lake, the catch being only sufficient for home consumption. The quantity taken annually by means of hand lines is about 10,000 pounds; the catch by cast nets is much less, amounting probably to about 3,000 pounds.

On account of the slight density of the water no oysters are found here, except occasionally in the lower end of the lake. In 1887 some were found which were almost large enough for market, but they were destroyed by the freshets in the spring of 1888. The reefs on which these oysters appear are at the extreme southern end of the lake and directly in the "pass." They cover an area of from 2 to 3 miles long and about three-quarters of a mile wide, the length running north and south.

GALVESTON BAY.

Leaving Sabine Lake and going southwestwardly along the coast there are no fishing localities until Galveston Bay is reached, a distance of about 60 miles. Between Sabine Lake and Galveston Bay the coast is entirely without harbors, and is uninhabited except by ranchmen.

Galveston Bay is the second largest in area and commercially the most important of the bays on the Texas coast. It lies between the mainland and Galveston Island and Bolivar Peninsula. East Bay, Trinity Bay, and West Bay are tributary to Galveston Bay. Much of the waters of West Bay, however, find an outlet into the Gulf of Mexico through San Luis Pass. East Bay lies between Bolivar Peninsula and the mainland It is 15 miles long and varies in width from 1 to 7 miles. The average depth of water in this tributary is from 5 to 7 feet. Trinity Bay lies north of Galveston Bay, and into this tributary the Trinity, San Jacinto, and smaller rivers empty. On account of its distance from the sea and the number of rivers emptying into it, the waters of Trinity Bay are quite fresh. The average depth of water in this tributary is between 9 and 11 feet. West Bay separates Galveston Island from the mainland, and is about 2½ miles in breadth and 23 miles in length. It is very shallow, being at no point more than 7 or 8 feet in depth and in some places is forded by cattle. Oyster Bay, sometimes called Christmas Bay, is a tributary of West Bay, and most of its waters find outlet through San Luis Pass. The area of Galveston Bay and its tributaries is estimated at 565 square miles, Laguna Madre with an area approximating 811 square miles being the only larger body of water in Texas.

The abundance of fish in Galveston Bay seems to have somewhat decreased during the past several years, and the crews seining here catch on an average a less quantity per seine than those in the other important fishing sections along the coast. Although quantities of fish are shipped into the interior from Galveston Bay, yet at times the catch is not sufficient to supply the local demand, and large consignments are received from other fishing ports. The great bulk of the catch is sold at Galveston City, but occasionally some of the boats run up Buffalo Bayou and dispose of their catch at Houston, while a few fish are sold at Wallisville, Harrisburg, and other villages on the shores of Galveston Bay. More of the so-called "cheap fish" are saved by Galveston Bay fishermen than elsewhere along this coast. This is due to the larger local demand among poor people.

The total number of professional fishermen living around Galveston Bay and its tributaries in 1890 was 440. Of these, 284 lived on the island of Galveston, 52 on Bolivar Peninsula, 48 at Buffalo Bayou and Oyster or Christmas Bay, and some on the mainland between Virginia Point and Chocolate Bayou. All of these men depended on oystering and fishing for a living, except those on Bolivar Peninsula and on the middle and western part of Galveston Island, who gave attention to truck farming as well as to the products of the bay. Besides these regular fishermen, about 150 men engage at times in fishing with cast nets, crab pots, etc., and 96 men were constantly employed in transporting and marketing the fishery products.

The fisheries prosecuted.—The bay-seine fishery and the oyster industry are the two principal fisheries prosecuted in this locality, and the persons engaging in one of these do not as a rule engage in the other. Several minor fisheries are also carried on, as the surf-seine the shrimp, flounder, crab, and cast-net fisheries, and the line fishery for red snappers and other fish.

The bay-seine fishery.—In 1890 there were 165 men employed in the bay-seine fishery. They used 60 seines valued at $7,550, 58 sail craft worth $19,690, and skiffs and life cars to the value of $3,150. The catch amounted to 1,418,500 pounds, for which the fishermen received $72,999. Of the sail craft, only two measured over 5 tons, the combined tonnage of these being 12.93 tons.

The wagon or surf-seine fishery.—In 1890 twelve "wagon" or surf seines were owned and fished here chiefly by the truck farmers, who sold their produce in Galveston. No boats are used in this fishery, and the catch is hauled to market in wagons; hence the name for this fishery. The surf seines are made nearly similar to the bay seines; the chief difference is that they are not quite so long, being only 50 to 60 fathoms in length. The depth is from 4½ to 6 feet, and the value is about $80 each. They are hauled in the surf on the south side of the island, and two men are required to each seine. The catch, which amounts to about 40,000 pounds in each year, consists principally of sand trout (*Cynoscion nothus*), croakers, and large redfish, with a much smaller quantity of many other species. As these species are found in greater abundance in the bays, this fishery has not become very important. The fishermen, or in many instances their wives, take the catch to Galveston, where they sell it from house to house about the city. On account of the manner in which they are disposed of, these fish usually return to the fishermen a higher price per pound than those taken by the bay seines. Galveston Island is the only place in Texas at which these seines were found in use.

Spearing of flounders.—Flounders are taken from the waters of Galveston Bay at night by the method known as "jacking," which is practiced all along the Atlantic coast. No one depends on this fishery, and it is prosecuted only during the summer months. About 30 men around Galveston Bay engage in it at times. The men go out in the shallow water "afoot," carrying a torch in one hand and a spear in the other. When a flounder is discovered it is picked up by means of the spear and placed in the bag or basket carried on the arm holding the torch. The quantity of flounders taken annually in this manner in Galveston Bay is about 25,000 pounds, and the price received by the fishermen is about 6 cents per pound. There is always a good demand in the markets for these fish.

The cast-net fishery.—About ninety-five cast nets are operated by as many persons from the docks, etc., around Galveston. These nets are worth on an average about $3.75 each, the value ranging from $2 to $8, according to the size, which varies from 4 to 10 feet in diameter. The nets are used only at odd times by the wharf laborers and other persons when work is slack. The catch amounts to about 28,000 pounds annually and consists chiefly of mullet, with a small quantity of other fish and some shrimp. When not consumed at home the fish are generally peddled about the city by the fishermen, who receive on an average about 6 cents per pound for them.

The hook-and-line fisheries.—Aside from the red-snapper fishery, but few fish are taken by hooks and lines in the vicinity of Galveston, and these mainly by sportsmen and wharf-idlers, the latter usually fishing off the docks with short lines. Occasionally some fish are taken in the surf on the south side of Galveston Island by means of long hand lines. The method employed is common on the Atlantic coast from New Jersey to Florida for taking many varieties of fish. The line is several hundred feet in length, and has a hook and weight at one end. The other end is fastened to a peg driven in the sand near the water's edge, or to one arm of the person using it. After coiling the line on his arm the fisherman goes back a hundred feet or more from the water. Then, running rapidly toward the surf and swinging the weighted hook around his head, he throws it far out into the water. Immediately the line is drawn in, either hand over hand or by the fisherman running up the bank. The fish taken in this manner are usually much larger than the average of the same species taken in the seines. The most abundant are redfish, trout, and occasionally bluefish, the latter species being more numerous during the last three or four years. The quantity taken in this manner and from the bay is about 35,000 pounds annually.

It was formerly customary for a number of the harbor and freight boats around Galveston to make several fishing trips during the year to the red-snapper banks off Galveston Island. Ordinarily these trips were made during the dull season and were engaged in as much for pleasure as for profit. Some of the boats, however, made quite a business of it. In this way, during certain years, as much as 200,000 pounds of red snappers were brought to Galveston. This fishery began about 1881 and reached a maximum in 1885. The schooner *Edna C.*, tonnage 23.06, was one of the best boats engaged in this fishery, but during a storm on September 18, 1885, while on a trip to the banks, this vessel was lost with all on board. Since then few boats have engaged to any extent in taking red snappers. In each of the years 1887, 1888, and 1889 there were three regular freight vessels that made trips to the banks, while in 1890 there were only two such vessels. The crew usually consisted of five men to each vessel. The catch of 1889 was reported to be 22,000 pounds, while in 1890 it was only 4,800 pounds.

The oyster industry.—Galveston Bay has a greater area of natural oyster beds than any other bay in Texas, but the reefs are not so plentifully supplied with oysters as some others in the State. This is to some extent due to overfishing. In 1890 215 men living on the shores of Galveston Bay were engaged in oystering, using 127 sailboats valued at $42,900, and other apparatus valued at $3,740. The catch amounted to 235,300 bushels of oysters, for which the fishermen received $72,140. A small part of this catch was obtained from Matagorda Bay by Galveston oystermen who fished there for a few weeks. None of the sail craft employed in the oyster fishery of Galveston Bay measure over 5 tons.

The best grounds in Galveston Bay proper lie off Shoal and Dollar points on the western side of the bay, and off Stevenson and Smith points on the east side. The opening of the canal from Brazos River to West Bay is supposed to have had a beneficial effect on the oysters of that bay, as the fresh water constantly flowing in preserves an equality in the density of the water of that region.

It is estimated that there are about 50 square miles of natural oyster-grounds in Galveston Bay and its tributary bays. The quantity of oysters taken from this area varies greatly, depending largely upon the facilities for obtaining a supply from Matagorda Bay, Morgan City, and elsewhere. In 1890 about 50,000 bushels of unculled oysters were taken from the natural reefs for planting purposes, thus advancing the catch for that year slightly beyond its usual proportions.

The following table exhibits the quantity of oysters taken during each of the past four years by the oystermen of Galveston Bay:

Year.	Bushels.	Value.
1887	155,000	$60,050
1888	220,000	78,000
1889	210,000	70,400
1890	235,300	72,140

The shrimp fishery.—Ten to fifteen years ago many shrimp were found in Galveston Bay, and a factory was erected for the purpose of canning them. In 1880 this establishment prepared 75,000 1-pound cans of shrimp, but a great decrease in the quantity necessitated the closing of the factory a few years later, and at present only enough are obtained for daily supply in the local market. These shrimp are taken by seines similar to the ordinary bay seines, except the mesh is much smaller. There were ten of these seines in use in Galveston Bay in 1890. Their average value is about $75, and the services of two men are required for the operation of each one. One small sailboat worth about $80 is used by each "shrimping" crew. The fishery is prosecuted in much the same manner as the bay-seine fishery. According to reports, the catch during the past ten years has steadily decreased. In 1888 it was 15,000 buckets, in 1889 it was only 13,500, while in 1890 it was still further reduced to 9,200 buckets. They are sold fresh, the wholesale price ranging from 35 to 55 cents per bucket, about 15 pounds to the bucket. The average size of these shrimp is scarcely so great as of those taken in the Barataria region of Louisiana, or at Tampico in Mexico, at each of which places large quantities are obtained.

The crab fishery.—While the taking of crabs in Galveston Bay is scarcely considered an industry, yet from 25,000 to 30,000 dozen are annually caught in trap nets and by hand lines. About 75 crab traps, worth about $4 per dozen, are used, as well as a quantity of short, cheap hand lines. The crab traps are made in a rough manner by the persons who fish them; the ordinary form consists of a barrel hoop, to which is attached a net bag. Bait is tied in the center of the hoop, and the trap is lowered from the wharf, to which it is fastened by means of a small cord. A number of times daily it is visited, raised, and the catch removed. The crabs are fished for by the negroes and the poor people about the wharves, who for the time find nothing else to do. The catch is usually peddled around the city, the price received averaging about 15 cents per dozen.

Fish and oyster markets.—The only wholesale fish and oyster markets on the shores of Galveston Bay are located at the city of Galveston, where there were in 1890 five wholesale dealers who handled these products. Besides these there were at Galveston also many others who handled oysters to a limited extent, while nearly all of the groceries in the city, as well as many restaurants, received from one to ten barrels daily from the fishermen. The property occupied by the five wholesale houses in that year was valued at $63,500, and 85 men were given employment.

When taking their catch to market the greater number of the Galveston fishermen run their boats into "vegetable slip," where the catch is sold in open market either to the wholesale dealers or to the many retail grocers or restaurant keepers.

It is an interesting sight to see the fishermen together with the truck-farmers who take their produce to market in small sailboats, as they congregate at their respective places in the "slip" every morning while awaiting buyers for their wares. In this place at times there may be counted nearly a hundred sailboats, constituting a regular "mosquito fleet." The list of their produce for sale is almost endless. One may find here a load of oysters, there potatoes, in another boat cauliflower and pigs, chickens here and terrapins there, ducks and crabs, fish and milk.

For oysters the marketmen pay from 75 cents to $1.50 per barrel, the average in 1890 being about $1. The greater part of the oysters were handled by the Galveston Packing Company, which, in addition to those secured from this bay, obtained large supplies from Matagorda Bay. The oysters are sold by the marketmen in various quantities and conditions. The local demand usually requires oysters in the shell, while the inland trade is mostly for the opened oysters. When sold in the shell the unit of measure is the barrel, holding about 3 bushels; the opened oysters are sold by the number, although there is a growing tendency to sell by the gallon. The openers are generally paid at the rate of $1.25 per 1,000, but one house has begun, instead, to pay 25 cents per gallon of solid meats. As the oysters are opened they are separated into two grades, selects and standards. They are then placed with ice in tubs holding from 1 to 5 gallons, or in tin cans, the capacity of which ranges from 25 to 200 oysters. The tin cans are hermetically sealed and shipped in boxes containing ice. They are sent into the interior by express, and the trade, which is growing rapidly, extends throughout Texas, Kansas, Nebraska, Colorado, and other Western States, and even so far distant as Chicago.

For most of the fish the wholesale marketmen usually give 6 cents per pound in the winter, and during the summer months sometimes as low as 4 cents per pound, and even less. These prices are for round fish. When shipped inland they are packed in ice and sent by express. The pompano, Spanish mackerel, flounder, robalo (*Centropomus undecimalis*), and a few other choice varieties, are sold almost entirely for consumption in the city, and at fancy prices, often as much as 50 cents per pound being obtained for some of them. The marketing houses also handle shrimp, turtle, terrapins, etc., as they may be taken by the fishermen, which is always in limited quantities.

MATAGORDA BAY.

Leaving Galveston Bay and going westward along the coast, at the mouths of most of the estuaries there are a few oyster reefs, from which at times the people living at the scattering hamlets and plantations obtain a "mess" of oysters. At Oyster Creek, Brazos River, San Bernard River, and Caney Bayou a few fish are taken by means of lines; but no established commercial fishery is met with until Matagorda Bay is reached, the entrance to which (Pass Cavallo) is about 125 miles from Galveston City.

This bay is inclosed between Matagorda Peninsula and the mainland. Its only channel to the Gulf of Mexico is through Pass Cavallo, which affords uncertain passage for vessels drawing 9 feet of water. Matagorda Peninsula, which separates Matagorda Bay from the Gulf, is 50 miles long and varies in width from a few rods to 1½ miles. It is quite low and sandy, and is in many places subject to an occasional overflow, permitting the waters of the bay to unite with those of the Gulf of Mexico.

The Colorado, Navidad, Lavaca, and other rivers, all combined draining an area of over 50,000 square miles, empty their waters into Matagorda Bay. This would render the water in the bay quite fresh, were it not for the large channel at Pass Cavallo.

Matagorda Bay is about 53 miles long, and the width varies from 2 to 14 miles. With its tributaries, Lavaca, Carankaway, Trespalacios, and smaller bays, it covers an area approximating 440 square miles. The depth of water in the bay varies from a few inches to 14 feet. It averages from 10 to 12 feet, except in the eastern end of the bay, where the ordinary depth is from 4 to 8 feet. Under the influence of a strong southeast wind this bay becomes exceedingly rough, and during the last six years more fishing boats have been wrecked here than in all the remaining bays on the Texas coast.

The fisheries prosecuted.—The extent of the fisheries of Matagorda Bay has varied with the prosperity of the towns along its shores, and at no time has it been so great as the bay is capable of sustaining. The fish and oyster trade in 1884 and 1885 reached considerable proportions, but owing to the abandonment of the bay by the Morgan line of steamers in 1886 it very considerable decreased in the years following. In 1890 the fisheries of this bay gave steady employment to 109 men and supported 30 others for a few weeks. The property invested in the fisheries was valued at $18,196. The total weight of fishery products amounted to 893,200 pounds, for which the fishermen received $33,693. Of this amount $29,200 was obtained from the sale of oysters, the taking of which constitutes by far the most important fishery in the bay. The bay-seine fishery, although of little importance, ranks second in extent among the fisheries of Matagorda Bay. A few cast nets are used, and some hook-and-line fishing is done.

The bay-seine fishery.—Seventeen men sailing from Port Lavaca engaged in the bay-seine fishery in 1890. They used five sailboats, valued at $1,650, and seines, skiffs, and live-fish cars to the value of $610. The catch in that year amounted to 102,750 pounds, for which the fishermen received $3,593. In 1889 an equal force was employed in this fishery, and the catch amounted to 88,800 pounds, valued at $3,110. The fishing-grounds are situated in the shoal waters of Matagorda Bay and its estuaries, and in the eastern part of Espiritu Santo Bay. The catch is landed at Port Lavaca, from which place it is distributed throughout the State by the wholesale dealers. Every year several crews of seine fishermen from Galveston go to Matagorda Bay to fish, sending their catch home by the steamer *Cumberland*. The supply of fish is much greater than the present market demands, and the fishermen are frequently idle for several days at a time because the markets are overstocked.

Cast-net, hook-and-line, and other fisheries.—About thirty cast nets are used at times on the shores of Matagorda Bay by the regular seine and oyster fishermen and by other persons. The catch consists chiefly of mullet, shrimp, and a few trout (squeteague), and amounts to about 15,000 pounds annually, the usual price for which is 3 or 4 cents per pound. No commercial hook-and-line fishery has been established at Matagorda Bay, yet about 10,000 pounds of various species of fish are annually taken by sportsmen and others. These consist chiefly of redfish, trout, jewfish, etc., and the catch is almost entirely used for home consumption.

Quantities of green turtle are taken in Matagorda Bay by the Aransas Bay fishermen, but no one living in this section engages in fishing for them. Shrimp also are found, but except the few taken in the cast nets none are brought to the settlements.

The oyster industry.—The finest oyster reefs in Texas are located in Matagorda Bay. The total area of productive grounds in this bay at present known to the fishermen approximates 45 square miles. There are doubtless many beds which have not yet been discovered. The best-known oyster-grounds are Tiger Island reef, Trespalacios reef, Old Town grounds, and those in the extreme eastern section of the bay, which are sometimes known as the Live Oak grounds.

The oysters obtained from Tiger Island reef are probably not surpassed by any on the Texas coast, either in abundance, condition, or shipping qualities. This reef is located about 3 miles from the mouth of the Colorado River, and about 28 miles from Pass Cavallo, the outlet of the bay, and where the fresh water from the river mingles with the salt water of the bay. The depth of water on this reef ranges from 6 inches to 6 feet. Indeed, at times during the prevalence of a strong northeast wind some portions of the reef are uncovered with water for several days, and yet the oysters continue in excellent condition. The formation of the shell of the oysters on this reef is somewhat peculiar. It is rather smooth on the outside, is very hard, quite deep and massive, without sharp edges, and somewhat resembles the shell of the quahog or southern clam. This is doubtless largely due to the great quantity of lime in the water. Many of the counties in the valley of the Colorado River are noted for their liberal deposits of limestone, and great quantities of it are washed down the river and over these oyster-grounds.

The Trespalacios grounds are located about 15 miles W. by SW. from Tiger Island reef and just north of Half Moon reef. The oysters on these grounds differ in many respects from those of Tiger Island reef; they are longer, with rougher shells, and usually are not in so good condition. It is reported that several years ago the oysters on Trespalacios grounds "died out," on account of an overabundance of fresh water. After that time oysters were not fished for on these reefs until the spring of 1891, when a few were taken.

The Old Town grounds are located off Old Town, a short distance north of the former site of Indianola. Prior to 1875 very fine oysters were obtainable from these reefs, but they gradually disappeared and the location of the reefs was almost forgotten. During the winter of 1890–91 it was discovered that these beds were again productive and they were fished on at the time of my visit. These oysters resemble in appearance and flavor those obtained from the Trespalacios grounds.

In the muddy grounds east of the Tiger Island reef many clusters of very large oysters are found. These grounds are frequently called the Live Oak or East Matagorda grounds. They cover a large area, but the oysters are very much scattered. These oysters are finely flavored and very large, some of the individual meats weighing 4 ounces or more.

On account of the small demand and the poor marketing facilities, the oyster industry of Matagorda Bay has not reached a full development. The home market requires only a small quantity. The nearest shipping-point to the Tiger Island reef is Port Lavaca, over 40 miles distant, and the facilities offered at that point are limited.

The number of men living on the shores of Matagorda Bay and engaged in taking oysters in 1890 was reported to be 84. They used 35 sailboats valued at $12,400, and 45 skiffs which, with the tongs used, were valued at $926. The catch amounted to 109,350 bushels of oysters, for which the fishermen received $29,200.

The following table shows the catch of oysters during the past four years by the fishermen of this bay:

Year.	Bushels.	Value.
1887	48,000	$13,000
1888	53,700	15,450
1889	65,850	19,800
1890	109,350	29,200

Many oysters have also been obtained from this bay during each of the past four years by men hailing from Galveston, Aransas Pass, and Corpus Christi; but their catch has been included in the figures for the localities in which the oystermen lived.

Marketing houses.—The only wholesale fish and oyster markets on the shores of Matagorda Bay are the two located at Port Lavaca. Here 8 men are employed and the value of property occupied is about $1,000. The quantity of fishery products handled is quite small, and the marketing methods employed do not materially differ from those practiced at other points on the coast. As a site for an oyster cannery this bay is probably not surpassed by any on the coast of the Gulf of Mexico. The best oysters gathered there in 1890 were sold on the reefs at 60 cents per barrel to vessels making occasional trips, and if the oystermen could have disposed of their catch every night they would doubtless have been willing to accept 50 cents per barrel at the reefs. These oysters cost delivered at Corpus Christi and Galveston about $1 per barrel.

ESPIRITU SANTO BAY.

Espiritu Santo Bay, which lies southwest of Matagorda Bay, is 15 miles long and averages about 4 miles in width. Including its tributaries, Shoalwater Bay, Pringes Lake, etc., its limits extend over an area of about 61 square miles. It probably contains more islands than any other bay on the Texas coast. By means of two bayous it has outlet into Pass Cavallo, the outlet of Matagorda Bay. No rivers empty into Espiritu Santo Bay, but at its western end it receives the greater portion of the fresh water of San Antonio Bay, consequently the water here is quite fresh, and oysters occur only in very limited quantities, if at all. In the eastern half of the bay, where the water is not so fresh, the conditions are very favorable to oysters. The depth of water in this section is from 1 to 8 feet, and averages about 5 feet. In this shoal water ordinarily the ground is not muddy and appears to be quite free from shifting sand. The area of the oyster reefs is approximated at 6 square miles.

No settlements exist on the shore of Espiritu Santo Bay. The seine fishermen from Port Lavaca, and occasionally those from Aransas Bay, fish here. Port Lavaca is about 25 miles distant and Aransas Pass about 50 miles. This bay has a local reputation for an abundance of fish, but is rather far from marketing centers.

SAN ANTONIO BAY.

Directly west of and emptying the greater portion of its waters into Espiritu Santo Bay lies San Antonio Bay. Its area approximates 129 square miles. Into it empty the Guadalupe and San Antonio rivers and smaller streams. The waters of the bay are comparatively fresh and no oyster reefs whatever are found there, except in the extreme western portion, the oysters of which are frequently destroyed by spring freshets, and are rarely taken by the fishermen.

On the Guadalupe River, a few miles above its mouth, some catfish are taken by fishermen from Aransas Bay. Aside from this, because of the lack of settlements along the shores, there are no fisheries prosecuted in San Antonio Bay. Its fresh water will probably prevent the ordinary fisheries of this coast from ever being extensively carried on here.

MESQUIT BAY.

This beautiful sheet of water forms connection between San Antonio and Aransas bays, and covers an area of about 23 square miles. Besides its outlet into Aransas Bay, it has a narrow passage to the Gulf of Mexico through Cedar Bayou. The depth of water is from 1 to 6 feet, and averages about 4 feet; but in the channel among the islands a depth of 15 or more feet may be found. The bottom is mostly covered with thick mud. There are several shoals or narrow places in the channel through this bay that very much impede navigation and frequently cause even the shallow fishing craft to await a higher tide or a change of the wind.

In many places in this bay are found small reefs from which fine oysters may be obtained. In fact, wherever the ground is sufficiently firm for the oysters to "gain a footing" they appear to do well. At low tide one may go on many of the small exposed reefs and pick up a bushel or more of oysters. Instances are reported in which 30 bushels of fine oysters have, in three hours, been picked up by one man from an area less than 100 feet square. Cedar Bayou, which connects this bay with the Gulf of Mexico, produces some of the largest oysters found on the coast of the Gulf States, and their flavor is excellent; many of these are so large that less than 80 will fill a 3-bushel barrel. The reefs of other localities are better known and less difficult of access, and those of Mesquit Bay and Cedar Bayou have, therefore, received little attention. When the oyster industry of Texas has been fully developed, it is probable that Mesquit Bay will be one of the best places along the coast for bedding and growing oysters. There are no towns on the shores of this bay, hence such fish as are obtained from the waters thereof are taken by men living in other localities.

ARANSAS BAY.

Aransas Bay lies southwest of Mesquit Bay and empties its waters into the Gulf of Mexico through Aransas Pass. The Mission, Aransas, and other rivers, all together draining an area of about 2,200 square miles, empty their waters into this bay. One of its tributaries, Copano Bay, nearly equals it in area. It also has several smaller estuaries, viz, St. Charles Bay, Mission Bay, Puerto Bay, Shallow Bay, etc. The area of Aransas Bay and its tributaries is 163 square miles. Its greatest length measures nearly 20 miles, and the average width of the bay proper is about 5 miles. Its largest tributary, Copano Bay, is about 13 miles long and 5 miles wide.

The depth of water in Aransas Bay proper ranges from a few inches to 14 feet, the latter depth being found in front of the city of Aransas Pass and about 1½ miles from shore. The average depth of water is about 10 feet. Southwest of Goose Island and from 1½ to 2 miles distant there is a channel 30 feet deep.

In the eastern portion of the bay there are a number of reefs over which the depth of water ranges from a few inches to 6 feet. The most prominent of these reefs are Grass Island, Half Moon, Long, Pelican, and Poverty reefs. In Copano Bay, the northern portion of Aransas Bay, the depth of water does not exceed 10 feet and the average is not more than 7. In this tributary are Shell Bank reef, Copano reef, Lap Reef bank, and Lap reef; these reefs are narrow, but extend several miles in length. As there is little depth of water over them they materially affect the navigation of the bay even by small fishing craft.

Importance of the fisheries.—Since the abandonment of the beef-packing business about 1880, and up to the present time, the fisheries have been the most important of the industries prosecuted at Aransas Pass and Fulton. In January of 1880 a small establishment for canning fish was erected here by Messrs. Kearney & Mercer, but it was in operation only a short while. The fish marketed fresh were shipped on the steamers of the Morgan Steamship Line to Galveston and other ports, and thence distributed throughout the interior. This business was quite extensive for several years before those steamers abandoned this port.

On the completion of the San Antonio and Aransas Pass Railroad in 1888, a number of fishermen from Matagorda Bay moved here, and two fish-marketing houses were established. In 1890 these two were consolidated, but before the close of that year another market-house was erected, and the two are now doing business.

In 1890 there were engaged in the fishery industries of Aransas Bay 210 men, using property valued at $59,540. The catch amounted to 2,055,150 pounds, for which the fishermen received $62,822. The taking of fish by means of bay seines is the most important fishery here. The oyster industry ranks second, and considerable attention is given to the capture of green turtle. A few fish are taken by means of hook and line, and quantities of crabs, flounders, mullet, etc., are taken.

The bay-seine fishery.—In 1890 29 seines were used in taking fish for the Aransas Pass markets, and 90 men were employed in operating them. The catch amounted to 1,198,000 pounds of scale fish valued at $41,925, and 46,100 pounds of green turtle and terrapins, for which the fishermen received $1,637. The number of sail craft employed in the bay-seine fishery in that year was 27, the value of which was $11,600. Of these only 5 were over 5 tons measurement.

The price received by the fishermen for their catch was 3½ cents per pound in 1890; it was 3½ and 4 cents in 1889, while in 1887 and 1888 it was only 3 cents per pound round weight.

During the last two or three years, on account of the abundance of fish and the good shipping facilities, the seine fishery has been more prosperous at Aransas Bay than at other points along the Texas coast. The average catch of fish to each man engaged in this fishery at Aransas Bay in 1890 was 13,823 pounds, valued at $484.

The favorite fishing-grounds are north of Live Oak Peninsula, in Shallow Bay, along the shores of St. Joseph Island, in Redfish Bay, and St. Charles Bay. Seines are not used in the rivers nor outside in the Gulf of Mexico.

Hook-and-line and other fisheries.—In May and June numbers of persons engage in taking jewfish with hook and line, and about 25,000 pounds are captured annually. The catch is usually sold to the marketmen at 4 cents per pound. The quantity of redfish, trout, tarpon, etc., taken by means of hooks and lines by sportsmen and the professional fishermen who engage at odd times in this fishery is about 35,000 pounds annually. These would sell in the local markets for about $1,200.

In most of the rivers in this section of the State there are many catfish, but no established fishery for taking them exists here as in Louisiana. These fish are especially abundant in the Guadalupe River, which empties into San Antonio Bay. They are very popular, in many places being preferred to trout (squeteague) and redfish. The market for them in the State was developed by the dealers at Morgan City, La.

A few cast nets are used here, and flounders and crabs are taken by means of spears and lines, respectively. These fisheries, however, are of minor importance.

The oyster industry.—Next to the seine fishery the taking of oysters is the most important fishery of Aransas Bay. Twenty-six men were employed in this fishery in 1890, and the catch amounted to 26,550 bushels, for which the fishermen received $6,600. The reefs resorted to change from year to year, on account of the freshets occasionally destroying many of the beds. During some years the greater part of the oysters handled are obtained from reefs in Matagorda Bay. The best-known reefs in Aransas Bay and tributaries are located off the northeast section of St. Joseph Island and in the southern waters of Copano Bay. In the extreme eastern part of Aransas Bay there are several small and scattered reefs which are quite productive. The area of the grounds in this bay and its tributaries that have produced oysters during the past ten years is estimated at 15 square miles.

The depth of water over the oyster beds varies from a few inches to 8 or more feet. No oysters are obtained from grounds more than 7 feet under water, although there are probably many beds in such places.

Only a small part of the oysters shipped from the shores of Aransas Bay are obtained from its waters. In recent years the supply has been largely drawn from Matagorda Bay, while Espiritu Santo, Mesquit, and Corpus Christi bays have furnished a few for this market.

The green-turtle fishery.—Green turtle (*Chelonia mydas*) have at times appeared in large numbers in Aransas Bay. In 1869 the beef-packeries began to can them. When these canneries were closed about ten years ago, a small factory was established at Fulton for preparing turtle meat for market in 1 and 2 pound tin cans. This is still continued.

The weight of the green turtle taken on the Texas coast varies from 10 to 1,000 pounds, and averages about 270 pounds. When they arrive in Texas waters they are in poor condition, but they fatten rapidly and are best for the market from August to the end of the season.

Aransas and Matagorda bays and the lower end of Laguna Madre are favorite fishing-grounds; yet at times the nets are set in other bays on the coast, and trips are made even beyond the Rio Grande. The season for "turtling" begins in March and closes in October, June to September being the best time for this fishery.

Green turtle are never taken with seines on this coast, nor are they usually hunted on the beaches during the breeding season. Gill nets are the common means of capture, the length varying from 60 to 100 feet, and the depth from 7 to 10 feet. The size of the mesh ranges from 14 to 16 inches square, the twine used being from 48 to 60 medium-laid. The nets are made by the fishermen, and about 2½ pounds of twine are necessary for each one. No lead line is used, only a float line being required. The cost of each net, ready for use, including ropes, cost of making, etc., is about $15. Each fishing crew should have twenty or more of these nets.

The nets are set in the "runs" or channels to which the turtle resort to feed. The order in which they are set varies with the "lay of the land." One of the lower ends of the net is fastened by means of a rope to an anchor, leaving the net to swing freely with the current. Each one is generally placed at a distance from the other slightly greater than the length of the net, so that the nets may swing clear of each other when the current changes. A turtle swimming through the "run" is likely to pass a "flipper" through the mesh of one of these nets; and while endeavoring to extricate it, becomes completely entangled and is easily secured. The daily catch varies from nothing to 20 turtles, an average of 2 or 3 being quite good. The depth of water in which the nets are set is usually from 9 to 14 feet. The best fishing is done at night, but the day time is very good if moderate trade winds prevail and the water be slightly rough.

Green turtle are gradually becoming less abundant on the coast of Texas, yet on account of the increasing demand for them the annual catch is probably increasing. The turtles are either disposed of at the Fulton canning factory or are sold to the fresh-fish marketmen, who ship them to the interior and even to New York City. Those sent to the latter place go by the regular line of steamers from Galveston, to which port they are sent by rail or general freight boats from Aransas Pass. They are shipped alive, and live a great length of time out of water.

The fishermen usually receive from 1 to 2 cents per pound for their catch. While awaiting a suitable market the turtles are kept in "crawls," or pens, made of poles driven in the bottom of the bay a few inches from each other, and sufficiently long to project a few feet above the surface of the water. If properly fed, the turtle may be retained several months in such inclosures.

The cannery at Fulton was established on a small scale in 1881. In 1890 about 900 green turtles, weighing 243,000 pounds, were reported as being received at this cannery. About 40,000 2-pound cans of turtle meat, and 300 dozen 2-pound cans and 500 dozen 3-pound cans of "turtle soup" were prepared. It is quite difficult to prepare these products so that they will keep a suitable length of time, such work requiring close attention and the greatest cleanliness.

The shells of the green turtle have no recognized commercial value.

Marketing of fishery products.—In 1890 there were two wholesale fish and oyster markets at Aransas Pass. The number of men employed was 31, and the capital invested $23,000. All the fishery and game products of the region were handled by these two houses, and in the same manner as is common along the coast. One of the marketing houses was connected with an ice plant and the fish were preserved in dry cold storage while awaiting orders from the interior.

CORPUS CHRISTI BAY.

Southwest of Aransas Bay and connected with it by Corpus Christi Bayou is situated Corpus Christi Bay. This is a beautiful body of water, very nearly circular in shape, and, together with its tributaries, covers about 185 square miles. The average depth of water is fully 14 feet. At present the only navigable outlet is through Aransas Pass by way of Corpus Christi Bayou. This bayou had a natural depth of water of about 4 feet, but by Morris and Cunningham's Cut it has been made navigable for vessels drawing 7 feet.

The only estuaries entering Corpus Christi Bay are the Nueces River and Oso Creek. The latter, as implied by its name, is quite salty. It is wide and shallow and drains but a small area; in fact, it is more of a tributary bay than a creek. The Nueces River drains about 10,000 square miles of territory, and at times during the spring it empties great quantities of fresh water into the bay.

The fisheries prosecuted.—In Corpus Christi Bay all the fish common to the bays along the Texas coast are found. In 1886, when Indianola was destroyed, many of the fishermen from that place came to Corpus Christi, and these, together with a large number of men who formerly fished at Point Isabel, are now plying their trade here. The total number of men engaged in the fishery industry of this bay in 1890 was reported to be 175, and the capital invested $44,330. The catch amounted to 1,238,550 pounds, for which the fishermen received $45,625. Only two of the fisheries prosecuted here have any commercial importance; these are the bay-seine fishery and the oyster industry. Many green turtle are handled in the wholesale markets of Corpus Christi, but they are purchased of the fishermen hailing from Aransas Bay and Point Isabel. Shrimp are found to a limited extent, but no fishery has been established for taking them. Crabs and a few flounders are taken by boys and wharf-idlers for local consumption.

The bay-seine fishery.—In 1890 there were engaged in the seine fishery at Corpus Christi 70 men, using 16 sailboats valued at $5,200, and seines, skiffs, and live-fish cars to the value of $2,820. The catch amounted to 719,950 pounds, for which the fishermen received $24,965. This fishery is gradually increasing in extent at Corpus Christi. The sail craft employed are somewhat larger than those used in the other bays of Texas. The market men report that redfish are growing scarcer and that sheepshead are rather more plentiful than formerly. The price received by the fishermen for their catch has been for the past several years about 3½ cents per pound for the ordinary fish.

Hand-line and other fisheries.—Many redfish, trout, jewfish, etc., are taken by means of hand lines by the Corpus Christi fishermen and sportsmen, and occasionally a visit is made to the red-snapper banks off Aransas Pass. The hook-and-line fishery does not, however, have any commercial rank. The total quantity of fish taken in this manner is about 25,000 pounds annually. These would sell in the markets for about $1,000.

A large number of cast nets are used by boys and others for fishing off the wharves and along the shores. The catch, which consists of mullet, trout, etc., amounts to about 20,000 pounds annually.

Spears are in use to a small extent in the shallow waters, for the purpose of obtaining flounders, the annual catch amounting to about 4,000 pounds.

Crab fishery.—As at other points along the Texas coast, crabs are abundant in Corpus Christi Bay. There is, however, little demand for them in the markets, and even this is entirely for local consumption; hence no one engages in taking them to so great an extent as to depend on it for a living. The crabs are taken by means of dip nets, baited lines, etc. The catch is mostly peddled about the city and sells at 15 to 30 cents per dozen.

The oyster industry.—The area of the natural oyster reefs in Corpus Christi Bay, at present known to the fishermen, is estimated at 13 square miles. The beds are located principally near the shore between the San Antonio and Aransas Pass Railroad bridge and Ingleside Cove. A few small reefs lie directly off the piers at Corpus Christi, and about halfway between Corpus Christi and the mouth of Oso Creek there are others. At the entrance of Oso Creek into the bay and around Shamrock Point a few oysters have been obtained. But the two last-mentioned reefs are somewhat distant from the city and the water is deep and frequently rough, so that they are rarely fished on.

On account of the great depth of water in Corpus Christi Bay, the condition of only such grounds as are located in the shoal waters near the shore are known to the fishermen. There seems to be no reason to doubt that many oyster reefs at present unknown exist in the deeper waters of this bay, as well as in the other bays along the coast.

Frequently spring freshets occur on the Nueces River, and the great quantities of fresh water emptied into the bay destroy many oysters. Occasionally these freshets bring down quantities of sand and mud, which cover the oyster beds and prove very destructive.

In 1890 the number of men engaged in oystering from Corpus Christi Bay was 40. They used 13 sailboats, valued at $6,100, and skiffs and tongs to the value of $390. The catch of oysters amounted to 65,400 bushels, for which the fishermen received $18,350.

Prior to the season of 1890–91 no instruments other than tongs had been used for taking oysters in Corpus Christi Bay. During that season, however, a small dredge was used on the schooner *C. Highland*, 16.36 tons measurement. This was the first attempt to utilize dredges in the taking of oysters in this State. The work done was completely satisfactory, and doubtless many more dredges would have been employed during the following season had not the State legislature prohibited their further use.

Fish and oyster markets.—There were two wholesale dealers at Corpus Christi in 1890, who handled nearly all the fish and oysters taken by the Corpus Christi fishermen; also many oysters obtained from Matagorda and Aransas bays.

LAGUNA MADRE AND THE LOWER RIO GRANDE.

Opening directly into Corpus Christi Bay, and extending southward a distance of 120 miles to Boca Chica, lies Laguna Madre, so called because of the numerous smaller lagoons or shallow bays extending inland that are tributary to it. Laguna Madre is from 2 to 13 miles wide, and covers an area of about 811 square miles. It is very shallow, averaging but little over 2 feet in depth, and in many places the ground is quite bare at low tide. It is not navigable except in limited areas.

On account of the saltness of the water, few fish are found in Laguna Madre, except at the extreme lower end near Point Isabel, where the less salty water of the Gulf of Mexico finds entrance through Brazos Santiago and Boca Chica. The depth of water here varies from 3 to 6 feet. All the species of fish common along the Texas coast are found here, and many of them in abundance. But the fisheries are not prosecuted to any great extent on account of the small market for the catch.

Bay-seine fishery.—The bay-seine fishery employs two seines, four men being required for each seine. These men work probably about one hundred and fifty days in the year. The catch, which amounts to about 75,000 pounds annually, is bunched and sent by rail to Brownsville and Matamoras once or twice each week, particular attention being paid to having them on the markets on "fast days." Each bunch of fish weighs about 5 pounds, and these are sold in the markets for "two bits" (25 cents) each. The weight of fish in a bunch varies according to the supply and demand, but the price per bunch does not ordinarily change.

The seine fishermen also catch shrimp in their seines, the quantity obtained annually being about 30,000 pounds. These are marketed both fresh and dried.

Catfish on the Lower Rio Grande.—In the Rio Grande, between its mouth and Hidalgo, a distance of about 100 miles, yellow and silver catfish are abundant. The quantity taken on the American side is about 30,000 pounds annually. Aside from this no fishery is reported from the Lower Rio Grande.

Cast-net and crab fisheries.—About twenty cast nets are used at Point Isabel at times. The catch consists of mullet, shrimp, trout, etc., but chiefly of the first named variety. It amounts to about 10,000 pounds annually, some of which is consumed locally and the rest sent to Brownsville.

A few crabs are taken here by traps and lines. The catch, however, is quite small on account of the limited market demand.

Green-turtle fishery.—About 50,000 pounds of green turtle are obtained annually, one sailboat and three men being employed; but on account of the distance from market the prices received by the fishermen are small, averaging not over a cent per pound. A large factory for canning green turtle, oysters, fish, game, etc., was for a short while in operation at Point Isabel.

The oyster industry.—Four men, with three small sailboats, are reported as having engaged in taking oysters by means of tongs in 1890.

The oyster reefs near Point Isabel are quite scattering, and are spread over about 3 square miles. The most productive grounds are located along the shore of the mainland, about 3 or 4 miles west of Point Isabel. Some small reefs are included between Long Island and the mainland, and at various other points. The total quantity of oysters taken annually from this section is about 4,200 bushels. Many more might be obtained, but the catch is restricted by the small demand.

STATISTICS.

Table of persons employed in the fisheries of Texas in 1890.

How engaged.	Sabine Lake.	Galveston Bay.	Matagorda Bay.	Aransas Bay.	Corpus Christi Bay.	Laguna Madre and lower Rio Grande.	Total.
Bay-seine fishery	8	165	17	90	70	8	358
Oyster industry		215	84	26	40	4	369
Surf-seine fishery		24					24
Shrimp-seine fishery		20					20
Turtle fishery				*19		3	*22
Miscellaneous fisheries †	26	163	30	50	40	19	328
Marketing and canning		‡96	8	41	25	2	172
Total	34	683	139	210	175	36	1,277

* Sixteen of these men engaged also in the oyster fishery during the winter, hence they are included only once in the totals.

† Of 328 men employed in "miscellaneous fisheries" only the following number depended on the fisheries for a living: Sabine Lake, 6; Galveston Bay, 16; and Corpus Christi Bay, 10.

‡ This includes 11 men on the steamer *Cumberland*, engaged in transporting fish and oysters.

Table of apparatus and capital in the fisheries of Texas in 1890.

Designation.	Sabine Lake.		Galveston Bay.		Matagorda Bay.		Aransas Bay.	
	No.	Value	No.	Value.	No.	Value.	No.	Value.
Sail craft, bay-seine fishery	2	$350	58	$19,690	5	$1,650	27	$11,600
oyster fishery			127	42,900	35	12,400	11	4,400
other fisheries			10	800			1	700
Skiffs, bay-seine fishery	2	20	176	1,950	6	60	32	330
oyster fishery			210	2,140	45	380	17	170
other fisheries	6	30					2	30
Apparatus of capture, etc.:								
Bay seines	2	200	60	7,550	5	500	29	4,350
Surf seines			12	900				
Shrimp seines			10	750				
Cast nets	30	95	95	355	30	100	50	180
Turtle nets							200	2,000
Crab traps			75	25				
Lines, spears, etc		70		1,050		10		55
Oyster tongs			240	1,600	84	546	29	175
Live-fish cars	10	61	120	1,200	5	50	55	550
Transporting steamer			1	15,000				
Shore property				64,500		1,000		25,000
Cash capital				30,000		1,500		10,000
Total		826		190,410		18,196		59,540

Designation.	Corpus Christi Bay.		Laguna Madre and lower Rio Grande.		Total for the State.	
	No.	Value.	No.	Value.	No.	Value.
Sail craft, bay-seine fishery	16	$5,200	2	$260	110	$38,750
oyster fishery	13	6,100	3	450	189	66,250
other fisheries			1	300	12	1,800
Skiffs, bay-seine fishery	16	240	2	18	234	2,618
oyster fishery	13	130	3	25	288	2,845
other fisheries			6	92	14	152
Apparatus of capture, etc.:						
Bay seines	16	2,400	2	200	114	15,200
Surf seines					12	900
Shrimp seines					10	750
Cast nets	90	280	20	60	315	1,070
Turtle nets			6	72	206	2,072
Crab traps			12	3	87	28
Lines, spears, etc		40		100		1,325
Oyster tongs	40	260	4	25	397	2,606
Live-fish cars	18	180	4	20	212	2,061
Transporting steamer					1	15,000
Shore property		17,500		500		108,500
Cash capital		12,000				53,500
Total		44,330		2,125		*315,427

* In addition to this amount $3,695, not elsewhere enumerated, representing the value of the provisions, etc., carried by the vessels of Galveston, Aransas, and Corpus Christi bays, is to be added to give the total investment.

Table showing by apparatus and species the products of the fisheries of Texas in 1890.

Apparatus and species.	Sabine Lake.		Galveston Bay.		Matagorda Bay.		Aransas Bay.		Corpus Christi Bay.		Laguna Madre and lower Rio Grande.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Bay seines:														
Bluefish			6,000	$300	500	$20	8,000	$262	3,000	$105			17,500	$687
Buffalo	13,800	$690											13,800	690
Catfish	5,500	275											5,500	275
Croakers	2,000	100	64,000	3,172	4,750	166	53,000	1,560	42,000	1,215	2,200	$77	167,950	6,290
Flounders			20,700	1,060	5,950	238	22,000	757	12,000	480	3,000	90	63,650	2,625
Hogfish or capitaine			17,000	850	1,100	44			7,000	280	750	30	25,850	1,204
Jackfish or crevallé			23,650	1,140	1,500	45	20,000	700	10,000	320	1,200	36	56,350	2,241
Jewfish			4,000	200			3,500	114	2,000	60			9,500	374
Mullet			16,950	625	1,000	25	6,000	120	3,000	45			26,950	815
Perch or bream	1,000	50	18,500	900	1,200	36	6,000	210	4,000	120	1,000	30	31,700	1,346
Pike	800	40	20,400	1,000	1,000	35	5,000	170	4,500	135	750	22	32,450	1,402
Pompano			2,000	600									2,000	600
Redfish or channel bass	6,500	370	418,000	21,755	28,500	982	389,000	14,775	219,800	8,083	9,000	365	1,070,800	46,330
Rockfish or striped bass			5,000	250			3,000	103	1,000	38			9,000	391
Sand trout	500	30	46,850	2,300	2,950	103	45,000	1,545	31,250	950	2,600	90	129,150	5,018
Sea trout	7,000	350	387,350	20,803	30,850	1,079	327,500	11,461	185,700	6,598	10,000	380	948,400	40,671
Sheepshead	5,000	250	306,900	14,829	18,450	645	268,000	8,827	154,200	5,236	6,500	260	759,050	30,047
Shoemaker			7,800	380			3,000	88	1,500	45			12,300	513
Spanish mackerel			10,000	600	1,000	55	9,000	358	5,000	300			25,000	1,313
Terrapin	2,700	650	2,400	600			1,100	282					6,200	1,532
Turtle			2,000	80			45,000	1,355					47,000	1,435
Miscellaneous fish	2,200	88	39,000	1,555	4,000	120	30,000	875	34,000	955	*39,800	1,200	149,000	4,793
Total	47,000	2,893	1,418,500	72,999	102,750	3,593	1,244,100	43,562	719,950	24,965	76,800	2,580	3,609,100	150,592
Surf seines:														
Croakers			8,000	440									8,000	440
Redfish or channel bass			6,000	390									6,000	390
Sand trout			10,000	650									10,000	650
Miscellaneous fish			15,000	920									15,000	920
Total			39,000	2,400									39,000	2,400
Shrimp seines:														
Shrimp			138,000	4,510									138,000	4,510

* Of this amount, 34,800 pounds were shrimp, valued at $1,050.

Table showing by apparatus and species the products of the fisheries of Texas in 1890—Continued.

Apparatus and species.	Sabine Lake.		Galveston Bay.		Matagorda Bay.		Aransas Bay.		Corpus Christi Bay.		Laguna Madre and lower Rio Grande.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Lines:														
Catfish	7,000	$340	7,500	$225							25,000	$1,250	39,500	$1,815
Jewfish			2,500	100			30,000	$1,200	5,000	$200			37,500	1,500
Redfish or channel bass	2,500	125	4,000	200			24,000	800	8,000	320			38,500	1,445
Red snapper			4,800	240									4,800	240
Sea trout	3,200	160	3,000	210									6,200	370
Sheepshead	2,000	80	7,400	345									9,400	425
Miscellaneous fish	7,000	250	8,000	520	10,000	$400	16,000	600	12,000	480	13,500	550	66,500	2,800
Total	21,700	955	37,200	1,840	10,000	400	70,000	2,600	25,000	1,000	38,500	1,800	202,400	8,595
Cast nets:														
Mullet			15,000	600					10,000	300	4,000	120	29,000	1,020
Perch or bream			3,000	180									3,000	180
Shrimp					1,000	30			4,000	160	2,000	80	7,000	270
Sea trout											1,500	60	1,500	60
Miscellaneous fish	3,000	190	10,000	400	14,000	470	16,000	600	6,000	290	2,000	60	51,000	2,010
Total	3,000	190	28,000	1,180	15,000	500	16,000	600	20,000	750	9,500	320	91,500	3,540
Spears:														
Flounders			27,000	1,600			36,000	1,440	4,000	160			67,000	3,200
Crab traps, etc:														
Crabs			162,500	4,200			13,200	440	11,800	400	3,300	55	190,800	5,095
Turtle nets:														
Green turtle							490,000	7,580			48,000	410	538,000	7,990
Oyster tongs:														
Oysters			1,647,100	72,140	765,450	29,200	185,850	6,600	457,800	18,350	29,400	1.700	3.085,600	127,990
Grand total	71,700	4,038	3,497,300	160,869	893,200	33,693	2,055,150	62,822	1,238,550	45,625	205,500	6,865	7,961,400	313,912

THE OYSTER LAW OF TEXAS.

The oyster law at present operative in this State, and to which reference has been made in the foregoing text, is as follows:

An act for the preservation of oysters and oyster beds, and for protecting the rights of persons to the same, and affixing penalties, and providing locations for planting oysters. (Laws of 1891, chapter 98.)

Be it enacted by the legislature of the State of Texas, That oyster beds shall be public and private; all those not designated as private, shall be public; all natural oyster beds and oyster reefs shall be deemed public. No person shall take or catch oysters from any public beds for market or sale or planting from the first day of May to the first day of September in any year. Any person offending against the provisions of this section shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined for each offense not less than ten nor more than fifty dollars.

2. When oysters are culled or selected from public beds, those not wanted for market or sale or for family use, shall be planted while alive, by the person or persons taking them, on the beds from which they were taken, or some other bed, public or private, and any person violating the provisions of this section shall be guilty of a misdemeanor, and upon conviction thereof shall be fined for each offense not less than ten dollars nor more than fifty dollars.

3. Where any creek, bayou, lake, or cove, not made a navigable stream by the laws of this State or of the United States, runs through the lands of any person, such person or other lawful occupant shall have the exclusive right to use said creek, bayou, lake, or cove for gathering, planting, or sowing oysters within the metes and bounds of the original grant or patent of said land; but if said creek, bayou, lake, or cove is not included in the survey of said lands, then the exclusive rights of the riparian owner shall extend to the mindle of said creek, bayou, lake, or cove.

4. Any person who is an actual bona fide citizen of the State of Texas shall have the right of obtaining a location for planting oysters and making private oyster beds within any public navigable waters of this State, other than those mentioned in section 3 of this act, by designating a square space not exceeding five hundred and thirty-eight yards square, intended by him for such purpose, by not less than four buoys anchored, or four stakes firmly and permanently planted, one at each corner of such location, and by establishing posted notices of the same on one or more of said corner stakes or buoys; said stakes shall project at least four feet above ordinary tides and shall be not less than six inches in diameter if of wood or three inches in diameter if of iron, and any person so locating as aforesaid shall be protected in his possession thereof against trespass thereon, in like manner as free holders are protected in their rights for a term of fifteen years after filing with the county clerk his notice of location: *Provided,* That no person shall have the right to locate any of the public oyster beds or oyster reefs within the public navigable waters of this State under this act or under any pre-existing law. All oyster locations made under this act shall expire at the end of fifteen years from the date of filing the notice of location with the county clerk, and said location shall then revert to the State, as if the same had never been located: *And provided further,* That no person shall locate any private oyster bed in the public navigable waters of this State within one hundred yards of low-water mark of any shore without the consent of the riparian owner, said owner only having that right, nor shall anyone be permitted in any wise to interfere with navigation by inclosure of said oyster beds.

5. At any time not exceeding sixty days after placing in position any one or more of said corner posts or buoys upon one of which shall be placed the notice hereinbefore required, the locator shall file, with the county clerk of the county in which his location lies, a notice of his location. The same shall be a notice to whom it concerns that the locator has on a certain date, naming it, located a private oyster bed on a

certain space, describing it by such metes and bounds as will suffice to locate it on the ground or water, and that he has placed posts or buoys as required by law. If such notice be filed before the four corners are designated by posts or buoys, the notice shall so state and be followed in sixty days by a supplementary notice after the four corners are all designated by posts or buoys. Notices of location shall in all cases state that the location described does not conflict with any other private bed, and that it is not on any public bed or oyster reef. The notices filed with the clerk as aforesaid shall further state that the locator is a bona fide citizen of the State of Texas. It shall be signed and sworn to by the locator or his agent; the county clerk shall record such notices in a well-bound book to be kept for that purpose, and the original with a certificate of registration returned to the locator. The county clerk shall receive for his services in recording such notices the same fee as is charged for recording deeds. The original or certified copies from the records shall be admissible in evidence under the same rules governing the admission of deeds or certified copies thereof. When the location lies in more than one county the notice shall be filed in all the counties in which the location is situated, or otherwise the location will be effective only as to those portions lying in the county or counties in which the notice or notices are filed. Upon complying with the provisions of this act, the right of the locator shall date from the placing of the first post or buoy. All oyster beds planted, created, or established in accordance with sections 3 and 4 of this act shall be private oyster beds, and the owners of the same shall be entitled to all the privileges and protection of this act, after having caused his claim to be duly posted and recorded in the county clerk's office as herein provided.

6. That it shall not be lawful for any person to plant or purchase oysters for planting, bedding, or depositing, or for marketing or for any other purpose whatever, from the 1st day of May to the 1st day of September in any year, and if any person shall violate the provisions of this section, or either of them, he shall be deemed guilty of a misdemeanor, and on conviction he shall be fined for each offense not less than ten nor more than one hundred dollars.

7. If any person shall willfully take oysters from a private bed or shall take oysters deposited by one making up a cargo for market or for family use without the consent or permission of the owner thereof, he shall be deemed guilty of theft, and upon conviction shall be fined in any sum not less than fifty nor more than two hundred dollars, and by confinement in the county jail for a term of not less than twenty days nor more than twelve months.

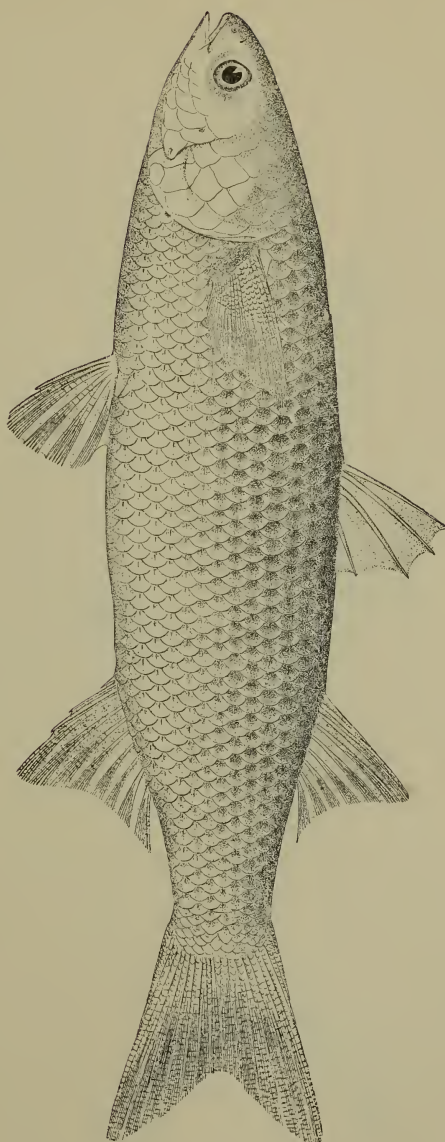
8. It shall be unlawful for any person or persons to rake, dredge, or excavate with machinery any public oyster bed or oyster reefs in the waters of this State. Any person or persons who shall violate the provisions of this section shall on conviction be fined in any sum not less than five hundred nor more than one thousand dollars. Each day's violation of any of the provisions of this section will constitute a separate offense.

9. Any person who shall willfully deface, injure, or destroy or remove any post or buoy, or any part thereof used to designate the corners or boundaries of any private oyster beds without the consent of the owner of said private oyster bed, shall be deemed guilty of malicious mischief and punished accordingly.

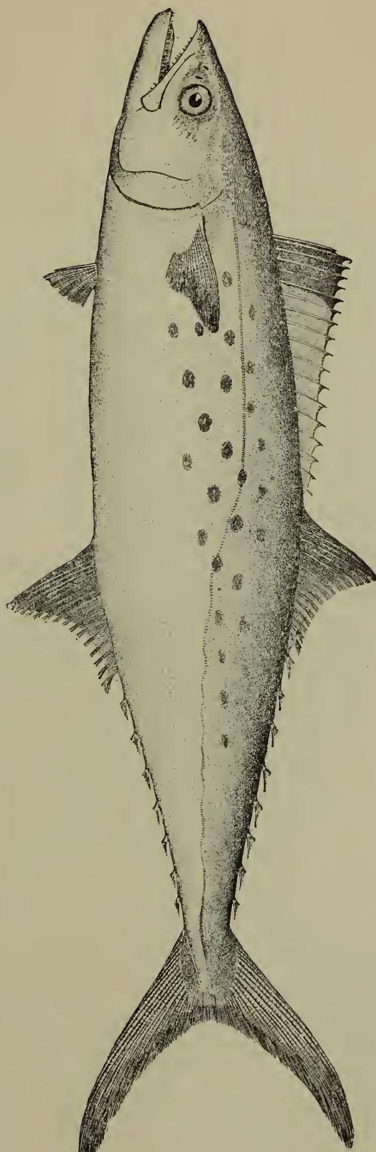
10. No person, firm, or corporation shall ever own, lease, or otherwise control more than six hundred and forty acres of land covered with water, the same being oyster locations in this State, and any corporation that now holds six hundred and forty acres or more of such oyster locations shall not be permitted hereafter to acquire, own, lease, or otherwise control more, provided that no corporation shall own or lease, or otherwise control any such land covered by water unless such corporation shall be duly incorporated under the laws of this State.

11. All laws and parts of laws in conflict with the provisions of this act are hereby repealed.

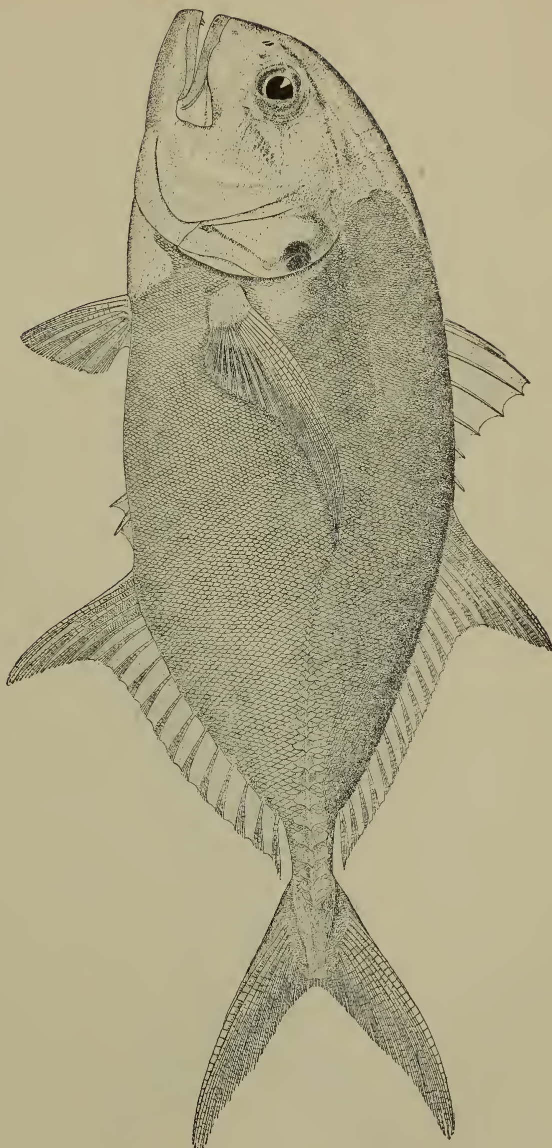
12. [Emergency clause.]



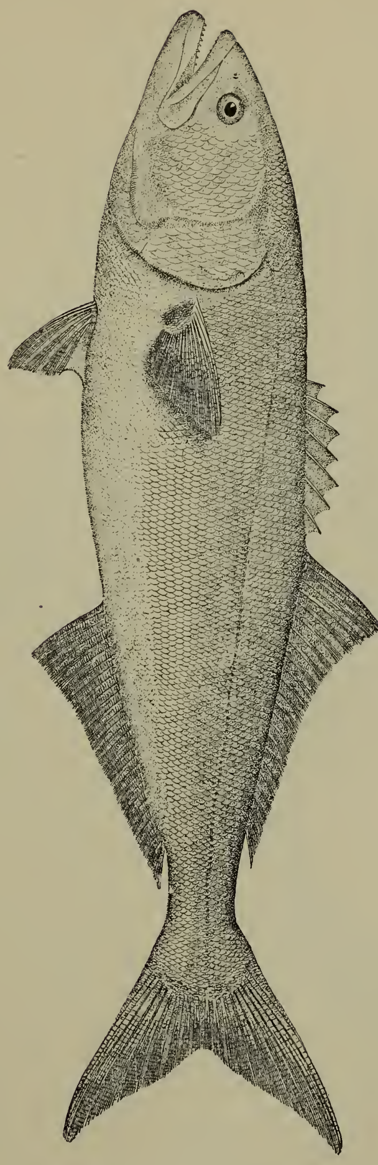
MUGIL CEPHALUS Linnæus. *Striped mullet.*



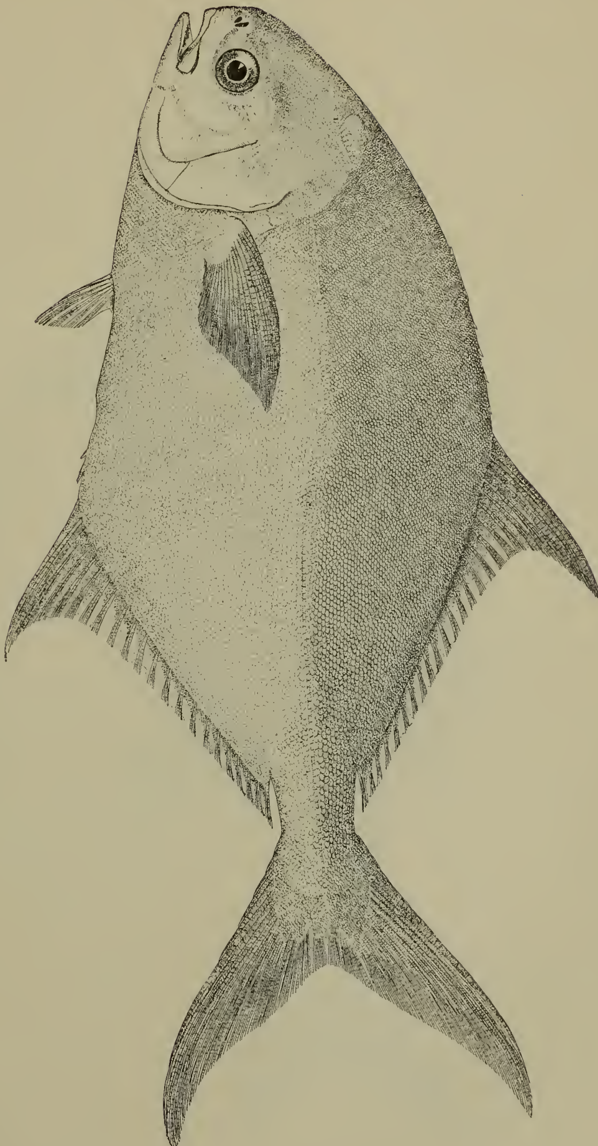
SCOMBEROMORUS MACULATUS (Mitchill). *Spanish mackerel.*



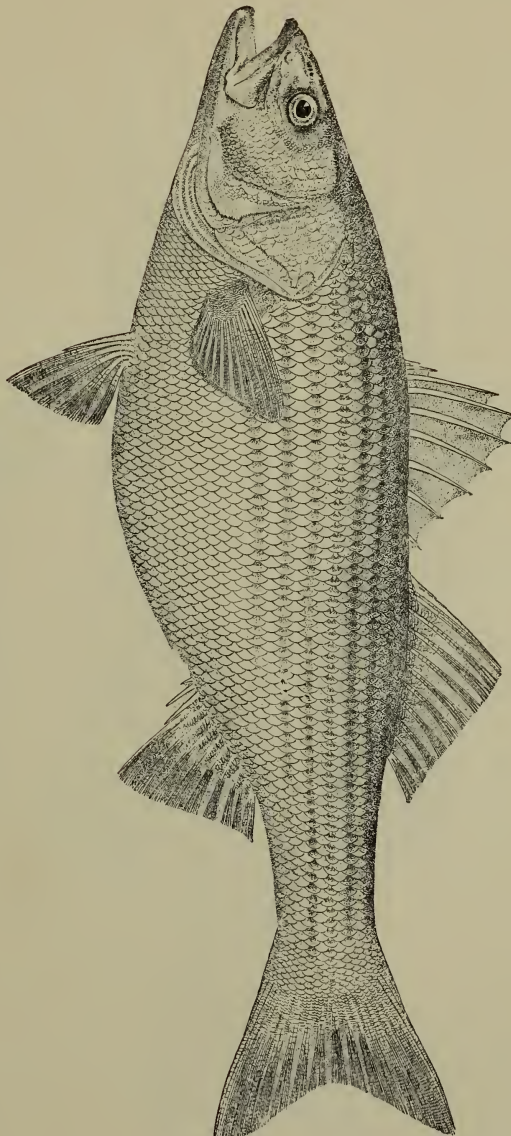
CARANX HIPPOS (Linnæus). *Crevallé; Jackfish.*



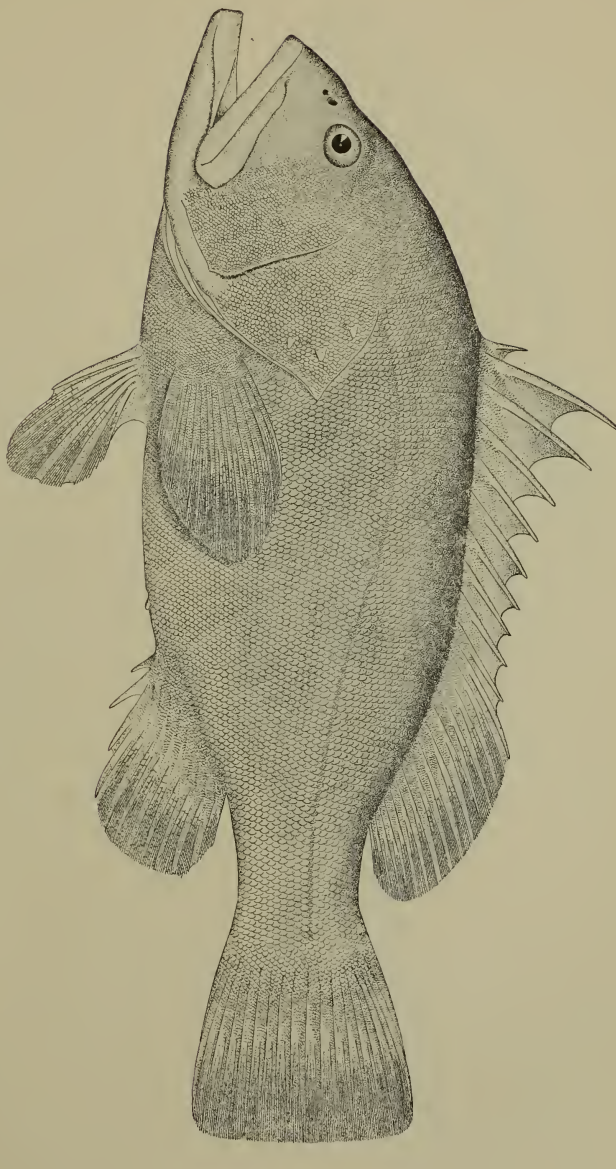
POMATOMUS SALTATRIX (Linnæus). *Bluefish.*



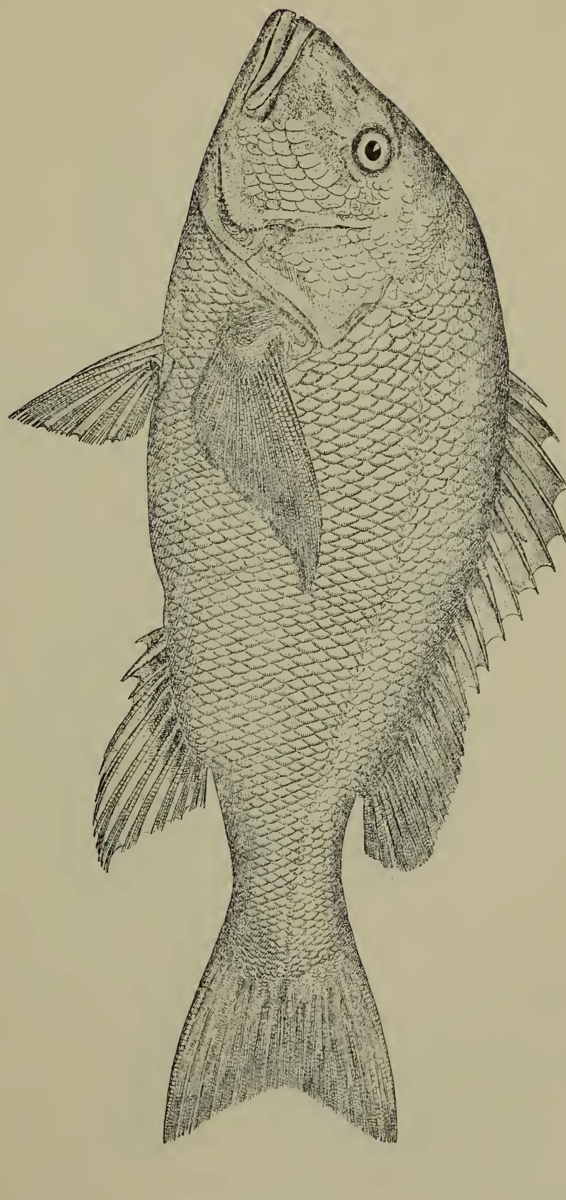
TRACHYNOTUS CAROLINUS (Linnæus). *Pompano.*



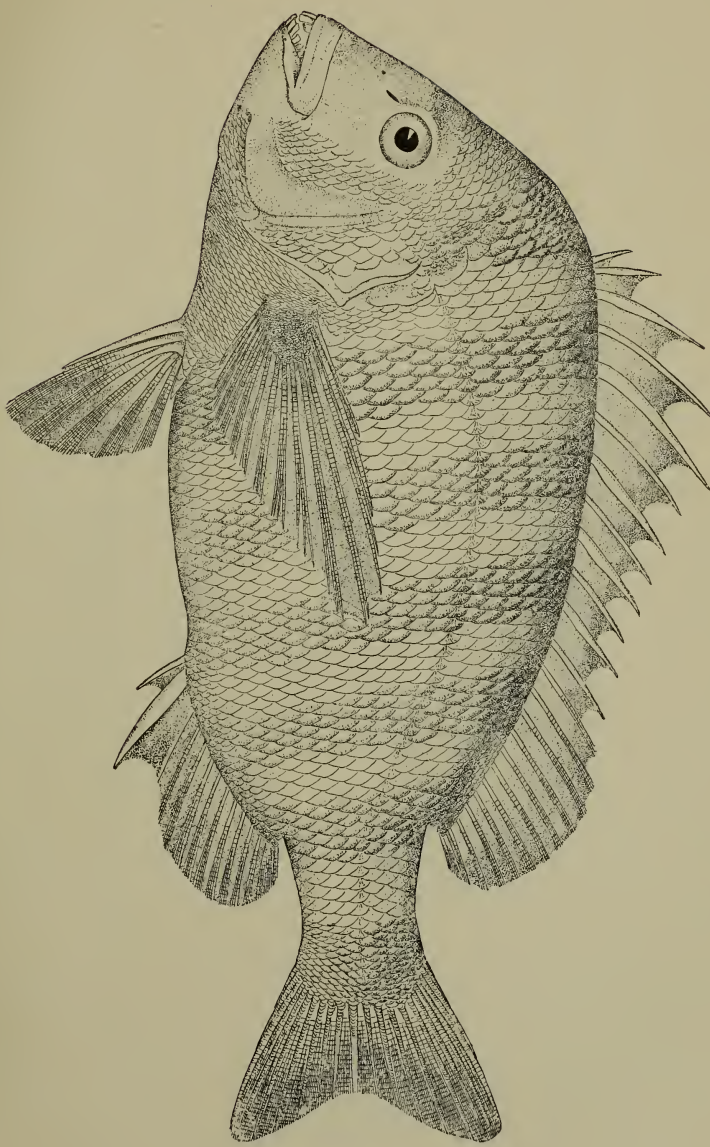
ROCCUS LINEATUS (Bloch). *Striped bass; Rockfish.*



EPINEPHELUS NIGRITUS (Holbrook). *Jewfish.*

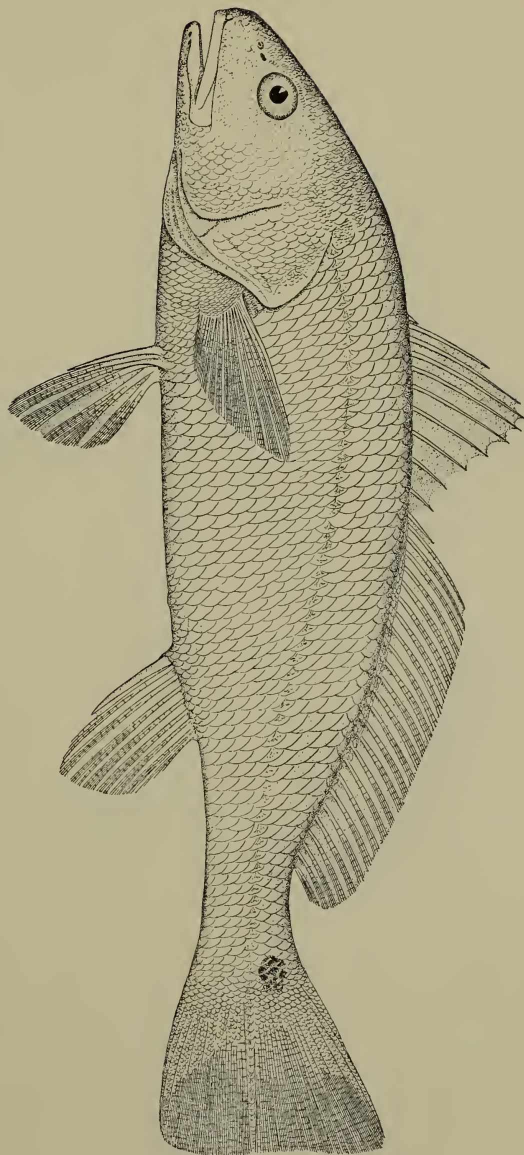


LUTJANUS AYA (Bloch). *Red snapper.*

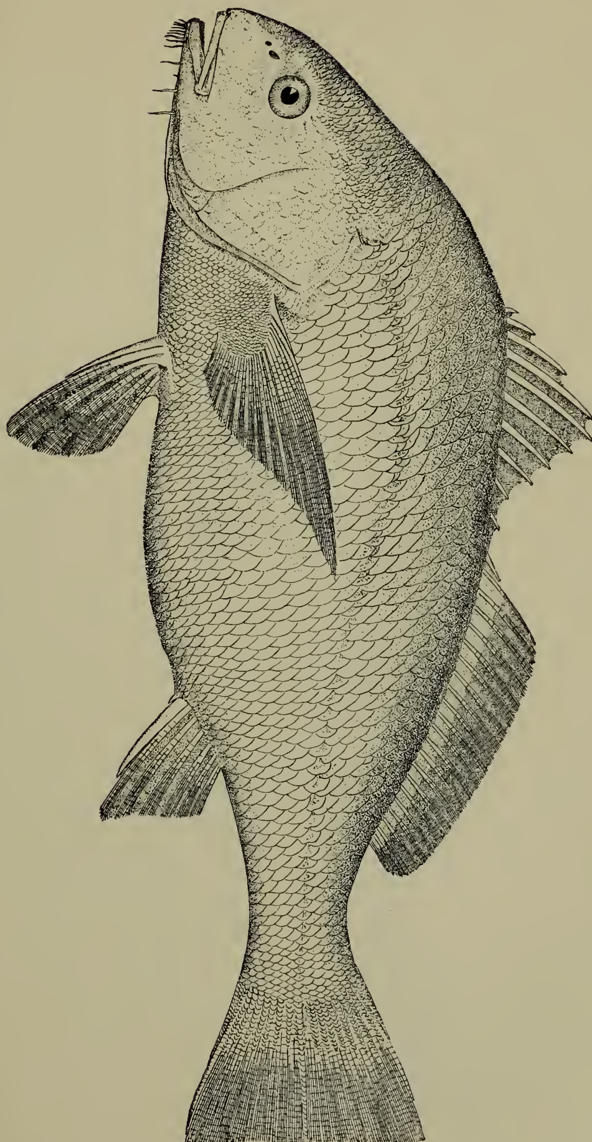


ARCHOSARGUS PROBATOCEPHALUS (Walbaum). *Sheepshead.*

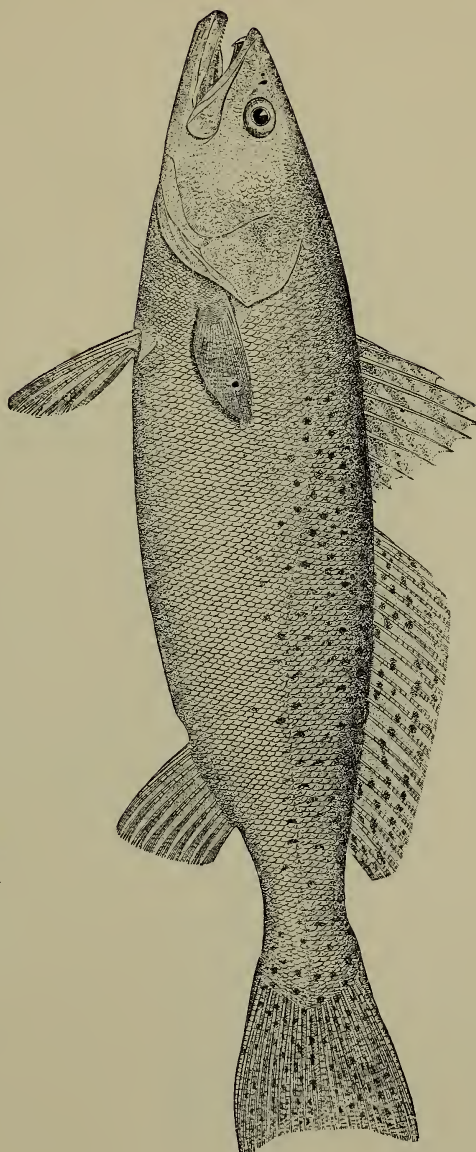
PLATE 22.



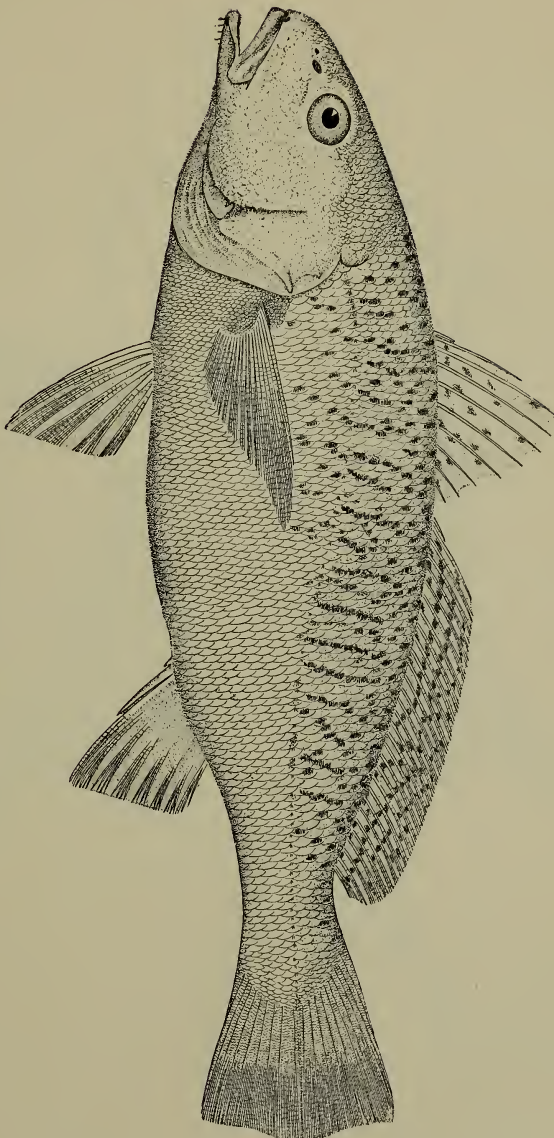
SCIÆNA OCELLATA (Linnæus). *Redfish; Channel bass.*



POGONIAS CROMIS (Linnæus). *Drum.*

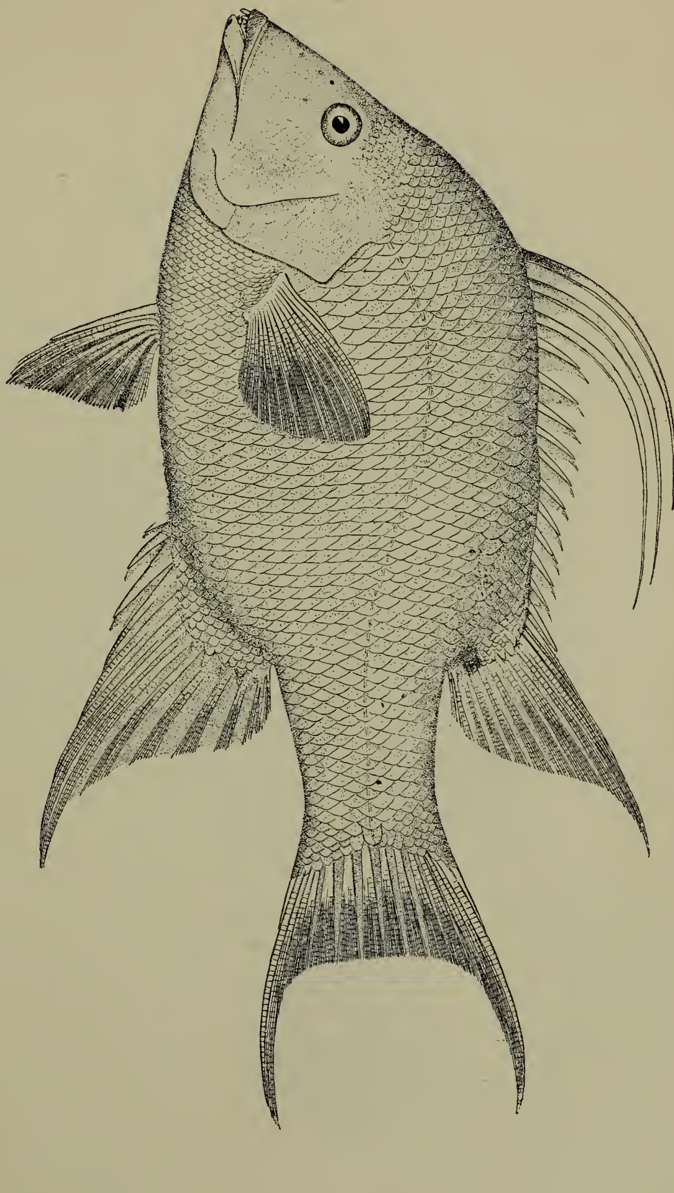


CYNOSCION NEBULOSUS (Cuvier and Valenciennes). *Trout; Sea trout.*

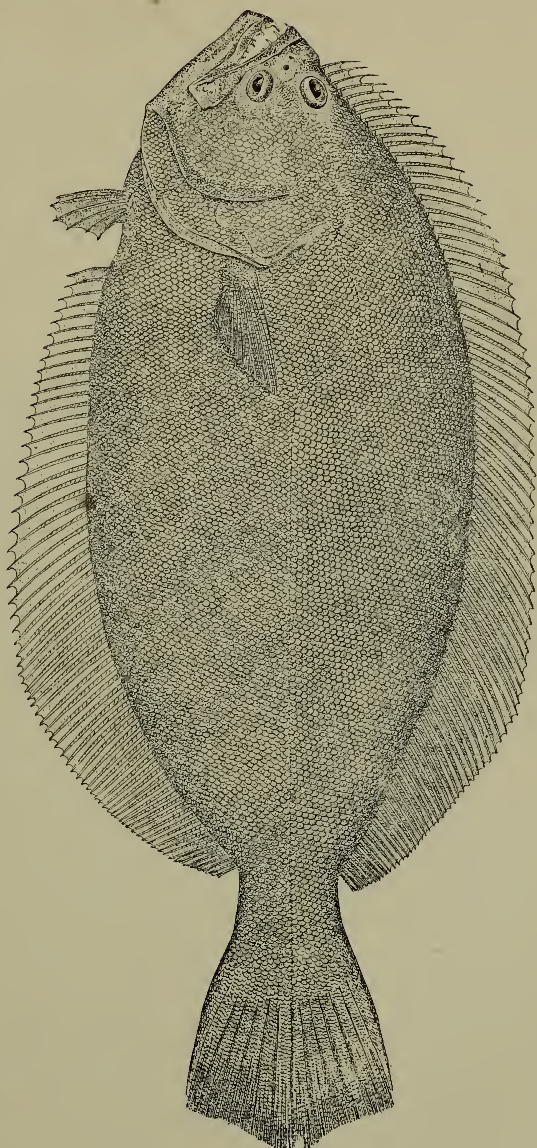


MICROPOGON UNDULATUS (Linnæus). *Croaker.*

PLATE 26.



LACHNOLAIMUS FALCATUS (Linnæus). *Hogfish; Capitaine.*



PARALICHTHYS LETHOSTIGMA Jordan and Gilbert. *Flounder.*

4.—A REVIEW OF THE SPAROID FISHES OF AMERICA AND EUROPE.

By David Starr Jordan and Bert Fesler.

In the present paper is given a review of the genera and species of *Sparidæ* (porgies, snappers, grunts, etc.) found in the waters of America and Europe. The family of *Sparidæ* is here provisionally accepted with the limitations as given in the "Synopsis of the Fishes of North America" (Jordan & Gilbert, 1883). It is recognized as containing those perciform fishes which have maxillary and ventral sheaths and which lack the peculiarities of certain other groups. In this sense the family would contain the *Sparidæ* and *Pristipomatidæ* of Günther or the *Sparidæ*, *Hæmulidæ* (*Pristipomatidæ*), *Lutjanidæ*, and *Pimelepteridæ*, of Dr. Gill. While it is evident that the group as here accepted is a somewhat heterogeneous one, it is still doubtful what division it should undergo in order to represent most faithfully the relations of its constituent parts. For the present, therefore, we may leave the group as defined by Jordan & Gilbert:

Body oblong, or more or less elevated, covered with moderate-sized, adherent scales, which are more or less strongly ctenoid or almost cycloid. Lateral line well developed, concurrent with the back, not extending on the caudal fin. Head large, the crests on the skull usually largely developed. No suborbital stay; mouth moderate or large, usually terminal, low, and horizontal. Premaxillaries protractile; maxillary without supplemental bone, for most of its length slipping under the edge of the preorbital, which forms a more or less distinct sheath; preorbital usually, but not always, broad; teeth various and variously placed; lower pharyngeals separate; gills, four, a large slit behind the fourth; pseudobranchiæ large; gill-rakers moderate; gill membranes separate, free from the isthmus; preopercle serrate or entire; opercle without spines; sides of head usually scaly; dorsal fin single, continuous, or deeply notched, sometimes divided into two fins, the spines usually strong, depressible in a groove; the spines heteracanthous, that is, alternating, the one stronger on the right side, the other on the left; the spines 10 to 18 in number; anal fin similar to the soft dorsal, and with 3 spines; ventral fins thoracic, the rays I, 5, with a more or less distinct scale-like appendage at base; caudal fin usually more or less concave behind; air bladder present, usually simple; pyloric cœca few or many; vertebræ usually 10+14=24, 16+18=34 in one subfamily.

The family comprises about 55 genera and some 450 species, chiefly inhabiting the shores of warm regions. All of them are valued as food. They are known by a great variety of names, many of them being variations of the Greek πάγρος, which becomes Pargus, Pargo, Porgie, Pogy, etc. The names Snapper and Grunt are also applied to many species. The group is closely related to the *Serranidæ* on the one hand, the genus *Xenistius* being very close to the Serranoid genus *Kuhlia;* on the other hand, *Scorpis*, *Kyphosus*, etc., approach the *Chætodontidæ.*

The material on which the present paper is based is primarily that contained in the collection of the University of Indiana. All the material in the Museum of Comparative Zoölogy has also been examined, and much of that in the United States National Museum, as well as the collections of the Leland Stanford Junior University. A large share of the material in the British Museum and in the Museum at Paris has also been carefully compared.

The work of preparing this review was begun in 1888, but the junior author having been called away from Bloomington its completion was deferred. Later, increased executive duties on the part of both authors rendered its completion difficult, and it has been thought best to publish it in its present unfinished condition rather than to wait for a time of leisure sufficient for its completion. It is hoped that it may serve as a basis for further study in the important group of which it treats. In several of the genera a detailed synonymy of the species is not attempted, only an outline being given. For purposes of comparison, the European genera are included, and a list of European species in each genus is appended. The names of genera not found in America are inclosed in brackets in the following analysis.

The *Sparidæ* of America and Europe seem to fall naturally into twelve well-marked subfamilies, which may be thus compared:

ANALYSIS OF SUBFAMILIES OF SPARIDÆ.

I. Carnivorous species; intestinal canal of moderate length; teeth in the jaws not all incisor-like; vertebræ usually 10+15.

a. Spines of premaxillary not extending to the occiput; the mouth moderately protractile.

b. Vomer with teeth.

c. Teeth in jaws unequal, some of them more or less canine-like. (No distinct* tubercles from the cranium for the articulation of the epipharyngeal bones; enlarged apophyses for the articulation of palatine and preorbital bones; anterior four vertebræ without parapophyses; maxillary long, formed essentially as in the *Serranidæ*.)

d. Nostrils remote from each other; the anterior tubular, near the end of the snout; vomerine teeth coarse, molar; teeth in jaws large, the lateral teeth molar; (skull as in *Lutjaninæ*)..HOPLOPAGRINÆ, I.

dd. Nostrils near together, placed just before eye, the anterior not tubular; vomerine teeth villiform, the patch ∧, ↑, or ◊ shaped; teeth in jaws all acute; no incisors or molars..........LUTJANINÆ, II.

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*See Gill, Proc. U. S. Nat. Mus. 1884, 351.

cc. Teeth in jaws very small, equal; vomerine teeth minute, in a ◊-shaped patch; dorsal fin deeply divided; skull with the temporal crest very low, running straight forward to the supraorbital ridge.
XENICHTHYINÆ, III.

bb. Vomer without teeth; palatines and tongue toothless.

d. Teeth on sides of jaws not molar; maxillaries formed essentially as in the *Serranidae*.

e. Teeth subequal, or those of the outer series more or less enlarged; no strong canines; preopercle more or less serrate, rarely entire; air bladder not constricted.................. HÆMULINÆ, IV.

ee. Teeth very unequal, one or both jaws with strong canines; preopercle entire; dorsal fin continuous.................... DENTICINÆ, V.

dd. Teeth on sides of jaws molar; maxillaries peculiar in form and in articulation, unlike those of the *Serranidæ*.

f. Anterior teeth conical, or else more or less incisor-like; preopercle entire; dorsal fin continuous; preorbital broad... SPARINÆ, VI.

ff. Anterior teeth as well as lateral teeth molar-like; preopercle denticulate; dorsal fin divided into two; preorbital narrow.
BORIDIINÆ, VII.

aa. Spines of premaxillary extending backward to the occiput, so that the mouth is excessively protractile, as in the genus *Gerres;* teeth in jaws small or wanting; vomer with minute teeth or none; dorsal fin continuous or deeply notched; preorbital narrow; preopercle entire...................................... MÆNINÆ, VIII.

II. Herbivorous species; intestinal canal elongate; anterior teeth in jaws incisor-like; no molars or canines; premaxillaries moderately protractile.

g. Lower rays of pectorals branched like the upper; air bladder usually with two long horns; vertebræ 24 to 27; dorsal spines, 10 to 14.

h. Pyloric cœca few; teeth fixed; vertical fins not scaly; no teeth on vomer.................................... SCATHARINÆ, IX.

hh. Pyloric cœca very numerous.

i. Soft part of dorsal and anal fins naked or partly scaled; head more or less naked; teeth in broad bands, all freely movable, none on vomer................................ GIRELLINÆ, X.

ii. Soft parts of vertical fins closely scaly; teeth more or less fixed, usually present on vomer .... KYPHOSINÆ, XI.

gg. Lower rays of pectorals simple; vertebræ in increased number (about 34); dorsal fin long; the anterior part with 15 to 17 spines, the posterior with 18 to 20 soft rays; anterior teeth incisor-like; vomer with or without teeth; scales very small; pyloric cœca 2 to 4 .... APLODACTYLINÆ, XII.

Of these subfamilies, the *Hoplopagrinæ*, *Xenichthyinæ*, and *Boridiinæ*, are exclusively American. The *Denticinæ* and *Scatharinæ* are confined to the Old World.

ANALYSIS OF EUROPEAN AND AMERICAN GENERA OF SPARIDÆ.

Subfamily I.—HOPLOPAGRINÆ.

(*Sparidæ* with the anterior nostrils tubular, at the end of the snout.)

Anterior nostril remote from the other, close to the premaxillary, in the end of a barbel or tube; vomer with a few molar teeth; teeth of jaws coarse and blunt, the lateral teeth molar; dorsal spines continuous with the soft rays, which are scaly at base; intestinal canal short; skull and general anatomy essentially as in *Lutjanus*. One genus, in the eastern Pacific.

a. Vomer, with about three coarse molar teeth; dorsal spines 10; scales large; gill-rakers few; tongue and palatines toothless; lower pharyngeals narrow, with small conical teeth.......................................HOPLOPAGRUS, 1.

Subfamily II.—LUTJANINÆ.

(*Sparidæ* with pointed teeth only, some of them canine-like, and with villiform teeth on the vomer.)

Nostrils normal; teeth in jaws all pointed, some of these teeth larger than others, forming more or less distinct canines; vomer and palatines with villiform teeth; lower pharyngeals narrow, with slender teeth; no "distinct tubercles from the cranium for the articulation with the upper pharyngeals; enlarged apophyses for articulation with the palatines and preorbitals; anterior vertebræ without parapophyses." (*Gill.*) Scales large; dorsal fin single or divided; intestinal canal short, with few cœca.

Species numerous in all tropical seas, the vast majority of them referable to the typical genus, *Lutjanus*. Several of them occur at considerable depths, and one (*Verilus sordidus*) is a true deep-water fish. The fishes of the group present some analogies to the *Serranidæ*.

a. Interorbital area not flat nor separated from the occipital region, the median and lateral crests procurrent on it, and the frontal narrowed forward; dorsal fin continuous, the spines not separated by a notch from the soft rays.

b. Prefrontals, with the articular facets arising from diverging V-shaped ridges; basi-sphenoid, with an anterior lobiform extension; soft dorsal and anal scaly; dorsal spines 10 or 11 (in American species); tongue with teeth (at least in adult specimens).

c. Fronto-occipital crest ceasing anteriorly far from front of frontal; prefrontal with posterior areas impressed, long and cribriform; no pterygoid teeth; caudal fin lunate; gill-rakers rather few, shortish ......LUTJANUS, 2.

cc. Fronto-occipital crest continued on ethmoidal projection; prefrontals with posterior areas short and excavated above and in front; pterygoid teeth present (in the adult) in a narrow band; caudal fin very deeply forked; gill-rakers numerous, rather long ....OCYURUS, 3.

bb. Prefrontals with the articular facets developed from simple tubercles and not V-shaped; basi-sphenoid not lobigerous; canines small; soft rays of dorsal 10 or 11.

d. Prefrontals with the posterior are ascribriform; pterygoid with a broad patch of teeth (in adult); hyoid bones and tongue with teeth; canines very small or obsolete; dorsal spines 12 (or 13); soft dorsal and anal somewhat scaled; top of head scaled to before middle of eye; gill-rakers numerous ..................................RHOMBOPLITES, 4.

dd. Prefrontals with the posterior areas solid and somewhat tumid; pterygoids, hyoid bone, and tongue toothless; dorsal spines 10; soft dorsal and anal scaleless...APSILUS, 5.

aa. Interorbital area flat, separated by a transverse line of demarcation from the occipital, by which the median as well as the lateral crests are limited; frontals wide in front; tongue and pterygoids toothless; soft rays of dorsal 10 or 11.

e. Dorsal fin continuous; frontals not cavernous; supraorbital margin crenate; periotic region much swollen outwards and with the bones thin and polished; preorbital moderate; frontals behind, with funnel-shaped foramina; soft dorsal and anal scaleless; last rays of dorsal and anal produced ....APRION, 6.

ee. Dorsal nearly or quite divided into two fins by a deep notch; eyes very large; preorbital very narrow.

f. Frontals not cavernous, simply normally perforate; supraorbital margins crenate; periotic region little convex and with the bones thick, unpolished; prefrontals behind, with funnel-shaped foramina; body comparatively elongate; head naked above and on snout; soft dorsal and anal naked; peritoneum and lining of gill-cavity pale; caudal deeply forked; color crimson.................................ETELIS, 7.

ff. Frontals cavernous (like those of *Sciænoids*), with longitudinal, osseous bars, leaving interspaces in front of transverse ridge and on each side near the front; supraorbital margins smooth; prefrontals behind, with simple foramina for olfactory nerves; body comparatively short and deep; head scaly above and on jaws and snout; soft dorsal and anal scaly at base; peritoneum and lining of gill-cavity black; caudal lunate. Deep-water species, blackish-purple in color.....VERILUS, 8.

Subfamily III.—XENICHTHYINÆ.

(*Sparidæ*, with minute subequal teeth on jaws and vomer; none on palatines; and with the upper jaw moderately protractile.)

Body compressed, covered with small, thin, ctenoid, silvery scales; top of head, cheeks, opercles, part of preorbital and crown scaly; mouth small, oblique, with small recurved teeth in jaws; preorbital narrow; a rhomboid patch of small teeth on vomer; few teeth or none on the tongue and palatines; gill-rakers long and slender; dorsal fins nearly separate, the anterior of slender spines; the soft rays scaly. Intestinal canal short; the pyloric cœca not examined. Skull not studied, the crests conspicuous, the temporal running forward to join the supraoccipital.

Shore fishes, the species few, confined to the eastern Pacific, where three genera are known. They show many resemblances to the *Serranidæ*, especially to the genus *Kuhlia*.

a. Dorsal rays, X or XI–I, 12 or 13, the spinous part of the fin at least half longer than soft part; anal rays, III, 10 or 11.

b. Dorsal fins entirely separated, interval between them four-fifths of eye; the spinous dorsal half longer than soft; nostrils small, close together. XENOCYS, 9.

bb. Dorsal fins connected at base, the spinous part about double length of soft part...XENISTIUS, 10.

aa. Dorsal rays, XI–I, 18 or 19, the soft part longer than the spinous part; anal rays about III, 18...................................XENICHTHYS, 11.

Subfamily IV.—HÆMULINÆ.

(*Sparidæ* with the teeth all pointed, none on vomer or palatines; without strong canines, the premaxillaries not greatly protractile, the maxillaries serranine, and the air bladder simple.)

Body generally oblong, compressed, covered with large or small scales; jaws with bands of teeth, the outer series of which are often enlarged, but not so as to form specialized canines; no teeth on vomer, palatines, or tongue; preopercle usually serrate, the serræ rarely obsolete; dorsal fin continuous. Intestinal canal short, with few pyloric cœca.

Shore fishes of the warm seas, the majority of the numerous species American. The fishes of this group present numerous resemblances to the *Sciænidæ*, in which family they were placed by Cuvier

a. Chin with a central groove behind the symphysis of the lower jaw.

b. Mouth more or less wide, the lips scarlet in life posteriorly; soft parts of vertical fins densely scaly to their margins.......... HÆMULON, 12.

bb. Mouth more or less narrow; soft fins naked or with scales on their basal parts.

c. Anal fin short, its rays III,7 to III,10; dorsal fin more or less emarginate, its spines rather robust.

d. Body ovate, the back elevated; depth greater than length of the head; outer teeth of upper jaw enlarged; lips thick; second anal spine strong; soft rays of dorsal and anal scaly at base.. ANISOTREMUS, 13.

dd. Body oblong, the depth usually less than length of head; lips not very thick.

e. Preopercle very sharply serrate, the serræ at angle much enlarged, those below angle turned forward; outer teeth in both jaws considerably enlarged; soft rays of dorsal and anal more or less scaly; second anal spine enlarged .... CONODON, 14.

ee. Preopercle finely serrate, the serræ at the angle scarcely enlarged, those below not antrorse; teeth subequal, or the outer in upper jaw somewhat enlarged; gill-rakers very short and weak.... POMADASIS, 15.

cc. Anal fin long and low, its rays III,10 to III,13; dorsal fin low, scarcely emarginate; anal spines small; preopercle finely serrate or entire; outer teeth of jaws scarcely enlarged; gill-rakers moderate, rather slender .... ORTHOPRISTIS, 16.

aa. Chin with pores but with no central groove at the symphysis; soft rays of vertical fins naked or partly scaled; preopercle finely serrate.

f. Anterior profile parabolic or nearly straight; teeth small, the outer usually more or less enlarged; gill-rakers slender and comparatively long. (Appearance of *Orthopristis.*)

g. Anal fin long, with 10 to 13 soft rays; dorsal fin deeply notched; soft dorsal and anal naked, with no distinct sheath at base. ISACIA, 17.

gg. Anal fin short, with seven soft rays; dorsal fin low and scarcely emarginate; soft dorsal and anal more or less densely scaly. [PARAPRISTIPOMA, 18.]

ff. Anterior profile concave above the eye; snout gibbous; outer teeth in both jaws enlarged and blunt (appearance of *Anisotremus*); gill-rakers small and slender........................ GENYATREMUS, 19.

Subfamily V.—DENTICINÆ.

(*Sparidæ* with canines in one or both jaws and with no incisors nor molars nor teeth on the vomer.)

Body oblong; jaws with conical teeth only, some of them, at least in upper jaw, enlarged and canine-like; no teeth on vomer, palatines, or tongue; upper jaw moderately protractile; dorsal continuous, its soft rays naked; intestine short, with few pyloric cœca; preopercle entire; preorbital broad. Genera 6 or 7; species numerous, chiefly of the seas of the Old World, the group apparently forming a transition from the *Lutjaninæ* to the *Sparinæ*.

a. Dorsal spines 11 or 12 (rarely 10), scales rather small, those on cheek in more than 3 rows; those in lateral line about 60; mouth large, the lower jaw projecting.................................[DENTEX, 20.]

aa. Dorsal spines 10; scales rather large, those on cheek usually in 3 rows; those in the lateral line about 50; mouth moderate, the jaw subequal, dorsal or caudal fins often filamentous............NEMIPTERUS, 21.

Subfamily VI.—SPARINAE.

(*Sparidæ* with the anterior teeth conical or incisor-like, the lateral teeth molar.)

Body oblong or elevated, with rather large scales; mouth small, the premaxillary little protractile; front of jaws with conical or incisor-like teeth, side of jaws with two or more series of rounded molars; no teeth on vomer, palatines, or tongue; maxillary short, peculiar in form and in articulation; dorsal fin continuous; posterior nostril largest, and more or less oblong or slit-like. Intestinal canal short, with few pyloric cœca.

Shore fishes of the tropical seas, especially abundant in the West Indies and in the Mediterranean.

a. Second interhæmal bone enlarged, hollowed anteriorly, or pen-shaped, receiving the posterior end of the air bladder in its anterior groove; posterior nostril slit-like; cheeks scaly.

b. Front teeth narrow, compressed, forming lanceolate incisors; the first spine-bearing interneural with an antrorse spine; temporal crest obsolete; lateral crest nowhere coalescing with the supraoccipital crest; interorbital area flattish, with two low ridges; a small foramen in each of these above front of pupil; interorbital area much contracted anteriorly; a strongly projecting prefrontal process which makes an acute angle with the supraorbital.......STENOTOMUS, 22.

bb. Front teeth conical or canine-like; first spine-bearing interneural without antrorse spine; temporal crest very thin and high, joining the lateral crest which forms part of the margin of orbit above middle of eye, both crests coalescing with the supraoccipital in the cavernous anterior part of the interorbital area; interorbital area somewhat contracted anteriorly; prefrontal process very strong, making an obtuse angle with the supraorbital; this process forming a conspicuous knob above the long posterior nostril........CALAMUS, 23.

aa. Second interhæmal spine normal, not "pen-shaped;" cheeks scaly.

c. Front teeth conic, not compressed; no incisors; occipital crest coalescent with the temporal crests; no antrorse spine on first interneural; dorsal spines usually 11 to 13.

d. Anterior teeth in both jaws strong, decidedly canine-like; body more or less deep and compressed...............................SPARUS, 24.

dd. Anterior teeth in both jaws cardiform and not canine-like; body oblong or elongate.......................................[PAGELLUS, 25.]

cc. Front teeth incisor-like; no canines.

e. Incisors broad; molars in 2 to 4 series in each jaw.

f. First spine-bearing interneural with an antrorse spine in front.

g. Supraoccipital and temporal crests nowhere coalescent, the interorbital area not swollen; frontal bone in the interorbital area thin, concave in transverse section; temporal crest low, separated from supraoccipital crest by a flattish area which extends forward on each side of supraoccipital crest and to groove of premaxillary spines. (Incisors conspicuously notched.) .... LAGODON, 26.

gg. Supraoccipital and temporal crests coalescent anteriorly, both disappearing in the gibbous interorbital area; frontal bone between eyes transversely convex and more or less honeycombed; temporal crest separated from occipital crest by an excavated area, bounded anteriorly by the lateral crest, which merges into the supraoccipital above eye. (Incisors entire or with a shallow notch.)
ARCHOSARGUS, 27.

ff. First spine-bearing interneural without antrorse spine above; skull essentially as in *Archosargus*, the frontal bone more cavernous.
DIPLODUS, 28.

ee. Incisors narrow; molars in a single series in each jaw; no antrorse interneural spine; snout produced .... [CHARAX, 29.]

Subfamily VII.—BORIDIINÆ.

(*Sparidæ* with molar teeth only, none on the vomer or palatines.)

Body rather elongate, covered with moderate scales; mouth small; each jaw with two or three rows of coarse molar teeth; no teeth on vomer, palatines, or tongue; nostrils roundish, subequal near eye; dorsal fin divided almost to base, the spines high; preopercle serrulate. A single genus found on the coast of Brazil.

a. Short snout; preorbital narrow; dorsal spines, 12; anal fin small; caudal forked.
BORIDIA, 30.

Subfamily VIII.—MÆNINÆ.

(*Sparidæ* with the premaxillaries greatly protractile, their spines extending backward to the occiput.)

Body oblong or elongate, covered with moderate or small ciliated scales; mouth moderate or small, extremely protractile, the spines of the premaxillaries extending backward to the occiput; teeth small or wanting; dorsal continuous or divided, the spines very slender; preopercle entire; intestine short, with few pyloric cœca. Shore fishes, chiefly of the Old World. In the form of the mouth they present analogies to the *Gerridæ*.

a. Jaws with teeth; dorsal spines very feeble.

b. Vomer with minute teeth; body oblong, compressed; dorsal fin continuous, its rays XI, 11 .... [MÆNA, 31.]

bb. Vomer without teeth.

c. Dorsal fin with its outline nearly continuous, its rays XI, 11; body compressed; scales moderate, 60 to 70 .... [SPICARA, 32.]

cc. Dorsal fin divided to base, its rays XIII, 9; body subcylindrical; scales very small (about 90) .... [CENTRACANTHUS, 33.]

aa. Jaws toothless; dorsal fins, 2; the spines very slender, about 13 in number; body elongate; lower pharyngeals with cardiform teeth.
ERYTHRICHTHYS, 34.

Subfamily IX.—SCATHARINÆ.

(Herbivorous *Sparidæ* with fixed incisor teeth in the front of the jaws only; no molars, no teeth on the vomer or palatines; the pyloric cœca few in number and the vertical fins not scaly.)

Body oblong or elevated, with scales of moderate or rather small size. Mouth moderate, with immovable incisor teeth in the front of the jaws, no molar teeth, and with no teeth on vomer, palatines, or tongue; lower rays of pectoral branched; vertical fins naked; intestinal canal elongate, with few pyloric cœca. Air bladder usually with two posterior horns.

Herbivorous shore fishes, the numerous species nearly all confined to the waters of the eastern Atlantic.

a. Pyloric cœca few (about 4); teeth fixed; cheeks and opercles scaly; vertical fins naked.
b. Incisor teeth broad, in a single series, with no cardiform teeth behind them.
c. Incisor teeth broad, notched at tip.
d. Incisor teeth with no other teeth behind them.
e. Body elongate, subcylindrical; dorsal spines 14 or 15, eyes large. [BOX, 35.]
ee. Body oblong, compressed; dorsal spines 11; eyes small...[BOOPS, 36.]
dd. Incisor teeth with a band of small granular teeth behind them; a series of pointed teeth on sides of jaws; body oblong, ovate, compressed; dorsal rays XI, 14 ....[OBLADA, 37.]
cc. Incisor teeth lanceolate, with no other teeth behind them; body oblong, compressed; dorsal rays XI, 11.....................[SCATHARUS, 38.]
bb. Incisors narrow, lanceolate, with a band of cardiform teeth behind them; body oblong, ovate, compressed; dorsal spines 10 or 11. [SPONDYLIOSOMA, 39.]

Subfamily X.—GIRELLINÆ.

(Herbivorous *Sparidæ* with a band of movable incisor teeth in front of each jaw; no molars; few teeth if any on palatines; the opercles scaleless; the pyloric cœca very numerous and the dorsal not closely scaled.)

Body oblong, with scales of moderate or small size; mouth moderate, with movable incisor teeth in a band in the front of each jaw; no teeth on vomer or tongue, sometimes a few teeth on palatines; all rays of pectoral branched; dorsal and anal scaly at base. Intestinal canal elongate, with many pyloric cœca.

Herbivorous shore fishes, found only in the Pacific Ocean.

a. Incisors all tricuspid.
b. Dorsal spines 14 or 15; each jaw with a series of flat, movable, tricuspid incisors, behind which is a broad band of similar smaller ones; dorsal continuous, its spines low......................GIRELLA, 40.
bb. Dorsal spines 12 or 13; "in both jaws series of flat tricuspid teeth, behind which is a band of similar teeth, less developed and replacing the former;" soft dorsal and anal elevated...........DOYDIXODON, 41.

Subfamily XI.—KYPHOSINÆ.

(Herbivorous *Sparidæ*, with incisor-like teeth in the jaws, no molar teeth, and with the soft rays of vertical fins densely scaly; intestinal canal long with many pyloric cœca.)

Body oblong or ovate, compressed, covered with small scales; similar scales enveloping soft parts of vertical fins and more or less encroaching on the head; mouth small, with the anterior teeth more or less incisor-like; no molars; villiform teeth on palatines and usually on vomer and tongue; preorbital narrow. Intestinal canal very long, with numerous pyloric cœca.

Herbivorous shore fishes, chiefly of the Pacific Ocean.

a. Top of head as far back as posterior margin of eyes naked; incisor teeth narrow, equal, rounded, with no smaller teeth behind them; no teeth on vomer or tongue; spinous dorsal much longer than soft dorsal; soft anal higher and shorter than soft dorsal............HERMOSILLA, 42.

aa. Top of head as well as sides and jaws closely scaled; broad bands of teeth behind the incisors; villiform teeth on vomer, palatines, and tongue; dorsal spines low; incisor teeth lanceolate.

b. Incisor teeth strong, with horizontal, backward-projecting roots; soft dorsal and anal not elevated ....KYPHOSUS, 43.

bb. Incisor teeth very narrow, without evident roots.

c. Anal fin short, 3¾ in length of body, its rays III, 19; dorsal spines gradually increasing in height to the sixth, then decreasing backward; soft dorsal and anal not falcate; preopercle slightly serrate; teeth narrow but evidently compressed........................MEDIALUNA, 44.

cc. Anal fin long, 2½ in length of body, its rays about III, 25; dorsal spines graduated, increasing in height to the last; soft dorsal and anal not falcate; teeth cylindrical (?).......................CÆSIOSOMA, 45.

Subfamily XII.—APLODACTYLINÆ.

(Herbivorous *Sparidæ*, with the vertebræ and dorsal rays in increased number, the lower pectoral rays simple, not branched; jaws with flat incisor teeth in front, and no molar teeth; the fins separate.)

Body oblong, compressed, with very small scales; cheeks and opercles scaly; mouth small, little protractile; jaws with one or more series of flat incisors, which are usually 3 to 5 cuspid; a band of small cardiform teeth behind these in the upper jaw; teeth sometimes present on the vomer; opercles unarmed; cheek and opercles scaly; six lower rays of pectoral simple; dorsal fins separate, both very long, the first of 15 to 18 spines, the second of 18 to 21 soft rays; anal fin short; vertical fins scaly at base; intestines long, with 2 to 4 pyloric cœca; vertebræ in increased number (said to be 16+18=34 in *Aplodactylus arctidens*).

Species few, inhabiting the South Temperate zone of the Pacific Ocean, the increased number of vertebræ apparently according with their dwelling in cooler waters. The species are referred to a single genus, which resembles *Girella* in the form of the head and in dentition, but differs in the technical characters mentioned above.

a. Pectoral with 6 simple rays; dorsal spines 15 to 17.........APLODACTYLUS, 46.

Subfamily I.—HOPLOPAGRINÆ.

I. HOPLOPAGRUS.

Hoplopagrus Gill, Proc. Ac. Nat. Sci. Phila. 1862, 253 (*Güntheri*).

Type: *Hoplopagrus güntheri* Gill.

Etymology: ὅπλον, singular of ὅπλα, arms, armor; πάγρος, porgy.

One species of this remarkable generic type is known. With a close resemblance in nearly all respects to *L. caxis*, and other ordinary *Lutjani*, it strikingly differs in the structure of the nostrils and in the dentition from all other fishes of this type.

ANALYSIS OF SPECIES OF HOPLOPAGRUS.

a. Body oblong-ovate, short, deep, and compressed, the back arched, the body abruptly contracted to the base of the short caudal peduncle; anterior profile slightly and evenly convex. Snout rather long and pointed, its length 2½ in head; mouth small, the maxillary scarcely reaching to front of orbit, its length 2⅘ to 3 in head; teeth in jaws arranged as in the *Lutjani*, but coarse and blunt, the lateral teeth of both jaws rounded and molar-like, more blunt in large examples; upper jaw with about 2 coarse, rather long canines; vomer with about 3 to 5 coarse molar teeth; palatines and tongue toothless; lower jaw rather weak, included; anterior nostril at the extreme front of the snout, close to the premaxillary, in the extremity of a barbel-like tube which hangs down above the mouth and is nearly as long as the eye; posterior nostril a rather long and narrow oblique slit, near the front of the eye; eye small, near the middle of the length of the head, 4½ in head (young); interorbital space rather broad and convex, its width 4½ in head; preorbital broad, its least width 3½ to 4½ in head; vertical limb of preopercle oblique, sharply serrate, the teeth rather fine above, coarse at the angle; emargination of preopercle sharp and deep, more conspicuous than in most species of *Lutjanus*, the knob of interopercle conspicuous; gill-rakers few and short, about 7 developed on lower part of anterior arch, besides several rudiments; opercle without spinous projections; scapular scale serrate. Temporal crest of skull very short, coalescing with the orbital rim. Scales rather small, regularly arranged, those above lateral line in series which are throughout parallel with the lateral line; those below in horizontal series; temporal region with a band of one or two series of large scales; cheeks with about 7 rows of scales; top of head naked. Dorsal spines rather low and strong, the fin somewhat deeply emarginate; soft dorsal high, angular, and pointed in outline, the last ray not two-fifths the height of the middle ones, which are 2 in head; caudal short, feebly lunate, the upper lobe 1⅗ in head; anal high and pointed, the middle rays reaching base of caudal, a little more than half length of head; anal spines strong, the second longer and stronger than third, 2⅘ in head; pectoral long, 3 in body; ventral 1½. Color olive brown, body with about six rather conspicuous narrow whitish crossbands, extending a little obliquely backward, and broadest below, irregular in number and width; a round, dusky blotch near base of last rays of soft dorsal; fins mostly dusky olive, the pectorals pale, ventrals and anal darkest; top of head with some small dark spots. Head, 2⅗ in length; depth, 2½. D. X, 14; A. III, 9. Scales 6-47-16........GÜNTHERI, 1.

1. HOPLOPAGRUS GÜNTHERI. (Pargo.)

Hoplopagrus güntheri Gill, Proc. Ac. Nat. Sci. Phila. 1862, 253 (Cape San Lucas); Steindachner, Ichth. Beiträge, VI, 1878, 1 (Altata); Jordan & Gilbert, Bull. U. S. Fish. Comm. 1882, 107, 112 (Mazatlan, Punta Arenas); Jordan & Swain, Proc. U. S. N. M. 1884, 429 (Mazatlan); Evermann & Jenkins, Proc. U. S. N. M. 1891, 145 (Guaymas).

Habitat: Pacific coast of tropical America, from Guaymas to Panama.

Etymology: Named for Dr. Albert Günther.

This remarkable species is a common food-fish of Mazatlan, where it is known as the "*pargo*." The specimens examined by us are from Mazatlan and Guaymas. Dr. Gill has very properly considered it the type of a distinct subfamily, *Hoplopagrinæ*. Its peculiarities are certainly stronger than those of the other genera associated with *Lutjanus*, although in the structure of the cranium itself it does not materially differ from *Lutjanus*.

Subfamily II.—LUTJANINÆ.

II. LUTJANUS.

Lutjanus Bloch, Ichthyologia, IV, 107, 1790 (*lutjanus*).
Dipterodon Lacépède, Hist. Nat. Poiss., IV, 167, 1803 (*plumieri*=*synagris*, etc.).
Diacope Cuv. & Val., Hist. Nat. Poiss., II, 410, 1828 (*sebæ*, etc.) (preoccupied in *Lepidoptera*).
Mesoprion Cuv. & Val., Hist. Nat. Poiss., 441, II, 1828 (*unimaculatus*, etc.).
Genyoroge Cantor, Malayan Fishes, 1850, 12 (*notata*).
Neomænis Girard, U. S. Mex. Bound. Surv., 1859, 18 (*emarginatus*=*griseus*).
?**Proamblys** Gill, Proc. Ac. Nat. Sci. Phila. 1862, 236 (*nigra*=*macolor*).
Hypolites Gill, l. c., 236 (*retrospinis*).
Evoplites Gill, l. c., 236 (*pomacanthus*=young of *L. kasmira*).
?**Macolor** Bleeker, Poiss. Amboin. Nederl. Tidsc. Dierkunde, 277, 1867 (*macolor*).
Rabirubia Jordan & Fesler, subg. nov. (*inermis*).
Raizero Jordan & Fesler, subg. nov. (*aratus*).

Type: *Lutjanus lutjanus* Bloch, an East Indian species.

Etymology: From *Ikan Lutjang*, a Japanese or Malayan name of the species.

This is a very large genus, the most extensive in the family, even after the separation as distinct genera of numerous aberrant forms. Perhaps the group may admit of further subdivision, but this can not be carried out without a wider knowledge of it than we now possess. The peculiar notching of the preopercle on which the genus *Genyoroge* has been based is certainly a character of minor importance, as it disappears by degrees in different species. Most European writers have called this genus *Mesoprion*, after Cuvier. This is an unnecessary violation of the law of priority, as *Lutjanus* and *Dipterodon* are both prior to *Mesoprion*.

ANALYSIS OF AMERICAN SPECIES OF LUTJANUS.

a. Top of head covered with scales, these extending forward at least as far as middle of eye.

b. Preopercle with a sharp deep notch, into which fits a knob from the interopercle; temporal crest not confluent with orbital rim, but nearly or quite confluent with supraoccipital crest in front (*L. kasmira*); lower limb of preopercle coarsely serrate; scales above lateral line in very oblique series. (*Evoplites* Gill.)

c. Body rather elongate, the depth 3 in length; profile to nape nearly straight; snout pointed, 3½ in head; supraoccipital crest low; preorbital moderate, 6⅔ in head; mouth moderate; the jaws subequal, the maxillary reaching front of pupil, 2⅔ in head; both jaws with a narrow band of villiform teeth, outside of which are moderate canines; tongue toothless; vomer with a Λ-shaped band of teeth and with no backward prolongation on median line. Gill-rakers short and slender, 10 developed. Eye large, 4 in head; nostrils small, well separated, the posterior oblong; preopercle strongly serrate above the notch. Scales rather small, (7) 9–54–17, the rows above lateral line very oblique, nowhere parallel with the lateral line, 7 or 8 rows on cheeks, anterior largest, one row on interopercle; top of head scaled as far forward as front of pupil; 10 rows of scales between eye and suprascapula; soft dorsal and anal scaly. Dorsal spines low and strong, the fourth spine longest, 3 in head; soft dorsal rounded, the longest ray 4½ in head; anal moderate, its free edge straight, the second spine longest, 2⅔ in head; pectorals long, 1⅛ in head. Color golden brown with 5 sky-blue longitudinal stripes, each broadly and sharply margined with dark blue; the whole band as broad anteriorly as the interspaces, growing narrower behind the dark-blue border, nearly as wide on each side as the median pale-blue band. A faint median blue streak from occiput to front of dorsal, then a band of three blue streaks as above stated, from occiput above eye to ninth dorsal spine; second from upper edge of eye to middle of soft dorsal; third from middle of eye to last ray of dorsal; fourth from upper jaw along lower eye to middle of base of caudal peduncle, when it ends abruptly; fifth from end of maxillary to above last ray of anal; fins all pale, the dorsal partly edged with black; no black lateral spot. Head 2⅔ in length; depth, 3; D. x, 14; A. III, 8. Scales, 9-54-17.................................... VIRIDIS, 2.

aa. Top of head naked as far back as the nape.

d. Preopercle with a sharp, deep notch, into which fits a knob from the interopercle. (*Genyoroge* Cantor.)

e. Body elongate; snout pointed, about 3 in head; eye 4½; maxillary extending to opposite middle of eye; both jaws with strong, unequal canines; tongue with teeth; preopercle with a deep and narrow slit into which the process of the interopercle fits; anterior profile of head nearly straight; preorbital broad; dorsal spines low, strong, the fourth 3 in head; second anal spine shorter and stronger than third, soft dorsal and anal rounded; caudal lunate, pectoral falcate, 1⅔ in head. Body bluish gray, silvery gray below; 11 to 14 faint silvery cross streaks; anal, caudal, tips of ventrals, and upper part of dorsal blue-black; pectoral greenish, with a dark spot at its base. Head, 3; depth, 3½, D. x, 15; A. III, 8. Scales, 8–46–15. (*Steindachner*.)....... CANINUS, 3.

dd. Preopercle with its vertical limb entire, or with a broad, shallow emargination only.

f. Dorsal spines normally 10.

g. Anal rays III, 7 to III, 9; lower limb of preopercle with the serræ small or wanting. (*Dipterodon* Lacépède.)

h. Soft dorsal normally with 14 rays (dorsal rays rarely X, 13).

i. Anal fin rounded, its middle rays less than half length of head; no black lateral spot.

j. Developed gill-rakers 7 to 9, usually with few rudiments, if any; preorbital deep; caudal lunate; shallow-water species, olivaceous in color, more or less marked by crossbands when young, often with a blue streak along the preorbital.

k. Vomerine teeth forming a ∧ or ⩚ shaped patch, the backward prolongation on median line very short or wanting; scales above lateral line in oblique series, which are not throughout parallel with lateral line; body comparatively elongate, the depth 3 to $3\frac{1}{2}$ in length; upper and lower canines very strong, lower considerably stronger than in other species; month very large; vertical fins dusky; size very large.

l. Maxillary $2\frac{3}{7}$ in head; preorbital $5\frac{1}{2}$ in head; maxillary reaching nearly or quite to middle of eye, $2\frac{3}{5}$ to $2\frac{1}{2}$ in head; base of pectoral dusky; head, $2\frac{7}{8}$ in length; depth, $3\frac{2}{5}$. D. X, 14; A. III, 8. Scales, 6–48–13. NOVEMFASCIATUS, 4.

ll. Maxillary $2\frac{2}{7}$ in head; preorbital $4\frac{3}{4}$ in head; maxillary reaching past middle of eye, about $2\frac{1}{3}$ in head; usually a black spot or shade at base of pectoral; head, $2\frac{3}{4}$; depth, 3; D. X, 14; A. III, 8. Scales, 7–50–12 .... CYANOPTERUS, 5.

kk. Vomerine teeth forming an anchor-shaped patch, with a distinct backward prolongation on the median line; second anal spine longer and stronger than third; upper canines strong; lower moderate or small.

m. Scales above lateral line arranged in series which are not throughout parallel with lateral line, being oblique and irregular, at least below the second dorsal.

n. Body comparatively elongate, the depth $2\frac{3}{4}$ to 3 in length; snout rather pointed; mouth large, $2\frac{1}{2}$ in head; soft dorsal, anal, and caudal blackish, tinged with wine color, always becoming dusky in spirits; body dark greenish, more or less reddish below; blue streak on preorbital disappearing early; specimens from deep water with more or less red. Head, $2\frac{3}{4}$; depth, $2\frac{7}{8}$. D. X, 14; A. III, 8. Scales, 7–50–12 .... GRISEUS, 6.

nn. Body comparatively deep, depth about $2\frac{1}{2}$ in length; snout long and pointed; mouth rather small, maxillary about 3 in head; soft dorsal, anal, and caudal orange or yellow, becoming pale in spirits.

o. Scales moderate, about nine in an oblique series from first dorsal to lateral line; about 55 vertical series above lateral line between gill-opening and base of caudal; lateral line with more than 40 pores; a whitish area below eye; blue streak along suborbital region, usually not disappearing with age; head, $2\frac{1}{2}$; depth, $2\frac{4}{7}$. D. X, 14; A. III, 8. Scales, 9–56–15 .... JOCÚ, 7.

oo. Scales unusually large; 5 or 6 in an oblique series from first dorsal to lateral line; about 45 vertical series above lateral line between gill-opening and base of caudal; lateral line with less than 40 pores; blue streak on suborbital region not permanent; head, 2½; depth, 2½. D. x, 14; A. III, 8. Scales, 6–44–13.... CAXIS, 8.

mm. Scales above lateral line in horizontal series which are throughout more or less distinctly parallel with the lateral line; snout long and pointed, 3 in head; pectoral fin long, 1¼ in head; color brownish, with faint silvery streaks along rows of scales on sides, a pale-blue streak along suborbital and preorbital; fins yellowish. Head, 2⅗; depth, 2⅗; D. x, 14; A. III, 18. Scales, 5–45–12........ ARGENTIVENTRIS, 9.

jj. Developed gill-rakers more numerous, about 10, with several rudiments before them (in *L. buccanella*; not examined in *L. lutjanoides*).

p. (Caudal deeply forked; mouth small, maxillary reaching posterior nostril; preopercle slightly notched, little serrate; canines strong; tongue with teeth; soft dorsal and anal rounded; pectoral pointed, 4½ in total length; color brownish-green, with 6 brown crossbands; a broad greenish stripe from opercle to base of caudal. D. x, 14; A. III, 8.) (*Poey*.) (Hybrid probably of *chrysurus-jocu*.)

LUTJANOIDES, 10.

pp. Caudal moderately forked; mouth large, maxillary reaching anterior edge of eye, 2⅗ in head; preopercle serrate, the serræ strong on angle; canines medium; vomerine teeth in an anchor-shaped patch; eye large; the base and axil of pectoral with a jet-black blotch; scales moderate, about 8 in oblique series from the lateral line to the first dorsal spine, about 63 vertical rows above lateral line; second anal spine long, about 2⅗ in head. Color crimson; caudal peduncle and caudal fin largely yellow; iris orange-red; no lateral blotch. Head, 2½; depth, 2⅖. D. x, 14. A. III, 8. Scales, 8–63–15.

BUCCANELLA, 11.

ii. Anal fin angulated, its median rays produced, the longest in adult at least half head; body rather robust; upper canines rather long; lower small; color more or less red, the young with a black lateral blotch.

q. Scales above the lateral line arranged in series which are not throughout parallel with the lateral line; side with a black blotch, which usually disappears with age; anal fin bright red.

r. Teeth on vomer in an anchor-shaped patch, with a median backward prolongation; lingual teeth well developed; snout rather pointed; maxillary reaching edge of pupil, 2½ in head; caudal edged with black.

s. Iris golden-yellow in life. Scales rather small, 9-52-10, about 50 pores in the lateral line; body rather slender, the depth 2½ in length; second anal spine about 3½ in head; gill-rakers 9 below angle; eye large, 4⅘ in head in adult; preorbital 5⅘ in head. Head, 2⅝ in length. D. x, 14; A. iii, 9. Color bright rose-red, with golden streaks.......VIVANUS, 12.

ss. Iris rose-red. Scales rather large, 8-46-14; body robust, the depth 2⅝ in length; second anal spine about 4 in head; gill-rakers about 8 below angle; eye moderate, 5½ to 6 in head in adult; preorbital 5. Head, 2⅗. D. x, 14; A. iii, 9. Color rose-red, nearly uniform; size large.
AYA, 13.

rr. Teeth in vomer in a Λ-shaped patch, without distinct prolongation on the median line; lingual teeth very few or none; snout rather pointed; maxillary reaching edge of eye, 2⅐ in head; scales rather small, 10-67-17; about fifty pores in lateral line; color, greenish above, rosy below; a small but distinct lateral blotch; young with oblique blue streaks above; fins mostly brick-red, especially the anal; a pearly streak below eye. Head, 2⅝; depth, 2⅜. D. x, 14; A. iii, 8. Scales, 10-67-17..ANALIS, 14.

qq. Scales above the lateral line arranged in series which are more or less distinctly parallel throughout with the lateral line; no black lateral blotch; scales rather large; 5 or 6 between first dorsal spine and lateral line; lateral line with 47 pores; vomerine teeth in a ⋀-shaped patch; lingual teeth well developed; maxillary reaching front of pupil, $2\frac{3}{4}$ in head; color red, dusky above; a blue streak on suborbital; anal and ventral fins dusky. Head, $2\frac{3}{4}$; depth, 3. D. x, 14; A. III, 7. Scales, 5-47-11.

COLORADO, 15.

hh. Soft dorsal with 12 rays (rarely 13); body oblong, the back not greatly elevated; upper canines moderate, lower small or obsolete; scales above lateral line in very oblique series; anal fin low, its outline rounded.

t. Mouth moderate; maxillary $2\frac{3}{5}$ to $2\frac{3}{4}$ in head.

u. Caudal not deeply forked; gill-rakers rather few (8 or 9 besides rudiments).

v. Pectoral short, $1\frac{2}{3}$ in head; teeth on vomer in an anchor-shaped patch; color olivaceous, no black lateral blotch; lower jaw included. Head, $2\frac{3}{4}$; depth, 3. D. x, 12; A. III, 8. Scales 8-51-x. (Hybrid *griseus-synagris?*) .....BRACHYPTERUS, 16.

vv. Pectoral long, more than two-thirds length of head; color chiefly red; a large black lateral blotch; lower jaw slightly projecting.

w. Vomerine teeth in an anchor-shaped patch, with a distinct backward prolongation on median line; color red; back and sides with rows of dark bluish-gray spots following the series of scales; similar spots on sides of head; fins reddish. Head, $2\frac{3}{4}$; depth, $2\frac{3}{4}$. D. x, 12; A. III, 8. Scales, 7-53-15......GUTTATUS, 17.

ww. Vomerine teeth in a ⋀ or ⩚ shaped patch, the prolongation on median line very short or wanting; color rosy greenish above, sides of head and body with numerous longitudinal stripes of golden yellow; soft dorsal and caudal red; lower fins yellow. Head, $2\frac{3}{5}$; depth, $2\frac{4}{5}$. D. x, 12; A. III, 8. Scales, 8-60-15.

SYNAGRIS, 18.

uu. Caudal deeply forked; the gill-rakers rather numerous, about 10 on lower part of the anterior arch; teeth on vomer in an anchor-shaped patch; body rather elongate, compressed; lower jaw projecting or not; eye small; scales small; the lateral line with about 50 pores; anal spines graduated. Color reddish, with horizontal yellow streaks; no black lateral blotch. Head, 3; depth, 3. D. x, 13; A. III, 9. Scales 9–53–15. (Hybrid *synagris-chrysurus?*). AMBIGUUS, 19.

tt. Mouth large; maxillary $2\frac{2}{5}$ in head; teeth on vomer in an anchor-shaped patch; lower jaw strongly projecting; body rather elongate, strongly compressed; eye very large, red; scales rather small, the lateral line with about 50 pores; caudal little forked; second and third anal spines subequal. Color dark brown; pale below, flushed with red; fins mostly red; a large black lateral blotch. Head, $2\frac{1}{2}$; depth, $2\frac{1}{3}$. D. x, 12; A. III, 8. Scales, 9–62–14. MAHOGONI, 20.

gg. Anal rays III, 10 to III, 11. (*Rabirubia* Jordan & Fesler.) Body slender; snout pointed; mouth moderate, the maxillary extending beyond the anterior edge of orbit; canines moderate; teeth on tongue well developed; vomerine patch of teeth anchor-shaped, with a sharp backward prolongation; scales above lateral line in very oblique series; pectoral fins short; caudal deeply forked; anal spines very small; color dusky, each scale with a shining silvery spot. Head, 3; depth, $3\frac{1}{4}$. D. x, 13; A. III, 11. Lat. l., 50 ....INERMIS, 21.

ff. Dorsal spines 11; body elongate; scales large, those above lateral line in about four series, which are fully parallel with the lateral line. (*Raizero* Jordan & Fesler.) Soft dorsal and anal low; vomerine teeth in a /\-shaped patch; lingual teeth present; gill-rakers few; color, brown, with distinct silvery stripes along the rows of scales, young with silvery crossbars; lower fins dusky. Head, 3; depth, $3\frac{1}{5}$. D. XI, 12; A. III, 7. Scales 5–45–12 ....ARATUS, 22.

2. LUTJANUS VIRIDIS.

Diacope viridis Valenciennes, Voyage de la Vénus, 1845, 303, pl. 1, f. 2 (very bad) (Galapagos Islands).
Genyoroge viridis, Günther, I, 180 (copied).
Lutjanus viridis, Jordan, Proceedings U. S. National Museum 1888, 330 (Tres Marias).

Habitat: Galapagos, Tres Marias, and Revillagigedos islands.

Etymology: *Viridis*, green, a very inappropriate name, as the species is brown with blue stripes.

This interesting species is a near ally of *Lutjanus kasmira* (Forskål) (=*L. bengalensis* Bloch). It belongs to the subgenus *Evoplites*, a group well represented in the East Indies, but with no other American allies. A single specimen was obtained by Alphonse Forrer, from the Tres Marias Islands, near Mazatlan. Several others have been since taken by Dr. C. H. Gilbert at the Revillagigedos Islands, where it is very abundant.

Lutjanus kasmira (from Swatow, China) differs from *Lutjanus viridis* in the following respects: Body deeper (depth $2\frac{3}{5}$); scales smaller (8) 12–62–22; the back more elevated and the profile steeper; snout, 3 in head; preorbital, 6; maxillary, $2\frac{3}{5}$; second anal spine, $3\frac{1}{5}$; lower lateral band wanting; a vague dark lateral blotch present, larger than eye; bands less sharply defined than in *L. viridis*, the pale-blue median streak in each band twice as wide as the dark border, the whole band narrower, its width one-third to one-fourth that of the golden-brown interspaces; no median dorsal streak.

3. LUTJANUS CANINUS.

? *Mesoprion pargus* Cuv. & Val., II, 473, 1828 (Puerto Rico).
Genyoroge canina Steindachner, Ichthyol. Notizen, IX, 18, 1869 (Lagos, Brazil).

Habitat: Brazilian fauna.

Etymology: *Caninus*, doglike, a reference to the canine teeth.

Steindachner's description of *Genyoroge canina* agrees in all respects with the young of *Lutjanus cyanopterus*, except that the preopercle in *L. caninus* is said to have the deep emargination found in *L. viridis* and in the group called *Genyoroge*. We accept it provisionally as a distinct species, solely on this character. The scanty description of *M. pargus* probably refers to a specimen of *L. cyanopterus*, but the statement "le tuberosité de son interopercule est assez prononcé" suggests *L. caninus*. The type, probably a dried skin, we have failed to find in the museum in Paris.

4. LUTJANUS NOVEMFASCIATUS. (Pargo Prieto.)

Lutjanus novemfasciatus Gill, Proc. Ac. Nat. Sci. Phila. 1862, 251 (Cape San Lucas, very young); Jordan & Gilbert, Proc. U. S. N. M. 1881; *ibid*, l. c., 1882, 360 and 365 (Cape San Lucas, Panama); *ibid*, Bull. U. S. F. C. 1882, 107, 110, 112 (Mazatlan, Panama, Punta Arenas); Jordan & Swain, l. c., 1884, 443; Evermann & Jenkins, Proc. U. S. N. M. 1891, 146 (Guaymas).

Mesoprion pacificus Bocourt, Ann. Sci. Nat. Paris, p. 223, 1868 (Tauesco, Pacific coast of Guatemala).

Lutjanus pacificus, Vaillant & Bocourt, Mission Scientifique au Mexique, 1881 (?), 123, pl. (?) III, f. 2.

Lutjanus prieto Jordan & Gilbert, Proc. U. S. N. M. 1881, 232, 338, 353, 355 (San Blas, Mazatlan); Jordan & Gilbert, l. c., 1882, 360, 361 (Cape San Lucas).

Habitat: Pacific coast of tropical America.

Etymology: *Novem*, nine; *fasciatus*, banded, a character seen only in the very young.

This large fish is the Pacific representative of *Lutjanus cyanopterus*, to which it bears a strong resemblance. In fact, except for the slightly smaller mouth of *L. novemfasciatus*, the two species are scarcely distinguishable. It is generally common on the Pacific coast of tropical America, and at Mazatlan it is known as *pargo prieto*. It was first described from very young specimens, which bear little resemblance to the adult, although comparisons of specimens have assured us of their identity. The nine crossbands, which suggested the inappropriate specific name of *novemfasciatus*, are characteristic only of the very young. The name *Mesoprion pacificus* was overlooked by Jordan and Gilbert, who published the first satisfactory account of the species under the name of *Lutjanus prieto*.

5. LUTJANUS CYANOPTERUS. (Cubera.)

Mesoprion cyanopterus Cuv. & Val., II, 472, 1828 (Brazil); Jordan, Proc. U. S. N. M. 1886, 534 (examination of type).

Lutjanus cyanopterus, Jordan & Swain, l. c., 534.

? *Mesoprion pargus* Cuv. & Val, II, 473, 1828 (Puerto Rico).

Mesoprion cynodon Poey, Repertorio, II, 268, 1868; Poey, Proc. Ac. Nat. Sci. Phila. 1863, 185 (Cuba; not of Cuv. & Val.).

Lutjanus cynodon Poey, Synopsis, 1868, 294.

Lutjanus cubera Poey, Ann. Lyc. Nat. Hist. N. Y., 75, 1871 (Cuba); Poey, Enumeratio, 1875, 27; Jordan & Swain, l. c., 442 (Havana).

Lutjanus dentatus (A. Duméril), Vaillant & Bocourt, Miss. Sci. au Mex., 1881, 125 (Brazil); Jordan, l. c. (examination of type)

Habitat: Pacific coast of tropical America.

Etymology: κυάνεος, blue; πτερόν, fin.

This species is common in the markets of Havana, where it is known as *cubera*. It grows to a very considerable size, and specimens of less than 5 pounds weight are very rare in the markets. But one specimen was obtained by Prof. Jordan, no others small enough to be readily preserved in alcohol being seen. A specimen from Carthagena, United States of Colombia, is in the museum at Cambridge. The species seems to have an indifferent reputation as a food-fish, being often unwholesome. It has always a ragged appearance in the market, its scales being less firmly attached than those of other species.

This species is very closely related to *L. griseus*, but so far as we have seen the two may always be distinguished by the difference in form of the vomerine patch of teeth and by the development of the canines of the lower jaw. These are larger in *L. cyanopterus* than in any other American species. This species is almost identical with *L. novemfasciatus* of the Pacific coast, the somewhat larger mouth being the most marked point of difference. The dusky area or spot at base of pectoral is more distinct in the Atlantic form. The *dentatus* of Duméril and the *cyanopterus* of Cuvier and Valenciennes are identical with *L. cubera* Poey. This is shown by the examination of the original types. *M. pargus* C. & V. is probably the same, as is possibly *Genyoroge canina* Steindachner.

6. LUTJANUS GRISEUS.

(Gray Snapper; Mangrove Snapper; Caballerote; Lawyer.)

Turdus pinnis branchialibus carens (Mangrove snapper), Catesby, Hist. Carolina, 1743, tab. 9.

Caballerote Parra, Descr. Dif. Piezas, Hist. Nat., 1787, taf. 25, f. 1.

Labrus griseus Linnæus, Syst. Nat., x, 1758, 283 (after Catesby); Linnæus, Syst. Nat., xii, 1766, 474; Gmelin, Syst. Nat., 1788, 1283 (copied); Bloch & Schneider, Systema Ichthyol., 1801, 268 (copied).

Lutjanus griseus, Jordan, Proc. U. S. N. M. 1884 (identification of Catesby's figure); Jordan & Swain, l. c., 439.

Sparus tetracanthus Bloch, Ichthyol., pl. 279, 1790 (on a drawing by Plumier).

Cichla tetracantha, Bloch & Schneider, Syst. Ichth., 1801, 338 (copied).

Anthias caballerote Bloch & Schneider, Syst. Ichth., 1801, 310 (after Parra).

Mesoprion caballerote Poey, Repertorio, ii, 1868, 157; Poey, Proc. Acad. Nat. Sci. Phila. 1863, 187 (Cuba).

Lutjanus caballerote, Poey, Synopsis, 293, 1868; Poey, Enumeratio, 1875, 26; Poey, Bull. U. S. F. C. 1882, 118 (Key West); Jordan & Gilbert, Syn. Fish. N. A., 1883, 921; Jordan, Bull. U. S. F. C. 1884 (Key West); Jordan, Proc. U. S. N. M. 1884, 126 (Key West).

Bodianus vivanet Lacépède, iv, pl. 4, f. 3, 1803 (Martinique; on a drawing by Plumier).

Mesoprion griseus, Cuv. & Val., Hist. Nat. Poiss., ii, 1828, 469 (San Domingo); Guichenot, Ramon de la Sagra, Hist. Cuba, 26 (Cuba); Günther, i, 194, 1859, (Cuba, Jamaica, Puerto Cabello, British Guiana).

Lutjanus griseus, Cope, Trans. Am. Philos. Soc. 1871, 470 (St. Kitt's).

Lobotes emarginatus Baird & Girard, 9th Smithsonian Rept. 1855, 332 (Beesley Point, New Jersey).

Neomænis emarginatus, Gill, Proc. Ac. Nat. Sci. Phila. 1861, 94 (Beesley Point).

Lutjanus caxis, Gill, Rept. U. S. F. C. 1872–73, 806; Goode, Bull. U. S. N. M. 1879, 137 (West Florida); Jordan, *op. cit.*, 1880, 19 (Indian River, Florida); Bean, *op. cit.*, 1880, 96 (Bermuda); Jordan & Gilbert, Syn. Fish. N. A., 1883, 578 (not *Sparus caxis* Bloch & Schneider).

Lutjanus stearnsi Goode & Bean, Proc. U. S. N. M. 1878, 179 (Pensacola); Jordan & Gilbert, Syn. Fish. N. A., 1883, 549 (copied); Bean & Dresel, Proc. U. S. N. M. 1884, 163 (Jamaica).

Habitat: New Jersey to Florida and Brazil.

Etymology: *Griseus*, gray.

This species is very common along our South Atlantic and Gulf coasts and occasionally strays northward as far as New Jersey, being the northernmost in its range of any member of the genus in the Atlantic. It is everywhere known as the "gray snapper." In Florida and the Bahamas, where the coasts are lined by mangrove bushes, among which the young of this species abound, the name "mangrove snapper" comes into use. The name "lawyer" is also occasionally heard, in allusion to the skill shown by the species in eluding nets. To the Spanish fishermen of Cuba and Key West the species is, as in the time of Parra, known as *caballerote*. It inhabits waters of varying depths, large specimens being often found very near the shore, while others may be taken in waters of considerable depth, in company with *Lutjanus aya*. These latter individuals are much redder than those found in shoal water; their color is paler and the body is in general a trifle less elongate. Such correspond to the form named *Lutjanus stearnsi*.

The synonymy of this species is considerable. It is evidently the *Caballerote* of Parra, as Professor Poey has shown, and therefore the *Anthias caballerote* of Bloch & Schneider. Earlier than this comes *Labrus griseus* L., based on the Mangrove Snapper of Catesby, a rough and inaccurate figure, but still resembling this species, and like the *Caballerote* identifiable by the persistent vernacular name. *Sparus tetracanthus* appears to be the same, as also *Bodianus vivanet*. *Mesoprion griseus* Cuv. & Val. is identified by Poey with *Lutjanus caxis*, but to us the description resembles much more the present species, which has thus twice received the specific name of *griseus*. *Lobotes emarginatus* is based on a young specimen of *Lutjanus griseus*, afterwards made the type of the genus *Neomænis*.

The identification by Poey of *Lutjanus caxis* with *Mesoprion griseus* has led American writers to suppose this species to be the true *Lutjanus caxis*, an error only recently corrected. The true *L. caxis*, the *cají* of the Havana markets, has not yet been seen north of Key West.

Lutjanus stearnsi, described from Pensacola, we are unable to separate from ordinary deep-water specimens of *L. griseus*. So far as we can see, the gradation is perfect. This identity has been already recognized by Dr. Bean.

Dr. Günther identifies with his *Mesoprion griseus* one or two species described by Cuvier and Valenciennes from the west coast of Africa. It is impossible from the brief descriptions to settle this question, and the confusion in the synonymy given by Dr. Günther shows that his material was insufficient to form any definite opinions.

This species is closely allied to *L. caxis* on the one hand, and to *L. cyanopterus* on the other; the former is deeper and differently colored, as already stated; the latter is similar in form and color, but has the dentition of lower jaw and vomer different. *L. griseus* rarely exceeds 6 or 8 pounds in weight. Specimens are in the Museum at Cambridge from Gonaives, Haiti, Maranhão, and the Bermudas.

7. LUTJANUS JOCÚ. (Dog Snapper; Jocú.)

Jocú Parra, Descr. Dif. Piezas, Hist. Nat., I, 1787, tab. 25, f. 2 (Cuba).
Anthias jocú Bloch & Schneider, Syst. Ichthy., 310, 1801 (based on Parra).
Mesoprion jocú, Cuv. & Val., II, 466, 1828 (Antilles, Martinique); Poey, Repertorio, 268, 1867 (Cuba).
Lutjanus jocú, Poey, Synopsis, 292, 1868 (Cuba); Poey, Enumeratio, 26, 1873; Vaillant & Bocourt, Miss. Sci. au Mex., IV, 1881,? 129, pl. V, f. 19, synonymy much confused; Jordan, Proc. U. S. N. M. 1884, 125 (Key West); Jordan & Swain, l. c., 435; Jordan, Proc, U. S. N. M. 1890, 319 (Bahia); Jordan, l. c., 1889, 648 (St. Lucia).
Mesoprion litura Cuv. & Val., II, 467, 1828 (Cayenne, St. Thomas); Jordan, l. c., 1886, 524 (examination of type).
Mesoprion cynodon, Günther, I, 194, 1859 (San Domingo, Jamaica; not of Cuv. & Val.; excl. syn.).

Habitat: West Indies, north to Florida Keys, south to Bahia.

Etymology: From Cuban name *jocú*.

This species is about equally abundant with *L. caxis* about Florida Keys and Cuba. The English-speaking fishermen call it "dog snapper," the Spanish "*jocú*." The fishermen usually distinguish the *jocú* by the presence of a pale area below the eye, but the only certain distinction lies in the size of the scales. These are much smaller in *L. jocú* than in *L. caxis*. *Mesoprion litura* Cuv. & Val. is this species, as is also apparently *Mesoprion cynodon* Günther. In the synonymy of the latter species several distinct species are confounded, as also by Vaillant & Bocourt under the name *Lutjanus jocú*.

Specimens of *L. jocú* from Bahia and Maranhão are in the museum at Cambridge.

8. LUTJANUS CAXIS. (Schoolmaster; Cají.)

?*Perca marina pinnis branchialibus carens* (Schoolmaster), Catesby, Hist. Carolina etc., 1743, tab. 41 (Bahamas; figure very poor, the pectoral fins omitted; may be *L. jocú*).
Caxis Parra, Descr. Dif. Piezas, Hist. Nat., 1787, tab. 8, f. 2 (Havana).
?*Perca apoda* ("Forster, Catal. of Anim., 21, MS. 1774; printed 1844), Walbaum, Artedi, Piscium, 1792, 351 (based on the Schoolmaster of Catesby).
Sparus caxis Bloch & Schneider, Ichthyol., 1801, 284 (after Parra).
Mesoprion caxis, Poey, Repertorio, II, 269, 1868.
Lutjanus caxis, Poey, Synopsis, 1868, 293 (Cuba); Poey, Enumeratio, 1875, 25; Jordan, Proc. U. S. N. M. 1884, 125 (Key West), (not of several American writers); Jordan & Swain, l. c., 435 (Key West, Havana); Jordan, l. c., 1889, 648 (St. Lucia); Jordan, l. c., 1890, 319 (Bahia).
Bodianus striatus Bloch & Schneider, Syst. Ichth., 1801, 335, tab. LXV (West Indies; misprinted *albostriatus*, p. 237; called *B. fasciatus* on plate).
Lutjanus acutirostris Desmarest, Prem. Déc. Ichthyol., 12, tab. 3, 1823 (Cuba).
Mesoprion cynodon, Cuv. & Val., II, 465, 1828 (Martinique, San Domingo); Bocourt, Ann. Nat. Hist., Paris, 1868, 224; Jordan, Proc. U. S. N. M. 1886, 534 (examination of type).
Mesoprion linea Cuv. & Val., II, 468, 1828 (Cuba, San Domingo); Jordan, l. c.
Mesoprion flavescens Cuv. & Val., II, 472, 1828 (Martinique); Jordan, l. c.
Mesoprion albostriatus Peters, Berliner Monatsberichte, 1865, 111 (on the type of Bloch & Schneider).

Habitat: West Indies, north to Key West, south to Bahia.

Etymology: The plural of the Cuban name, *cají*, formerly spelled *caxí*.

This species is very abundant in the markets of Havana, where it is still known as *cají* (in old Spanish *caxí*, of which "*caxis*" is a plural form). This persistence of the common name is the only certain basis of identification of Parra's *Caxis*. It is almost equally common at Key West, where, as in Catesby's time, it is known as the "schoolmaster." The latter name is, however, indifferently applied by the fishermen to *Lutjanus jocú* also.

There seems to be little doubt, in spite of the difference in color, which seems to be the fault of the printer, that the *acutirostris* of Duméril is *L. caxis*. We have examined the original types of *cynodon*, *linea*, and *flavescens*, which are identical with *L. caxis*.

Peters adopts Schneider's name *albostriatus* (apparently originally a mere slip of the pen for *striatus*), "because another species has been lately named *Mesoprion striatus*." Peters identified Schneider's type with "*Mesoprion linea* C. & V."

This species is closely allied to *L. griseus* and still more nearly to *L. jocú*. The latter is very similar in form and coloration, but has decidedly smaller scales. The former is more elongate, and has the vertical fins always dark, while in *caxis* and *jocú* yellowish colors predominate.

Specimens of *L. caxis* are in the museum at Cambridge from Cuba, Sombrero, and Jérémie, Haiti. A specimen from Pernambuco is more elongate (depth $2\frac{4}{5}$ in length), and the lower teeth a little stronger.

We provisionally reject the name *apoda*, although older than *caxis*, because it may have been intended either for this species or *jocú*, while the bad figure must have been drawn from memory by Catesby. Not one fisherman in ten in the Florida Keys can distinguish the "schoolmaster" from the "dog snapper." The fishermen of Cuba are, however, more skillful in separating their *cají* from the *jocú*.

9. LUTJANUS ARGENTIVENTRIS. (Pargo Amarillo.)

Mesoprion argentiventris Peters, Berlin. Monatsber., 1869, 704 (Mazatlan).

Lutjanus argentiventris, Jordan, Proc. Ac. Nat. Sci. Phila. 1883, 285 (Mazatlan); Jordan & Swain, l. c., 434 (Mazatlan, Panama); Evermann & Jenkins, Proc. U. S. N. M. 1891, 146 (Guaymas).

Mesoprion griseus, Günther, Fishes Central America, 1863, 385 (name only; not of Cuv. & Val.).

Lutjanus argentivittatus, Jordan & Gilbert, Proc. U. S. N. M. 1881, 354; Jordan & Gilbert, Bull. U. S. F. C. 1882, 107, 110 (Mazatlan, Panama); Jordan & Gilbert, Proc. U. S. N. M. 1882, 625 (Panama), (*lapsus calami* for *argentiventris*).

Habitat: Pacific coast of tropical America.

Etymology: *Argenteus*, silvery; *venter*, belly.

This species, the *pargo amarillo* of the Mazatlan fishermen, is generally common on the Pacific coast of Mexico and Central America. It bears considerable resemblance to *L. caxis*, *jocú*, and *griseus*, but is distinct from all of these.

Our specimens are from Mazatlan and Guaymas. Specimens from Panama are in the museum at Cambridge.

10. LUTJANUS LUTJANOIDES.

Ocyurus lutjanoides Poey, Ann. Lyc. Nat. Hist., IX, 319, 1871 (Cuba).
Lutjanus lutjanoides Poey, Enumeratio, 1875, 30; Jordan & Swain, l. c.

Habitat: Cuba. One specimen known.

Etymology: *Lutjanus*: εἶδος, form.

This species is known to us only from the description of Poey, who has suggested the possibility of its being a hybrid between *O. chrysurus* and *L. caxis*. It is not unlikely that it is a hybrid, but its smaller scales suggest its relationship to *L. jocú* rather than to *L. caxis*.

11. LUTJANUS BUCCANELLA. (Sesí de lo Alto; Oreille Noire.)

Mesoprion buccanella Cuv. & Val., II, 1828, 455 (Martinique); Guichenot, Ramon de la Sagra, Cuba, 23 (Cuba); Günther, I, 198 (Cuba, Jamaica).
Lutjanus buccanella, Poey, Synopsis, 1868, 295; Poey, Enumeratio, 27; Jordan & Swain, l. c.; Jordan, l. c., 1889, 648 (St. Lucia).
Mesoprion caudanotatus Poey, Memorias, I, 440, about 1858, tab. 3, f. 2 (Cuba, young); Poey, Repert., II, 158, 1868.

Habitat: West Indies.

Etymology: *Boucanelle*, a name used in Martinique.

This small and strongly marked species is common in the deeper waters about Havana, and is known in the markets as *sesí* or *sesí de lo alto*. A specimen was taken by the *Albatross* at St. Lucia. The synonymy of the species offers no difficulty. A young specimen was once described by Poey as a distinct species under the name of *Mesoprion caudanotatus*, but its identity with *L. buccanella* is unquestionable.

12. LUTJANUS VIVANUS. (Pargo de lo Alto; Silk Snapper.)

Mesoprion vivanus Cuv. & Val., II, 454, 1828 (Martinique); Jordan, Proc. Ac. Nat. Sci. Phila. 1883, 286; Jordan, Proc. U. S. N. M. 1886 (examination of types) (not *Lutjanus vivanus* Jordan & Swain).
Lutjanus vivanus, Jordan, l. c., 1889, 648 (St. Lucia).
Mesoprion aya Cuv. & Val., II, 1828, 457 (San Domingo); Guichenot, Ramon de la Sagra, Hist. Cuba, 24 (Cuba); Günther, I, 198, 1859 (Jamaica); Poey, Repertorio Pisc. Cubens., I, 1867, 267 (probably not *Bodianus aya* Bloch).
Mesoprion profundus Poey, Memorias, II, 150, 1860 (Cuba); Poey, Repertorio, II, 1868, 157; Poey, Synopsis, 1868, 294.
Lutjanus profundus Poey, Enumeratio, 1875, 28; Jordan & Swain, l. c.
Lutjanus purpureus Poey, Enumeratio Pisc. Cubens., 1875, 29 (name taken from *Mesoprion purpureus* Cuv. & Val., II, 471, 1828; the name *purpureus* evidently a slip of the pen for *aya*).
Lutjanus torridus Cope, Trans. Am. Philos. Soc., 468, 1869 (St. Kitts).

Habitat: West Indies.

Etymology: From the French name *vivanet*, used at Martinique, probably allied to *vivax*, "lively."

This handsome species is rather common in the markets of Havana, where it is known as the *pargo de lo alto*. When fresh it may always be known by the bright yellow color of the eye, a color which does not entirely fade in spirits. It is evidently the *Mesoprion aya* of Cuvier & Valenciennes, but it is apparently not the original *Bodianus aya* of Bloch, as the latter species is said by Marcgrave and Bloch to have the iris red.

Poey recognizes, under the name of *Lutjanus purpureus*, a second species, which differs from *L. profundus* only in having small scales very close to the eye. This seems to be a character of little importance on which to recognize a distinct species.

The name *purpureus* is credited to Cuvier, but, in the single place (vol. II, p. 457) where the name occurs, *purpureus* is evidently a mere slip of the pen for *aya*. Probably it was originally a manuscript name, for which the latter name, from Bloch, was taken.

Lutjanus torridus, loosely described and poorly figured by Prof. Cope, seems to be this species rather than the red snapper, as it has been formerly identified by us. We have examined Cope's type in the Museum of the Academy at Philadelphia. It is 11 inches long and in poor condition, but it probably belongs to *L. vivanus* rather than to *L. aya*.

In the review of this genus by Jordan and Swain, the close relations of *L vivanus* with *L. aya* were not apprehended. The two species are in fact very similar in structural characters, *L. vivanus* being distinguished chiefly by the slenderer body, smaller scales, longer anal spines, more numerous gill-rakers, and larger eye, the iris of which is always bright yellow. The types of *Mesoprion vivanus* must be referred to the present species rather than to *L. aya*, unless, a very improbable supposition, they represent still another species not yet recognized. We are therefore obliged to adopt for the "*pargo de lo alto*" the name of *L. vivanus*, rather than the appropriate one of *L. profundus* given to it by Prof. Poey.

13. LUTJANUS AYA.

(Red Snapper; Pargo Colorado; Pargo Guachinango.)

Acara aya Marcgrave, Hist. Brasil., 167, 168, 1648.
Bodianus aya Bloch, Ichthyol., taf. 227, 1790 (based on Marcgrave); Lacépède, IV, 286, 287, 1803 (copied).
Lutjanus aya, Goode, Bull. U. S. N. M., V, 1876, 55 (Bermudas); Jordan, Man. Vert., ed. 5, 1888, 139.
Bodianus ruber Bloch & Schneider, Syst. Ichthy., 1801, 330 (based on Marcgrave).
Lutjanus vivanus, Jordan & Swain, l. c., 453 (not type).
Mesoprion campechanus Poey, Mem., II, 149, 1860 (Cuba).
Lutjanus campechianus Poey, Syn., 294, 1868 (Cuba); Poey, Ann. Lyc. Nat. Hist. N. Y., 317, 1870 (Cuba); Poey, Enumeratio, 29, 1875 (Cuba); Poey, Bull. U. S. F. C. 1882, 118 (Key West); Jordan & Gilbert, Syn. Fish. N. A., 1883, 921 (copied); Jordan, Proc. U. S. N. M. 1884, 125 (Key West).
Lutjanus blackfordi Goode & Bean, Proc. U. S. N. M. 1878, 176 (Pensacola); Goode, Proc. U. S. N. M. 1879, 114 (St. Johns River); Goode & Bean, *op. cit.*, 1879, 137, 156 (Pensacola); Bean, *op. cit.*, 1880, 96; Goode & Bean, *op. cit.*, 1882, 238; Jordan & Gilbert, *op. cit.*, 1882, 275 (Pensacola); Jordan & Gilbert, Syn. Fish. N. A., 1883, 549; and of Goode & Bean and recent American writers generally.

Habitat: Long Island to Brazil; especially abundant in the Gulf of Mexico.

Etymology: From the Portuguese name, *Acara aya*.

This species, the most valuable food-fish of the genus in the waters of the United States, is very abundant in rather deep water in rocky places around the Florida coast. At Pensacola it is taken in great numbers. It is one of the most important food-fishes of our southern coasts. About Key West it is also taken in large numbers, but only in the deep waters, and it is taken thence alive in the wells of the fishing smacks to the markets of Havana. On the American coast it is known everywhere as "red snapper," or to the Spaniards as *pargo colorado*. In Havana it bears the name of *pargo guachinango*, "Mexican snapper," because it is brought to that city from the Mexican coast. According to Poey it is comparatively rare in Cuban waters, although daily seen in the markets. Specimens are in the museum at Cambridge, from Rio Janeiro; these seem to be entirely similar to the red snapper of our markets; in some of these the stomach is wrong side out, indicating that they came from deep water.

The synonymy is somewhat complicated, and some doubt exists as to the proper specific name. We identify the names *aya* and *ruber*, based on the *Acara aya* of Marcgrave, as belonging to the common red snapper. This is said to be a red *Lutjanus*, 3 feet in length, and with a red circle around its iris; it is therefore far more likely to have been this species than the small *Lutjanus vivanus*, with which it has been identified by Cuvier. As this species occurs on the Brazilian coast, and as it corresponds to Marcgrave's and Bloch's descriptions, there is not much doubt as to its identity, the more so as it is probable that all the large *Lutjani* of our waters are now known.

The type of *Mesoprion campechanus* examined by us at Havana is a stuffed skin of a young fish apparently belonging to this species. In this specimen the eye is larger than it should be in a red snapper of that size, it being, as Poey has correctly stated, 4 in head. This large size is, however, probably due to the shrinkage of the orbit in drying. Poey also counts "65 scales above the lateral line and 53 below," a larger number than others count in this species. This difference is doubtless dependent on the method of counting.

The type of *Lutjanus blackfordi* is of course the present species, and the first good description of the species is that published by Goode & Bean under this name. We are forced, however, to adhere to our original view, that the name *campechanus* certainly belongs to the same fish, and the still older name *aya* is as well authenticated as the names given by Bloch are likely to be. We can not therefore make use of the name *blackfordi* as the specific name of the red snapper.

14. LUTJANUS ANALIS. (Mutton-fish; Pargo; Pargo Criollo.)

Anthias quartus rondeleti (Mutton-fish), Catesby, Nat. Hist. Carolina, 1743.

Mesoprion analis Cuv. & Val., II, 452, 1828 (San Domingo); Poey, Memorias, II, 146, 1860, tab. 13, fig. 9 (Cuba); Poey, Repertorio, I, 266, 1867 (Cuba); Poey, Synopsis, 294, 1868 (Cuba).

Lutjanus analis, Poey, Enumeratio, 1875, 29 (Cuba); Jordan, Proc. U. S. N. M. 1884, 125 (Key West); Vaillant & Bocourt, Miss. Sci. au Mexique, 1881, 119, pl. V; Jordan & Swain, l. c.; Jordan, l. c., 1889, 648 (St. Lucia); Jordan, l. c., 1890, 319 (Bahia).

Mesoprion sobra Cuv. & Val., II, 453, 1828 (Martinique); Guichenot, in Ramon de la Sagra, Hist. Cuba, Poiss., 22; Günther, I, 209.

Mesoprion isoodon Cuv. & Val., IX, 443, 1833 (San Domingo).

Mesoprion isodon, Günther, I, 1859, 206 (copied).

Mesoprion vivanus Günther, I, 263, 1859 (Jamaica, Bahia; not of Cuv. & Val.).

Lutjanus vivanus, Cope, Trans. Am. Philos. Soc., 1869, 470 (New Providence, St. Croix).

?*Mesoprion rosaceus* Poey, Ann. Lyc. Nat. Hist. N. Y., IX, 317, 1870 (Cuba).

?*Lutjanus rosaceus* Poey, Enumeratio, 1875, 30.

Habitat: Pensacola to Brazil.

Etymology: *Analis*, from the elevated anal fin.

This species is rather common at Key West, where, as elsewhere in the West Indies, it is known as mutton-fish. At Havana it is the *pargo* (*par excellence*) or *pargo criollo*. It is perhaps the most important food-fish of the Havana markets, being always abundant and its flesh always healthful. It reaches a large size, and its flesh is fairly flavored, although not very delicate.

The names *analis* and *sobra* of Cuvier & Valenciennes seem to belong to this species without question. *Mesoprion isodon* is identified by Vaillant with *L. analis* on comparison of typical examples. *Lutjanus rosaceus* is described as a distinct species from a large specimen 27½ inches in length. The only tangible distinction which we find in the long description is that the eye is one-sixth the length of the head, while in *L. analis* of the same size the eye is 8½ in the head. We hesitate to admit *L. rosaceus* as distinct from *L. analis*. The larger eye and redder coloration perhaps indicate a specimen from deeper water than usual.

Specimens of this species are in the museum at Cambridge from Nassau, Rio Janeiro, and Rio Grande do Norte.

15. LUTJANUS COLORADO. (Pargo Colorado.)

Lutjanus colorado Jordan & Gilbert, Proc. U. S. N. M. 1881, 338, 351, 355 (Mazatlan); Jordan & Gilbert, Bull. U. S. N. M. 1882, 107, 110 (Mazatlan, Panama); Jordan & Swain, l. c.; Evermann & Jenkins, Proc. U. S. N. M. 1891, 147 (Guaymas).

Habitat: Guaymas to Panama.

Etymology: Spanish, *colorado*, red (colored), in allusion to the common name *pargo colorado*.

16. LUTJANUS BRACHYPTERUS.

Lutjanus brachypterus Cope, Trans. Am. Phil. Soc. 1871, 470 (New Providence); Jordan and Swain, l. c., 447 (description of type).

Habitat: Bahama Islands.

Etymology: βραχύς, short; πτερόν, fin.

Of this species, a single specimen only is known. It is allied to *L. griseus*, although apparently distinct from that species and from all others known to us. In its technical characters it approaches most closely to *L. synagris*, near which species it is convenient to place it in our analytical key. If we suppose the type of *L. ambiguus* to be a hybrid, *synagris-chrysurus*, we may suspect *L. brachypterus* to represent a hybrid of *griseus* and *synagris*. The evidence in the latter case is less striking than in the former.

17. LUTJANUS GUTTATUS. (Flamenco.)

Mesoprion guttatus Steindachner, Ichthyol. Notizen, IX, 18, 1869, taf. VIII (Mazatlan).
Lutjanus guttatus, Jordan & Gilbert, Proc. U. S. N. M. 1881, 354; Jordan & Gilbert, *op. cit.*, 1882, 625 (Panama); Jordan & Gilbert, Bull. U. S. F. C. 1882, 107, 110 (Mazatlan, Panama); Jordan & Swain, l. c.; Evermann & Jenkins, Proc. U. S. N. M. 1891, 147 (Guaymas); Jordan, l. c., 1889, 181 (Panama).

Habitat: Guaymas to Panama.

Etymology: *Guttatus*, spotted.

This species represents *Lutjanus synagris* on the Pacific coast. It is a common food-fish at Guaymas, Mazatlan, and Panama.

18. LUTJANUS SYNAGRIS. (Lane Snapper; Biajaiba.)

Salpa purpurescens variegata (Lane Snapper), Catesby, Hist. Nat. Carol. 1743, tab. 17.

Sparus synagris Linnæus, Syst. Nat., x, 280, 1758 (after Catesby); Linnæus, *op. cit.*, XII, 470; Gmelin, Syst. Nat., 1788, 1275; Bloch & Schneider, Syst. Icth., 1801, 274 (copied).

Lutjanus synagris, Poey, Enumeratio, 1875, 27 (Cuba); Poey, Bull. U. S. F. C. 1882, 118 (Key West); Jordan & Gilbert, Syn. Fish. N. A., 1883, 922; Jordan, Bull. U. S. F. C. 1884 (Key West); Jordan, Proc. U. S. N. M. 1884, 125 (Key West); Jordan & Swain, l. c.; Jordan, l. c., 1889, 648 (St. Lucia); Jordan, l. c., 1890, 319 (Bahia).

Sparus vermicularis Bloch & Schneider, Syst. Ichth., 1801, 275 (on a drawing by Plumier).

Lutjanus aubrieti Desmarest, Prém. Dec. Ichth., 17, 1823, pl. 2 (Cuba); Vaillant & Bocourt, Miss. Sci. Mex., 1881 (?), 126 (Jamaica, Hayti, Cuba, Montevideo).

Mesoprion uninotatus Cuv. & Val., II, 449, 1828 (San Domingo, Martinique); Agassiz, Spix, Pisc. Brasil., 1829, pl. 65; Castelnau, Anim. Nouv. ou rares Amér. Sud, 4; Guichenot, Ramon de la Sagra, Cuba, 21; Günther, I, 202, 1859 (Cuba, Puerto Cabello, San Domingo, Jamaica, Bahia).

Lutjanus uninotatus, Poey, Synopsis, 1868, 294; Cope, Trans. Am. Philos. Soc. 1871, 470 (St. Martin's).

Habitat: Florida Keys to Aspinwall and Brazil.

Etymology: *συναγρίς*, an old name of *Dentex dentex*, a species which this one was thought to resemble.

This species is very common almost everywhere from Tampa to Brazil. It reaches but a small size, rarely exceeding a foot, and it inhabits chiefly shallow waters. It is known about the Florida Keys and Bahamas as "lane snapper," and in Cuba as "*biajaiba*." In Havana it is one of the most common food-fishes, in abundance not exceeded by any other species. Its strongly marked coloration renders its recognition from descriptions easy, and little doubt exists in its extensive synonymy.

There is no doubt whatever as to the species intended by the lane snapper of Catesby. The name *synagris* of Linnæus is, therefore, without doubt the one which should be retained for the species.

Specimens of *L. synagris* are in the Museum at Cambridge, from Gonaives and Jérémie, Haiti, Porto Seguro, Havana, Ceara, Rio Janeiro, Maranhão, and Victoria.

19. LUTJANUS AMBIGUUS.

Mesoprion ambiguus Poey, Memorias Cuba, II, 152, 1860, tab. 12, f. 4; tab. 13, f. 18 (Cuba); Poey, Synopsis, 295.

Lutjanus ambiguus Poey, Enumeratio, 1875, 30; Jordan and Swain, l. c.

Habitat: Cuba.

Etymology: *Ambiguus*, uncertain.

This species is very well distinguished from *Lutjanus synagris* and from *Ocyurus chrysurus*; but it presents such a singular blending of the characters of the two as to lend much probability to Poey's conjecture that it is a hybrid of *Lutjanus synagris* with *Ocyurus chrysurus*. Two specimens are known, the one sent by Poey to the U. S. National

Museum and described in the paper of Jordan & Swain; the other, sent by Poey to the Museum at Cambridge, is very similar, with well-forked caudal and numerous gill-rakers. The lower jaw is, however, scarcely projecting, and the pectoral short, $1\frac{3}{5}$ in head.

20. LUTJANUS MAHOGONI. (Ojanco.)

Mesoprion mahogoni Cuv. & Val., II, 447, 1828 (Martinique); Günther, I, 203 (copied); Jordan, Proc. U. S. N. M. 1886 (examination of type).

Lutjanus mahogoni, Jordan & Swain, l. c.

Mesoprion ricardi Cuv. & Val., II, 447, 1828 (Martinique); Jordan, l. c. (exam. of type).

Mesoprion ojanco Poey, Memorias, II, 150, tab. 13, f. 10, 1860 (Cuba); Poey, Synopsis, 295, 1868.

Lutjanus ojanco Poey, Enumeratio, 1875, 28 (Cuba).

Habitat: West Indies.

Etymology: *Mahogoni*, the English mahogany, from the brown coloration.

This species is rather common in the markets of Havana, where it is known as *ojanco*, in allusion to the large eye. It does not reach a large size. This is, of course, the species described by Poey under the name of *Lutjanus ojanco*. The types of *M. mahogoni* and *M. ricardi*, examined by us in Paris, are the same as Poey's species.

21. LUTJANUS INERMIS.

Mesoprion inermis Peters, Berliner Monatsber., 1869, 705 (Mazatlan).

Lutjanus inermis Jordan, Proc. Ac. Nat. Sci. Phila. 1883, 285 (Mazatlan); Jordan & Swain, l. c., 459; Jordan & Bollman, l. c., 1889, 181 (Panama).

Habitat: Mazatlan to Panama.

Etymology: *Inermis*, unarmed.

Only two specimens known; one is in the Museum at Berlin and is said to have come from Mazatlan; the other was taken by the *Albatross* at Panama. It is quite unlike any other American species. It is perhaps related to *Lutjanus mitchilli*, a species lately described by Dr. Günther, from Madras.

22. LUTJANUS ARATUS. (Pargo Raizero.)

Mesoprion aratus Günther, Proc. Zoöl. Soc. Lon. 1864, 145 (Panama, Chiapas); Vaillant & Bocourt, Miss. Sci. au Mexique, 1881, 122 (Chorera, near Panama).

Lutjanus aratus, Jordan & Gilbert, Proc. U. S. N. M. 1881, 355; Jordan & Gilbert, *op. cit.*, 1882, 625 (Panama); Jordan & Gilbert, Bull. U. S. F. C. 1882, 107, 110, 112 (Mazatlan, Panama, Punta Arenas); Jordan & Swain, l. c., 460.

Habitat: Pacific coast of tropical America.

Etymology: *Aratus*, plowed, from its striped coloration.

This species, the "*pargo raizero*" of the Mazatlan fishermen, is generally common on the Pacific coast and reaches a considerable size. It bears little resemblance to any other American species, its squamation resembling that of *Hæmulon maculicauda*. Specimens from Panama are in the museum at Cambridge.

III. OCYURUS.

Ocyurus Gill, Proc. Ac. Nat. Sci. Phila. 1862, 236 (*chrysurus*).

Type: *Sparus chrysurus* Bloch.

Etymology: ὠκύς, swift; οὐρά tail.

The skull of the single species now referred to *Ocyurus* deviates so far from that of the ordinary *Lutjanus* that its separation as a distinct genus seems to be fully justified. The species shows numerous minor peculiarities, as the peculiar form of the body, the large caudal fin, the small head, as well as an increased number of gill-rakers and the presence (in the adult) of pterygoid teeth.

ANALYSIS OF SPECIES OF OCYURUS.

a. Gill-rakers long and numerous, about 20 developed on lower part of arch; mouth small; lower jaw projecting; canines small, in upper jaw only; body elliptical, elongate, with very slender caudal peduncle; caudal fin deeply forked, longer than head; eye small; occipital keel high; preorbital narrow; teeth on vomer in an anchor-shaped patch; adult with a narrow band of teeth on pterygoids; scales small, those above lateral line in very oblique series; soft dorsal and anal low; anal spines weak; olivaceous, somewhat rosy-tinged; a broad yellow lateral band, with yellowish blotches above it and some yellow streaks below it; caudal deep yellow; other fins mostly yellow. Head, 3¼ in length; depth, 3. D. x, 13; A. III, 8 or 9. Scales 8–65–16 .... CHRYSURUS, 23.

23. OCYURUS CHRYSURUS. (Yellow-tail; Rabirubia.)

Acara pitamba Marcgrave, Hist. Brasil., 1648, 155.

Rabirubia Parra, Descr. Dif. Piezas, Hist. Nat., pl. 20, f. 1, 1787 (Cuba).

Sparus chrysurus Bloch, Ichthyol., taf. 262, 1790 (after Marcgrave); Lacépède, Hist. Nat. Poiss., IV, 115, 1803 (copied).

Grammistes chrysurus, Bloch & Schneider, Syst. Ichth., 1801, 187 (copied).

Mesoprion chrysurus, Cuv. & Val., II, 459, 1828 (Martinique); Guichenot, Ramon de la Sagra, Hist. Cuba, 24, about 1850 (Cuba); Günther, I, 186, 1859 (Puerto Cabello, Jamaica, Trinidad).

Ocyurus chrysurus Gill, Proc. Ac. Nat. Sci. Phila., 1862, 236 (name only); Poey, Synopsis, 295, 1868; Cope, Trans. Am. Philos. Soc., 1871, 468 (St. Martins, New Providence, St. Croix); Poey, Enumeratio, 1875, 40 (Cuba); Poey, Bull. U. S. F. C. 1882, 118 (Key West); Jordan & Swain, l. c.; Jordan, l. c., 1890, 319 (Bahia).

Lutjanus chrysurus, Vaillant, Miss. Sci. au Mexique, 1875, 133, pl. V; Jordan & Gilbert, Syn. Fish. N. A., 1883, 921; Jordan, Proc. U. S. N. M. 1884, 125 (Key West).

Anthias rabirubia Bloch & Schneider, Syst. Ichth., 1801, 309 (after Parra).

Sparus semiluna Lacépède, Hist. Nat. Poiss., IV, 141, 1803 (on a copy of a drawing by Plumier).

Mesoprion aurovittatus Agassiz, Spix, Pisc. Brasil., pl. 66, 1829 (Brazil).

Ocyurus aurovittatus, Poey, Syn. Pisc. Cubens., 1868, 295; Poey, Enumeratio, 31 (Cuba).

Ocyurus melanurus, Goode, Proc. U. S. N. M. 1879, 114 (name only; after *Perca melanura* L., which is a *Hæmulon* and not a *Lutjanus*).

Lutjanus melanurus, Jordan & Gilbert, Syn. Fish. N. A., 1883, 548.

Ocyurus rijgersmæi Cope, Trans. Am. Phil. Soc. 1871, 468 (St. Kitts).

Habitat: Atlantic coast of tropical America, southern Florida to Brazil.

Etymology: *χρυσός*, gold; *οὐρά*, tail.

This species is very abundant at Key West, where it is known as "yellow-tail." In Cuba it is perhaps, next to *L. analis* and *L. synagris*, the commonest of the snappers. It is there known as the *rabirubia*.

The synonymy of this species offers little difficulty. The earlier names, *chrysurus*, *rabirubia*, *semiluna*, seem to admit of no doubt. *Aurovittatus* is admitted as a distinct species by Poey, who has seen it but once, and distinguishes it by the absence of yellow spots on the back. Without further evidence we can not regard the claims of *aurovittatus* to distinction as worthy of consideration. The use of the name *melanurus* for this species by Dr. Goode is certainly an error. There can be no reasonable doubt of the pertinence of *Perca melanura* L. to *Hæmulon melanurum* (*dorsale* Poey). We have examined the specimens from St. Kitts, described by Prof. Cope under the name of *Ocyurus rijgersmæi*. These without much doubt are simply brightly-colored adults of this species.

Specimens of this common species are in the museum at Cambridge, from Rio Grande del Norte, Rio Janeiro, Ceará, Porto Seguro, and Nassau. It is evident from the collections made by Agassiz in Brazil that the *Lutjanine* fishes of that region are identical with those of the West Indian fauna.

IV. RHOMBOPLITES.

Rhomboplites Gill, Proc. Ac. Nat. Sci. Phila. 1862, 237 (*aurorubens*).

Type: *Centropristis aurorubens* Cuv. & Val.

Etymology: *ῥόμβος*, rhomb; *ὁπλίτης*, armed; from the form of the vomerine patch of teeth.

This genus is closely allied to *Lutjanus*, but the cranial peculiarities and extension of the villiform teeth over the pterygoid and hyoid bones seem to warrant generic separation. The form of the vomerine patch of teeth is also somewhat peculiar. But one species is known.

ANALYSIS OF SPECIES OF RHOMBOPLITES.

a. Eye large, 3½ to 4 in head; scales small, 10–72–19; gill-rakers numerous, about 18 below angle; dorsal spines twelve, high and slender; vomerine teeth arranged in a ◇-like patch; lower jaw projecting; preorbital narrow; caudal rather deeply forked; color vermilion red, with sinuous golden streaks; fins red; iris red. Head, 3⅓; depth, 3½. Scales, 10–72–19. D. XII, 11; A. III, 8. AURORUBENS, 24.

24. RHOMBOPLITES AURORUBENS. (Cagon de lo Alto.)

Centropristis aurorubens Cuv. & Val., Hist. Nat. Poiss., III, 45 (Brazil, Martinique, San Domingo); Storer, Synopsis, 1846, 288 (copied).
Mesoprion aurorubens, Günther, I, 207, 1859 (Jamaica).
Rhomboplites aurorubens Gill, Proc. Ac. Nat. Sci. Phila. 1862, 236; Goode & Bean, Proc. U. S. N. M. 1879, 136 (Charleston, Pensacola); Bean, Proc. U. S. N. M. 1880, 96 (Charleston); Jordan, Proc. U. S. N. M. 1884 (Pensacola); Jordan & Swain, l. c.; Jordan, l. c., 1890, 319 (Bahia).
Lutjanus aurorubens, Vaillant & Bocourt, Miss. Sci. au Mexique, 1875; Jordan & Gilbert, Syn. Fish. N. A., 1883, 549.
Mesoprion elegans Poey, Memorias, II, 153, 1860 (Cuba.)
Rhomboplites elegans, Poey, Repertorio, II, 158, 1868; Poey, Synopsis, 1868, 295; Poey, Enumeratio, 1875, 31.
Aprion ariommus Jordan & Gilbert, Proc. U. S. N. M. 1883, 142 (Pensacola).

Habitat: West Indies, north to Charleston, south to Rio Janeiro.

Etymology: *Aureus*, golden; *rubens*, reddish.

This species is not uncommon in deep waters as far north as Charleston and Pensacola. It is not unfrequently seen in the markets of Havana, where it is known as *cagon* or *cagon de lo alto*. Specimens from Pensacola and Havana are fully identical. Specimens from the coast of Carolina are somewhat deeper than those from Cuba, and with the yellow streaks more pronounced, becoming dark brown in spirits. One of these, in the U. S. National Museum, has 13 dorsal spines. It is not, however, otherwise essentially different.

We see no reason to doubt that this species is the original *Centropristis aurorubens* of Cuv. & Val. We therefore adopt the earlier name instead of the name *elegans*, given to it by Poey. The young specimens taken from the stomachs of red snappers at Pensacola, and described by Jordan & Gilbert as *Aprion ariommus*, seem to be the young of this species. The pterygoid teeth are undeveloped, and covered by skin in young examples.

Specimens of *Rhomboplites aurorubens* are in the museum at Cambridge from Maranhão and Rio Janeiro.

V. APSILUS.

Apsilus Cuv. & Val., Hist. Nat. Poiss., VI, 1830, 548 (*fuscus*).
Tropidinius (Gill MSS.), Poey, Synopsis Pisc. Cub., 1868, 296 (*arnillo = dentatus*).

Type: *Apsilus fuscus* Cuv. & Val.

Etymology: *α* privative; *ψιλός*, bare or bald; the meaning not evident.

This very distinct species has essentially the cranial structure of *Lutjanus*, with the scaleless fins, peculiar squamation, and dentition of *Aprion*. We have examined the East Indian species, *Apsilus fuscus*, and find it generically identical with the American species, which must therefore be placed in *Apsilus*, leaving *Tropidinius* as a synonym.

ANALYSIS OF AMERICAN SPECIES OF APSILUS.

a. Body rather deep (depth, 2⅗ in length); head large, 3 in body. D. x, 10; A, III, 8; scales small, regularly arranged, 8–60–16; those above lateral line in series parallel with the lateral line; gill-rakers numerous, about 17 on lower part of arch; mouth rather small, the canines moderate; tongue toothless; vomerine teeth in a /\-shaped patch; preorbital narrow; caudal well forked; anal spines graduated; last rays of anal slightly produced, the lobes pointed; color, dusky violet, without distinct markings.......................................DENTATUS, 25.

25. APSILUS DENTATUS. (Arnillo.)

Apsilus dentatus Guichenot, in Ramon de la Sagra, Hist. Cuba, Poiss., 29, pl. 1, f. 2, 1845 (Havana).
Mesoprion dentatus, Günther, I, 188, 1859 (Jamaica).
Tropidinius dentatus, Jordan & Swain, l. c.
Mesoprion arnillo Poey, Mem. II, 154, 1860 (Cuba).
Tropidinius arnillo, (Gill MSS.), Poey, Synopsis, 296, 1868 (Cuba); Poey, Enumeratio, 30, 1875.
Lutjanus arnillus, Cope, Trans. Am. Philos. Soc. 1869, 470 (St. Croix).

Habitat: West Indies.

Etymology: *Dentatus*, toothed.

This beautiful little fish is rather common in the markets of Havana, where it is known as *arnillo.* The name *dentatus* is set aside by Poey in favor of his later name *arnillo*, because the species is a *Lutjanus* rather than an *Apsilus*, and all the *Lutjani* are dentate. Such reasons are not sufficient to warrant interference with the law of priority. The species, however, is a genuine *Apsilus*, and has perhaps stronger teeth than its congener *fuscus.*

VI. APRION.

Aprion Cuv. & Val., Hist. Nat. Poiss., VI, 1830, 543 (*virescens*).
? **Chætopterus** Temminck & Schlegel, Fauna Japonica, Poiss., 78, 1850 (*dubius*).
Pristipomoides Bleeker, Natuurk. Tijdschr. Nederl. Ind., 1852, III, 574 (*typus*).
Platyinius Gill, Proc. Ac. Nat. Sci. Phila. 1863, 237 (*vorax=macrophthalmus*).
? **Sparopsis** Kner, Fische Mus. Godeffroy, 1868, 303 (*elongatus*).

Type: *Aprion virescens* Cuv. &. Val.

Etymology: *α* privative; *πρίων*, a saw.

The superficial characters separating *Aprion* from *Lutjanus* are not very important, but the structure of the upper part of the cranium (in the species examined, *macrophthalmus* and *virescens*) differs widely from that of *Lutjanus*, *Ocyurus*, *Rhomboplites*, and *Apsilus*, closely resembling that of *Etelis*, with which genus *Aprion* has very near affinities.

The American species (*macrophthalmus*) has been made by Dr. Gill the type of a genus *Platyinius*, regarded as distinct from *Aprion.* An examination of *Aprion virescens* shows that our species has the same form of the skull, differing chiefly in the specific characters of deeper body, weaker teeth, and narrower preorbital. It is strange that so excellent a naturalist as Dr. Klunzinger should regard *Aprion* merely as a subgenus under *Centropristis* (Fische des Rothen Meers, p. 16).

ANALYSIS OF AMERICAN SPECIES OF APRION.

a. Body oblong-elliptical, the depth 3 in length; scales large, regularly arranged, 7–60–15, those above lateral line in series parallel with the lateral line; gill-rakers numerous, about 17 on lower part of arch; mouth rather small, the canines feeble; tongue toothless; opercle ending in an evident spine; preopercle serrate on angle; vomerine teeth in a ∧-shaped patch; caudal well forked; anal spines graduated; last ray of dorsal and anal produced; D. x, 11; A, III, 8. Head, 3; Color, rose-red, with some pearly markings............MACROPHTHALMUS, 26.

26. APRION MACROPHTHALMUS. (Voraz.)

Centropristis macrophthalmus Müller & Troschel, in Schomb. Hist. Barbadoes, 666, 1848 (young).

Elastoma macrophthalmus, Cope, Trans. Am. Philos. Soc. 1869, 468 (St. Martins, New Providence, St. Croix).

Aprion macrophthalmus, Jordan & Swain, l. c.

Mesoprion vorax Poey, Mem. II, 151, 1860 (Cuba).

Platyinius vorax, Gill, Proc. Acad. Nat. Sci. Phila. 1863, 237 (generic diagnosis); Poey, Synopsis, 292, 1868; Poey, Enumeratio, 31, 1875.

Habitat: West Indies.

Etymology: *μακρός*, large; *ὀφθαλμός*, eye.

This species is rather common in the markets of Havana, where it is known as *voraz*, by which the specific name *vorax* has been suggested.

According to Poey the *Centropristis macrophthalmus* of Müller & Troschel was based on the young of this species; if so, the latter name has the right of priority. This species agrees closely with the descriptions of *Aprion filamentosus* (Cuv. & Val.) from the islands east of Africa, but it would be premature to unite two species from such widely separated localities without an actual comparison of specimens. Dr. Klunzinger regards the two species as identical. According to his account, however, *A. filamentosus* is a slenderer fish, the depth 4½ in the total length (3⅗ in *A. macrophthalmus*), and the scales are 7–55–14, the caudal more deeply forked, the lobes 3 times the middle rays (2⅗ times in ours).

VII. ETELIS.

Etelis Cuv. & Val., Hist. Nat. Poiss., II, 127, 1828 (*carbunculus*).

Elastoma Swainson, Nat. Hist. Fishes, II, 168, 202, 1839 (*oculatus*).

Hesperanthias Lowe, Fishes of Madeira, 1843, 14 (*oculatus*).

Macrops Duméril, Ichth. Analytique, 1856, 279 (*oculatus*).

Etelis Gill, Proc. Ac. Nat. Sci. Phila. 1862, 447.

Type: *Etelis carbunculus* Cuv. & Val.

Etymology: *Etelis*, a name used by Aristotle for some fish not recognizable.

The synonymy and relations of this interesting genus have been well discussed by Dr. Gill in the paper above cited. In spite of the difference in the form of its dorsal, the relations of *Etelis* with *Aprion* are very close. The skulls in the two are almost identical, as has already been noticed by Poey and Gill.

ANALYSIS OF AMERICAN SPECIES OF ETELIS.

a. Body elongate, fusiform; caudal peduncle long, slender; profile convex on snout, thence straightish to occiput; the nape low, not keeled; snout short, rather pointed, $3\frac{3}{5}$ in head; eye very large, 3 in head; preorbital very narrow, its least width 14 in head; mouth moderate, oblique, the lower jaw projecting; maxillary reaching middle of eye, $2\frac{1}{10}$ in head, its surface scaly; two canines of upper jaw very sharp and projecting forward and downward; canines of lower jaw not differentiated; tongue without teeth; vomer with a narrow ∧-shaped patch of teeth; gill-rakers long and slender; opercle ending in an evident spine; maxillary with about 12 scales; region behind eye well scaled; top of head and snout naked; lower jaw with a few imbedded scales; base of soft dorsal and anal scaleless; dorsal spines rather high and strong, the longest spine 2 in head, the spines thence becoming almost regularly and gradually shorter to last spine, which is little longer than first spine; margin of soft dorsal straight, the rays 3 in head, the last ray slightly elongate; anal similar to soft dorsal; its last ray considerably produced; anal spines slender and graduated; caudal very deeply forked, the upper lobe the longer, its length four times length of middle rays; upper lobe almost filamentous, longer than head; pectorals falciform, reaching almost to anal, $1\frac{1}{5}$ in head. Color in life, brilliant rose-red; bases of the scales deeper and belly abruptly paler rosy; mouth reddish within; lining of gill-cavity reddish; fins all rosy; spinous dorsal and caudal bright red, the other fins paler. Head, $3\frac{1}{4}$; depth, $3\frac{1}{2}$. D. X, 11; A. III, 8. Scales, 5–53–12; 50 pores. OCULATUS, 27.

27. ETELIS OCULATUS. (Cachucho.)

Serranus oculatus Cuv. & Val., II, 1828, 266 (Martinique).
Elastoma oculatus, Swainson, Nat. Hist. Fishes, II, 168, 202, 1839 (generic diagnosis).
Hesperanthias oculatus, Lowe, Fishes Madeira, 1843, 14 (generic description).
Centropristis oculatus, Müller & Troschel, in Schomb. Hist. Barbadoes, 666, 1848.
Anthias oculatus, Günther, I, 92, 1859 (Jamaica, Madeira).
Etelis oculatus, Gill, Proc. Ac. Nat. Sci. Phila. 1862, 447 (Cuba); Poey, Synopsis, 292, 1868 (Cuba); Poey, Enumeratio, 31, 1875; Jordan & Swain, l. c.
Macrops oculatus, Duméril, Ichth. Analytique, 1856, 279 (*fide* Gill).

Habitat: West Indies.

Etymology: *Oculatus*, furnished with eyes; a reference to its large eyes.

This very beautiful species is abundant in the markets of Havana, where it is known as *cachucho*. It is found in rather deep water, with such forms as *Lutjanus vivanus*, *buccanella*, *mahogoni*, *Rhomboplites aurorubens*, *Aprion macrophthalmus*, and *Apsilus dentatus*. These fishes are a little lower down in the bathymetric scale than *Lutjanus aya*, which in turn inhabits deeper water than the other *Lutjani*. In still deeper water is found *Verilus sordidus*, which is a true deep-water fish. The *cachucho* reaches a length of 2 feet or more, and is esteemed as a food-fish. The synonymy of the species offers no complications, although its generic relations have been often misunderstood. This and some other Cuban *Lutjaninæ* bear considerable resemblance to certain Japanese types, but it is improper to regard them as specifically identical with their Asiatic representatives until specimens have been fully compared.

VIII. VERILUS.

Verilus Poey, Memorias de Cuba, II, 125, 1860 (*sordidus*).

Type: *Verilus sordidus* Poey.

Etymology: "Veril, a Spanish word meaning 'haut de fond coupé à pic,' apparently an allusion to the form of the teeth. 'Ne vous mettez pas en peine sur l'origine du nom, les meilleurs, ne sont pas les plus étymologiques, par cela même qu'ils ont une signification rarement exclusive.'" (*Poey.*)

The genus is technically close to *Etelis*, although the single known species is very different from *Etelis oculatus*. The cavernous character of the skull is the most striking feature of the genus *Verilus*.

ANALYSIS OF SPECIES OF VERILUS.

a. Body oblong, compressed, rather robust; caudal peduncle short and thick; head large; profile almost straight from snout to origin of spinous dorsal, and not at all steep; snout very short and blunt, 4 in head; eye very large, 2¼ in head; interorbital space flat, its width 4⅔ in head; occipital keel very low; preorbital very narrow, 7 in eye, nearly 20 in head; maxillary reaching middle of eye, 2 in head; mouth large, oblique, the lower jaw projecting; upper jaw with two moderate canines in front; lower jaw with two or three small canines directed nearly horizontally backward; vomer with a narrowly ∧-shaped patch of teeth; tongue and pterygoids without teeth; gill-rakers numerous, their length almost half diameter of eye, x + 17; preopercle with posterior margin weak and flexible, almost entire, becoming somewhat serrate at the angle and on lower limb; scales large; the rows horizontal below the lateral line; those above rather irregular, the series running upward and backward; head scaly everywhere, the scales generally smaller than on body; base of soft dorsal and anal somewhat scaly; spinous and soft dorsals entirely separate; first spine 4⅓ in second, which is 2⅚ in head, the spines thence becoming gradually shorter to ninth spine, which about equals length of first spine; last rays of dorsal and anal not produced; anal similar to soft dorsal, its margin rather more concave; anal spines moderate, the third slightly longer than second; caudal fin short, broad, moderately forked, the upper lobe longer, its length scarcely twice that of middle rays; pectorals long, reaching to origin of anal, 1⅓ in head; pseudobranchiæ very evident. Color dusky gray, slightly paler below; tips of spinous dorsal and ventrals jet black, the fins otherwise colored as the body; posterior edge of caudal dusky; lining of gill-cavity, peritoneum, and posterior part of mouth jet black. Head, 2⅗; depth, 3. D. IX, 10; A. III, 7. Scales, 4–43–9; 41 pores........SORDIDUS, 28.

28. VERILUS SORDIDUS. (Escolar Chino.)

Verilus sordidus Poey, Memorias, II, 125, 1860, tab. 12, f. 6 (Cuba); Poey, Repertorio, II, 157, 1867; Poey, Synopsis, 291, 1868; Poey, Enumeratio, 32, 1875.

Habitat: About Cuba in deep water.

Etymology: *Sordidus*, sordid, from the dull color, in contrast with the brightness of *Etelis oculatus*.

This species is rarely taken in deep water off the coast of Cuba. It is known to the fishermen as *Escolar chino*. It has never been seen elsewhere. The specimen before us was obtained in the Havana market.

Subfamily III.—XENICHTHYINÆ.

IX. XENOCYS.

Xenocys Jordan & Bollman, Proc. U. S. N. M. 1889, 160 (*jessiæ*).

Type: *Xenocys jessiæ* Jordan & Bollman,

Etymology: ξένος, strange; ὠκύς, swift.

This genus is closely related to *Xenistius*. The single species inhabits rocky shores in the eastern Pacific and is a fish of remarkably graceful form.

ANALYSIS OF SPECIES OF XENOCYS.

a. Body elliptical, compressed; mouth moderate, the lower jaw projecting, the broad maxillary reaching nearly to the middle of pupil, 2$\frac{2}{7}$ in head; eye large, its length less than snout, 3$\frac{4}{5}$ in head; preorbital narrow, 2$\frac{2}{3}$ in eye, entire; teeth very small, the bands wider than in *Xenistius californiensis;* those on vomer in a ʌ-shaped patch; nostrils minute, close together, the anterior round, the posterior oblong; preopercle with fine serræ, the lower bluntish; opercle without spines; gill-rakers long and slender, x+23; cheeks and top of head with small scales; lower jaw and snout with rudimentary scales; maxillary naked; scales on body small, firm, ctenoid; dorsal fins wholly separate, the spines slender and pungent, the fourth half of head; soft dorsal longer than anal, its base $\frac{4}{5}$ of an eye's diameter shorter than spinous dorsal; third anal spine longest, 4 in head; soft parts of vertical fins covered with small scales; caudal deeply forked, its peduncle slender, the upper lobe 1$\frac{1}{7}$ in head; pectorals long, pointed, 1$\frac{2}{5}$ in head; color grayish black, silvery below, with 7 distinct straight parallel stripes on back and sides, extending forward on top and sides of head; fins dusky, except the ventrals. Head, 3$\frac{1}{2}$ in length; depth 2$\frac{2}{3}$. D. x–i, 13; A. iii, 11. Scales, 8–51–15 .... JESSIÆ, 29.

29. XENOCYS JESSIÆ.

Xenocys jessiæ Jordan & Bollman, Proc. U. S. N. M. 1889, 160 (Charles Island).

Habitat: Galapagos Islands.

Etymology: Named for Mrs. Jessie Knight Jordan.

This species is known from numerous specimens (41166, U. S. N. M.), the longest 8$\frac{1}{2}$ inches long, taken by the *Albatross* at Charles Island, one of the Galapagos.

X. XENISTIUS.

Xenistius Jordan & Gilbert, Syn. Fish. N. A., 1883, 920 (*californiensis*).

Type: *Xenichthys californiensis* Steindachner.

Etymology: ξένος, strange; ἱστίον, sail, dorsal fin.

This genus contains, so far as known, but a single species. It is closely related to *Xenichthys*, but it is remarkably distinguished by the relative development of the vertical fins.

ANALYSIS OF SPECIES OF XENISTIUS.

a. Body oblong-elliptical, the back a little elevated; head compressed; mouth moderate, terminal, very oblique, the lower jaw strongly protruding; maxillary narrow, reaching front of pupil, 2½ in head; eye large, 3¼ to 3½ in head, the eye smaller and the bones of the head firmer than in *Xenichthys;* teeth small, sharp, in very narrow bands, those on vomer in a /\-shaped patch, but so small as to be scarcely appreciable; preopercle with fine sharp serræ; nostrils small, round; gill-rakers long and slender, x + 15 to 20; scales small, firm; dorsal fins almost separated; spines slender but pungent; third dorsal spine longest, 1⅔ in head, the others gradually shortened; soft dorsal and anal similar to each other, short, shorter than spinous dorsal, the anterior rays much higher than in the species of *Xenichthys;* first soft ray of anal 3 in head; soft dorsal and anal scaly; pectoral fins rather long, 1¼ in head, not reaching vent; color bluish above, silvery below; continuous dusky stripes on upper part of body, 3 above lateral line, 3 or 4 below; upper fins dusky, lower mostly pale. Head, 3 in length; depth, 3. D. XI–I, 12; A. III, 10; lat. l., 52 .... CALIFORNIENSIS, 30.

30. XENISTIUS CALIFORNIENSIS.

Xenichthys californiensis Steindachner, Ichth. Beitr., III, 3, 1875 (San Diego); Streets, Bull. Nat. Mus., VII, 49, 1877 (Cerros Island); Jordan & Gilbert, Proc. U. S. N. M. 1881, 278 (Cerros Island); Jordan & Gilbert, Bull. U. S. F. C. 1881, 326 (Cerros Island); Jordan & Gilbert, Syn. Fish. N. A., 1883, 547 (Cerros Island).

Xenistius californiensis, Jordan & Gilbert, Syn. Fish. N. A., 1883, 920 (generic diagnosis); Evermann & Jenkins, Proc. U. S. N. M. 1891, 144 (Guaymas).

Habitat: Coast of lower California, from San Diego to Guaymas.

Etymology: From California.

This interesting little fish seems to be rather rare along the coast of lower California, and more abundant in the Gulf. One of our specimens was taken at San Diego by Mrs. Rosa Smith Eigenmann, the other by Jenkins and Evermann at Guaymas. The species described from San Salvador as *Xenichthys xenurus* by Jordan & Gilbert (Proc. U. S. N. M. 1881, 454) is a species of *Kuhlia*, a genus of *Serranidæ*.

XI. XENICHTHYS.

Xenichthys Gill, Proc. Acad. Nat. Sci. Phila. 1863, 82 (*xanti*).

Type: *Xenichthys xanti* Gill.

Etymology: ξένος, strange; ἰχθύς, fish.

This genus contains two species from the eastern Pacific. It shows a remarkable combination of characters, well justifying the name *Xenichthys*. The genus is certainly allied to *Pomadasis*, in spite of its resemblance to the Serranoid genus *Kuhlia*.

ANALYSIS OF SPECIES OF XENICHTHYS.

a. Pectoral fin falcate, about as long as the head and reaching to front of anal fin; eye very large, $2\frac{1}{3}$ in head; snout broad and flat; mouth oblique, the maxillary $2\frac{1}{5}$ in head; teeth quite small, those on vomer scarcely developed; none on palatines or tongue; lower jaw much projecting; preopercle very finely serrulate; gill-rakers slender and rather long, x+17; nostrils small, oblong; the longest $\frac{2}{3}$ pupil; body compressed, the back somewhat elevated; longest dorsal spine not half length of head; soft dorsal and anal low, covered with small scales; caudal forked; anal spines short, graduated, the second stouter; first soft ray of anal less than $\frac{1}{2}$ head; head, 3 in length; depth, 3. D. XI–I, 17, or 18; A. III, 17. Scales, 56. Color, steel-blue above, silvery below................AGASSIZII, 31.

aa. Pectoral fin short, $1\frac{1}{2}$ in head, not reaching nearly to the vent; eye very large, 3 in head; mouth oblique, the dentition much as in *X. agassizii;* occasionally very small teeth on vomer; none on palatines or tongue; preopercle with weak, sharp serræ on its vertical limb; gill-rakers moderate, the longest half diameter of pupil. Form of the preceding; third dorsal spine longest, $1\frac{2}{3}$ in head; soft dorsal and anal low, covered with small scales; caudal forked; anal spines small, graduated. Head, 3 in length; depth, 3. D. XI–I, 18; A. III, 17, Scales, 10–54–14. Color, bluish-gray, silvery below; upper parts with 7 or 8 faint blackish streaks along the rows of scales; mouth yellow within in life; fins yellowish, with scattered black specks, the edges of most of them dusky; young with two dark longitudinal streaks and a faint spot at base of caudal...............XANTI, 32.

31. XENICHTHYS AGASSIZII.

Xenichthys agassizii Steindachner, Ichth. Beitr., III, 6, 1875 (Galapagos Islands); Jordan & Gilbert, Bull. U. S. F. C. 1881, 326 (copied).

Habitat: Galapagos Islands.

Etymology: Named for Louis Agassiz.

Our specimen of this species is one of the original types, received by us from the Museum of Comparative Zoölogy. It is very close to the next species, differing chiefly in the length of the pectoral.

32. XENICHTHYS XANTI.

Xenichthys xanti Gill, Proc. Ac. Nat. Sci. Phila. 1863, 82 (Cape San Lucas, description erroneous); Jordan & Gilbert, Bull. U. S. F. C. 1881, 326 (copied); Jordan & Gilbert, Proc. U. S. N. M. 1882, 360 (types of *X. xanti*); Jordan & Bollman, l. c., 1889, 181 (Panama).

Xenichthys xenops Jordan & Gilbert, Bull. U. S. F. C. 1882, 325 (Panama).

Habitat: Pacific coast of tropical America, from Cape San Lucas to Panama.

Etymology: Named for John Xantus.

This species is rather abundant at Panama, where numerous specimens were obtained by Prof. Gilbert. The original types of *X. xanti* are young examples of the same species. In the original description the dorsal rays were wrongly counted as XI–I, 14, the scales of the lateral line described as different from the others, but no difference of any importance exists.

Subfamily IV.—HÆMULINÆ.

XII. HÆMULON.

Diabasis * Desmarest, Première Décade Ichthyologique, 1823, 34 (*parra; flavolineatus;* not of Hoffmannsegg, Coleoptera, 1819).
Hæmulon Cuvier, Règne Animal, ed. 2, 1829 (*elegans*, etc.).
Orthostœchus Gill, Proc. Acad. Nat. Sci. Phila. 1862, 255 (*maculicauda*).
Hæmylum (Scudder MSS.) Putnam, Bull. M. C. Z., 1863, 12 (*elegans*, etc.).
Diabasis (Scudder MSS.) Putnam, l. c. (*album*; name only).
Anarmostus (Scudder MSS.) Putnam, l. c. (name only; *flavolineatum*, etc.).
Bathystoma (Scudder MSS.) Putnam, l. c. (name only; *jeniguano*, etc.).
Brachygenys (Scudder MSS.) Poey, Synopsis Piscium Cubensium, 1868, 319 (name only; *tæniatum*).
Lythrulon Jordan & Swain, Proc. U. S. N. M. 1884, 287 (*flavoguttatum*).
Hæmulon Cuv. & Val., Günther, Gill, Poey, Goode, etc.
Diabasis Bennett, Bleeker et auct.

Type: *Hæmulon elegans* Cuvier=*Sparus sciurus* Shaw.

Etymology: *αἷμα*, blood; *οὖλον*, the singular of *οὖλα*, the gums.

All the species of *Hæmulon* are American. The genus is very closely related to *Pomadasis* Lacépède (=*Pristipoma* Cuv.), the only tangible points of difference being the large mouth with curved gape and the closely scaled soft dorsal and anal fins. All the species have more or less of orange on the inside of the mouth, a trait of coloration not found in *Pomadasis*. The amount of redness is greatest in those species having the largest mouth. It is true that certain species of *Pomadasis* (*humilis*, etc.) have the mouth larger than in certain species of *Hæmulon* (*chrysargyreum*). It is also true that while the soft dorsal and anal in many of the species referred to *Pomadasis* are free from scales, in certain of the subgenera or genera related to the latter genus (*Brachydeuterus*, *Anisotremus*) these fins are hardly less scaly than in *Hæmulon*. It is probably also true that certain species of *Hæmulon* (*chrysargyreum*) are more closely related to species of the section *Brachydeuterus* (*axillaris*, *nitidus*, *leuciscus*) than this section is to some other species usually placed in the same genus. There is no doubt, however, that the species of *Hæmulon* form a natural group, and no writer since Desmarest and Cuvier has questioned the right of this group to generic rank. It has been generally conceded that the group will not admit of further subdivision. The most aberrant of the species (*maculicauda*) was, in 1862, recognized by Dr. Gill as the type of a distinct genus, *Orthostœchus*, distinguished by the arrangement of its scales. In 1862 these fishes were the subject of an elaborate study by Mr. Samuel H. Scudder. Nothing has, however, been published by this writer, our

* Le poisson que je viens de décrire me paraît, selon les principes de classification ichthyologique de M. Cuvier, devoir former un genre à part. Je lui donne le nom de *Diabasis*, *Διάβασις* (*transitio*), pour indiquer ses rapports, d'une part, avec les *Acanthoptérygiens* des genres Lutjan et Pristipome, et de l'autre avec les poissons placés dans la famille des Squamipennes. (Desmarest.)

knowledge of his conclusions being limited to a nominal list published by Prof. F. W. Putnam (Bulletin Mus. Comp. Zool., 1863, 12).

In this list four generic names are recognized, two of them new, but not defined, and hence not requiring notice. The species are thus grouped:

> **Hæmylum,** *formosum* (*plumieri*), *elegans*, *arara* (*plumieri*).
> **Diabasis,** *albus*.
> **Anarmostus,** *flavolineatus*, *serratus* (*parra*).
> **Bathystoma,** *melanurum* (*aurolineatum*), *chrysopterum* (*rimator*).

Later, another genus, *Brachygenys*, likewise left undefined, was proposed by Mr. Scudder for *tæniatum* Poey. It is mentioned by Poey (Syn. Pisc. Cubens., 1868, p. 319). We are unable to see any distinction whatever for the groups called *Hæmulon*, *Diabasis*, and *Anarmostus*, and think that if these be recognized as genera most of the remaining species should be elevated to the same rank. *Bathystoma* and *Brachygenys* are better differentiated, but neither in our opinion should be regarded as a distinct genus. No advantage is likely to come from such minute generic subdivision. Most writers have adopted for this genus the very appropriate name of *Hæmulon*, given to it by Cuvier in 1829. This name is not strictly correct in its form, and it has been sometimes, with a greater approach to classical exactness, written *Hæmulum*, which is an abridgment of the full form, *Hæmatulum*. By a curious blunder several purists have written *Hæmylum*, which is much worse than *Hæmulon*. The name is expressly stated by Cuvier to be derived from αἷμα, blood, and οὖλον, the singular of οὖλα, the gums.

The name *Diabasis* of Desmarest (1823) has priority over *Hæmulon*, and has been substituted for the latter by Bennett, Bleeker, and others. This name is, however, preoccupied in Coleoptera by the genus *Diabasis*, Hoffmannsegg, 1819. There appears, therefore, no doubt of the propriety of the retention of the name *Hæmulon*. *Hæmulon sciurus* (Shaw) (*elegans* Cuvier), the first species mentioned by Cuvier, may be regarded as the type of the genus. Twenty species of *Hæmulon* are recognized by us as probably valid. These we arrange in five sections or subgenera, with the names *Hæmulon*, *Bathystoma*, *Brachygenys*, *Lythrulon*, and *Orthostœchus*. Of these, *Hæmulon* contains most of the species and exhibits a greater range of variation than the others. The young fishes in this group differ in proportions considerably from the adults. Besides the changes usual in other fishes, we may observe that in *Hæmulon* the young have the snout proportionally much shorter, so that the maxillary, although also much shorter in proportion, extends further back in comparison with the eye. Nearly all the species have, when young, two more or less sharply defined, dark, longitudinal stripes along the side, one or more along the top of the head, and a dark spot at the base of the caudal. These markings persist longer in some species than in others, but traces of them, at least, may be found in the young of nearly all the species of *Hæmulon*, *Anisotremus*, and *Pomadasis*. In a few species these markings persist during life. The species are all essentially alike in respect to the pores at the chin, the height and form of the soft dorsal, the form of the nostrils, the squamation of the fins, the direction of the lateral line, etc. These common characters are, therefore, not mentioned in the following descriptions. The peritoneum is black in all species examined.

In the descriptions below the scales above the lateral line are counted vertically from the first dorsal spine to the lateral line; those below the lateral line from the first anal spine obliquely upward and forward to the lateral line. The scales in a longitudinal series are, as here given, the number of vertical rows above the lateral line from head to base of caudal. This number is practically the same in all species of the genus, the variations above or below 50 being very slight. The number of oblique series of scales or of pores in the lateral line is in all cases about 10 fewer, or about 40.

ANALYSIS OF SPECIES OF HÆMULON.

a. Scales above lateral line arranged in very oblique series, not parallel with the lateral line.

b. Jaws subequal, or the lower included; mouth little oblique; gill-rakers comparatively few and short.

c. Dorsal spines 12 (sometimes 11 in *H. scudderi*); scales large; gill-rakers few and small (10 to 14 on lower part of anterior arch); frontal foramen a single or divided slit at the base of the high supraoccipital crest in front.

d. Mouth moderate or large, its cleft more than $\frac{1}{3}$ length of head; back more or less elevated; second anal spine strong, notably longer than third. (*Hæmulon.*)

e. Scales below lateral line anteriorly not especially enlarged.

f. Scales above lateral line anteriorly not much enlarged.

g. Maxillary $2\frac{1}{4}$ to $2\frac{2}{3}$ in head, not reaching center of eye (in adult).

h. Back and sides without yellow or blue stripes; each scale above with a median blackish spot, these forming undulating lines (spots rarely obsolete in adult, obscure or wanting in young); maxillary $2\frac{1}{2}$ to $2\frac{2}{3}$ in head.

i. Scales in a vertical row from first dorsal spine to lateral line 7 or 8 (9 in oblique series).

j. Mouth rather small, maxillary scarcely reaching to front of eye; back elevated; preorbital very deep, its least breadth greater than length of eye in adult, $4\frac{1}{2}$ to $4\frac{2}{3}$ in head in young; second anal spine not reaching to tip of last ray; snout long and pointed, $2\frac{1}{4}$ to $2\frac{2}{3}$ in head.

k. Sides with about six dark vertical bars; sides of head with blackish spots like those of body; dorsal spines not graduated; 2d anal spine when depressed not reaching tip of last spine. Head, 3; depth, $2\frac{3}{5}$. Scales, 7–51–14. D. XII, 17; A. III, 9....... SEXFASCIATUM, 33.

kk. Sides without dark bars; head unspotted; dorsal spines graduated; second anal spine, when depressed, reaching beyond tip of last spine. Head, 3; depth, $2\frac{2}{3}$. D. XII, 16; A. III, 7. Scales, 7 (or 8)-46 to 48-16....ALBUM, 34.

jj Mouth rather large, maxillary reaching front of pupil; back little elevated; preorbital rather narrow, its least width 5 in head; second anal spine reaching tip of last ray; snout rather long and pointed, $2\frac{1}{3}$ in head; back and sides with 4 or 5 black longitudinal streaks, which disappear only in very old examples. Head, $2\frac{4}{5}$; depth, $2\frac{3}{4}$. D. XII, 16; A. III, 8. Scales, 7-51-13. MACROSTOMA, 35.

ii. Scales in a vertical row from first dorsal spine to the lateral line, five or six.

l. Series of scales from scapular scale extending backward to front of soft dorsal; snout rather long and pointed; mouth small; the maxillary $2\frac{3}{4}$ to 3 in head; dorsal rays XII, 16; pectoral fins long, $\frac{3}{4}$ length of head; black spots on sides coalescing in continuous stripes. Head, $2\frac{4}{5}$; depth, $2\frac{2}{3}$. Scales, 5-44-10. D. XII, 16; A. III, 8..........BONARIENSE, 36.

ll. Series of scales from scapular scale not extending farther backward than the middle of spinous dorsal; snout shorter, not very acute; mouth larger, the maxillary about $2\frac{1}{2}$ in head; premaxillary spine about 3 in head; dark spots on scales not coalescent.

m. Depth of body about $2\frac{2}{3}$ in length; pectoral fins short, less than $\frac{2}{3}$ length of head; scales above lateral line scarcely enlarged. Head, 3; depth, $2\frac{2}{3}$. Scales, 6-50-14. D. XII, 14; A. III, 7........................PARRA, 37.

mm. Depth of body $2\frac{1}{2}$ in length; pectoral fins long, more than $\frac{7}{8}$ length of head; scales above lateral line somewhat enlarged (in adult). Head, $3\frac{1}{3}$; depth, $2\frac{1}{2}$. Scales, 5-49-13. D. XI, XII-16, 15; A. III, 7 ....SCUDDERI, 38.

hh. Back and sides with distinct, horizontal, yellow stripes, fading, but not disappearing, in spirits; no black spots anywhere; vertical fins usually dusky yellow; scales of sides slightly enlarged; maxillary $2\frac{1}{3}$ in head, reaching front of pupil; body not very deep; snout short, not $\frac{1}{3}$ length of head; second anal spine when depressed reaching tip of last ray, its length about half head. Head, 3; depth, $2\frac{4}{5}$. Scales, 7-55-14. D. XII, 16; A. III, 8 ....CARBONARIUM, 39.

gg. Maxillary nearly or quite half length of head, reaching center of eye in adult; no black spots or stripes anywhere in the adult (except under angle of preopercle).

n. Back and sides with rows of round silvery spots, one on each scale, these forming streaks which follow the direction of the rows of scales; ground color light olive-brown; anal high; a black blotch at base of caudal; fins all yellow; body rather elongate, the depth nearly 3 in length; the snout pointed; maxillary about 2⅓ in head; second anal spine 2⅓ in head. Head, 3; depth, 2⅚. Scales, 7–50–14. D. XII, 16; A. III, 8.
SCHRANKI, 40.

nn. Back and sides with continuous yellow stripes, which are horizontal and do not everywhere follow the direction of the rows of scales; ground color bluish-gray; back with a well-defined blackish area from first dorsal spine to base of caudal, this color covering most of soft dorsal and middle of caudal lobes; body rather elongate, the depth 3 in length; snout moderate; second anal spine 2⅖ in head. Head, 3; depth, 3. Scales, 8–56–17. D. XII, 16; A. III, 8.
MELANURUM, 41.

nnn. Back and sides of head and body with continuous blue stripes, horizontal, and not everywhere following the rows of scales; ground color bright yellow; fins yellow, the caudal dusky at base; snout moderate; teeth strong, the anterior canine-like; second anal spine 2½ in head; depth, 2⅗ in length. Head, 2⅘; depth, 2⅗. Scales, 7–53–14. D. XII, 16; A. III, 8..............SCIURUS, 42.

ff. Scales above lateral line anteriorly much larger than the other scales; sides of head with bright blue stripes, which extend for a short distance only on body; body without distinct markings; mouth very large, its cleft more than half head (in adult); premaxillary spine 2½ in head; anterior profile somewhat concave, the snout sharp, projecting; anal rather high, its second spine 2½ in head. Head, 2⅘; depth, 2⅘. Scales, 5–50–17. D. XII, 16; A. III, 8................PLUMIERI, 43.

ee. Scales below lateral line anteriorly much enlarged; head, back, and sides with continuous bright yellow stripes, those below following the direction of the scales, and therefore extremely undulating for the most part; body with two longitudinal black lines, the lower running from snout to base of caudal, ending in a black spot, the upper commencing in front of nostrils and separated from preceding by a pale band, extending backwards to posterior end of soft dorsal;

region in front of dorsal with black median line; other short black lines on head; black spot at angle of preopercle purplish-silvery in spirits; fins yellow; posterior teeth canine-like; body rather deep; snout short; mouth not large, the maxillary $2\frac{1}{3}$ in head; anal high, its second spine 2 in head. Head, 3; depth, $2\frac{3}{4}$. Scales, 6–50–11. D. XII, 14; A. III, 8.

FLAVOLINEATUM, 44.

dd. Mouth small, its cleft less than $\frac{1}{3}$ length of head; body rather elongate; second anal spine small; back and sides with longitudinal yellow stripes; teeth weak; gill-rakers rather few and small; snout very short, $2\frac{2}{3}$ in head; frontal foramina separate and placed some distance in front of the very low supraoccipital crest; premaxillary spine very short, $4\frac{1}{4}$ in head. (*Brachygenys* Scudder.)

o. Body elongate; the back not elevated, the depth $3\frac{1}{5}$ to $3\frac{2}{7}$ in body; eye very large, 3 in head; maxillary 3 to $3\frac{1}{4}$ in head, reaching little, if any, past front of eye; anal moderate, its spines small, the second $2\frac{3}{4}$ in head; fins all yellow; the caudal dusky in adult. Head, $3\frac{1}{5}$; depth, $3\frac{2}{7}$. Scales, 7–52–13. D. XII, 14; A. III, 9.

CHRYSARGYREUM, 45.

cc. Dorsal spines 13; anal fin low; preorbital low; gill-rakers in moderate or rather large numbers, 12 to 18 on lower part of arch; lower jaw not projecting; mouth little oblique; body comparatively elongate, the depth $2\frac{3}{4}$ to $3\frac{1}{2}$ in length: body with longitudinal yellowish stripes; scales rather small; frontal foramina long divided slits in front of supraoccipital crest; size small. (*Bathystoma* Scudder.)

p. Mouth large, the maxillary reaching middle of eye, its length about half head; gill-rakers rather short and few; scales moderate, 50 to 55 in the lateral line; second anal spine scarcely larger or longer than third, $2\frac{3}{4}$ or more in head.

q. Body oblong, the back moderately elevated, the depth $2\frac{3}{4}$ to 3 in length. Head, $2\frac{5}{7}$; depth, $2\frac{5}{6}$. Scales, 8–51–13. D. XIII, 15; A. III, 8 .... RIMATOR, 46.

qq. Body subfusiform, the back little elevated, the depth $3\frac{1}{8}$ to $3\frac{1}{2}$ in length. Head, 3; depth, $3\frac{2}{7}$. Scales, 8–51–13. D. XIII, 15; A. III, 8 .... AUROLINEATUM, 47.

pp. Mouth rather small, the maxillary not reaching to opposite middle of eye; its length not quite half head; gill-rakers numerous, rather long; scales small, about 70 in lateral line; second anal spine notably longer and larger than third; body more elongate than in other species, depth about 3½ in length. Head, 3½; depth, 3½. D. XIII, 13; A. III, 7. Scales, 7–70–18.
STRIATUM, 48.

bb. Lower jaw projecting beyond upper; snout very short; gill-rakers comparatively long and slender, about 22 on lower part of anterior arch; frontal foramina two short slits close together just in front of the high supraoccipital crest. (*Lythrulon* Jordan & Swain.)

r. Mouth small, very oblique, the maxillary reaching pupil, 2½ in head; head short, 3⅗ to 3⅘ in length; body rather deep; anal fin very low, its longest ray, when depressed, not nearly reaching middle of last ray; second anal spine little longer than third; scales of back and sides each with a pearly spot, these forming undulating streaks; dark blotch at base of caudal. Head, 3⅘; depth, 3⅓. Scales, 5–50–14. D. XII–XIII, 15; A. III, 9.
FLAVIGUTTATUM, 49.

aa. Scales above lateral line arranged in longitudinal series, which are throughout parallel with the lateral line; dorsal spines 13 (or 14); frontal foramina narrowly oval, wholly separate, some distance in front of the low supraoccipital crest; premaxillary spine short, 3½ in head; lower jaw projecting. (*Orthostœchus* Gill.)

s. Body oblong, the depth about 3 in length; snout short, 3½ in head; mouth small, the maxillary scarcely reaching front of pupil; eye large, 3⅗ in head; fins low; second anal spine little stronger or longer than third, 2⅖ in head; fourth dorsal spine 2; sides with alternate stripes of dark brown and light grayish, the latter formed by a light pale spot on the center of each scale; a dark blotch at base of caudal; vertical fins, gray. Head, 3⅓; depth, 2⁶⁄₇. Scales, 5–51–11. D. XIII (XIV), 15; A. III, 10.
MACULICAUDA, 50.

33. HÆMULON SEXFASCIATUM.

Hæmulon sexfasciatus Gill, Proc. Ac. Nat. Sci. Phila. 1862, 254 (Cape San Lucas); Steindachner, Ichth. Beitr., III, 1875 (Panama).
Hæmulon sexfasciatum, Jordan & Swain, l. c., 288; Evermann & Jenkins, Proc. U. S. N. M. 1891, 153 (Guaymas).
Diabasis sexfasciatus, Jordan & Gilbert, Bull. U. S. F. C. 1881 (324), 1882 (107, 110) (Mazatlan, Panama); Jordan & Gilbert, Proc. U. S. N. M. 1882, 361, 372, 626 (Cape San Lucas, Colima, Panama); Jordan, Proc. Ac. Nat. Sci. Phila. 1883, 286 (on Peters's type of *maculosum*).
Hæmulon maculosum Peters, Berliner Monatsberichte, 1869, 705 (Mazatlan).

Habitat: Pacific coast of tropical America, Guaymas to Panama.

Etymology: *Sex*, six; *fasciatus*, banded.

This species is the Pacific coast representative of *Hæmulon album*, from which it differs strikingly in its coloration. It reaches a similarly very large size, specimens upwards of two feet in length having been obtained at Mazatlan by Prof. Gilbert. It is generally common along the Pacific coast of tropical America. We have examined the types both of *Hæmulon sexfasciatum* and *Hæmulon maculosum*. There is no doubt of their identity. The very young examples, types of the former species, show the crossbands of the adult, but not the spots on the head.

Specimens are in the museum at Cambridge, from Acapulco.

34. HÆMULON ALBUM. (Margate-fish; Jalláo; Margaret Grunt.)

Perca marina gibbosa (Margate-fish) Catesby, Nat. Hist. Car., p. 2, pl. 2, 1742 (Bahamas).
Perca gibbosa Walbaum, Artedi Pisc., 1792, 348 (after Catesby), (not *Perca gibbosa* L.).
Calliodon gibbosus, Bloch & Schneider, Syst. Ichth., 1801, 312 (name and part of description from Catesby; excl. syn. pars).
Hæmulon gibbosum, Jordan, Proc. U. S. N. M. 1884, 126 (Key West); Bean & Dresel, Proc. U. S. N. M. 1884, 158 (Jamaica); Jordan & Swain, l. c., 290.
Hæmulon album Cuv. & Val., V, 241, 1830 (St. Thomas); Poey, Repertorio, I, 310, 1867; Poey, Syn. Pisc. Cubens., 1868, 312 (Cuba, Key West); Poey, Enum. Pisc. Cubens., 1875, 45; Günther, I, 311, 1859 (Jamaica); Poey, Bull. U. S. F. C. 1882, 118 (Key West).
Diabasis albus, Putnam, Bull. M. C. Z., 1863, 12 (name only); Jordan & Gilbert, Syn. Fish. N. A., 924, 1883 (copied).
Hæmulon microphthalmum Günther, I, 306, 1859 (America).
Hæmulon chrysopterum Goode, Bull. U. S. N. M., V, 1876, 53 (excl. syn.).

Habitat: West Indies, Florida Keys to Brazil.

Etymology: *Albus*, white.

Hæmulon album reaches a length of two feet or more, and is an important food-fish both at Key West and Havana. English-speaking fishermen everywhere call it margate-fish, while the Spanish call it *jalláo*. Specimens are in the museum at Cambridge from Havana, Nassau, and St. Thomas.

In all the species of *Hæmulon*, Cuban specimens are decidedly more dusky than those from Key West. In several species, however, certain Cuban specimens are much paler than the average even of Key West examples. This is true notably of *sciurus*, *carbonarium*, and *parra*. The pale form of *sciurus* has even received a different specific name (*multilineatum*), but we have no doubt that these differences depend on the character of the water or the bottom, and not on difference of species.

This is evidently the *Hæmulon album* of Cuvier and Valenciennes. Günther's *H. microphthalmum* belongs to the same species. The margate-fish of Catesby, erroneously referred by Linnæus to his *Perca chrysoptera* (*Pristipoma fulvomaculatum*), and by Cuvier to his *Hæmulon chrysopterum* (*rimator*), evidently belongs here. The *Calliodon gibbosus* of Bloch and Schneider is based on the figure of Catesby, which, together with the *Perca chrysoptera* L., is quoted in the synonymy. Still older is the name *Perca gibbosus* of Walbaum, likewise based on Catesby's margate-fish. But the name *Perca gibbosa* is preoccupied, having been used by Linnæus for the common sunfish, *Lepomis gibbosus*. The name *Hæmulon album* should therefore be retained.

35. HÆMULON MACROSTOMA.

Hæmulon macrostoma Günther, I, 308, 1859 (Jamaica); Jordan & Swain, l. c., 289 (copied).

Hæmulon fremebundum Goode & Bean, Proc. U. S. N. M. 1879, 340 (Clearwater Harbor, Florida; young); Bean & Dresel, Proc. U. S. N. M. 1884, 159 (Jamaica); Jordan & Swain, l. c., 297 (Key West).

Diabasis fremebundus, Jordan & Gilbert, Syn. Fish. N. A., 1883, 553 (copied); Bean, Cat. Fishes Exh. London, 1883, 57 (Garden Key, Florida).

Habitat: West Indies, north to Florida.

Etymology: μακρός, long; στόμα, mouth.

Besides the specimens examined by Jordan & Swain (Clearwater Harbor, Key West, Jamaica) we have examined specimens in the museum at Cambridge from Florida and St. Thomas. The large specimen from St. Thomas, a foot in length, is perfectly unicolor, only some of the upper scales having darker centers. After careful consideration we have decided that *H. macrostoma* Günther and *H. fremebundum* Goode & Bean must be identical, although there are one or two slight discrepancies in Günther's description.

36. HÆMULON BONARIENSE. (Black Grunt; Ronco Prieto.)

Hæmulon bonariense Cuv. & Val., V, 1830, 254 (Buenos Ayres).

Hæmulon canna Cuv. & Val., Hist. Nat. Poiss., V, 233, 1830 (Martinique); Günther, I, 311, 1859 (Jamaica, Puerto Cabello); Poey, Repertorio, I, 1867, 309 (not of Agassiz, 1829).

Hæmulon notatum Poey, Memorias, II, 179, 1860 (Cuba); Poey, Synopsis, 317; Poey, Enumeratio, 46.

Hæmulon retrocurrens Poey, Rep. Pisc. Cub., II, 236, 461, 1868 (Cuba).

Hæmulon continuum Poey, Enum. Pisc. Cub., 1875, 46 (Cuba); Poey, Anales Soc. Hist. Nat., Madrid, 1881, 210 (Puerto Rico).

Hæmulon parræ, Jordan & Swain, l. c., 292 (not *Diabasis parra* Desmarest).

Habitat: West Indies, south to Buenos Ayres.

Etymology: From Buenos Ayres.

This specimen is known to us from several specimens in the U. S. National Museum, from different points in the West Indies, and from the types of *H. bonariense* and *H. canna* Cuv. & Val. in the museum at Paris. Two specimens sent by Poey from Havana are in the museum at Cambridge. One of these (10576) is the type of *Hæmulon notatum* Poey. It is closely allied to *H. parra*, differing in the color, in the larger size of the scales and the differences in their arrangement, and in the longer snout and smaller mouth.

The synonymy of this species and the next is badly entangled, and we are not sure that we have correctly distributed it all. Our fish seems to correspond to the *Hæmulon notatum*, *continuum*, and *retrocurrens* of Poey. The other names of Poey (*acutum*, *albidum*, and *serratum*) seem to refer rather to the next species. The name *H. canna*, having been first used for *H. parra*, should give place to *Hæmulon bonariense.*

37. HÆMULON PARRA.

(Sailor's Choice; Ronco Blanco; Ronco Prieto; Bastard Margaret.)

Hæmulon caudimacula Cuvier, Règne Animal, ed. 2, 1829 (on *Uribaco* Marcgrave and *Diabase de Parra* Desmarest); Cuv. & Val, v, 236, 1830 (Bahia, Cuba); Günther, I, 1859, 313 (copied); Poey, Repertorio, I, 1867, 310; Jordan & Gilbert, Bull. U. S. F. C. 1881, 322 (redescription of original type).

Hæmulon canna Agassiz, Spix, Pisc. Brasil., 1829, p. 130, pl. 69 (not of Cuv. & Val.) (Brazil).

Hæmulon chromis (Broussonet MSS.) Cuv. & Val., v, 242, 1830 (Jamaica); Günther, Cat. Fish. Brit. Mus., I, 310 (Bahia, Jamaica).

Diabasis chromis, Jordan & Gilbert, Syn. Fish. N. A., 1883, 924 (Garden Key); Bean, Cat. Fish. Exh. London, 1883, 58 (Garden Key).

Diabasis parra Desmarest, Prem. Décade Ichthyol., 30, tab. 2, f. 2, 1823 (Havana).

Hæmulon parra, Jordan, l. c., 1889, 648 (St. Lucia); Jordan, l. c., 1890, 319 (Bahia).

Hæmulon acutum Poey, Memorias de Cuba, II, 180, 354, 1860 (Cuba); Poey, Synopsis, 315, 1868; Poey, Enumeratio, 45, 1875; Bean & Dresel, Proc. U. S. N. M. 1884, 158 (Jamaica); Jordan & Swain, l. c., 294.

Hæmulon albidum Poey, Memorias, II, 181, 1860 (Cuba); Poey, Synopsis, 316; Poey, Enumeratio, 46.

Hæmulon serratum Poey, Memorias, II, 181, 1860 (Cuba); Poey, Synopsis, 317; Poey, Enumeratio, 46; Poey, Anal. Hist. Nat. Madrid, 1881, 201 (Puerto Rico).

Anarmostus serratus, Putnam, Bull. M. C. Z., 12, 1863 (name only).

Hæmulon parræ, Jordan, Bull. U. S. F. C. 1884; Jordan, Proc. U. S. N. M., 1884, 126 (Key West).

Hæmulon parræ Castelnau, Anim. Nouv. ou Rar. Amer. du Sud, 10, 1855 (Bahia).

? *Hæmulon brevirostrum* Günther, Fishes Centr. Amer., 1869, 419 (in part, specimen from Puerto Cabello).

Habitat: West Indies; southern Florida to Brazil.

Etymology: Named for Don Antonio Parra, who first wrote on the natural history of Cuba.

This species is common at Key West, where it is known as "sailor's choice." It is not very often brought into the market, on account of its rather small size. The young are abundant along the shores, in number inferior only to *H. plumieri* and *H. rimator*. At Havana it is still more common, being brought into the market in large numbers every day. The darker specimens are called by the fisherman *Ronco prieto*, the paler ones *Ronco blanco*. While in Havana, Professor Jordan took especial pains to select specimens representing every variety of form and coloration in this species. In the very large collection secured we find specimens answering fairly to Poey's *serratum*, *albidum*, *acutum*, as well as other specimens variously intermediate. A type of *Hæmulon acutum* sent by Poey to the U. S. National Museum is identical with this species, as is also the type of *H. chromis* Cuv. & Val., preserved in the Museum at Paris. The original type of Desmarest's *Diabasis parra* is still preserved in the Museum at Paris. It belongs to the present species, for which it is the oldest name.

38. HÆMULON SCUDDERI. (Mojarra Prieta.)

Hæmulon scudderi Gill, Proc. Ac. Nat. Sci. Phila. 1862, 253 (Cape San Lucas); Steindachner, Ichth. Beitr., III, 18, 1875; Jordan & Swain, l. c., 296; Jenkins & Evermann, l. c. (Guaymas); Jordan & Bollman, l. c., 1889, 181(Panama).

Diabasis scudderi Jordan & Gilbert, Bull. U. S. F. C. 1881 (324), 1882 (107, 110) (Mazatlan, Panama); Jordan & Gilbert, Proc. U. S. N. M. 1882, 361, 626 (Cape San Lucas, Panama).

Hæmulon brevirostrum Günther, Fishes Centr. Amer., 1869, 418 (Panama).

Hæmulon undecimale Steindachner, Ichth. Beitr. III, 1875, 11 (Acapulco, Panama).

Habitat: Pacific coast of tropical America, Guaymas to Panama.

Etymology: Named for Samuel H. Scudder.

This species is the Pacific representative of *Hæmulon parra*. It reaches a similar size, is equally abundant, and passes through a similar range of variations and coloration. Most of the species collected by Prof. Gilbert at Mazatlan and Panama have 11 dorsal spines and correspond to the *Hæmulon undecimale* of Steindachner. Two or three of them have, however, 12 dorsal spines, as in the original types of *H. scudderi* and *H. brevirostrum*. We are unable to detect any other difference of importance among these specimens, and refer all to *H. scudderi*, regarding it as a species with the number of spines indifferently 11 or 12. No other species of *Hæmulon* ever has fewer spines than 12. If these should finally prove to be specifically distinct, the form with 11 spines should stand as *Hæmulon undecimale*, that with 12 spines as *Hæmulon scudderi*.

Specimens are in the museum at Cambridge from Lower California, Acapulco, and Panama. The three specimens from Acapulco have D. XII, those from Panama (types of *H. undecimale*) have D. XI.

39. HÆMULON CARBONARIUM. (Ronco Carbonero.)

Hæmulon carbonarium Poey, Memorias de Cuba, II, 176, 1860 (Cuba); Poey, Synopsis, 1868, 318; Poey, Enumeratio, 44, 1875; Jordan & Swain, l. c., 298; Jordan, l. c., 1890, 319 (Bahia).

Habitat: West Indies, south to Brazil.

Etymology: *Carbonarius*, coaly, an allusion to the common name.

This species is common at Havana, where it is known as *ronco carbonero*. It reaches a length of about 10 inches. We have examined specimens from St. Croix and Bermuda in the British Museum, where they are labeled *Hæmulon macrostoma.* In the museums at Washington, Cambridge, and Bloomington are specimens from Havana and Bahia.

40. HÆMULON SCHRANKI.

Hæmulon schranki Agassiz, Spix, Pisc. Brasil., 1829, 121, pl. 69 (Brazil); Evermann & Jenkins, Proc. U. S. N. M. 1891, 153 (Guaymas); Jordan, l. c., 1889, 648 (St. Lucia); Jordan, l. c., 1890, 319 (Bahia).

? *Hæmulon similis* Castelnau, Anim. Nouv. ou Rares, 1855, 11? (Bahia).

Hæmulon caudimacula Steind., Ichth. Beitrage, III, 15, 1875 (Acapulco, Rio Janeiro, Rio Grande do Sul, Maranhão; not of Cuv. & Val.).

Diabasis steindachneri Jordan & Gilbert, Bull. U. S. F. C. 1881, 322 (Mazatlan, Panama); Jordan & Gilbert, Bull. U. S. F. C. 1882, 107, 110 (Panama, Mazatlan); Jordan & Gilbert, Proc. U. S. N. M. 1882, 361, 372 (Cape San Lucas, Colima).

Hæmulon steindachneri, Jordan & Swain, l. c., 299.

Hæmylon flaviguttatum Bean, Proc. U. S. N. M. 1880, 96 (Colima; no description; not of Gill).

Habitat: Pacific coast of tropical America; coast of Brazil, north to St. Lucia.

Etymology: Named for Schrank, an early naturalist.

A species of small size, generally common on the Pacific coast of tropical America. It also occurs in abundance on the southeast coast of Brazil, and a specimen before us was taken by the *Albatross* at St. Lucia. We have examined numerous specimens from Brazil in the Museum of Comparative Zoölogy (from Rio Janeiro, Rio Grand do Sul, Para, Maranhão, and Acapulco); on comparing these with Pacific coast examples we can find no difference; the Brazilian fish seems to be the original of the poorly figured *Hæmulon schranki* of Agassiz; the Pacific coast form is *H. steindachneri.*

41. HÆMULON MELANURUM. (Jeníguana.)

Perca marina cauda nigra (Black-tail), Catesby, Hist. Car., tab. 7, f. 2, 1743 (Bahamas).

Perca melanura Linnæus, Syst. Nat., x, 292, 1758; XII, 486, 1766 (based on Catesby's figure); Gmelin, Syst. Nat., 1788, 1319.

Bathystoma melanurum, Putnam, Bull. M. C. Z., 1863, 12 (name only).

Hæmulon melanurum, Cope, Trans. Am. Phil. Soc. 1871, 471 (New Providence, St. Martins, St. Croix); Jordan & Swain, l. c., 300.

Hæmulon dorsale Poey, Memorias, II, 179, 1860 (Cuba); Synopsis, 1868, 308; Enumeratio, 1875, 44).

Habitat: West Indies.

Etymology: *μέλας,* black; *οὐρά,* tail.

This species is rather common at Havana, where it is known as *Jeníguana.* It reaches a length of about a foot. There seems to be no doubt of its identity with the "black-tail" of Catesby, on which is based the *Perca melanura* of Linnæus. Specimens are in the museum at Cambridge from Havana, St. Thomas, Sombrero, and Nassau.

42. HÆMULON SCIURUS. (Yellow Grunt; Ronco Amarillo.)

Anthias formosus Bloch, Ichthyol., taf. 323, 1790 (Antilles); Bloch & Schneider, Syst. Ichthyol., 1801, 305. (Not *Perca formosa* L., with which it is identified; the latter is *Diplectrum formosum*.)

Sparus sciurus Shaw, General Zoölogy, IV, 1803, pl. 64 (based on the description and figure of Bloch).

Hæmulon sciurus, Jordan, Proc. U. S. N. M. 1884, 126 (Key West); Jordan & Swain, l. c., 301.

Hæmulon elegans Cuvier, Règne Animal, 1829 (no description; on the figure of Bloch); Cuv. & Val., V, 227, 1830; Günther, I, 1859, 306 (Jamaica); Putnam, Bull. M. C. Z., 1863, 12 (name only); Poey, Repertorio, I, 309, 1867; Cope, Trans. Am. Phil. Soc. 1871, 471 (St. Croix).

Diabasis elegans, Jordan & Gilbert, Syn. Fish. N. A., 923 (specimen from Aspinwall); Bean, Cat. Fish. Exh. London, 1883, 58 (Key West).

Diabasis obliquatus Bennett, Zoölogical Journal, London, V, 1835, 90 (Jamaica).

Hæmulon luteum Poey, Memorias, II, 174, 354, 1860 (Cuba); Poey, Synopsis, 317; Poey, Enumeratio, 44; Poey, Anales Hist. Nat., Madrid, 1881, 201 (Puerto Rico).

Hæmulon multilineatum Poey, Memorias, II, 178, 1860 (Cuba); Poey, Synopsis, 318; Poey, Enumeratio, 44.

Hæmulon hians Haly, Ann. Nat. Hist., 1875, XV, 268 (Bahia).

Habitat: West Indies; Florida Keys to Brazil.

Etymology: *Sciurus*, squirrel, from the grunting noise. The species was confounded by Shaw with the squirrel-fish, *Holocentrus ascenscionis*.

This species is common both at Key West and Havana, and is known as the "yellow grunt" or "*ronco amarillo*." It is sometimes called the "boar grunt" by fishermen, who imagine it to be the male of *H. plumieri*. It was first noticed by Bloch, who called it *Anthias formosus*, identifying it incorrectly with *Perca formosa* of Linnæus. Shaw, who still supposed it to be *Perca formosa* of Linnæus, changed this name arbitrarily to *Sparus sciurus*. A fair description and figure are given, taken, we believe, from Bloch. In our opinion the name *sciurus* should be retained for the species, although so far as Shaw was concerned its introduction was a piece of meddling impertinence. Shaw's synonymy includes the Linnæan fish, and the name *sciurus* is taken from the common name (squirrel-fish) of the latter. The species which he had in mind, is, however, the present one, and it had before him received no tenable specific name. This confusion was first detected by Cuvier, who, however, failed to discriminate between the Linnæan type (*Serranus formosus*) and the figure of Catesby (representing *Hæmulon plumieri*), referred by Linnæus to the same species. Cuvier called the species *elegans*. Later Poey, on the basis of inaccuracies in coloration in a plate representing *H. elegans*, has considered the Cuban fish as distinct under the name of *luteum*, while a pale variety discussed above has been called *multilineatum*. There is no doubt that both of these names should be regarded as synonyms of *elegans*. The *Diabasis obliquatus* of Bennett is much more like this species than any other of the genus yet known. We think that it belongs here, though the blue stripes are represented as more oblique and more numerous than we have ever seen them. Specimens are in the museum at Cambridge from Havana, Porto Seguro, St. Thomas, Bermuda, and Puerto Rico.

43. HÆMULON PLUMIERI.

(Common Grunt; Ronco Ronco; Ronco Arará.)

Guabi coara brasiliensibus Marcgrave, Hist. Bras., 1648, 163 (Brazil).
Perca marina capite striato (the Grunt), Catesby, Hist. Carolina, etc., tab. 6, 1743 (Bahamas, etc.).
Labrus plumieri Lacépède, Hist. Nat. Poiss., III, 480, 1802, pl. 2, f. 2 (on a copy of a drawing by Plumier, identified with this species by Cuvier).
Diabasis plumieri, Jordan & Gilbert, Proc. U. S. N. M. 1882, 603 (Charleston); ibid., Syn. Fish. N. A., 1883, 971; Bean, Cat. Fish. Exh. London, 1883, 58 (Key West).
Hæmulon plumieri, Jordan, Proc. U. S. N. M. 1884, 126 (Key West); Jordan & Swain, l. c., 303; Jordan, l. c., 1889, 648 (St. Lucia); Jordan, l. c., 1890, 319 (Bahia).
Hæmulon formosum Cuvier, Règne Animal, 1829; Cuv. & Val., V, 1830, 230 (Martinique); Günther, I, 305, 1859 (Pernambuco, Jamaica); De Kay, New York Fauna, 1842, 86 (?New York); Cope, Trans. Am. Phil. Soc. 1871, 470 (St. Croix, New Providence) (not *Perca formosa* L.).
Hæmylum formosum, Putnam, Bull. M. C. Z., 1863, 12 (name only).
Diabasis formosus, Jordan & Gilbert, Proc. U. S. N. M. 1882, 276 (Pensacola); Jordan & Gilbert, Synopsis Fishes N. A., 553.
Hæmulon arcuatum Cuv. & Val., IX, 481, 1833 (Charleston); Holbrook, Ichth. S. Car., 1860, 124, pl. XVII (Charleston); Goode, Proc. U. S. N. M. 1879, 113 (St. Augustine; no descr.); Bean & Dresel, Proc. U. S. N. M. 1884, 158 (Jamaica).
Hæmulon arará Poey, Memorias, II, 1860, 177 (Cuba); Poey, Synopsis, 1868, 318; Poey, Enumeratio, 1875, 45.
Hæmylum arará, Putnam, Bull. M. C. Z., 1863, 12 (name only).
Hæmulon subarcuatum Poey, Memorias, II, 1860, 419 (Cuba); Poey, Synopsis, 1868, 318; Poey, Enumeratio, 1875, 45.

Habitat: West Indies; Carolina to Brazil.

Etymology: For Father Plumier, an early naturalist who sent drawings of the fishes of Martinique to the museums of Europe.

This species is the "grunt" par excellence of our South Atlantic coast. It is not rare in West Florida and on the Carolina coast, while at Key West it is the most abundant food-fish, the amount taken during the year exceeding that of all other shore species combined. At Havana it is proportionally less common, though still the most abundant of its genus. It does not usually exceed a foot in length, although individuals 18 inches long are sometimes taken. These large grunts have the back and nape more elevated and correspond to Cuvier's *H. arcuatum*. This species was well represented by Catesby, but Linnæus has referred Catesby's figures to the synonymy of his *Perca formosa*, which is a *Diplectrum*. From this mistake it has come that the name *formosum* has been transferred from *Diplectrum formosum* to *Hæmulon*. This is inadmissible. The oldest name actually given this species is *Labrus plumieri* Lacépède; this name is based on a rough copy of a drawing by Plumier. Cuvier, who had examined this drawing, referred it to the present species, so there seems no doubt that the name *plumieri* belongs here. Poey's *H. subarcuatum* seems to be a color variety of his *H. arará*, which is the ordinary *plumieri*. Specimens are in the Museum at Cambridge from Tortugas, Havana, Jérémie, Hayti, St. Thomas, Maranhão, Bahia, Rio Janeiro, and Rio Grande do Norte.

44. HÆMULON FLAVOLINEATUM.

(French Grunt; Open-mouth Grunt; Ronco Condenado.)

Diabasis flavolineatus Desmarest, Prem. Décade Ichth., 1823, 35, pl. 2, f. 1; Desmarest, Dictionnaire Classique, v, 235, about 1825, tab. 98, f. 1 (Cuba).
Anarmostus flavolineatus, Putnam, Bull. M. C. Z., 1863, 12 (name only).
Hæmulon flavolineatum, Poey, Repertorio, I, 309, 1867; Poey, Synopsis, 318; Poey, Enumeratio, 45; Jordan, Proc. U. S. N. M. 1884, 126 (Key West); Jordan & Swain, l. c., 305; Jordan, l. c., 1889, 648 (St. Lucia).
Hæmulon heterodon Cuvier, Règne Animal, ed. 2, 1829 (*Diabase rayée* of Desmarest); Cuv. & Val., v, 1830, 255 (Martinique); Poey, Repertorio, I, 1867, 309.
Hæmulon xanthopteron Cuv. & Val., v, 1830, 254 (Martinique).
Hæmulon xanthopterum, Günther, I, 312, 1859 (Martinique, Jamaica, Trinidad, Puerto Cabello).
Hæmulum xanthopterum, Cope, Trans. Am. Philos. Soc. 1871, 471 (St. Croix).
Hæmylum xanthopterum, Bean, Proc. U. S. N. M. 1880, 96 (Bermuda; no description).

Habitat: West Indies; Florida Keys and Bermudas to Brazil.

Etymology: *Flavus*, yellow; *lineatus*, marked with lines.

This species is rather rare at Key West, where it is known as the "French grunt" or "open-mouth grunt." In Havana, it is more common, and is called "*ronco condenado.*" It reaches a length of nearly a foot. Its peculiar coloration and large lateral scales render it one of the most easily recognizable of the species. The young show two dark lateral stripes like the young of *H. parra*, *rimator*, etc. There is no doubt as to the name to be retained for this species, the name *flavolineatus* of Desmarest having clear priority over the names of species described by Cuvier, the description and figure given by him being very good. In the first description of the genus *Hæmulon*, the *Diabasis flavolineatus* is expressly mentioned by Cuvier as one of the species to be referred to the genus. The other names of the species are less certain. *H. heterodon* Cuv. certainly belongs here, and probably *H. xanthopteron* also. Specimens are in the Museum at Cambridge from Havana, Tortugas, Jérémie, Hayti, Bermudas, Bahamas, Amelia Island, Florida, Barbados.

45. HÆMULON CHRYSARGYREUM.

Hæmulon chrysargyreum Günther, I, 314, 1859 (Trinidad); Günther, Shore Fishes, Challenger, 7 (Fernando Noronha); Jordan & Swain, l. c. (copied); Jordan, l. c., 1889, 648 (St. Lucia).
Hæmulon tæniatum Poey, Memorias, II, 182, 1860 (Cuba); Poey, Syn. Pisc. Cub., 319; Jordan, Proc. U. S. N. M. 1884, 126 (Key West); Jordan & Swain, l. c., 307.
Brachygenys tæniata, Poey, Enum. Pisc. Cub., 1875, 47.

Habitat: West Indies; southern Florida to Brazil.

Etymology: χρυσός, gold; ἀργύρεος, silvery.

This little fish, the smallest of the genus, is abundant both at Key West and Havana. None of the specimens seen exceed six inches in length. This species approaches more closely than any other to the genus *Pomadasis.* It differs from the others in the less development of the cavernous structure of the skull, the foramina on the frontal region being inconspicuous. The specimens called *tæniatum* are identical with the types of *H. chrysargyreum*, the former name having been given to the young. Specimens are in the Museum at Cambridge from Havana and St. Thomas. In the British Museum, we have seen examples from Trinidad (types), St. Croix, and Fernando de Noronha.

46. HÆMULON RIMATOR. (Tom-tate; Redmouth Grunt; Cæsar.)

Hæmulon chrysopteron, Cuv. & Val., v, 1830, 240 (brought by Milbert from New York; erroneously identified with *Perca chrysoptera* L., which is an *Orthopristis*); DeKay, New York Fauna, Fishes, 1842, 85, pl. VII, f. 22 (New York market); Holbrook, Ichth. S. Car., 121, 1860 (Charleston).

Hæmulon chrysopterum, Günther, I, 313, 1859 (Jamaica; Trinidad).

Bathystóma chrysopterum, Putnam, Bull. M. C. Z., 13, 1863 (name only).

Diabasis chrysopterus, Jordan & Gilbert, Syn. Fish. N. A., 1883, 553; Bean, Cat. Fish. London Exh., 1883, 58 (Pensacola).

Hæmulon quadrilineatum, Holbrook, Ichth. S. Car., 1860, 195 (Charleston; not of Cuv. & Val.).

Hæmulon ? caudimacula, Poey, Syn. Pisc. Cub., 1875, 47 (Cuba; not of Cuv. & Val.).

Hæmulon parræ, Poey, Enum. Pisc. Cub., 1875, 47 (not *Diabasis parræ* Desm.).

Diabasis aurolineatus, Jordan & Gilbert, Proc. U. S. N. M. 1882, 276, 307 (Pensacola); *ibid*, 1882, 602 (Charleston); Jordan & Gilbert, Syn. Fish. N. A., 973, 1883; Bean, Cat. Fishes London Exh., 1883, 58 (Pensacola); Jordan, Proc. U. S. N. M. 1884, 126 (Key West; not *Hæmulon aurolineatum* Cuv. & Val.).

Hæmulon rimator (Jordan & Swain, MS.), Bean, Proc. U. S. N. M. 1884, 158 (Jamaica); Jordan & Swain, l. c., 308.

Habitat: West Indies; North Carolina to Trinidad; apparently more abundant on our South Atlantic coast than southward.

Etymology: *Rimator*, inquirer.

This species is very common about Charleston, where it is one of the most abundant food-fishes. About Pensacola and Key West the adult are less numerous, but at the latter place the young swarm everywhere about the wharves and shores. At Key West it is known as "Tom-tate." From its small size (rarely a foot in length) it is held in low esteem, and is not often brought into the market. It was not observed by Prof. Jordan at Havana. A specimen in our collection, sent by Prof. S. E. Meek from the New York market, is said to be from North Carolina.

The synonymy of this species has been much confused, although most of the confusion has been unnecessary. The name *chrysopterum* has been generally applied to the present species. This name comes from the *Perca chrysoptera* of Linnæus. This *Perca chrysoptera* was based on a specimen sent from Charleston by Dr. Garden. This specimen is still preserved in London, and it belongs, according to Dr. Bean, who has examined it, to the species called by Cuvier *Pristipoma fulvomaculatum*. This species should therefore be known as *Orthopristis chrysopterus*. With this *Perca chrysoptera* Linnæus wrongly associates the margate-fish of Catesby, which is *Hæmulon album*. Cuvier has identified both Catesby's fish and the Linnæan *Perca chrysoptera* with the present species, which he calls *Hæmulon chrysopteron*. It is evident from the above that the name *chrysopterum* can not properly be retained for this or any other species of *Hæmulon*. The name *aurolineatum* has been applied by Jordan & Gilbert to this species, but erroneously, as is shown beyond. Jordan & Swain have therefore given the species a new name, as none of those by which it has been called (*chrysopterum*, *aurolineatum*, *caudimacula*, *parræ*) were originally intended for it. The name *Hæmulon rimator* is given in allusion to the inquisitive habits shown by the young of this species. They swarm about the wharves and are a nuisance to the fishermen, nibbling off the bait.

Both *Hæmulon rimator* and *H. plumieri* have been recorded from "New York," but no good evidence exists that either species passes to the northward of Cape Hatteras. None of the others range far north of the Tropic of Cancer.

47. HÆMULON AUROLINEATUM. (Jeníguano.)

Hæmulon aurolineatum Cuv. & Val., Hist. Nat. Poiss., 1830, v, 237 (Brazil, San Domingo); Günther, I, 318 (Pernambuco); ? Cope, Trans. Am. Philos. Soc. 1871, 471 (St. Martins, name only); Jordan & Swain, l. c., 310; Jordan, l. c., 1889, 648 (St. Lucia); Jordan, l. c., 1890, 319 (Bahia).

Hæmulon jeníguano Poey, Memorias, II, 183, 1860 (Cuba); Poey, Synopsis, 319; Poey, Enumeratio, 47.

Bathystoma jeniguarno, Putnam, Bull. M. C. Z., 1863, 12 (name only).

Diabasis jeníguano, Jordan & Gilbert, Syn. Fish. N. A., 925, 1883 (Garden Key); Bean, Cat. Fish. London Exh., 1883, 58 (Garden Key).

Habitat: West Indies; Florida Keys to Brazil.

Etymology: *Aurum*, gold; *lineatus*, striped.

This little fish is very abundant at Havana, where it is often brought into the market. It is smaller in size than any other of the genus except *H. chrysargyreum*. It has been taken at Garden Key, Florida, but was not observed at Key West by Prof. Jordan. In its relations it is extremely close to *H. rimator*. It is more slender and fusiform in outline, and its coloration is usually of a deeper yellow, otherwise we are unable to point out any differences of importance.

We have adopted the name *aurolineatum* for this species, and not for *H. rimator*, on the strength of the following account of the typical specimen of *Hæmulon aurolineatum* received from Dr. H. E. Sauvage, of the museum at Paris:

Hæmulon aurolineatum, Brazil, Delalande, type. Length of the body, 0.220 m.; height of body, 0.055 m.; length of the head, 0.60 m. Height of the body contained nearly four times in the total length, and three and one-half without the caudal.

As the description of Cuvier & Valenciennes agrees in other respects equally well with either species, the above measurements leave no doubt of the identity of their type with *H. jeníguano*. *Hæmulon rimator*, young or old, is never so slender as the above measurements would indicate.

Specimens are in the museum at Cambridge from Havana, Rio Janeiro, Ceará, Maranhão, San Francisco, St. Thomas, and Porto Seguro. Among those from Cuba is Poey's type of *H. jeníguano*.

48. HÆMULON STRIATUM. (White Grunt.)

? *Capeuna brasiliensibus* Marcgrave, Hist., etc., Brasil., I, 1648, 155.
Perca striata Linnæus, Syst. Nat., ed. x, 1758, 233 (North America), and the copyists.
Hæmulon striatum Jordan, l. c., 1889, 648 (St. Lucia).
? *Grammistes trivittatus* Bloch & Schneider, Syst. Ichth., 1801, 188 (on the description of Marcgrave).
Diabasis trivittatus, Jordan & Gilbert, Syn. Fish. N. A., 1883, 554 (erroneously ascribed, after Holbrook, to the Carolina fauna).
? *Serranus capeuna* Lichtenstein, Abhandl. Berlin Akad., 1821, 288 (on the description of Marcgrave).
? *Hæmulon capeuna*, Cuvier, Règne Animal, 1829 (no description; after Marcgrave).
Hæmylum capeuna, Goode, Bull. U. S. N. M., v, 1876, 53 (Bermuda).
Hæmulon quadrilineatum Cuv. & Val., v, 1830, 238, pl. 120 (San Domingo); Günther, I, 316, 1859 (copied); Poey, Repertorio, I, 310, 1867; II, 161; Poey, Synopsis, 1868, 319 (Cuba); Poey, Enum. Pisc. Cub., 1875, 47; Cope, Trans. Am. Philos. Soc. 1871, 471 (St. Croix); Jordan & Swain, l. c., 311.
Hæmulon quinquelineatum, Poey, Memorias, II, 419, 1860 (Cuba).

Habitat: Bermudas to Brazil.

Etymology: *Striatus*, striped.

This is probably the species indicated by Linnæus under the name *Perca striata*. The number (13) of dorsal spines and the comparison with *P. melanura* render it certain that this species, *H. rimator*, or *H. aurolineatum* was intended. Of these, only the present species has the second anal spine especially strong ("*validissimus*"), and to this species the name *striatum* should apparently be referred.

The following is Linnæus's account:

"Striata, 22. *P. pinnis dorsalibus unitis, cauda bifida, corpore striato.*

"*D.* $\frac{13}{28}$. *P.* 15. *V.* $\frac{1}{6}$. *A.* $\frac{3}{11}$. *C.* 17.

"*Habitat in America septentrionali. Mus. de Geer. Opercula subserrata. Radius secundus analis validissimus. Cauda nigra non est, qua differt a P. melanura.*"

Specimens are in the museum at Cambridge from Havana and Bermuda.

49. HÆMULON FLAVIGUTTATUM.

Hæmulon flaviguttatus Gill, Proc. Ac. Nat. Sci. Phila. 1862, 254 (Cape San Lucas).
Hæmulon flaviguttatum Steind., Ichth. Beitr., III, 14, 1875 (Mazatlan, Acapulco, Altata, Panama); Streets, Bull. U. S. N. M., VII, 79, 1877 (Lower California); Jordan & Swain, l. c., 314; Evermann & Jenkins, Proc. U. S. N. M. 1891, 152 (Guaymas).
Diabasis flaviguttatus, Jordan & Gilbert, Bull. U. S. F. C. 1881 (324), 1882 (107, 110), (Mazatlan, Panama); Jordan & Gilbert, Proc. U. S. N. M. 1882, 361, 381, 626 (Cape San Lucas, Panama).
Hæmulon margaritiferum Günther, Proc. Zoöl, Soc. 1864, 147; Günther, Fishes Centr. Amer., 1869, 419, pl. LXV, fig. 2 (Panama).

Habitat: Pacific coast of tropical America, Guaymas to Panama.

Etymology: *Flavus*, yellow; *guttatus*, spotted.

This species is generally common along the Pacific coast of tropical America. It has no analogue among the Atlantic species. On account of the peculiarities of the form of the body, the snout, the mouth, and the vertical fins, and especially the increased development of the gill-rakers, we may regard it as the type of a distinct subgenus, which has been called *Lythrulon*. The cranium shows no special peculiarity except the shortness of the snout and the development of the high supraoccipital crest. Specimens are in the Cambridge museum from Acapulco. Our specimens were collected at Guaymas by Evermann & Jenkins.

50. HÆMULON MACULICAUDA. (Roncador Raiado.)

Orthostæchus maculicauda Gill, Proc. Ac. Nat. Sci. Phila. 1862, 255 (Cape San Lucas).
Hæmulon maculicauda, Steind., Ichth. Beitr., III, 14, 1875 (Mazatlan, Acapulco); Jordan & Swain, l. c., 315; Evermann & Jenkins, Proc. U. S. N. M. 1891, 152 (Guaymas).
Diabasis maculicauda, Jordan & Gilbert, Bull. U. S. F. C. 1881, 325, 1882, 110 (Panama); Jordan & Gilbert, Proc. U. S. N. M. 1882, 362, 372, 626 (Cape San Lucas, Panama, Colima).
Hæmulon mazatlanum Steindachner, Ichth. Notizen, VIII, 12, taf. VI, 1869 (Mazatlan).

Habitat: Pacific coast of tropical America, Guaymas to Panama.

Etymology: *Macula*, spot; *cauda*, tail.

This small species is rather common on the Pacific coast of tropical America. Its peculiar squamation, rendered more noticeable by the corresponding features of coloration, give it an appearance quite distinct in this genus. The snout is shorter than usual and the number of dorsal spines is increased. In other respects it departs less from the usual type than do *H. flaviguttatum* and *H. striatum*. The cranium differs little from the ordinary *Hæmulon* type. The specimens in the museum at Cambridge are from Acapulco. The specimens before us were collected at Guaymas by Evermann & Jenkins.

XIII. ANISOTREMUS.

Anisotremus Gill, Proc. Ac. Nat. Sci. Phila. 1861, 107 (*virginicus*).
Genytremus Gill, Proc. Ac. Nat. Sci. Phila. 1861, 256 (*bilineatus*).
Paraconodon Bleeker, Archiv. Neerl., XI, 272, 1876 (*pacifici*).

Type: *Sparus virginicus* Linnæus.

Etymology: ἄνισος, unequal; τρῆμα, aperture, from the pores at the chin.

This genus, like *Hæmulon*, to which it is closely related, contains numerous species, all of them restricted to the shores of tropical America. All the species undergo considerable change in form with age, and all of them are valued as food-fishes. The young are marked with two or three blackish lengthwise stripes. These disappear with age, quickest in the brightly colored species, and persist for a long time in species like *surinamensis* and *interruptus*, which agree in coloration with *Hæmulon parra* and related species.

Only a skeleton of the synonymy of this genus is here given.

ANALYSIS OF SPECIES OF ANISOTREMUS.

a. Scales above lateral line in series parallel with the lateral line.

b. Dorsal spines rather low, the longest not more than half length of head; second anal spine about half head.

c. Pectorals much shorter than head, not reaching tips of ventrals; dorsal rays XI, 13, the spines comparatively slender, the longest half head; eye more than twice as wide as the narrow preorbital. Body compressed, considerably elevated, the greatest height below the fifth dorsal spine; profile rounded from base of first dorsal spine to the nape, concave over the eyes, descending abruptly down the snout; interorbital area twice orbit; snout thick and obtuse; teeth villiform in both jaws, with an outer series of conical teeth; preopercle serrate, strongly on angle; a posterior notch in opercle between two obtuse and feeble points; soft dorsal about as high as spinous; second anal spine long and strong; caudal emarginate. Color dusky-grayish, with four irregular crossbands, which grow faint with age; scales silvery with purple reflections; membrane between the scales brown; fins blackish. Head, $3\frac{1}{5}$; depth, $2\frac{2}{5}$ to $2\frac{3}{4}$; D. XI, 13; A. III, 10. Scales, 7–47–13; second anal spine, 2 in head; fifth dorsal spine, 2; pectoral, $4\frac{1}{2}$............... PACIFICI, 51.

cc. Pectorals a little longer than head, about reaching anal fin; dorsal rays XII, 16, the spines short and stout, the longest $2\frac{1}{2}$ in head; eye $3\frac{1}{2}$, about one-fourth wider than the broad preorbital. Body ovate, compressed, the back rather strongly arched; anterior profile, rather steep and straightish, slightly depressed above eyes and at the nape; snout very short, blunt and thick; mouth very small, the maxillary not quite reaching to front of eye; lower jaw included; teeth cardiform, in broad bands, the outer series enlarged, but smaller than in *A. pacifici;* preopercle rather weakly serrate; gill-rakers short and weak, about 10 below angle; dorsal fin low, rather deeply emarginate, the soft rays more than two-thirds height of longest spines; anal rather low, its margin perfectly straight; second anal spine very robust; caudal moderately forked. Color grayish silvery; a faint dark bar from front of dorsal to level of base of pectorals; lower parts of sides with indistinct darker streaks; vertical fins and pectorals dusky yellowish; distal half of ventrals and base of anal blackish. Head, $3\frac{1}{5}$; depth, $2\frac{1}{8}$; D. XII, 16; A. III, 9; scales, 6–52–13; eye, $3\frac{1}{2}$; snout, 3; preorbital, $2\frac{5}{8}$; maxillary, $3\frac{1}{4}$; second anal spine, 2; fourth dorsal spine, $2\frac{1}{2}$; pectoral, 3; gill-rakers, X+10........................... CÆSIUS, 52.

bb. Dorsal spines very high, the longest $1\frac{3}{5}$ in head; second anal spine very long, about $1\frac{3}{4}$ in head; pectorals much shorter than head; interorbital area much less than width of orbit; snout obtuse, not much longer than eye; cleft of mouth small, the maxillary extending to front of eye; dorsal and anal spines exceedingly strong, the third dorsal spine the longest; snout naked, the remainder of the head being scaly; each ray of the soft fins accompanied by a series of minute scales, covering the caudal; caudal fin slightly emarginate. Color grayish-silvery, with five jet-black crossbands in the adult; fins blackish. Head, 3; depth, 2; D. XII, 16; A. III, 9; scales, 8–48–15; second anal spine, $1\frac{3}{4}$; third dorsal spine, $1\frac{3}{5}$ .... DOVII, 53.

aa. Scales above lateral line arranged in oblique series which are not parallel with the lateral line.

d. Scales comparatively large, less than nine in a vertical series between first dorsal spine and the lateral line; coloration olivaceous, the adult nearly plain, the young with two or more dusky lateral stripes which disappear with age; fins blackish.

e. Scales 5, 6–52–15 (lateral line with 49 pores); scales above lateral line on anterior part of body more or less enlarged, especially in the adult; young specimens with two black horizontal stripes, one of these from eye to a point just before the base of caudal, where it is interrupted, a round black spot following at base of caudal; another stripe above this and parallel with it; scales of anterior part of back more or less distinctly marked with black spots, one on each scale, these spots not confluent. Body oblong-elliptical, the back elevated, the profile strongly convex at nape, becoming straighter anteriorly; interorbital area a little more than eye; mouth short, the maxillary extending to anterior edge of eye; outside teeth of jaws conical, notably longer and stronger than the others; preopercle evenly serrate on vertical edge, weaker at angle; dorsal and anal spines strong, second anal stronger and a little longer than the highest dorsal spine, about half head; soft dorsal lower, about one-third head; pectoral falcate, as long as head; caudal forked. Head, 3; depth, 2½; D. XII, 16; A. III, 8 or 9; scales, 5 to 6–52–12 to 15; eye, 4; snout, 2⅔; second anal spine, 1⅞; fourth dorsal spine, 2; pectoral, 1 .... SURINAMENSIS, 54.

ee. Scales 7, 8–46–15 (lateral line with 54 pores), scales above lateral line anteriorly not especially enlarged; all specimens examined with three or four black lateral stripes, one from eye to near base of caudal, where it ceases abruptly, giving place to a round caudal spot as in the young of *A. surinamensis*, also a stripe from scapular scale to last dorsal ray, forming two spots on back of caudal peduncle (this stripe wanting in *A. surinamensis*); above this, one or two other stripes parallel with it; opercular membrane black. Anterior profile considerably steeper than in *A. surinamensis*. In all other respects, in specimens of the same age, this species seems to agree with *A. surinamensis*. Head, 3; depth, 2⅓; D. XII, 16; A. III, 8; eye, 2⅔; snout, 4½; preorbital, 4; pectoral, 1..... BICOLOR, 55.

dd. Scales rather small, more than 9 in a vertical series between the first dorsal spine and the lateral line.

f. Body not striped longitudinally with yellow or blue; preorbital narrow; gill-rakers, x+13.

g. Anterior part of body without jet-black vertical bar; axil jet-black, the spot encroaching on base of pectoral; a round black spot on base of last rays of dorsal and anal; body dark gray, with obscure darker streaks; fins pale, edge of opercle dusky; pectoral long, $1\frac{1}{10}$ in head, reaching front of anal. Body ovate, the back elevated, the profile from the tip of the short blunt snout to the last dorsal ray evenly rounded; lower profile straighter, angulated at end of base of anal; mouth moderate; teeth in broad bands, the outer in both jaws longer, close-set, slender and sharp; preopercle rather finely and not sharply serrate; dorsal fin divided almost to base, the tenth spine no longer than first; second anal spine stronger and a little longer than third, lower than soft rays; caudal forked. Head, 3; depth, 2⅓; D. XI, 14; A. III, 13; scales, 9 or 10–51–x; eye, 4; snout, 4; preorbital=pupil; maxillary, 3⅓; pectoral, $1\frac{1}{10}$; gill-rakers, x+13 .... SCAPULARIS, 56.

gg. Anterior part of body with a jet-black vertical bar which extends from between the fifth and seventh dorsal spines to opposite the lower edge of the pectoral; edge of opercle and base of pectoral black; pectoral longer than head. Body elongate-ovate, the back elevated, the anterior profile straightish to nape, thence regularly convex; lower profile straight, angulated at anal; mouth small; teeth setiform, arranged in broad bands, becoming shorter behind, longer and stronger in front; dorsal fin deeply notched, the tenth spine twice as long as first; second anal spine much stronger and almost twice as long as third, higher than soft rays; caudal forked. Head, $3\frac{1}{4}$; depth, $2\frac{2}{3}$; D. XII, 16 or 15; A. III, 11; scales, 11–62–21; eye, $4\frac{1}{2}$; snout, 3; preorbital, $5\frac{1}{2}$; maxillary, $3\frac{2}{3}$; second anal spine, $2\frac{1}{4}$; fourth dorsal, $2\frac{1}{10}$; pectoral, seven-eighths; gill-rakers, x+13.

DAVIDSONII, 57.

ff. Body with longitudinal stripes of blue or yellow or both; young with a black blotch at base of caudal; preorbital broad; gill-rakers, x+16.

h. Anterior part of body with two broad dark crossbars, the one from the nape obliquely forward through eye, the other from front of dorsal downward; behind these a series of horizontal stripes alternately yellow and blue; pectoral longer than head; second anal and fourth dorsal spines nearly equal.

i. Blue stripes on sides about six in number, very distinct, not nearly as wide as a scale; sharply edged with darker blue; their width about one-third that of the olive interspaces; additional blue stripes in the interspaces faint and few; vertical bands of head and shoulder brown. Body ovate, the back much elevated, the anterior profile steep, convex on snout, straightish over eye, nape very convex to base of third dorsal spine; mouth moderate, the maxillary extending to anterior edge of eye; jaws subequal; teeth arranged in bands, the outer much enlarged; about 10 gill-rakers, besides rudiments, below angle; dorsal fin high, slightly emarginate; spines slender, the highest slightly shorter and weaker than the second anal spine, which is more than half head; caudal lunate. Head, $3\frac{1}{5}$; depth, $2\frac{1}{10}$; D. XII, 16; A. III, 10. Scales, 10–56–17; eye, $3\frac{1}{2}$; snout, $2\frac{7}{8}$; preorbital, 4; maxillary, $3\frac{1}{4}$; second anal spine, $1\frac{3}{4}$; fourth dorsal spine, $1\frac{7}{8}$; pectoral, $\frac{7}{8}$; gill-rakers, x+16 .... TÆNIATUS, 58.

ii. Blue stripes on side as broad as a scale, each more than two-thirds the width of the golden-yellow interspaces, and each very faintly edged with darker; vertical bands on head and shoulder jet black. Body ovate, the back very much elevated, the anterior profile steep, slightly convex along snout and over eye, very much arched at nape; mouth small, the maxillary extending to anterior nostril; jaws subequal; outer row of teeth enlarged; about six gill-rakers, besides rudiments, below angle; dorsal fin low, emarginate, spines slender, the highest about equal in length to second anal spine, which is less than half head; caudal forked. Head, $3\frac{1}{8}$; depth, $2\frac{1}{10}$; D. XII, 17; A. III, 10, 11; scales, 11–56–17; eye, $4\frac{1}{8}$; snout, $2\frac{1}{2}$; preorbital, 4; maxillary, $3\frac{1}{2}$; second anal spine, $2\frac{1}{10}$; third-dorsal spine, $2\frac{1}{10}$; pectoral, $\frac{7}{8}$; gill-rakers, x+16.

VIRGINICUS, 59.

[Allied to *Anisotremus virginicus* is another species, which, on account of the imperfect description, should not be placed in the analysis.

CATHARINÆ, 60.]

hh. (Anterior part of body without dark crossbars, the body sometimes plain yellowish, the back usually violet, with 4 or 5 yellow lines; silvery below; snout short, not longer than width of eye; dorsal fin very deeply notched, with feeble spines; second and third anal spines equal in length; body a little more oblong than in *surinamensis*. D. XII, 13; A. III, 9. (*Cuv. & Val.*)..SERRULA, 61.

51. ANISOTREMUS PACIFICI.

Conodon pacifici Günther, Proc. Zoöl. Soc. London, 1864, 147 (Chiapas).
Pomadasis pacifici, Jordan & Gilbert, Proc. U. S. N. M. 1881, 385 (Panama).

Habitat: Pacific coast of Central America.

Etymology: From Pacific (Ocean).

This small, plain-colored species is rather common about Panama.

52. ANISOTREMUS CÆSIUS.

Pomadasys cæsius Jordan & Gilbert, Proc. U. S. N. M. 1881, 383 (Mazatlan).

Habitat: Pacific coast of Mexico.

Etymology: *Cæsius*, silver-gray.

This species is known from the three types taken in the harbor of Mazatlan and from a specimen at Cambridge from Acapulco.

53. ANISOTREMUS DOVII.

Pristipoma dovii Günther, Proc. Zoöl. Soc. London, 1864, 23 (Panama).
Pomasasis dovii, Jordan & Gilbert, Proc. U. S. N. M. 1881, 386 (Mazatlan, Panama).

Habitat: Pacific coast of tropical America.

Etymology: Named for Capt. John M. Dow.

This strongly-marked and handsome species is not rare on the Pacific coast of tropical America.

54. ANISOTREMUS SURINAMENSIS. (Pompon.)

Lutjanus surinamensis Bloch, Ichthyol., pl. 253, 1791 (Surinam).
Pristipoma surinamense, Cuv. & Val., V, 273, 1830 (same type).
Holocentrus gibbosus Lacépède, Hist. Nat. Poiss., IV, 344, 1803 (same type).
Pristipoma bilineatum, Cuv. & Val., Hist. Nat. Poiss., V, 271, 1830 (Martinique).
Anisotremus bilineatus, Jordan, Proc. U. S. N. M. 1890, 319 (Bahia); Jordan & Bollmann, l. c., 1889, 181 (Indefatigable Island).
Pristipoma melanopterum Cuv. & Val., l. c., 273 (Brazil).
Hæmulon obtusum Poey, Memorias, II, 1860, 182 (Havana).
Hæmulon labridum Poey, Memorias, II, 1860, 419 (Cuba).
Genytremus interruptus Gill, Proc. Ac. Nat. Sci. Phila. 1861, 256 (Cape San Lucas).
Pristipoma fürthi Steind., Ichth. Beiträge, V, 4, 1876 (Panama).
Pomadasys bilineatus and *fürthi*, Jordan & Gilbert, Proc. U. S. N. M. 1881, 385 (West Indies, Peru, Brazil, Magdalena Bay, Cape San Lucas, Gulf of California, Mazatlan, Panama, Galapagos Islands).

Habitat: Both coasts of tropical America, north to Cuba and Magdalena Bay.

Etymology: From Surinam.

This species is the most widely distributed of any of the genus. It reaches a larger size than the others and is subject to a considerable variation in form. Pacific Coast examples usually have the scales above the lateral line a little larger than usual in Atlantic specimens, but this difference can not be depended on and is variable. Should a tangible variety ever prove appreciable, the name *interruptus* should be retained for the West Coast form. Specimens are in the Museum of Comparative Zoölogy, from Havana (type of *Anisotremus obtusus* Poey), from Bahia, Rio Janeiro, Galapagos Islands, Panama, and Magdalena Bay. The largest of these is about 2 feet in length. The Galapagos specimens are darkest in color and with the snout rather sharper. Those from the Galapagos and from Rio Janeiro have the scales above the lateral line a little less enlarged, 9 in an oblique series, downward and backward from first dorsal spine (7 in Panama specimen, 8 in specimen from Magdalena Bay).

Lutjanus surinamensis Bloch is a dried and discolored specimen, which could have belonged to no other known species. Although 14 dorsal spines are figured and the body represented as marked with dark crossbands, we have no doubt of its identity, and therefore substitute the name *surinamensis* for *bilineatus*.

55. ANISOTREMUS BICOLOR. (Maria-Prieta.)

Pristipoma bicolor Castelnau, Anim. Nouv. ou Rares Amér. du Sud, 1850, 8, pl. 2, f. 2 (Bahia).
Anisotremus bicolor, Jordan, Proc. U. S. N. M. 1890, 319 (Bahia).
? *Pristipoma trilineatum* Poey, Memorias, II, 343, 1860 (Havana).
Pristipoma brasiliense Steindachner, Sitzungsb. k. Akad. Wiss. Wien, 1863, p. 1013 (Bahia).

Habitat: Coast of Brazil.

Etymology: *Bicolor*, two-colored.

This species is known to us from several specimens from the coast of Brazil (Bahia, Rio Grande do Norte, and Ceará), preserved in the museum at Cambridge, and from one taken by the *Albatross* at Bahia. It is very close to *A. surinamensis*, but has slightly larger scales and a somewhat different coloration, as well as a steeper and more gibbous front. *Anisotremus trilineatus* Poey may be the young of this species, but of this we are not sure.

56. ANISOTREMUS SCAPULARIS.

Pristipoma scapulare Tschudi, Fauna, Peruana, 1844, 12 (Huacho).
Diagramma melanospilum Kner, Sitzungsb. k. Akad. Wissenschaft, 1867, 4 (west coast of South America).
Pristipoma notatum Peters, Berl. Monatsb., 1869, 706 ("angeblich aus Mazatlan").
Pomadasys modestus, Jordan, Proc. Ac. Nat. Sci. Phila. 1883, 286 (probably not of Tschudi).

Habitat: Coast of Peru.

Etymology: *Scapula*, shoulder, from the shoulder spot.

Of this species, one specimen, 4865, from Callao, is in the museum at Cambridge. Others examined by us are in the museum at Berlin. It has the central pore at the chin, the failure to find which led Kner to place the species in *Diagramma*. It seems to be identical with Peters's type of *P. notatum*, preserved in the museum at Berlin, though it dis-agrees with Peters's description, the dorsal rays being XII, 15, not XVIII–I, 15, as stated by Peters. This species is probably the one poorly described by Tschudi under the name of *Pristipoma scapulare.* It is well distinguished by the color mark, which has suggested the names *scapularis*, *melanospilus*, and *notatus.*

57. ANISOTREMUS DAVIDSONI.

Pristipoma davidsoni Steind., Ichthyol. Beiträge, III, 6, 1875 (San Diego); Jordan & Gilbert, Proc. U. S. N. M. 1881, 385 (Catalina Island, San Diego).

Habitat: Coast of southern California.

Etymology: Named for Prof. George Davidson, of San Francisco.

This well-defined species is not rare about San Diego and neighboring islands. It has not been taken elsewhere.

58. ANISOTREMUS TÆNIATUS.

Anisotremus tæniatus Gill, Proc. U. S. N. M. 1861, 107 (Panama).

Habitat: The Pacific coast of tropical America, Magdalena Bay to Panama.

Etymology: *ταινία*, a ribbon; *tæniatus*, striped.

This species, the most brilliantly colored of the genus, is common on the Pacific coast of tropical America, where it replaces the closely allied *Anisotremus virginicus.* The differences between the two species, though slight, seem to be constant. Steindachner records the species from Magdalena Bay. Our specimens are from Mazatlan and Panama.

59. ANISOTREMUS VIRGINICUS. (Catalineta; Porkfish.)

Guatucupa juba Marcgrave, Hist. Brasil., 1648, 148 (Brazil).
Acara pinima Marcgrave, 1648, 152 (Brazil).
Sparus virginicus Linnæus, Syst. Nat., x, 281, 1758.
Pristipoma virginicum Günther, I, 288 (Jamaica).
Pomadasys virginicus Jordan & Gilbert, Proc. U. S. N. M. 1881, 385.
Anisotremus virginicus Gill, Proc. Ac. Nat. Sci. Phila. 1861, 107; Jordan, Proc. U. S. N. M. 1890, 319 (Bahia).
Sparus vittatus Bloch, Ichthyol., taf. 263, fig. 2, 1791 (after Marcgrave, *Acara pinima*).
Perca juba Bloch, l. c., taf. 308, fig. 2, 1791 (after Marcgrave).
Grammistes mauritii Bloch & Schneider, Syst. Ichthyol., 185, 1801 (after *Sparus vittatus*).
?Pristipoma catharinæ Cuv. & Val., v, 269, 1830.
Pristipoma rodo Cuv. & Val., v, 274, 1830.
Pristipoma acara pinima Castelnau, Anim. Nouv. ou Rares, 1856, 8.

Habitat: West Indies, Florida Keys to Brazil.

Etymology: Virginia, but the species does not reach thus far to the northward.

This well-known species is the commonest of the genus in the West Indies and is the only one which extends its range to the coast of Florida.

60. ANISOTREMUS CATHARINÆ.

Pristipoma catharinæ Cuv. & Val., v, 269, 1830 (Île Sainte Catharine du Brésil).

Habitat: Coast of Brazil.

Etymology: From the island of Santa Catarina.

This imperfectly known species probably belongs to *Anisotremus* and it is apparently nearest to *A. virginicus*, possibly identical with it. The following is a condensation of the account given by Cuvier & Valenciennes:

Body deep, much elevated at the nape; depth, 3 in total length with caudal; mouth, small; pores at chin, very small; dorsal notched, its spines long and strong; caudal emarginate; second anal spine longer than third, which is as long as first soft ray; ventrals longer than the short pectorals. Coloration nearly plain; sides with faint streaks. D. XII, 14; A. III, 10.

A drawing sent us by our friend, M. Alexandre Thominot, of the Museum at Paris, shows the general form of *A. virginicus*, the spines in the fins notably strong, especially the third and fourth of the dorsal and the second of the anal. M. Thominot says:

Nous ne possédons dans la collection du muséum qu'un exemplaire type du *Pristipoma catharinæ* de Cuv. & Val. Il porte le no. 1365ª et vient du Brésil par MM. Lesson & Garnot. Voici ce que nous trouvons:

D. $\frac{11}{16}$, P. $\frac{1}{16}$, V. $\frac{1}{5}$, A. $\frac{3}{11}$, C. 17.

Rayons épineux dorsaux robustes; le 1er est le plus court, le 3me le plus long. Tête contenue $3\frac{2}{3}$ à $3\frac{3}{4}$ fois dans la longueur totale; le diamètre de l'œil = la longueur du nez; préopercule fortement dentelé dans sa hauteur, râteaux branchiaux manquant d'un côté et en très mauvais état à l'opposé; pores du menton, vu le mauvais état de cette partie, sont presque incertains; hauteur du corps par une ligne perpendiculaire menée de la base du 3me rayon épineux de la dorsale au milieu des ventrales = à peu près le $\frac{1}{3}$ de l'étendue totale du sujet; caudale en croissant; je ne dis rien des pectorales, lesquelles ont le bout des rayons incomplet; les ventrales arrivent presque au cloaque.

This will probably prove to be a young example of *Anisotremus virginicus* in bad condition.

61. ANISOTREMUS SERRULA. (Têtê-de-Roche.)

Pristipoma serrula Cuv. & Val., v, 272, 1830 (Martinique).
Pristipoma auratum Cuv. & Val., l. c., 272 (Martinique).
Pristipoma spleniatum Poey, Memorias, II, 1860, 187 (Havana).

Habitat: West Indies.

Etymology: *Serrula*, a little saw, a translation of the French name "Petite-Scie," used at Martinique.

This species we have not seen. We place *spleniatus* in the synonymy of *serrula* with some doubt, as it may have been based on the young of *virginicus*. Except for the presence of the groove at the chin, as implied in the description of Cuvier and Valenciennes, we might suppose this species to be identical with *Genyatremus luteus*.

XIV. CONODON.

Conodon Cuv. & Val., Hist. Nat. Poissons, v, 156, 1830 (*antillanus* = *nobilis*).

Type: *Conodon antillanus* Cuv. & Val. = *Perca nobilis* L.

Etymology: κῶνος, cone; ὀδών, tooth.

This genus contains two closely related species, both from tropical America. The genus is close to *Pomadasis*, from which it is separated by the enlarged outer teeth and by the armature of the preopercle.

ANALYSIS OF SPECIES OF CONODON.

a. Back distinctly elevated and compressed, the depth about equal to length of head, 3⅙ in body; dorsal fins low, fourth and longest spine 1⅘ in head, longest dorsal ray 2¼ in head; second anal spine not 2 in head; second dorsal spine about one-half length of third; teeth of outer series enlarged, stout; preorbital at its least width more than half diameter of eye; D. XI, I, 13; A. III, 7; scales 6–55–13. Color silvery, darker above, with 8 dark bars which extend on sides below level of pectoral; sides with light-yellowish streaks in life...NOBILIS, 62.

aa. Back not elevated, the depth equal to length of head, 3⅗ in body; dorsal fin higher than in *nobilis*, fourth and longest spine 2⅙ in head, longest dorsal ray 3 in head; second anal spine 2 in head; second dorsal spine about one-third length of third; teeth of outer series slightly enlarged, slender; preorbital at its least width less than half diameter of eye; D. XI, I, 12; A. III, 7. Scales, 6–53–15. Color silvery, darker above with dark bars on sides which do not extend to level of pectoral..SERRIFER, 63.

62. CONODON NOBILIS.

Perca nobilis Linnæus, Syst. Nat, ed. x, 1758, 191 (North America).
Sciæna plumieri Bloch, Ichthyol., VI, 66, taf. 306, 1791 (Martinique).
Conodon plumieri, Günther, I, 304.
Sciæna coro Bloch, l. c., pl. 307, f. 2 (after *Coro-coro*, Marcgrave).
Cheilodipterus chrysopterus Lacépède, Hist. Nat. Poiss., III, 542, pl. 33, f. 1.
Conodon antillanus Cuv. & Val., v, 156, 1830.
Pristipoma coro Cuv. & Val., v, 266, 1830.

Habitat: West Indies, coast of Texas to Brazil.

Etymology: *Nobilis*, noble.

This species is not rare in the West Indies and is more common on the coast of Brazil. It has been once taken on the coast of Texas and is probably a species inhabiting sandy shores. The name *nobilis*, in all probability intended for this species, has priority over any other, although less doubt attaches to the name *plumieri*.

63. CONODON SERRIFER.

Conodon plumieri, Streets, Bull. U. S. N. M., VII, 50, 1877 (Boca Soledad, Lower California; not of Cuv. & Val.).
Conodon serrifer Jordan & Gilbert, Proc. U. S. N. M. 1882, 351 (same specimens).

Habitat: Pacific coast of Mexico.

Etymology: *Serra*, saw; *fero*, I bear.

This species is still known only from the original types, three specimens (17546, U. S. N. M.), taken by Dr. Streets at Boca Soledad on the Pacific coast of Lower California. It is close to *C. nobilis*, but slenderer, and somewhat different in armature.

XV. POMADASIS.

Pomadasis Lacépède, Hist. Nat. Poiss., IV, 1803, 516 (*argenteus*).
Les Pristipomes Cuvier, Règne Animal, ed. 1, 1817, 279 (*hasta*, etc.).
Pristipoma Cuvier, Règne Animal, ed. 2, 1829 (*hasta*, etc.).
Brachydeuterus* Gill, Proc. Ac. Nat. Sci. Phila. 1862, 17 (*auritus*).
Pseudopristipoma Sauvage, Bull. Sci. Philom., IV, 220, 1880 (*leucurum*).
Hæmulopsis Steind., Ichthyologische Notizen, VIII, 1869, 9 (*corvinæforme*).

Type: *Sciæna argentea* Forskål.

Etymology: πῶμα, operculum; δασύς, rough, hence more correctly written *Pomadasys.*

This genus is composed of small shore fishes, some of its representatives being found in most tropical seas. The three principal types, or subgenera, are all represented in American waters. The Pacific coast species of this genus are well known, but those of the Atlantic need further study and comparison. Several of the species enter fresh waters, and perhaps belong to the brackish-water fauna. Numerous species are found on the west coast of Africa and about the Cape Verde Islands, but so far as known none enter European waters.

ANALYSIS OF AMERICAN SPECIES OF POMADASIS.

a. Anal spine strong, the second much longer and stronger than the third; soft dorsal and anal nearly or quite naked.
b. Teeth in upper jaw in villiform bands, those in front more or less enlarged, acute (*Pomadasis*).
c. Dorsal spines, XII; preorbital broad.
d. Mouth large, maxillary reaching to anterior third of eye, about 2⅜ in head.
e. Scales rather small, 8–56–20. Body elongate-elliptical, compressed, somewhat elevated at nape; anterior profile straight from nape to end of snout; snout produced, blunt, rounded; preopercle and suprascapular scale coarsely serrated; dorsal fin deeply notched; dorsal spines low, the longest about 2¾ in head; soft dorsal short, its base contained about 2⅛ times in base of spinous portion; second anal spine very long and strong, about 1⅜ in head; soft dorsal and anal slightly scaly at base; pectoral short, not reaching vent. Coloration uniform. Head, 2⅛, depth, 3½; scales 8–56–20; D. XII, 12; A. III, 7; eye, 5; preorbital, 6⅓; snout, 3¼; maxillary 2⅜; pectoral, 5 in body; fourth dorsal spine, 2¾; second anal spine, 1⅜; soft dorsal, 2⅓ in spinous ....HUMILIS, 64.
ee. (Scales still smaller, 65 in a longitudinal series; body elongate, the depth 4⅓ in total length with caudal; head nearly 4; eye, 4 in head; maxillary extending a little beyond front of eye; anal spines strong, the second ⅔ the depth of body. Color nearly plain, silvery below. D. XII, 12; A. III, 7.) (*Poey*) ....PRODUCTUS, 65.

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* Erroneously supposed to be a genus of *Sciænidæ*, its typical species having been placed by Cuvier in *Larimus.*

dd. Mouth small, the maxillary not reaching to anterior edge of orbit, about 3⅓ in head; pectorals long, 1⅓ in head; scales large, 6–48–14. Body ovate-elongate, compressed, considerably elevated at nape; anterior profile straight or slightly concave from nape to point of snout; snout sharp and pointed; preopercle and suprascapular scale coarsely serrate; dorsal fin very deeply notched; dorsal spines long and strong, the longest about 2 in head; soft dorsal short; its base contained about $2\frac{1}{10}$ times in base of spinous portion; second dorsal spine very long and strong, about 2 in head; soft dorsal and anal with a single row of a few scales behind each ray near the base; pectoral long, reaching a little beyond the vent, about 3⅓ in body. Coloration in spirits dusky, with a metallic luster above, lighter below; about four dusky transverse bands extending to level of pectoral. Head, 2⅞; depth, 2⅞; scales, 6–48–14; D. XII, 13; A. III, 7; eye, 4½; preorbital, 4⅘; snout, 2⅞; maxillary, 3⅓; pectoral, 3⅓ in body; fourth dorsal spine, 2 in head; second anal spine, 2; soft dorsal, $2\frac{1}{10}$ in spinous........................MACRACANTHUS, 66.

cc. Dorsal spines, XIII; preorbital narrow.

f. Body moderately elongate, the depth 2⅘ to 3 in length.

g. Snout pointed, 3⅘ in head. Body elongate, compressed, the back elevated, high at the nape, the anterior profile rather irregular, varying with age; a more or less distinct frontal depression above eye in old specimens; mouth small, the maxillary barely extending to the anterior edge of orbit; lower jaw included; preopercle coarsely serrate, the teeth wide apart; teeth small, the outer scarcely enlarged; scales rather large, 6–54–16, those above the lateral line parallel; dorsal fin moderately notched; second anal spine very strong and long, reaching past tips of all the rays; pectoral short, caudal slightly lunate. Color rather plain, about 3 or 4 ill-defined longitudinal dark stripes along sides, one from point of snout to middle of base of caudal. Head, 3; depth 2⅘ to 3½; scales 6–54–16; D. XIII, 11–12; A. III–6, 7; eye, 3½ to 5; preorbital, 4 to 8; snout, 2⅔ to 3⅘; maxillary, 3 to 4; pectoral, 1⅙ to 1½; fourth dorsal spine, 1⅘ to 2¼; second anal spine, 1½ to 2; soft dorsal, 2 in spinous ....CROCRO, 67.

gg. Snout longer, moderately pointed, about 3 in head; body elongate, ovate, compressed, the back elevated, depth about 3 in length; pectorals rather long, 1⅓ in head; anterior profile steep and convex over snout, depressed above eye, becoming slightly convex at nape; top of head with a slight depression; mouth small, the maxillary barely reaching to the anterior edge of eye; preorbital very narrow; teeth arranged in narrow, thickly-set bands, those in front a little broader; preopercle and scapula strongly serrate, the serræ wide apart at angle; eye very large, about 3 in head; soft dorsal and anal slightly scaly at base; dorsal fin only moderately notched, the soft part much shorter and lower than the spinous portion; dorsal spines very high and stout; second anal spine very long and strong; pectoral long; caudal slightly lunate. Color uniformly silver gray, the base of each scale slightly darker. Head, 3; depth, 3; scales, 7–49–12; D. XIII, XIV–12; A. III, 7; eye, $3\frac{1}{5}$; preorbital, $5\frac{1}{4}$; snout, 3; maxillary, $3\frac{2}{3}$; pectoral, $1\frac{1}{8}$; fourth dorsal spine, $1\frac{1}{2}$; second anal spine, $1\frac{2}{5}$; soft dorsal, $2\frac{3}{4}$ in spinous......................BRANICKI, 68.

ff. Body very long and low, compressed, the back little elevated, the depth about $3\frac{3}{5}$ in length; pectorals shortish, $1\frac{1}{3}$ in head. Second anal spine very long, $1\frac{1}{4}$ in head; anterior profile irregular, straightish over snout, slightly convex above eye, occiput concave, convex at nape; mouth moderate, the maxillary reaching to front of pupil; preopercle and scapula very coarsely serrated, teeth at angle of preopercle almost spiny; eye large; base of soft dorsal and anal naked or slightly scaly; dorsal fin only slightly notched, the soft part about half as long as spiny portion; dorsal spines very strong; second anal spine very long, reaching beyond tips of last rays; pectoral short; caudal truncate. Color of body metallic grayish-golden with indistinct streaks and bands; belly lighter, fins dusky. Head, 3 to $3\frac{1}{2}$; depth, $3\frac{1}{2}$ to $3\frac{3}{4}$; scales, 6–54–14; D. XIII, 11 or 12; A. III, 6–7; eye, $3\frac{1}{2}$; preorbital, $5\frac{1}{2}$ to 8; snout, $3\frac{2}{5}$; maxillary, 3; pectoral, $1\frac{1}{8}$; fourth dorsal spine, $1\frac{4}{9}$ to 2; second anal spine, $1\frac{1}{4}$; soft dorsal, 2 in spinous......................RAMOSUS, 69.

bb. Teeth in upper jaw in broad villiform bands, not differentiated. (*Pseudopristipoma* Sauvage.)

h. Third dorsal spine produced, much longer than the others, about half length of head; second anal spine somewhat shorter; profile convex; scales nearly smooth; pectoral fin very long, as long as head; preopercle weakly serrate. Color silvery; lower fins white; a distinct dark blotch on opercle and a fainter one on sides below spinous dorsal. Body rather robust............................PANAMENSIS, 70.

aa. Anal spines small or moderate, the second little if any longer or stronger than third; anal lower than the soft rays; soft dorsal and anal largely covered with small scales; body oblong, not elevated; scales above lateral line parallel with the back. Color grayish, with light and dark stripes along rows of scales, these sometimes obscure. Scales large, about 6 in a vertical row between first dorsal spine and lateral line, 45 to 55 in the lateral line; dorsal spines, 12. (*Brachydeuterus* Gill.)

i. Pectoral fin long, nearly equal to head; preorbital broad, about as wide as eye.

j. Axillary blotch large, black, encroaching on the rays of the pectoral fin; pectoral fin nearly as long as head; body rather robust, the back elevated, the profile even; dorsal deeply notched; second anal spine short and stout, $3\frac{1}{2}$ to 4 in head; fins unspotted; body with faint dark crossbands; back and sides with dark stripes formed by dark spots along the rows of scales. Head, $3\frac{4}{5}$; depth, $3\frac{1}{2}$; D. XII, 16; A. III, 9; scales 6–50–10 ....AXILLARIS, 71.

ii. Pectoral fin short, much shorter than head; anal spines very small.

k. Preorbital narrow, not so broad as eye; the second anal spine shorter than the third; a large blackish rounded blotch, nearly as large as eye, behind the suprascapula at the origin of the lateral line. Body rather elongate, the mouth small, the maxillary not quite reaching front of eye. Head, 4 in length; depth, $3\frac{1}{2}$; eye, $3\frac{3}{4}$; snout, 3; pectoral, $1\frac{1}{3}$; fourth dorsal spine, 2 in head; second anal spine, nearly 4; D. XII, 15; A. III, 8; scales, 6–52–10. Silvery, darker above, with dark streaks along the rows of scales; scapular blotch conspicuous.................NITIDUS, 72.

kk. Preorbital broad, not narrower than eye; anal spines stoutish, the second little if any shorter than third; no dark blotch on scapular region.

l. Maxillary reaching front of eye, $3\frac{1}{2}$ in head; sides of back with distinct dark streaks along the rows of scales; head, $3\frac{1}{4}$ to $3\frac{3}{5}$ in length; depth, $3\frac{1}{3}$ to 4; eye, $4\frac{1}{5}$ in head; snout, $2\frac{3}{5}$ to $3\frac{1}{2}$; pectoral, $1\frac{1}{3}$; fourth dorsal spine, 2 to $2\frac{1}{2}$ in head; second anal spine, 3; upper lobe of caudal longer. D. XII, 15; A. III, 7; scales, 5–50–11. Color olivaceous, silvery below; the dark streaks conspicuous along the rows of scales.........................CORVINÆFORMIS, 73.

ll. Maxillary not reaching front of eye; sides with indistinct dark streaks or none; body rather elongate; coloration nearly plain; anal spines not graduated, the second stoutish and scarcely shorter than third; preorbital very deep, wider than eye; pectorals short, much shorter than head; color silvery, young with traces of dark crossbands and dark lengthwise streaks; maxillary not reaching eye; dorsal deeply notched. Head, 3 in length; depth, 3; D. XII, 15 or 16; A. III, 8; scales, 6–52–12; preorbital, $3\frac{4}{5}$ to 4 in head; fourth dorsal spine, $1\frac{3}{4}$; maxillary, $3\frac{1}{2}$ to $3\frac{3}{5}$ in head; snout, $2\frac{2}{3}$ to $2\frac{5}{6}$ in head.

m. Body moderately elongate, the depth 3 in length; anterior profile somewhat convex; preorbital, $3\frac{4}{5}$ in head, a little more than eye; anal spines moderate, the second $2\frac{3}{4}$ to 3 in head.........................LEUCISCUS, 74.

mm. Body more slender, the depth $3\frac{1}{10}$ in length; anterior profile straight; preorbital 4 in head, a little less than eye; anal spines smaller, the second $3\frac{3}{5}$ to 4 in head.
ELONGATUS, 75.

64. POMADASIS HUMILIS.

Pristipoma humile Kner & Steindachner, Sitzgber. Akad. Wiss. (Münch.), 1863, 222 (Rio Bayano, near Panama).

Habitat: Pacific coast of Central America, often or always in fresh waters.

Etymology: *Humilis*, humble.

This species is known from a few specimens, all taken from the Rio Bayano, near Panama. The two examined by us (30957) were taken by Capt. John M. Dow. In the same bottle was a specimen of *Joturus pichardi* (type of *Joturus stipes*), which is a strictly fresh-water species.

65. POMADASIS PRODUCTUS.

Pristipoma productum Poey, Memorias, II, 1860, 186 (Havana).

Habitat: West Indies.

Etymology: *Productus*, produced, from the long snout.

This species, which seems closely allied to *P. humilis*, is known only from Poey's descriptions. From *P. ramosus* it differs, if the descriptions can be trusted, in having but 12 dorsal spines.

66. POMADASIS MACRACANTHUS.

Pristipoma macracanthum Günther, Proc. Zoöl. Soc. Lond. 1864, 146 (Chiapas).

Habitat: Pacific coast of tropical America.

Etymology: μακρός, long; ἄκανθα, spine.

This species is generally common along the west coast of Mexico and Central America. The specimens examined by us are from Panama, Mazatlan, Chiapas, and Punta Arenas. The East Indian *Pomadasis hasta*, the type of *Pristipoma*, is allied to *P. macracanthus*, but has the back and the dorsal fin spotted, somewhat as in *P. suillus*.

67. POMADASIS CROCRO.

Pristipoma crocro Cuv. & Val., Hist. Nat. Poiss., v, 264, 1830.
Pristipoma cultriferum Poey, Memorias, II, 1860, 185.
Pomadasys approximans Bean & Dresel, Proc. U. S. N. M. 1884, 160 (Jamaica).

Habitat: West Indies, Cuba to Brazil.

Etymology: *Crocro*, the vernacular name at Martinique.

This species is generally common in the West Indies, especially on sandy coasts. The specimens examined by us are from Cuba (type of *Pristipoma cultriferum* Poey, in the museum at Cambridge), and from São Matheus, Itabapuana, and Cannarivieras, in Brazil.

68. POMADASIS BRANICKI.

Pristipoma branicki Steindachner, Denkschr. kaiserl. Akad. Wiss. Wien, XII, 28, 1879 (Tumbez, Peru).

Habitat: Pacific coast of tropical America.

Etymology: A personal name.

This small species closely resembles *P. crocro* and *P. ramosus*. It is generally common on the sandy coasts of tropical America on the Pacific side. The specimens seen by us are from Mazatlan, Panama, Rio Zanatenco, and Chiapas.

69. POMADASIS RAMOSUS.

Pristipoma ramosum Poey, Memorias, II, 1860, 186 (Havana).
Pristipoma boucardi Steindachner, Ich. Notizen, IX, 1, 1869 (Gulf of Mexico).

Habitat: West Indies, south to Brazil.

Etymology: *Ramosus*, branched, the soft rays of the ventrals being much branched.

Of this species we have examined a specimen 6 inches long (418, M. C. Z.) from Hayti. A number of specimens in the Museum of Comparative Zoölogy agree with this one, except that the anal spine is shorter, 2 in head; these bear an unpublished MSS. name given by Dr. Steindachner, but we are not prepared to separate them from *P. boucardi;* they are 10615, M. C. Z., São Matheus, the largest a foot in length, collected by Hartt & Copeland, and 2421, M. C. Z., from Rio Una, collected by Antonio de Lacerda. *Pristipoma boucardi* Steindachner seems to us identical with the specimen from Hayti. It is probable that this is the same as *P. ramosus* Poey, but the description of Poey is not very full.

70. POMADASIS PANAMENSIS.

Pristipoma panamensis Steindachner, Ich. Beiträge, III, 8, 1875 (Panama).

Habitat: Pacific coast of tropical America.

Etymology: From Panama.

This well-marked species is generally common on the Pacific coast of tropical America. Those examined by us are from Panama and Mazatlan.

71. POMADASIS AXILLARIS.

Pristipoma axillare Steindachner, Ich. Notizen, VIII, 7, 1869 (Mazatlan).
Pomadasis axillaris, Evermann & Jenkins, Proc. U. S. N. M. 1891, 151 (Guaymas).

Habitat: Pacific coast of Mexico.

Etymology: *Axillaris*, from the black axillary spot.

This species is known only from about Mazatlan, where it was found to be rather common by Dr. Gilbert, and from Guaymas, where it was obtained by Evermann & Jenkins. One of the specimens of *Pristipoma* "*leuciscus*" obtained in Lower California by Dr. Streets belongs to this species, the other to *P. nitidus*.

72. POMADASIS NITIDUS.

Pristipoma nitidum Steindachner, Ich. Notizen, VIII, 5, 1869 (Mazatlan).

Habitat: Pacific coast of tropical America.

Etymology: *Nitidus*, shining.

This small species has been taken at Mazatlan, Panama, and in the Gulf of California.

73. POMADASIS CORVINÆFORMIS.

Hæmulon corvinæforme Steindachner, Ich. Notizen, VII, 16, 1868 (Santos, Brazil).

Habitat: Coast of Brazil.

Etymology: *Corvina*, a genus of *Sciænidæ; forma*, shape.

This species has been taken a few times on the coast of Brazil. The specimen examined by us (4539, M. C. Z.) was collected by Agassiz at Rio Grande do Sul.

74. POMADASIS LEUCISCUS.

Pristipoma leuciscus Günther, Proc. Zool. Soc. London 1864, 147 (San Jose de Nicaragua, Chiapas).

Habitat: Pacific coast of tropical America.

Etymology: *Leuciscus*, a chub or shiner, from λευκός, white.

This species is not rare on the Pacific coast of Mexico. The specimens examined by us are from Mazatlan and Panama.

75. POMADASIS ELONGATUS.

Pristipoma leuciscus, var. *elongatus* Steindachner, Neue und seltene Fische aus dem k. k. Museum, 1879, 30, 52, Taf. 9, f. 2 (Tumbez, west coast of South America).

Habitat: Pacific coast of tropical America.

Etymology: *Elongatus*, elongate.

This species occurs with *P. leuciscus*, and so far as our experience goes it is the more common of the two. The differences between them are very slight. *Elongatus* is more slender, with straight profile, the preorbital broader, and the anal spines somewhat smaller, the third hardly as long as the second. In all other respects the two are identical and, at the best, *P. elongatus* must be regarded as a doubtful species. Possibly it is the male of *P. leuciscus*, but such sexual differences, or in fact any sexual differences, are unusual in the family.

XVI. ORTHOPRISTIS.

Orthopristis Girard, U. S. Mex. Bound. Survey, 1859, 15 (*duplex=chrysopterus*)
Microlepidotus Gill, Proc. Ac. Nat. Sci. Phila. 1862, 255 (*inornatus*).
Pristocantharus Gill, Proc. Ac. Nat. Sci. Phila. 1862, 256 (*cantharinus*).
Isaciella Jordan & Fesler, subg. nov. (*brevipinnis*).

Type: *Orthopristis duplex* Girard=*Perca chrysoptera* Linnæus.

Etymology: ὀρθός, straight; πρίστις, used for πρίστης, a saw, in reference to the evenly serrated preopercle.

This genus contains a considerable number of species differing from *Pomadasis* by the long anal fin, the smaller scales, and by the less development of the dorsal spines. Nearly all the species are American. The group is divided into three subgenera, the extremes of which differ considerably from each other.

For the sake of comparison, we introduce the single representative of this genus found in the waters of Europe.

ANALYSIS OF SPECIES OF ORTHOPRISTIS.

a. Dorsal spines, XII or XIII.

b. Soft dorsal and anal scaleless; mouth small; temporal crest, which arises from behind the eye, very low and inconspicuous, the upper edge below base of the high supraoccipital crest, which originates over the pupil (examined in *poeyi, chrysopterus, chalceus,* and *ruber*)......... [ORTHOPRISTIS.]

c. Preorbital narrow, more than 5 in head; second anal spine much stronger than third and about the same length, less than 3 in head and about equal in length to first anal ray; scales large, 7–49–13. Body compressed, the back moderately elevated; anterior profile a little concave and depressed above eye; preopercle finely and sharply serrate; gill-rakers short and slender; snout short, rather sharp, equal to maxillary; eye large; jaws subequal, with the outer teeth scarcely enlarged. Scales arranged above in series which are oblique only to second third of dorsal, behind that point horizontal. Dorsal fin low, but divided nearly to base; spines slender, the last one not half first soft ray, which is low but larger than the others; anal low, with concave margin; pectoral long; caudal forked, upper lobe longer. Color, grayish above, silvery below; dark opercular edging conspicuous; no distinct markings. Head, $3\frac{1}{3}$; depth, $3\frac{2}{3}$; D. XII, 15; A. III, 11; scales, 7–49–13; maxillary, $3\frac{3}{4}$; eye, $3\frac{3}{4}$; preorbital, $5\frac{2}{3}$; pectoral, 1; snout, $3\frac{3}{4}$; spinous dorsal, 2; second anal spine, $2\frac{1}{3}$; base soft dorsal in spinous, $1\frac{3}{5}$ ....BENNETTI, 76.

cc. Preorbital broad, less than 5 in head; second anal spine about as stout as third, more than 3 in head, not as long as first ray; scales small; anterior profile not concave.

d. Anal, III, 10 or 11; snout short and sharp, more than 3 in head; eye large, about 4 in head. Form and general appearance of *chrysopterus;* body oblong, compressed, the back elevated, the profile steep and nearly straight; convex at the nape; preopercle finely and sharply serrate; teeth small, outer above a little enlarged.

e. Lower jaw included; soft dorsal with 14 rays; scales large, 8–54–15; gill-rakers very short and slender, x + 15; pectoral short, $1\frac{1}{3}$ in head; maxillary not reaching to eye. Dorsal nearly continuous, the soft dorsal low, with convex outlines; anal rounded, not very low; second spine as long and as large as third, much shorter than soft rays; caudal moderate, the upper lobe longer. Color, bluish above, silvery below; a brownish spot on center of each scale above, these forming streaks much as in *lethopristis,* those above the lateral line less continuous and a little more wavy than in *lethopristis*; the young with two faint longitudinal dusky streaks on each side of back; both dorsals with rows of brownish spots. Head, $3\frac{1}{3}$; depth, $2\frac{3}{4}$; D. XII, 14; A. III, 10; scales, 8–54–15; maxillary, $3\frac{1}{2}$; eye, 4; preorbital, 4; pectoral, $1\frac{1}{3}$; snout, $3\frac{1}{2}$; spinous dorsal, $2\frac{1}{3}$; second anal spine, $3\frac{1}{2}$; anal ray, $2\frac{1}{3}$; base soft dorsal in spinous, $1\frac{1}{2}$...RUBER, 77.

ee. Jaws subequal; soft dorsal 15–16; scales small, 9–58–18; gill-rakers very short and small, x + 12; pectoral falcate, long, equal to head; maxillary reaching to eye. Outline of dorsal straight, no notch; spines low and slender; soft dorsal low and equal; anal rather higher and shorter, the spines graduated; edge of fin convex; caudal moderately forked, the upper lobe longer. Color paler than in *lethopristis;* pale chalky-bluish streaks along the edges of the rows of scales; a pale streak below base of dorsal; fins rather pale, the soft dorsal mottled with darker. Head, $3\frac{1}{4}$; depth, $2\frac{5}{6}$; D. XII or XIII, 15 or 16; A. III, 10 or 11; scales, 9–58–18; maxillary, $3\frac{1}{3}$; eye, $4\frac{2}{3}$; preorbital, $4\frac{1}{2}$; pectoral, $1\frac{1}{4}$; snout, $2\frac{2}{3}$; spinous dorsal $2\frac{1}{3}$; second anal spine, 4; anal rays, $2\frac{2}{3}$; base soft dorsal in spinous, $1\frac{1}{4}$ ....CHALCEUS, 78.

dd. Anal rays, III, 12 or 13; snout long and sharp, less than 3 in head; eye small, about 5 in head. Jaws equal, with a narrow band of slender teeth, the outer above a little larger; maxillary not reaching to eye; preopercle very slightly serrate above, the serræ blunt, obsolete below; gill-rakers short and slender, x + 12. Scales small; the crown, cheeks, and pieces of the gill-cover covered with small scales; snout in advance of the nostrils, suborbitals and lower jaw naked; dorsal and anal spines inclosed in a deep scaly sheath. Outline of dorsal slightly notched; anal rather high; pectoral shortish; caudal well-forked.

f. Second anal spine shorter than third, more than 5 times in head.

g. Body ovate-elliptical, much elevated at shoulders, depth less than 3 in body; scales comparatively small, 10–60–19; dorsal rays, 16. Color metallic brownish-olive above, changing to yellowish on belly; indistinct golden streaks along rows of scales; yellowish and bluish blotches on fin membranes. Head, $3\frac{1}{8}$; depth, $2\frac{3}{4}$; D. XII or XIII, 16; A. III, 12 or 13; scales, 10–60–19; maxillary, $3\frac{1}{3}$; eye, 5; preorbital, $3\frac{3}{5}$; pectoral, $1\frac{1}{4}$; snout, $2\frac{2}{5}$; spinous dorsal, $2\frac{7}{8}$; second anal spine, $5\frac{1}{2}$; anal rays, 3; base soft dorsal in spinous, $1\frac{1}{4}$.
CHRYSOPTERUS, 79.

gg. Body elongate-elliptical, slightly elevated at shoulders; depth, $3\frac{1}{4}$ in body; scales comparatively large, 8–60–16; dorsal rays, 15. Color metallic grayish-blue above, yellowish below; faint lighter streaks following the rows of scales; blotches on fin membranes. Head, $3\frac{1}{5}$; depth, $3\frac{1}{4}$; D. XII, 15; A. III, 12; scales 8–60–16; maxillary, $3\frac{1}{3}$; eye, 5; preorbital, $3\frac{3}{4}$; pectoral, $1\frac{1}{4}$; snout, $2\frac{1}{3}$; spinous dorsal, 3; second anal spine, $5\frac{2}{3}$; anal rays, 3; base soft dorsal in spinous, $1\frac{2}{5}$ .... POEYI, 80.

ff. Second anal spine about as long as third, less than 5 times in head; mouth small, maxillary 4 in head; snout short, $2\frac{3}{5}$ in head; spinous dorsal high, $2\frac{1}{2}$ in head. Body oblong, the back elevated, less so than in *chalceus*; the profile convex at the nape, depressed above eye, thence perfectly straight to the tip of snout. Color brownish gray above, soiled silvery below; upper parts with eight diffuse crossbands as wide as the interspaces, extending to below middle of sides; membrane of opercle dark, some dark streaks following rows of scales; dorsal with some dull orange and some pale round spots as in *chrysopterus*. Head, $3\frac{1}{5}$; depth, $2\frac{5}{6}$; D. XII or XIII, 15–16; A. III, 12; scales 9–60–18; maxillary, 4; eye, $4\frac{2}{3}$; preorbital, 4; pectoral, 1; snout, $2\frac{3}{5}$; spinous dorsal, $2\frac{1}{2}$; second anal spine, 4; anal rays, $2\frac{4}{5}$; base soft dorsal in spinous, $1\frac{1}{4}$.
CANTHARINUS, 81.

bb. Soft dorsal and anal covered with small scales. (*Isaciella* Jordan & Fesler.)

h. Preopercle entire; preorbital broad, $4\frac{3}{4}$ in head; mouth rather large, maxillary shorter than snout. Body rather elongate, in form intermediate between *brevipinnis* and *chalceus;* back elevated and compressed, especially anteriorly; profile regularly rounded; mouth larger than in other species of *Orthopristis;* teeth small, the outer above longer, slender, and close-set; maxillary not reaching to opposite front of eye; gill-rakers of moderate length, a little shorter than pupil, x + 14; snout long, moderately sharp; eye moderate; jaws subequal; scales large; some series of scales on soft dorsal and anal, a row close behind each ray.

Dorsal fin rather deeply notched; spines low and slender; soft dorsal low, highest toward the front; anal long and rather low, with straight free border; anal spines graduated, the third scarcely half height of first ray; pectoral falcate, rather long; caudal deeply forked. Color dark gray, not silvery; center of each scale dark, these spots forming continuous streaks along the rows of scales; those below the lateral line rather less distinct; fins rather dark; opercular membrane and axil dusky. Head, $3\frac{1}{4}$; depth, 3; D. XII, 14; A. III, 11; scales, 8–65–15; maxillary, 3; eye, $4\frac{3}{4}$; preorbital, $3\frac{3}{4}$; pectoral, $1\frac{1}{10}$; snout, $2\frac{1}{5}$; spinous dorsal, $2\frac{1}{5}$; second anal spine, $6\frac{1}{2}$; anal rays, $3\frac{1}{3}$; base soft dorsal in spinous, $1\frac{1}{8}$.

LETHOPRISTIS, 82.

hh. Preopercle weakly serrate; preorbital very narrow, $6\frac{1}{3}$ in head; mouth small, maxillary longer than snout. Body rather fusiform, somewhat compressed, the back elevated, anterior profile steep, convex; mouth with narrow bands of brush-like teeth, the outer above slender, close-set, and a little enlarged; maxillary reaching to anterior edge of eye; gill-rakers short and slender, x + 16; snout short, blunt; eye large; lower jaw included. Scales small, extending from preorbital to fork of caudal, covering base of pectoral ventrals, soft dorsal, and anal; base of each scale at base of trunk and posterior part of head, with minute scales; dorsal and anal fins inclosed in low scaly sheath. Dorsal fin slightly notched, last spine $1\frac{1}{8}$ in first ray; spinous dorsal low, spines slender; soft dorsal and anal low, third anal spine longest; pectoral sharp, falcate; caudal long, deeply forked. Color light-bluish gray, with brownish gray stripes following the rows of scales. Head, $3\frac{2}{5}$; depth, 3; dorsal, XIII, 16; A. III, 13 or 12; scales, 10–65–20; maxillary, $3\frac{1}{2}$; eye, $4\frac{1}{8}$; preorbital, $6\frac{1}{3}$; pectoral, 1; snout, $3\frac{4}{5}$; spinous dorsal, $2\frac{1}{2}$; second anal spine, $5\frac{1}{3}$; anal rays, $3\frac{3}{4}$; base soft dorsal in spinous, $1\frac{1}{4}$.

BREVIPINNIS, 83.

aa. Dorsal spines, XIV; scales very small; skull very broad and rounded, interorbital area wider than length of snout; preorbital very narrow; the temporal crest, which rises above the pupil, rather high, its top above middle of height of supraoccipital crest, which originates over front of pupil. (*Microlepidotus* Gill.)

i. Body rather elongate, slightly compressed, back moderately elevated, profile convex from nape to snout; mouth large, with numerous bristly teeth, curved inward, larger in front; maxillary reaching to anterior edge of eye; preopercle sharply serrate; gill-rakers short, x + 17; snout bluntish, equal to maxillary; eye very large; jaws subequal. Scales very small, extending from nostril to fork of caudal, covering base of pectoral, ventrals, last two rays of soft dorsal, and preorbital to level of pupil; dorsal and anal fins included in a deep, scaly sheath; dorsal fin deeply notched, last spine $1\frac{1}{2}$ in first ray; spinous dorsal high; spines slender; soft dorsal very low; anal slightly higher than soft dorsal, second spine longest; pectoral sharp, falcate; caudal sharp. Color, bluish-gray, with lighter longitudinal streaks. Head, $3\frac{1}{2}$; depth, $3\frac{1}{4}$; D. XIV, 15; A. III, 12; scales, 9–72–20; maxillary, $3\frac{1}{4}$; eye, $4\frac{3}{4}$; preorbital, $7\frac{1}{2}$; pectoral, $1\frac{1}{10}$; snout, $3\frac{1}{8}$; spinous dorsal, $2\frac{1}{8}$; second anal spine, 6; anal rays, $3\frac{3}{4}$; base soft dorsal in spinous, $1\frac{1}{2}$.

INORNATUS, 84.

76. ORTHOPRISTIS BENNETTI.

Pristipoma bennetti Lowe, Trans. Zoöl. Soc., II, 176 (Madeira Islands).
Pristipoma ronchus Valenciennes, Barker & Webb, Hist. Nat. Îles Canaries (Canary Islands).

Habitat: South coast of Spain and islands of the eastern Atlantic.

Etymology: For Mr. E. T. Bennett.

This species is common about the islands of the eastern Atlantic, and Steindachner mentions having taken four on the south coast of Spain. It has larger scales than the other species of *Orthopristis*. The specimens examined by us were sent from the museum at Vienna to the Museum of Comparative Zoölogy.

77. ORTHOPRISTIS RUBER.

Pristipoma rubrum Cuv. & Val., v, 1830, 283 (Brazil).
Pristipoma lineatum Cuv. & Val., v, 1830, 287 (Brazil).

Habitat: Coast of Brazil.

Etymology: *Ruber*, red, which the fish is not.

The species is probably not rare on the coast of Brazil. Our specimens (4538, M. C. Z.) were obtained at Rio Janeiro by Prof. Agassiz.

78. ORTHOPRISTIS CHALCEUS.

Pristipoma chalceum Günther, Proc. Zoöl. Soc. Lond. 1864, 146 (Panama.)
Pristipoma kneri Steindachner, Ich. Notizen, VIII, 1869, 3 (Mazatlan).
Orthopristis chalceus, Evermann & Jenkins, Proc. U. S. N. M. 1891, 149 (Guaymas).

Habitat: Pacific coast of tropical America.

Etymology: *Chalceus*, brazen.

This species is common on the Pacific coast of Mexico and Central America; everywhere the most abundant of the genus. Our specimens are from Mazatlan, Panama, and the Gulf of California. Others were taken by the *Albatross* at Panama, and about Chatham, Charles and Albemarle islands, in the Galapagos.

79. ORTHOPRISTIS CHRYSOPTERUS. (Pigfish.)

Perca chrysoptera Linnæus, Syst. Nat, ed. XII, 485, 1766 (Charleston).
Labrus fulvomaculatus Mitchill, Trans. Lit. and Phil. Soc. N. Y., 406, 1814 (New York).
Pristipoma fulvomaculatum of many authors.
Pristipoma fasciatum Cuv. & Val., v, 285, 1830 (New York).
Orthopristis duplex Girard, U. S. Mex. Bound. Survey, 1859, 15 (Indianola and Brazos Santiago, Texas).

Habitat: South Atlantic and Gulf coasts of the United States.

Etymology: χρυσός, gold; πτερόν, fin.

This common food-fish is abundant along the sandy shores of the eastern United States, from Long Island to the mouth of the Rio Grande.

80. ORTHOPRISTIS POEYI.

Orthopristis poeyi (Scudder MSS.) Poey, Synopsis, 1868, 312 (Havana).

Habitat: West Indies.

Etymology: Named for Prof. Felipe Poey.

Of this species we have examined several specimens, all from Havana. The species is very close to *Orthopristis chrysopterus*, but the body is more slender and the scales are rather longer.

81. ORTHOPRISTIS CANTHARINUS.

Pristipoma cantharinum Jenyns, Voyage Beagle, Fish., 49, 1842 (Galapagos Islands).
Hæmulon modestum Tschudi, Fauna Peruana, 11, 1844 (Peru).

Habitat: Pacific coast of tropical America.

Etymology: From *Cantharus* (=*Spondyliosoma*), a genus of sparoid fishes, which this remotely resembles.

This species is known to us from two examples, each about a foot long (4648, M. C. Z.), from the Galapagos Islands. Another, supposed to be of the same species, is in the U. S. National Museum from Guaymas. The scanty description of *Hæmulon modestum* Tschudi, a species said to be rare along the coast of Peru, agrees in all respects so far as it goes and is probably the same species. It could not be *Orthopristis chalceus*, *Orthopristis brevipinnis*, or *Isacia conceptionis*, as these species have the second anal spine quite small.

82. ORTHOPRISTIS LETHOPRISTIS.

Orthopristis lethopristis Jordan & Fesler, Proc. Ac. Nat. Sci. Phila. 1889, 36 (Galapagos Islands).

Habitat: Galapágos Archipelago.

Etymology: λήθομαι, to forget; πρίστις, used for πρίστης, a saw; a reference to the entire preopercle.

This species is known from the original type (26947, M. C. Z.), 15 inches long, from the Galapagos Islands.

83. ORTHOPRISTIS BREVIPINNIS.

Pristipoma brevipinne Steindachner, Ichth. Notizen, VIII, 1869, 10 (Mazatlan).

Habitat: Pacific coast of tropical America.

Etymology: *Brevis*, short; *pinna*, fin.

This species and the preceding form a transition from *Microlepidotus* to typical *Orthopristis*. From their resemblance to *Isacia conceptionis*, we have suggested for them the subgeneric name of *Isaciella*.

84. ORTHOPRISTIS INORNATUS.

Microlepidotus inornatus Gill, Proc. Ac. Nat. Sci. Phila. 1862, 256 (Cape San Lucas).
Orthopristis inornatus, Evermann & Jenkins, Proc. U. S. N. M. 1891, 148 (Guaymas).

Habitat: Gulf of California.

Etymology: *Inornatus*, not adorned.

This interesting species is known only from the Gulf of California. The specimens examined by us are from Cape San Lucas and Guaymas. The subgenus *Microlepidotus*, which it represents, is a well-marked group, perhaps worthy of recognition as a distinct genus.

XVII. ISACIA.

Isacia Jordan & Fesler, gen. nov. (*conceptionis*).

Type: *Pristipoma conceptione* Cuv. & Val.

Etymology: From *Isaki*, a Japanese name of *Parapristipoma trilineatum* (=*Pristipoma japonicum* Cuv. & Val.).

We separate from the genus *Parapristipoma* an American species (*conceptione*), which differs from the type of *Pristipoma* much as *Orthopristis* does from *Pomadasis*. The anal fin is very long in this species, and it lacks the peculiar sheath of scales found in *Parapristipoma*. The gill-rakers are well developed in both groups, but the outline of the dorsal is in *Isacia* more as in *Pomadasis*. Although this species has been referred to *Pristipoma*, it lacks the symphyseal groove.

ANALYSIS OF SPECIES OF ISACIA.

a. Dorsal fin deeply notched; anal fin long; caudal fin forked.

b. Dorsal spines 13 or 14, the soft dorsal about half as long as spinous portion; lower jaw projecting. Body oblong-elliptical, moderately compressed; anterior profile nearly straight, a little depressed above eye; snout short and sharp; mouth small, oblique; teeth small, arranged in bands, the outer above a little enlarged; preorbital narrow; preopercle finely serrate; gill-rakers long and slender, x+22; scales above the lateral line arranged in very oblique series; those below horizontal; soft fins, naked; dorsal spines slender and rather high; soft dorsal rather low; anal spines small, graduated, second spine about half as long as first ray; pectoral about as long as head; caudal moderately forked. Color bluish-silvery below, a dark streak along each row of scales below the lateral line, these being horizontal and parallel; some scales above lateral line having pale centers, these making scattered paler spots; axil dusky. Head, $3\frac{1}{2}$; depth, $2\frac{3}{4}$; D. XIII–XIV, 12 to 14; A. III, 13; scales, 10–65–16; eye, $4\frac{2}{3}$; snout, $4\frac{1}{4}$; maxillary, $3\frac{1}{5}$; pectoral, $1\frac{1}{15}$; third dorsal spine, 2; second anal spine, 6; soft dorsal, $1\frac{1}{5}$ in spinous.................................CONCEPTIONIS, 85.

85. ISACIA CONCEPTIONIS

Pristipoma conceptione Cuv. & Val., v, 268, 1830 (Chile).

Habitat: Coast of Chile and Peru.

Etymology: From Concepcion in Chile.

This species is an ally of *Orthopristis brevipinnis*. As, however, it lacks the central groove at the symphysis, it can not be referred to the same genus. The specimens seen by us are from Mexillones in Peru and from Caldera and Paraca in Chile. One specimen has 14 dorsal spines, the others 13.

XVIII. PARAPRISTIPOMA.

Parapristipoma Bleeker, Archives Néerlandaises, VIII, 1872 (*trilineatum*).

Type: *Perca trilineata* Thunberg, from Japan.

Etymology: *παρά*, near; *Pristipoma;* the genus being intermediate between *Pomadasis* and *Plectorhynchus*.

We follow Bleeker in referring to this genus the species *viridense* (*octolineatum*), which is certainly very closely allied to *Parapristipoma trilineatum*. Along with this we place the second European species, *mediterraneum*, which, although having something in common with the type of *Plectorhynchus*, is nearer *Parapristipoma* than to *Plectorhynchus chætodonoides*. The genus called *Plectorhynchus* (=*Diagramma* Cuvier) contains some 40 species, all confined to the eastern Pacific and the Indian Ocean. The species of *Parapristipoma* have comparatively long and slender gill-rakers, a character overlooked by Bleeker. The extension of the scales at the bases of dorsal and anal is also characteristic, as is also the scaliness of the lower jaw and suborbital bones. As this genus has received little attention, we give the following:

ANALYSIS OF EUROPEAN SPECIES OF PARAPRISTIPOMA.

a. Dorsal fin low and nearly continuous; anal short and high; dorsal and anal both with a scaly sheath at base; caudal fin lunate; gill-rakers long and slender; scales small.

b. Soft dorsal nearly as long as spinous part; dorsal spines twelve; lower jaw included. Body elliptical, stout, dorsal and ventral outlines nearly straight, anterior profile steep and straightish, much convex at nape; snout long and sharp; teeth arranged in broad bands, the outer above scarcely enlarged; eye large; preopercle sharply serrate; gill-rakers long and slender, x+21; scales small, about 64 pores in the lateral line; soft dorsal and anal scaled at base; dorsal fin low, fifth and sixth spines longest, the others subequal; anal deeply sheathed, soft part high and pointed, the second spine long and slender, not quite equal to third; pectoral pointed; caudal shallow-forked. Color, grayish brown, with two or three faint longitudinal lines along the sides; edge of fins dusky. Head, $3\frac{1}{3}$; depth, $2\frac{2}{3}$; D. XII, 17; A. III, 8 to 10; eye, $3\frac{1}{2}$; snout, 3; maxillary, $3\frac{1}{2}$; pectoral, $1\frac{1}{6}$; fifth dorsal spine, $2\frac{3}{5}$; second anal spine, $2\frac{4}{5}$; soft dorsal, $1\frac{1}{10}$ in spinous. Scales, 65–70 .... MEDITERRANEUM, 86.

bb. (Soft dorsal about two-thirds length of spinous part; dorsal spines 13; pectoral fin short, $1\frac{1}{2}$ in head; lower jaw projecting. Body rather stout, the back moderately elevated, the depth about equal to length of head, 3 in body; mouth moderate, the maxillary reaching past front of eye; eye, $3\frac{1}{2}$ in head, the eye much wider than the narrow preorbital and lower than snout; dorsal fin continuous, the spines rather low and slender; second anal spine rather long and strong; about equal to third and rather shorter than the soft rays; preopercle sharply serrate; soft dorsal and anal scaly; D. XIII, 14; A. III, 7; scales small, 12–57–23. Coloration olivaceous, with four narrow sky-blue longitudinal streaks on each side of back, the lowest and broadest at level of eye; traces of a fifth streak on cheek; fins blotched with dark. Sometimes nearly plain olivaceous, with the fins dark-edged.) (*Steindachner.*) VIRIDENSE, 87.

86. PARAPRISTIPOMA MEDITERRANEUM.

Diagramma mediterraneum Guichenot, Expl. Algerie, 45, pl. 3, 1850 (Algiers).

Habitat: Western Mediterranean.

Etymology: From Mediterranean Sea.

This species is not uncommon in the eastern Mediterranean. The specimen examined by us (22429, M. C. Z.) is from Cadiz in Spain.

87. PARAPRISTIPOMA VIRIDENSE. (Burro; Corvinato.)

Pristipoma viridense Cuv. & Val., v, 287, 1830 (Cape Verde Islands).
Pristipoma octolineatum Cuv. & Val., IX, 487, 1833 (Cape Verde Islands).

Habitat: Northwest coast of Africa; south coast of Spain and the neighboring islands.

Etymology: From Cape Verde—*viridis*, green.

This species is known to us from descriptions. According to Steindachner it is rare on the coast of Spain (Cadiz and San Lucar de Barrameda) and common on the Canary Islands, especially about Teneriffe. Steindachner suggests that the name *viridense*, given to plainly colored specimens, and that of *octolineatum*, given to those with blue stripes, belong to the same species, as occasional individuals are found in which the blue stripes are wanting. Günther counts 80 scales in *viridense*, and Steindachner but 55 to 57 in *octolineatum*. In the latter case only the scales having pores in the lateral line are counted, in the former the number of cross rows. Dr. Günther records the species from St. Vincent; probably St. Vincent of the Cape Verde Islands is meant,* not the St. Vincent of the Lesser Antilles. According to Steindachner, this species lacks the median groove at the chin, and, as already noticed by Bleeker, it is closely related to the Japanese species, *trilineatum*, which is the type of the genus *Parapristipoma*.

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* In confirmation of this opinion, I have the following note from my friend, Dr. G. A. Boulenger, of the British Museum:

"You are perfectly right, and I had independently arrived at the same opinion as yourself with regard to 'St. Vincent: McGillivray.' You will find specimens of the West African *Tarentola delalandi* from St. Vincent, Cape Verde, Macgillivray, mentioned in my Catalogue of Lizards, vol. 1, p. 199."

XIX. GENYATREMUS.

Genyatremus Gill, Proc. Ac. Nat. Sci. Phila. 1862, 256 (*cavifrons*).

Type: *Diagramma cavifrons* Cuv. & Val. = *Lutjanus luteus* Bloch.

Etymology: γένυς, chin; α, privative; τρῆμα, aperture.

This genus contains a single American species, an *Anisotremus* without central pore at the chin. From *Plectorhynchus*, it differs much as *Anisotremus* differs from *Orthopristis* and *Pomadasis*.

ANALYSIS OF SPECIES OF GENYATREMUS.

a. Body ovate, compressed, the back much elevated, the depth a little less than half body; anterior profile evenly convex at nape, gradually becoming concave to front of eye, where it rapidly descends straightish to point of snout; interorbital area flat, about equal to eye; occipital crest arising opposite middle of pupil, its base rising on the highly arched frontals considerably above top of the low temporal crest. Head small; snout blunt and short; mouth moderate, the maxillary reaching past anterior edge of orbit; anterior nostril oblong, much larger than posterior; preorbital very narrow, about one-fourth as wide as eye; eye large, 3 in head; preopercle strongly serrate on angle, the serræ gradually becoming weaker on both limbs; gill-rakers weak, about 7 below angle, besides rudiments. Dorsal fin high, the fifth spine longest, the last spine slightly longer than the preceding one and about two-thirds as long as the first ray; anal fin lower than soft dorsal, the second spine longer and stronger than third; pectorals short; caudal subtruncate. Scales small, not parallel with the lateral line, arranged obliquely above and horizontally below, largest below the lateral line; vertical fins scaleless; scapular scale very evident, about three times as long as broad; lateral line not following outline of back, wavy below the soft dorsal. Color in spirits uniform golden, with numerous longitudinal stripes of a brighter color following the rows of scales below the lateral line. Head, $3\frac{2}{3}$; depth, $2\frac{1}{4}$; D. XIII, 12; A. III, 11; scales, 11–52–19 .... LUTEUS, 88.

88. GENYATREMUS LUTEUS.

Lutianus luteus Bloch, Ichthyologia, taf. 247, 1791 (Martinique, on a drawing by Plumier).
Grammistes hepatus Bloch & Schneider, Syst. Ichth., 1801, 187 (after Bloch).
Diagramma cavifrons Cuv. & Val., v, 1830, 290, pl. 123 (Rio Janeiro).
?*Pristipoma serrula* Cuv. & Val., v, 272 (Martinique).
?*Pristipoma auratum* Cuv. & Val., l. c., 272 (Martinique).

Habitat: Lesser Antilles to Brazil.

Etymology: *Luteus*, yellow.

This species seems to be not rare on the coast of Brazil and the Lesser Antilles, probably on sandy coasts. It has not been found in Cuba. There is not much doubt that the *Lutianus luteus* of Bloch was intended for this species, although in the drawing of Plumier, from which it was taken, the fin rays are very inexactly indicated.

Subfamily V.—DENTICINÆ.

XX. DENTEX.

Dentex Cuvier, Règne Animal, ed. I, 1817, 273 (*dentex*).
Polysteganus Klunzinger, Fische des Rothen Meeres, 1870, 763 (*nufar*).
Synagris Bleeker, Systema Percarum Revisum, 1875, 278 (*dentex*; after *Synagris* Klein, not *Synagris* Günther.)

Type: *Sparus dentex* Linnæus.

Etymology: *Dens*, tooth; *dentex*, with large teeth.

This genus contains numerous species found on the coast of the Old World, none of them in America. The species found in Europe are:

89. **DENTEX MACROPHTHALMUS** (Bloch). (**Goggle-eye; Cachucho.**) Mediterranean Sea and neighboring waters.

90. **DENTEX DENTEX** (Linnæus). (**Dentao; Denton.**) Shores of southern Europe and northern Africa; common.

91. **DENTEX MAROCCANUS** (Cuv. & Val.). Southern Spain and Morocco.

92. **DENTEX FILOSUS** (Valenciennes). Algiers and southward; not yet recorded from the European side of the Mediterranean.

XXI. NEMIPTERUS.

Nemipterus Swainson, Nat. Hist. Fishes, etc., II, 1839, 223 (*filamentosus*).
Synagris Günther, Cat. Fish. Brit. Mus., I, 1859, 373 (*furcosus*; not *Synagris* Bleeker).
Dentex Bleeker, Systema Percarum Revisum, 1875, 278 (*filamentosus*).

Type: *Dentex furcosus* Cuv. & Val.

Etymology: νῆμα, thread; πτερόν, fin.

This genus contains some twenty species, very closely allied to the species of *Dentex*, from which genus it is not quite certain how they should be separated. All are Asiatic, except one, which is very imperfectly known and may be a true *Dentex*. The name *Nemipterus* has priority over *Synagris* for this group.

ANALYSIS OF AMERICAN SPECIES OF NEMIPTERUS.

a. First dorsal spine, upper lobe of caudal, and first ray of ventral produced in long filaments; depth, 3¾ in total length, with caudal; head, 4; D. X, 9; A. III, 7; color red. (*Cuv. & Val.*) .... MACRONEMUS, 93.

93. NEMIPTERUS MACRONEMUS.

Dentex filamentosus Cuv. & Val., VI, 254, pl. 155, 1830 (Surinam; not *Cantharus filamentosus* Rüppell, also a *Nemipterus*).
Synagris macronemus Günther, I, 380 (after Cuvier).

Habitat: Surinam.

Etymology: μακρός, long; νῆμα, thread.

This species is known only from the description of the original type, a young specimen said to have been sent by Diepering from Surinam, but which not unlikely came from the East Indies. *Nemipterus macronemus* agrees very closely with *Nemipterus nematophorus* Günther, from Sumatra. According to Bleeker the chief differences are these, that in *macronemus* but one dorsal spine is filamentous, in *nematophorus* two; in *macronemus* the fins are more pointed. All these are doubtful characters and it is probable that *Nemipterus macronemus* came from Sumatra rather than from Surinam.

Subfamily VI.—SPARINÆ.

XXII. STENOTOMUS.

Stenotomus Gill, Canadian Naturalist, August, 1865 (*argyrops*).

Type: *Sparus argyrops* Linnæus = *Sparus chrysops* Linnæus.

Etymology: *στενός*, narrow; *τομός*, cutting; from the narrow incisors.

This genus contains, so far as known, three species, all American; one lives in rather deep water and differs considerably from the others. The genus is close to *Calamus*, from which the flattened incisors mainly distinguish it.

ANALYSIS OF SPECIES OF STENOTOMUS.

a. First dorsal spine as long as eye, the second about as long as third, which is about 2 in head; temporal crest obsolete; frontal bones not gibbous or porous; antrorse spine attached to the fourth interneural by a downward projecting spur about twice as long as the spine.

b. Body elongate-ovate, the depth gradually decreasing from first dorsal spine to caudal peduncle; anterior profile not steep, nape slightly convex, a slight depression above and behind eye, convex over snout; pectoral about as long as head, 3⅓ in body; scaly sheath at base of soft dorsal and anal inconspicuous; snout long and pointed, 2 in head; eye large, less than width of preorbital, about 3⅗ in head; interorbital area very convex; six strong conical teeth in front of upper jaw and eight in lower; molar teeth coarser and larger than in *S. chrysops;* scales on cheek reaching to top of eye, the upper rows less distinct than the lower, the anterior row of about 20 scales; caudal fin moderately forked, the middle ray about 2¼ in longest ray. Color nearly plain dull-silvery, with golden longitudinal streaks following the rows of scales; axil dusky; ventrals dark. Head, 3; depth, 2⅕; D. XII, 12; A. XIII, 11; scales, 8-54-15..ACULEATUS, 94.

bb. Body ovate-elliptical, the depth about the same from the first dorsal spine to the eleventh; anterior profile steep, nape convex, a strong depression above and in front of eye, straightish over snout; pectoral less than head, about 3½ in body; a scaly sheath very conspicuous at base of soft dorsal and anal fins; temporal crest obsolete; supraoccipital crest continuous with the frontal bones; snout short, 2½ in head; eye small, narrower than the preorbital, about 4¼ in head; incisor teeth very narrow, almost conical; molars in two rows above; scales on cheek extending above the upper margin of eye, the anterior row composed of about 20 scales; caudal fin forked, the middle ray about 4 in longest ray. Color brownish, somewhat silvery below, everywhere with bright reflections, but without distinct markings in the adult; soft parts of vertical fins mottled with dark in adult; young faintly barred; axil dusky. Head, 3½; depth, $2\frac{1}{10}$; D. XII, 12; A. III, 11; scales, 8-50-16..............CHRYSOPS, 95.

aa. First and second dorsal spines very short, their length about 3 in eye; third, fourth, and fifth more or less filamentous, the third longer than head. Temporal crest rudimentary, persisting in a swelling on the basal portion of the supraoccipital; antrorse spine attached directly to the interneural; no downward projecting part evident. Body subovate, the back anteriorly much elevated, the depth about half the length to base of caudal; anterior profile steep and straightish, convex on nape and above eye; supraoccipital crest making a sharp angle over eye with a porous gibbous portion of the frontal bones; snout short, about 2 in head; eye large, a little less than width of preorbital, about $3\frac{1}{2}$ in head; anterior teeth of jaws small, in a close-set band, the outer series a little enlarged, compressed and lanceolate, much as in *S. chrysops;* molars in two rows; dorsal spines very broad and flat; scales on the anterior part of body much enlarged; anterior row of scales on cheek much enlarged, extending to level of pupil, about 12 scales in the first series; scaly sheath at base of soft dorsal and anal very conspicuous; pectoral a little longer than head, $2\frac{2}{3}$ in body; caudal fin little forked, the middle ray about $1\frac{1}{2}$ in longest ray. Color light olive; silvery below; the young with faint, very narrow darker bars. Head, $3\frac{1}{6}$; depth, 2; D. XII, 12; A. III, 12. Scales 5–50–15.......CAPRINUS, 96.

94. STENOTOMUS ACULEATUS. (Southern Porgy.)

Chrysophrys aculeata Cuv. & Val, VI, 137, 1830 (Charleston).

Habitat: South Atlantic and Gulf coasts of the United States.

Etymology: *Aculeatus*, spined.

This species closely resembles the northern scup, which it more or less replaces southward. Our specimens are from Charleston.

95. STENOTOMUS CHRYSOPS. (Scup; Porgy; Scuppaug.)

Sparus chrysops Linnæus, Syst. Nat., ed. XII, 1766, 471 (Charleston).
Sparus argyrops Linnæus, Syst. Nat., ed. XII, 1766, 471 (Charleston; young).
Sparus xanthurus Lacépède, Hist. Nat., Poiss., IV, 120, 1803 (after *argyrops*).
Labrus versicolor Mitchill, Trans. Lit. & Phil. Soc., I, 464, 1815.
Sargus ambassis Günther, I, 449, 1859.

Habitat: Atlantic coast of the United States from Cape Cod to South Carolina.

Etymology: χρυσός, gold; ὤψ, eye.

This species is one of the commonest food-fishes of our Atlantic coast. According to Dr. Bean, who has examined Linnæus' original types, both *chrysops* and *argyrops* were based on examples of this species.

96. STENOTOMUS CAPRINUS.

Stenotomus caprinus Bean, Proc. U. S. N. M. 1882 (Snapper Banks, Pensacola).

Habitat: Deep waters off the west coast of Florida.

Etymology: *Caprinus*, like a goat, the species having been sent in under the name of "goat-head porgy," which was a misunderstanding of the name of "jolt-head porgy," which is *Calamus bajonado*.

This species is as yet known only from numerous examples taken from the stomachs of snappers (*Lutjanus*) and groupers (*Epinephelus*) on the Florida snapper banks.

XXIII. CALAMUS.

(Pez de Pluma.)

Calamus Swainson, Nat. Hist. Fishes, II, 1839, 222 (*calamus*).
Grammateus Poey, Ann. Lyc. Nat. Hist. N. Y., 1872, 182 (*microps*).

Type: *Pagellus calamus* Cuv. & Val.

Etymology: *Calamus*, a quill or reed, from the quill-like interhæmal.

This genus contains a number of species, all American, all very closely related, and valued as food-fishes. The best-known species are described in detail by Jordan & Gilbert, Proc. U. S. N. M. 1883, p. 14 *et seq.*

ANALYSIS OF SPECIES OF CALAMUS.

a. Scales comparatively small, 8, 9–54 to 58–18, 19;* about 6 vertical rows of scales on base of preopercle, with about 12 scales entering into the formation of the lower margin; species of large size, with the preorbital deep, the pectoral fin long, and the outer teeth strong.

b. Body very deep, the back elevated, the depth in adult half the length to base of caudal; outer teeth about $\frac{10\text{-}12}{12\text{-}16}$ in number, the outer one on each side in one or both jaws sometimes enlarged, canine-like, sometimes directed forwards, especially in the adult.

c. Preorbital with reticulations of the bluish ground color around bronze spots; canines of upper jaw usually vertical, but sometimes, especially in old examples, directed more or less horizontally forwards; body deeper than in other species, depth $1\frac{9}{10}$ to $2\frac{1}{4}$; anterior profile not very steep, slightly curved; depth of preorbital less than half head; eye large, $3\frac{1}{2}$ to $3\frac{3}{4}$ in head; dorsal spines strong, the longest $2\frac{1}{5}$ to $2\frac{1}{3}$ in head; pectorals a little more than one-third body. Color silvery, the base and center of each scale golden, the edge bluish, these colors forming distinct streaks; a deep-violet streak below eye, not extending on eye or opercle; preorbital dull violet, this color forming reticulations around brassy spots; axil golden, with a violet bar; ventrals more or less dusky. Head, $3\frac{1}{4}$; depth, 2; scales, 8–56–18; D. XII, 12; A. III, 10 .... CALAMUS, 97.

cc. Preorbital region, snout, cheek, and opercles brassy, crossed by horizontal, wavy, non-reticulating lines of violet blue, brightest on preorbital and snout; a sky-blue blotch behind eye over the opercle, extending a short distance on body; outer canines of upper jaw directed horizontally forward, except in the very young, these teeth longer than in *C. calamus;* anterior profile nearly straight and very steep to the nape, then strongly convex; depth of preorbital a little more than half head; pectoral 3 in body. Color silvery, each scale with a violet spot above and orange spots below; sides with dark crossbands in life, which disappear at death; ventrals chiefly yellow; axil slightly dusky. Head, $3\frac{1}{8}$; depth, 2; scales, 8–58–18; D. XII, 12; A. III, 10... PRORIDENS, 98.

bb. Body more elongate, the depth $2\frac{1}{6}$ to $2\frac{3}{4}$ in length.

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* Scales above the lateral line are counted from the base of the first dorsal spine, those below the lateral line from the base of the first anal spine.

d. [Upper jaw with a strong antrorse canine on each side, as in *C. proridens;* preorbital with blue, wavy stripes; eye small; preorbital deep; cheeks with 6 rows of scales; dorsal high; pectoral reaching front of anal; cheeks with blue flexuous lines, anastomosed and forming rivulations; spinous dorsal edged with black; depth of body, $2\frac{4}{5}$ in length to base of caudal.] (*Guichenot.*) PENNATULA, 99.

dd. Upper jaw without antrorse canines, the anterior teeth strong, $\frac{4-6}{6-8}$ one on each side of upper jaw more or less enlarged; body rather oblong, the snout long and pointed, the anterior profile forming a nearly even curve to front of dorsal; depth, $2\frac{1}{6}$ to $2\frac{2}{5}$ in length to base of caudal; eye about $3\frac{1}{2}$ to 5 in head; preorbital less than half head, about $\frac{1}{3}$; dorsal spines slender, the highest $2\frac{1}{2}$ to $2\frac{2}{3}$ in head; pectorals $2\frac{1}{5}$ in body. Color, dull brassy, with little blue; a faint-blue stripe below eye; preorbital dull coppery, usually plain, sometimes faintly veined with bluish; axils yellowish; ventrals scarcely dusky. Young, as in other species, with dark crossbands. Head, $3\frac{1}{7}$; depth, $2\frac{1}{6}$; scales, 8–56–19; D. XII, 12; A. III, 10 ....BAJONADO, 100.

aa. Scales comparatively large, 6, 7–45 to 52–13, 14; about 5 vertical rows of scales on base of preopercle with about 9 scales entering into the formation of the lower margin; no antrorse canines.

e. Pectoral fins long, about 3 in body.

f. Scales of moderate size, 50 to 52 in the lateral line; body very deep, the back elevated, depth about $2\frac{1}{5}$ to base of caudal; longest dorsal spine about half head.

g. Canines short and strong, about $\frac{6-8}{6-8}$; preorbital narrow, its least width $2\frac{1}{2}$ to $2\frac{2}{3}$ in head; snout short, $1\frac{4}{5}$ to 2 in head; mouth small, maxillary about $2\frac{2}{3}$ in head; eye moderate, about $4\frac{1}{2}$ in head in adult; pectoral about $2\frac{1}{2}$ in body. Body much compressed, the back considerably elevated, the anterior profile steep and regularly convex from base of first dorsal spine to point of snout. Color brassy olive, with darker crossbands and few violet marks; preorbital plain brownish; an inky axillary spot; ventrals dusky. Head, $3\frac{1}{4}$; depth, $2\frac{1}{6}$. Scales, 6–50–13. D. XII, 11; A. III, 10 ....BRACHYSOMUS, 101.

gg. Canines moderate, about $\frac{8-10}{10}$; preorbital broad, its least width about $2\frac{1}{4}$ in head; mouth moderate, maxillary about $2\frac{1}{2}$ in head; eye moderate, about $3\frac{2}{3}$ in head; pectoral about $2\frac{2}{5}$ in body. Body moderately compressed, rather elongate, the back only moderately elevated, the anterior profile convex to eye, thence straight to point of snout. Color smutty silvery, with dark crossbands; blotches on the fins; no black axillary spot. Head, $3\frac{1}{4}$; depth, $2\frac{1}{5}$; scales, 7–51–14; D. XII, 12; A. III, 10. ....LEUCOSTEUS, 102.

ff. Scales large, about 46 (45 to 48) in lateral line; body rather elongate, the depth about $2\frac{1}{4}$ in body; longest dorsal spine about $2\frac{1}{2}$ in head.

h. Canines small, about $\frac{10}{12}$; eye large, about 3 in head; preorbital narrow, about equal to eye; mouth small, the maxillary about $2\frac{1}{2}$ in head; dorsal spines, XI. (Dorsal outline forming a comparatively regular arch, the back being elevated, the anterior profile steep and nearly straight. Color plumbeous gray, with a blue spot on each scale, preorbital with blue streaks; a blue streak below eye; a blue point in the axil; fins pale.) (*Poey.*) Head, $3\frac{1}{10}$; depth, $2\frac{1}{5}$; scales (?); D. XI?; A. III?.......MACROPS, 103.

hh. Canines moderate, $\frac{8}{10}$, the outer on each side sometimes enlarged; eye rather small, about $4\frac{1}{3}$ in head in adult; preorbital very deep, about $2\frac{1}{6}$ to $2\frac{2}{5}$ in head; mouth large, the maxillary about $2\frac{1}{6}$ to $2\frac{2}{5}$ in head; dorsal spines, XII. Body rather oblong, the back not strongly arched, the anterior profile rather evenly curved, less convex than in *C. arctifrons;* head narrowed above, the occipital crest as high as eye. Color dull silvery, faintly banded; preorbital plain; axils dusky; ventrals pale; edge of opercle dusky. Head, 3 to $3\frac{1}{3}$; depth, $2\frac{1}{4}$. Scales, 6–46–11; D. XII, 12; A. III, 10. TAURINUS, 104.

cc. Pectoral fin short, about $3\frac{1}{2}$ in body.

i. Dorsal outline forming a comparatively regular arch, the anterior profile from the snout to the base of the spinous dorsal evenly convex; the back elevated, the depth in the adult about $2\frac{1}{6}$ in length; eye small, $3\frac{4}{5}$ to $4\frac{1}{2}$ in head; canines subequal, $\frac{8}{10}$; preorbital not very deep, $2\frac{1}{2}$ to 3 in head; pectoral shortish, $3\frac{1}{2}$ in body; longest dorsal spine $2\frac{1}{3}$ in head. Color, dull silvery, with pearly spots on scales of back; preorbital bluish, plain or with pearly markings, without blue stripes; a faint pale streak below eye; axil with a small inky black spot; ventrals blackish; dark crossbars on body, usually persistent. Head, $3\frac{1}{5}$; depth, $2\frac{1}{6}$; scales, 6–48–13; D. XII, 12; A. III, 10......................PENNA, 105.

ii. Dorsal outline not forming a regular arch, the anterior profile straight from base of spinous dorsal to nape, where a rather sharp angle is formed, thence straightish above eye, the snout convex; body rather elongate, the depth about $2\frac{1}{2}$ in length.

j. Preorbital deep, its depth $2\frac{1}{4}$ in head, and nearly twice diameter of eye, which is 4 to 5 in head; pectoral $3\frac{2}{3}$ in body; longest dorsal spine, $2\frac{1}{2}$ in head; canine teeth, $\frac{8}{10}$. Body oblong, the back little elevated, not nearly so much as in *C. penna,* the anterior profile unevenly curved, very convex before eye; head narrow above; back nearly straight along base of spinous dorsal. Color olivaceous, with dark bars or spots, the centers of many scales pearly; six yellowish spots along the lateral line; preorbital brownish, usually with dashes of golden yellow; membrane of opercle orange; fins mostly barred or spotted; ventrals pale, faintly barred. Head, $3\frac{1}{4}$; depth, $2\frac{2}{3}$; scales, 6–48–13; D. XII, 12; A. III, 10..........................ARCTIFRONS, 106.

jj. Preorbital not deep, its depth $2\frac{1}{2}$ in head; pectoral short, $1\frac{1}{5}$ in head; dorsal fins low, the longest spine about 3 in head; canines $\frac{8}{8}$, moderate, equal. Body little elevated, the anterior profile rather strongly convex, the curve continuous from snout to middle of dorsal. Color olivaceous, with darker crossbands; preorbital plain; a dark axillary spot; a blue subocular band; ventrals dark. Head, $3\frac{1}{3}$; depth, $2\frac{1}{2}$. Scales in lateral line, 46. D. XII, 12; A. III, 10..............................MEDIUS, 107.

97. CALAMUS CALAMUS. (Saucer-eye Porgy.)

Pagellus calamus Cuv. & Val., VI, 1830, 206, pl. 152 (Martinique, San Domingo).
Chrysophrys calamus, Günther, I, 487, 1859 (Bahia, Trinidad, Cuba, Jamaica; several species confounded).
Calamus calamus, Jordan & Gilbert, Proc. U. S. N. M. 1884, 17 (Key West, Havana).
Calamus megacephalus Swainson, Nat. Hist. Fish., II, 222, 1839 (after Cuv. & Val.); Guichenot, Revision des Pagels, Mem. Soc. Imp. Cherbourg, XIV, 112; Poey, Ann. Lyc. Nat. Hist., N. Y., 1872, 178.
Pagellus orbitarius Poey, Memorias, II, 1860, 201 (Havana).
Sparus orbitarius Poey, Synopsis, 1868, 308.
Calamus orbitarius Poey, Ann. Lyc. Nat. Hist., N. Y., 1872, 179, pl. VI, f. 2.
Calamus macrops, Jordan & Gilbert, Syn. Fish. N. A., 1883, 927 (Garden Key).

Habitat: West Indies, north to Florida Keys.

Etymology: *Calamus*, a reed, the equivalent of *pez de pluma*.

This species, described in detail in the paper of Jordan & Gilbert above mentioned, is generally common about Key West and Havana, reaching a length of 15 inches. It is, however, nowhere so abundant as *proridens* or *bajonado*. Among the specimens in the museum at Cambridge are some of the types of *Calamus orbitarius*. In some of these none of the canines are turned forward, and none of the specimens collected by Dr. Jordan show this character. In others the outermost of the seven or eight canines in the upper jaw is turned directly forward, as in *C. proridens*. Some of these also show an approximation to the head coloration of *C. proridens*. The dorsal spines and the depth of the preorbital show that all these belong to *C. calamus*. *Calamus megacephalus* Poey is based on specimens of *C. calamus*, with the antrorse canines of *C. proridens*. The implication of a confusion in Poey's description made by us (Proc. U. S. N. M. 1883, 16, 18) is probably unwarranted, as his specimens at Cambridge agree with his description. The direction of the teeth is less valuable as a diagnostic character than our specimens led us to suppose.

98. CALAMUS PRORIDENS. (Little-head Porgy; Pez de Pluma.)

Calamus megacephalus Jordan & Gilbert, Syn. Fish. N. A., 1883, 926 (Florida Keys; not of Swainson).
Calamus pennatula Jordan & Gilbert, Proc. U. S. N. M. 1884, 15 (Key West, Havana; not of Guichenot).
Calamus proridens Jordan & Gilbert, Proc. U. S. N. M. 1884, 150 (Key West).

Habitat: West Indies, north to the Florida Keys.

Etymology: *Prora*, prow; *dens*, tooth, from the projecting canines.

This species, the most brightly colored of the genus, is very abundant about the Florida Keys. It is not quite so common either at Key West or at Havana as *Calamus bajonado*, but in both places either species far outnumbers all the remaining species combined.

99. CALAMUS PENNATULA.

Calamus pennatula Guichenot, Revision des Pagels, 116 (Martinique).

Habitat: West Indies.

Etymology: *Pennatula*, diminutive of *penna*, a quill.

This species is known only from Guichenot's description, which has been verified by us on the original type by Mr. Alexandre Thominot. It seems to be close to *C. providens*, differing in the elongate body.

100. CALAMUS BAJONADO. (Jolt-head Porgy; Bajonado.)

Bajonado Parra, Dif. Piezas Hist. Nat., 1787, 13, lam. 8 (Havana).

Sparus bajonado Bloch & Schneider, Syst. Ichth., 1801, 284 (after Parra).

Pagellus bajonado, Poey, Proc. Ac. Nat. Sci. Phila. 1863, 177; Poey, Synopsis, 1868, 308 (Havana).

Calamus bajonado, Poey, Ann. Lyc. Nat. Hist., N. Y., 1872, x, 176, pl. vi, f. 1 (Havana); Poey, Enumeratio, 55, 1875; Poey, Ann. Soc. Hist. Nat. Esp., x, 1881, 328 (Puerto Rico); Jordan & Gilbert, Proc. U. S. N. M. 1884, 20 (Key West, Havana, and elsewhere).

Pagellus caninus, Poey, Memorias, Cuba, ii, 199, 1860 (Havana); Guichenot, Rev. Pagels, 123.

Calamus plumatula Guichenot, Rev. Pagels, 119 (Martinique); Jordan, Proc. U. S. Nat. Mus. 1886, 537 (reëxamination of type).

Habitat: West Indies, north to Florida Keys.

Etymology: *Bajonado*, the Cuban name, apparently equivalent to bayonet, and probably alluding to the interhæmal.

This species at Key West and at Havana is the most abundant of the genus, and reaches a larger size than any of the others. The largest seen by us were 22 inches long. It is the dullest in color of the large species. Specimens from Porto Seguro and from the Bermudas are in the museum at Cambridge. The type of *Calamus plumatula* now in the museum at Paris is a young *bajonado*.

101. CALAMUS BRACHYSOMUS. (Mojarra Garabata.)

Sparus brachysomus Lockington, Proc. U. S. N. M. 1880, 284 (Magdalena Bay); Jordan & Gilbert, Proc. U. S. N. M. 1881, 277 (Picheluogo, Lower California); Jordan & Gilbert, Proc. U. S. N. M. 1884, 21 (Mazatlan); Evermann & Jenkins, Proc. U. S. N. M. 1891, 153 (Guaymas).

Habitat: Gulf of California and neighboring waters.

Etymology: βραχύς, short; σῶμα, body.

This species, which is allied to the Atlantic species *leucosteus*, is common about the Gulf of California. A specimen from Magdalena Bay is in the museum at Cambridge.

102. CALAMUS LEUCOSTEUS. (White-bone Porgy.)

Calamus bajonado, Jordan & Gilbert, Syn. Fish. N. A., 1883, 926 (Charleston); Jordan & Gilbert, Proc. U. S. N. M. 1882, 604 (not *bajonado*, Bloch & Schneider).
Calamus leucosteus Jordan & Gilbert, Cat. Fishes N. A., 1885, 91 (Charleston).

Habitat: South Atlantic coast of United States, in rather deep water.

Etymology: λευκός, white; ὀστέον, bone.

This species is known from several examples sent from the markets of Havana by Mr. Charles C. Leslie. The name "white-bone porgy" distinguishes it from *Stenotomus chrysops*, but the source of this name is unknown to us.

103. CALAMUS MACROPS.

Calamus macrops Poey, Ann. Lyc. Nat. Hist. N. Y., 1872, 181, f. 3 (Havana).

Habitat: West Indies.

Etymology; μακρός, long (large); ὤψ, eye.

This species is known only from Poey's description and figure. We have seen no specimens corresponding to it.

104. CALAMUS TAURINUS.

Chrysophrys taurina Jenyns, Zoöl. Beagle, Fishes, 1842, 56, pl. VII, 12 (Galapagos Islands); Valenciennes, Voyage Venus, V, 330, 1855 (Galapagos Islands).
Calamus taurinus, Jordan & Bollman, Proc. U. S. N. M. 1889, 181.
Chrysophrys cyanoptera Valenciennes, l. c. (Charles Island), pl. 4, f. 2 (Galapagos).

Habitat: Galapagos Islands.

Etymology: From *taurus*, bull; bull-headed.

Of this species we have examined several specimens in the museum at Cambridge, from Charles Island, one of the Galapagos. Specimens were also obtained from the same locality by the *Albatross*.

105. CALAMUS PENNA. (Little-mouth Porgy; Sheepshead Porgy.)

Pagellus penna Cuv. & Val., VI, 209, 1830 (Brazil); Guichenot, in Ramon de la Sagra, Hist. Cuba, 82 (Cuba).
Calamus penna, Guichenot, Revision Pagels, 114 (Brazil, Cuba, Martinique); Jordan & Gilbert, Proc. U. S. N. M. 1881, 21 (Key West); and in other papers.
Pagellus microps Guichenot, Ramon de la Sagra, Hist. Cuba, 188, tab. 3, f. 1 (Havana).
Calamus microps Guichenot, Revision Pagels, 118 (Cuba); Jordan, Proc. U. S. N. M. 1886, 537 (examination of type).
Pagellus humilis Poey, Synopsis, 1868, 308 (Havana).
Grammateus humilis Poey, Ann. Lyc. Nat. Hist. N. Y., 1872, 182; Poey, Enumeratio, 1875, 56.
Pagellus milneri Goode & Bean, Proc. U. S. N. M. 1879, 134 (Charlotte Harbor, Florida); Jordan & Gilbert, Synopsis, 1883, 556.

Etymology: *Penna*, a quill or pen.

The dark spot in the axil is a diagnostic mark of this species. The types of *milneri* and *penna* are identical. A small specimen in the museum at Cambridge, which may be the type of Poey's *Grammateus humilis*, belongs to this species. This example is 6 inches long, the eye nearly 4 in head, the depth 2½ in length, and the pectoral as long as head.

The type of *Calamus microps* Guichenot is in the museum at Paris. It agrees with *Calamus penna* in all respects except the size of the eye, which is 4⅘ in head. It is probably not a distinct species.

Specimens of *C. penna* are in the museum at Cambridge from Rio Janeiro, St. Thomas, Havana, Camaru, and Rio Grande do Sul.

106. CALAMUS ARCTIFRONS. (Grass Porgy; Shad Porgy.)

Calamus arctifrons Goode & Bean, Proc. U. S. N. M. 1882, 425 (Pensacola); Jordan & Gilbert, Synopsis, 1883, 928 (Pensacola); Jordan & Gilbert, Proc. U. S. N. M. 1884, 23 (Key West); Jordan & Swain., Proc. U. S. N. M. 1884, 232 (Cedar Keys).

Habitat: Gulf of Mexico, from Pensacola to Key West.

Etymology: *Arctus*, contracted; *frons*, forehead.

This small porgy is common in the eelgrass about Key West, and ranges northward at least to Pensacola.

107. CALAMUS MEDIUS.

Grammateus medius Poey, Ann. Lyc. Nat. Hist. N. Y., 1872, 183, pl. VII, f. 4 (Havana); Poey, Enumeratio, 1875, 56 (Havana).

Habitat: West Indies.

Etymology: *Medius*, medium.

We refer to this species a specimen from Havana (21838, M. C. Z.), 15 inches long. The species seems to be allied to *C. penna*, differing in the more elongate form.

XXIV. SPARUS.

Sparus Artedi, Genera Piscium, 1738, 35 (*aurata*, etc.).
Sparus Linnæus, Syst. Natura, ed. x, 1758, 277 (*aurata*, etc.), restricted to *aurata* by Bleeker, Gill, and various authors.
Pagrus Cuvier, Règne Animal, ed. I, 1817, 272 (*argenteus*=*pagrus*).
Aurata Risso, Europe Mérid., III, 356, 1826 (*aurata*).
Chrysophrys Cuvier, Règne Animal, ed. II, 1829 (*aurata*).
Chrysoblephus Swainson, Nat. Hist. Fishes, etc., II, 1839, 221 (*gibbiceps*).
Argyrops Swainson, l. c. (*spinifer*).
Pagrichthys Bleeker, Nederl. Ind. Nat. Tijdschr., XXI, 60, 1860.

Type: *Sparus aurata* L.

Etymology: *σπάρος*, *sparus*, an old name of some fish of this genus.

This is a large genus, chiefly represented in the waters of the Old World, and comprising a considerable variety of forms. The species have been commonly distributed in two genera: *Pagrus* with the molar teeth in two series, and *Sparus* (*Chrysophrys*) with the molars in three or more. This character has not much importance, and Steindachner has proposed to substitute for it the following:

Sparus: Teeth behind the canines, with the apex rounded, granulated, or globose; molars in two or more series.

Pagrus: Teeth behind the canines acute, subulate or setaceous; molars in two or more series.

Although in general appearance *Sparus aurata* and *Sparus pagrus* differ considerably, and also considerably from other aberrant species, as *S. gibbiceps* and *S. spinifer*, there is no important difference in the skull or skeleton, and we place all in one genus. To this genus *Pagellus* is very closely allied.

But one species of *Sparus* is yet known from America. In Europe are found:

§ SPARUS.

108. SPARUS AURATA (L.). Southern Europe north to England.

109. SPARUS CÆRULEOSTICTUS Cuv. & Val. Northwest coast of Africa (lately obtained in Sicily by Prof. Doderlein).

§ PAGRUS.

110. SPARUS PAGRUS L. Southern Europe north to England; common also along the South Atlantic and Gulf coasts of the United States.

111. SPARUS EHRENBERGI (Cuv. & Val.). Mediterranean Sea; rare.

112. SPARUS BERTHELOTI (Valenciennes). Western Mediterranean and neighboring islands.

ANALYSIS OF AMERICAN SPECIES OF SPARUS.

a. Molar teeth in two series; teeth behind the canines slender; scales large (about 55). (*Pagrus.*)

b. Dorsal spines not elongate; second anal spine stronger but not longer than third, about 4 in head; pectoral fin elongate, reaching about to fourth soft ray of anal. Body oblong, the back moderately elevated, the profile parabolic; preorbital deep: D. XII, 10; A. III, 8. Scales 6–56–13. Life color, golden olive; the middle of each scale pinkish, so that the fish appears red; sides and below flushed silvery; many scales of back and sides each with a round purplish-blue spot, these forming streaks along the rows of scales; fins mostly reddish. PAGRUS, 110.

110. SPARUS PAGRUS. (Red Porgy.)

Sparus pagrus L., Syst. Nat., ed. X, 1758, and of many authors.
Sparus argenteus Bloch & Schneider, 1801, 271.
Pagrus argenteus, Cuvier, Règne Animal, I, 1817, 272.
Pagrus vulgaris Cuv. & Val., VI, 142, 1830, and of most European writers.
Pagrus argenteus, Goode & Bean, Proc. U. S. N. M. 1879, 133 (Pensacola).
Sparus pagrus, Jordan, Proc. U. S. N. M. 1882, 278 (Pensacola) and elsewhere.

Habitat: Southern Europe and South Atlantic and Gulf coasts of the United States.

Etymology: πάγρος, *pagrus*, the old name, which has become *pargo* and *porgy* in modern tongues.

This species, common in southern Europe, has been several times taken on the snapper banks about Pensacola. There seems to be no difference between American and European specimens, except that in European descriptions we find no allusion to the blue spots characteristic of the American fish.

XXV. PAGELLUS.

Pagellus Cuv. & Val., VI, 169, 1830 (*erythrinus*).

Type: *Sparus erythrinus* Cuv. & Val.

Etymology: French, *pagel;* a derivative or diminutive of *pagre* and *Pagrus.*

This genus is very close to *Sparus*, from which it differs in no very important character, the skull and skeleton in the two being essentially alike, and the only tangible distinctions lying in the weaker dentition and more elongate form of *Pagellus*. The four recognized species are all European, one being doubtfully accredited to the coast of Brazil.*

The species are:

113. PAGELLUS ERYTHRINUS (L.). Southern Europe, etc., north to England.

114. PAGELLUS ACARNE Cuv. & Val. Southern Europe, etc., north to England.

115. PAGELLUS CENTRODONTUS (De la Roche). Southern Europe north to England.

116. PAGELLUS BOGARAVEO (Brünnich). Southern Europe, etc.

117. PAGELLUS MORMYRUS (L.). Mediterranean and neighboring waters; said to occur in Brazil.

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* ANALYSIS OF SUPPOSED AMERICAN SPECIES OF PAGELLUS.

a. Color, golden silvery, with seven narrow blackish crossbars, sometimes duplicated. Body oblong, compressed; mouth very protractile, the maxillary bent; eye 5 in head, which is a little less than depth of body. D. XI, 12; A. III, 10. Scales 6–64–13 .... MORMYRUS (*pernambucensis*).

PAGELLUS MORMYRUS.

Sparus mormyrus Linnæus, Syst. Nat., 1758, ed. X.
Pagellus mormyrus Cuv. & Val., VI, 200, and of nearly all European authors.
Pagellus goreensis Cuv. & Val., VI, 203, 1830 (Gorea).
Pagellus pernambucensis Cuv. & Val., VI, 216, 1830 (Pernambuco?).

Habitat: Mediterranean Sea and neighboring coasts; ascribed on very doubtful authority to America.

Etymology: *Mormyrus*, *μόρμυρος*, a name given by Aristotle to this species.

The claim of this species to a place among American fishes is the presence in the Museum of Berlin of a stuffed example, received by Bloch from "Fernambouc," and bearing the label "*Sparus pernambucensis.*" Günther mentions three specimens in the British Muséum from "St. Vincent," collected by McGillivray. As already noticed, there is an island St. Vincent in the Cape Verde group where this species is common, as well as one among the Lesser Antilles, where it has not yet been taken. The specimens of McGillivray came from the Cape Verde Island of St. Vincent. The occurrence of any *Pagellus* in America is yet to be verified.

XXVI. LAGODON.*

Lagodon Holbrook, Ich. South Carolina, 59, 1860 (*rhomboides*).

Type: *Sparus rhomboides* L.

Etymology: λαγός, hare; ὀδών, tooth.

This genus contains a single species, very abundant along the Atlantic coasts of the United States. The essential character of the genus is in the form of the skull.

ANALYSIS OF SPECIES OF LAGODON.

a. Upper jaw with two rows of molars; dorsal spines, 12; second anal spine not longer than third; body elongate, elliptical; depth, 2 to 2⅗ in length; head, 3⅕; head flattened, muzzle pointed, profile not very steep; eye moderate, 1⅓ to 1½ in snout, 1 in interorbital, 4 in head; mouth moderate, maxillary not reaching to front of orbit, 3⅓ in head; incisors $\frac{8}{4}$, deeply notched; molars in two series in each jaw; dorsal spines all rather high, the highest about 2 in head; caudal deeply forked; ventrals short and broad; pectorals moderate, upper rays reaching past origin of anal; bluish above, paler below; sides with 8 to 12 golden longitudinal stripes and about 6 dark crossbars; a black blotch above pectoral; anal with a light margin; dorsal and anal each with a median golden stripe. D. XII, 11; A. III, 11; scales, 10–65 to 70–17 .... RHOMBOIDES, 118.

118. LAGODON RHOMBOIDES.

(Pinfish; Bream; Sailor's Choice; Chopa Spina.)

Sparus rhomboides Linnæus, Syst. Nat., ed. XII, 470, 1766 (Charleston, on a specimen from Dr. Garden); Schöpf, "Schrift, der Naturf. Freunde, Berlin, VIII, 153," 1788 (New York); Gmelin, Syst. Nat., 1275, 1788 (copied); Shaw, "Genl. Zool., IV, 447, 1803."

Sargus rhomboides Cuv. & Val., Hist. Nat. Poiss., VI, 68, pl. 143, 1830 (New York, New Orleans); DeKay, Fishes New York, 93, pl. 71, fig. 228, 1842 (New York); Storer, Synopsis Fishes, 333, 1846 (copied); Günther, Cat. Fish. Brit. Mus., I, 447, 1859 (Southern United States).

Lagodon rhomboides Holbrook, "Ichth. S. Car., 58, pl. 8, fig. 1," 1860 (South Carolina); Gill, Cat. Fish. East Coast, 27, 1873; Poey, Syn. Pisc. Cub., 318, 1868 (Cuba); Gill, Cat. Fish. East Coast, 27, 1873; Poey, Enumeratio Pisc. Cub., 58, 1875 (Cuba); Uhler & Lugger, Fishes of Maryland, 104, 1876 (Maryland); Goode, Fishes Bermuda, Am. Journ. Sci. and Arts, 1877, 292 (Bermuda); Jordan & Gilbert, Proc. U. S. N. M. 1878, 378 (Beaufort); Goode & Bean, Proc. U. S. N. M. 1879, 133 (Pensacola); Jordan, Proc. U. S. N. M. 1880, 19 (eastern Florida); Jordan, Proc. U. S. N. M. 1880, 22 (St. Johns River); Bean, Proc. U. S. N. M. 1880, 95 (St. Johns River); Jordan & Gilbert, Proc. U. S. N. M. 1882, 278 (Pensacola); Jordan & Gilbert, Proc. U. S. N. M. 1882, 605 (Charleston); Bean, Cat. Fish. Internat. Fish. Ex. London, 57, 1883 (Galveston, Texas); Henshall, Florida, 239, 1884 (east and west coasts, Florida Keys); Gill, Standard Nat. Hist., III, 222, 1886; Eigenmann & Hughes, Proc. U. S. N. M. 1887, 66.

* In the synonymy and treatment of *Lagodon*, *Archosargus* and *Diplodus* we follow closely the paper by Eigenmann & Hughes (Proc. U. S. Nat. Mus. 1887, 65 *et seq.*). This paper was based on the material before us.

Diplodus rhomboides Jordan & Gilbert, Syn. Fish. N. A., 558, 1883; Jordan, Proc. U. S. N. M. 1884, 129 (Key West); Jordan & Swain, Proc. U. S. N. M. 1884, 233 (Cedar Keys); Jordan, Cat. Fish. N. A., 91, No. 1064, 1885 (name only); Jordan, Proc. U. S. N. M. 1886, 28 (Beaufort, N. C.).
Perca rhomboidalis Goode & Bean, Proc. U. S. N. M. 1885, 20 (not of Linnæus).

Habitat: Atlantic and Gulf coasts of the United States, Cape Cod to Cuba.

Etymology: ῥόμβος, rhomb; εἶδος, appearance.

This species is very common all along the eastern coast of the United States south of New York, and on the Gulf coast as far west as Pensacola.

XXVII. ARCHOSARGUS.

Archosargus Gill, Canadian Naturalist, August, 1865 (*probatocephalus*).

Type: *Sparus probatocephalus* Walbaum.

Etymology: ἀρχός, chief; σαργός, *Sargus*, an old name of *Diplodus*.

This genus, like *Lagodon* and *Stenotomus*, which show the same character of the procumbent dorsal spine, is confined to American waters. There are two color types in the genus, one group being made up of species with broad black crossbands, the other of species with golden streaks and inconspicuous crossbands, resembling the species of *Lagodon*.

ANALYSIS OF SPECIES OF ARCHOSARGUS.

a. Occipital crest rather thin, its honeycomb structure not exposed. Species with streaks of steel-blue and golden, the dark crossbands narrow, disappearing with age, about one-third the interspaces; a black humeral spot.

b. Dorsal spines 13; incisors $\frac{4}{4}$ on each side; side of back with 8 or 9 golden streaks, which are narrower than the metallic-blue interspaces.

c. Scales 9–48–15; pectoral fin not quite reaching second anal spine; body rather deep and compressed, the depth 2 to $2\frac{1}{4}$ in length; head $3\frac{1}{2}$; profile rounded, steep; mouth moderate, the maxillary not reaching front of orbit, 3 to $3\frac{1}{2}$ in head; eye large, as broad as preorbital, $3\frac{3}{4}$ to 4 in head, $1\frac{1}{4}$ in interorbital width. Incisors $\frac{4}{4}$ on each side, entire, or with a shallow notch; molars 3-rowed above, 2-rowed below. Fifth dorsal spine highest, 2 to $2\frac{1}{2}$ in head; second anal spine strong, recurved, $2\frac{1}{2}$ in head; ventrals moderate, $4\frac{1}{2}$ to $4\frac{3}{4}$ in head, not nearly reaching vent. Olivaceous, silvery below, the upper parts with golden longitudinal stripes alternating with bluish interspaces; humeral spot larger than eye. D. XIII, 10; A. III, 10 or 11; scales, 8 or 9–45 to 50–14 to 16.......................................UNIMACULATUS, 119.

cc. Scales 7 or 8–48–15; pectoral fin reaching second anal spine; body rather less deep, the snout a little longer; ventrals shorter, 5 to $5\frac{3}{4}$ in head; otherwise essentially as in the preceding, of which it is the Pacific coast representative. POURTALESII, 120.

bb. [Dorsal spines 12; incisors $\frac{4}{4}$ on each side. Depth $2\frac{9}{10}$ in total length; head more than 4; eye $3\frac{1}{2}$ in head, 1 in snout; maxillary extending to a point between the pupil and the "interior" border of eye; profile with a slight depression above the eye; second anal spine much longer than the third. Color grayish, belly white; 8 golden longitudinal bands; a black shoulder-spot. D. XII, 10; A. III, 9.] (*Poey*)..............................TRIDENS, 121.

aa. Occipital crest broad, its honeycomb structure plainly exposed at its upper margin; dorsal spines 12; species without blue or golden markings, but with about seven broad black crossbands crossing the body; no distinct shoulder-spot. Body much compressed; dorsal outline strongly arched; ventral outline almost straight. Profile straight and steep anteriorly. Depth 2 to 2½ in length; head 3½. Head compressed, deep; mouth large, almost horizontal; maxillary 2⅗ in head; eye placed high, 4 in head, 1½ in interorbital, 1½ in suborbital. Incisors $\frac{8}{8}$, entire or slightly emarginate, serrate in the young; molars in three series above, in two below; those of the inner series larger, those behind the incisors very small. Highest dorsal spine 1½ in head; caudal not deeply forked; second anal spine about twice in head, much longer than third. Ventrals not nearly reaching vent; pectorals reaching past beginning of anal. Color, head dark; body silvery-gray, with 5 to 7 dark bars, which are less distinct in the adult; base of pectorals, black. D. XII, 10 or 12; A. III, 10 or 11.

d. Incisors broad, their breadth about half their length. Scales, 7–48–15. PROBATOCEPHALUS, 122.

dd. Incisors narrower, their breadth 2½ in their length. Scales, 7–44–14. ARIES, 123.

119. ARCHOSARGUS UNIMACULATUS. (Salema.)

Salema Marcgrave, Hist. Pisc. Brasil., 153, 1648 (Brazil).

Bream Brown, "Jamaica, 446, No. 1," 1756.

Perca unimaculata Bloch, pl. 308, 1792 (Brazil), (on a figure by Prince Maurice).

Grammistes unimaculatus, Bloch & Schneider, Syst. Ichth., 184, 1801 (after Bloch).

Sargus unimaculatus, Cuv. & Val., Hist. Nat. Poiss., VI, 62, 1830 (Rio Janeiro, Martinique); Storer, Syn. Fish. N. A., 334, 1845 (copied); Günther, Cat. Fish Brit. Mus., I, 446, 1859 (Bahia, Rio Janeiro, Guatemala, Puerto Cabello, Jamaica); Günther, Fishes Cent. America, 386, 1866 (Belize).

Diplodus unimaculatus Jordan & Gilbert, Proc. U. S. N. M. 1884, 128 (Key West); Bean, Proc. U. S. N. M. 1884, 158; Jordan, Cat. Fish. N. A., 91, No. 1065, 1885; Jordan, Proc. U. S. N. M. 1886, 43 (Havana); Eigenmann & Hughes, l. c., 1887, 69.

Sparus salin Lacépède, Hist. Nat. Poiss., IV, 136, 1803 (based on *unimaculatus* of Bloch).

Sargus humeri-maculatus Quoy & Gaimard, Voyage Freycinet, Zoöl., 297, 1825 (Rio Janeiro).

Sargus flavolineatus Cuv. & Val., Hist. Nat. Poiss., VI, 60, 1830 (Cuba; Storer, Syn. Fish U. S., 333, 1845 (copied); Günther, Cat. Fish. Brit. Mus., I, 446, 1859 (copied); Poey, Syn. Fish. Cub., 310, 1868 (copied); Poey, Enumeratio, 57, 1875 (copied).

Diplodus flavolineatus, Jordan, Proc. U. S. N. M. 1886, 42 (Havana).

Sargus caribæus Poey, Mem. Pisc. Cub., II, 197, 1860 (Cuba); Poey, Fauna Puerto Riqueña, 328, 1881 (Porto Rico).

Diplodus caribæus, Jordan & Gilbert, Syn. Fish. N. A., 930, 1883 (copied).

Habitat: West Indies; north to Key West, south to Rio Janeiro.

Etymology: *Unimaculatus*, having one spot.

The numerous specimens examined by us are from Key West and Havana.

The specimens examined by Eigenmann and Hughes, now before us, differ decidedly in the proportions, the color, and the size of the teeth; but while the differences of the extremes are very marked, the intergradation is so perfect that no tangible specific distinctions can be made out. We have only the deeper form (*flavolineatus*) from Key West, while we have both extremes from Havana. As far as we are able to judge from the figures and the descriptions, the *unimaculatus* of Bloch & Schneider, Cuv. & Val., and Jordan & Gilbert, the *caribæus* of Poey, and the *humeri-maculatus* Quoy & Gaimard represent the more slender form, while the *flavolineatus* Cuv. & Val. represents the deeper form. The differences of the extreme forms seem to be these:

The deeper form (*flavolineatus*).	*The more slender form* (*unimaculatus*).
Greatest depth, 2 in length.	Greatest depth, 2½ in length.
Ventral outline very much rounded.	Ventral outline almost straight.
Distance from insertion of first dorsal spine, obliquely to snout, 1¼ in depth.	Distance from insertion of first dorsal spine, obliquely to snout, 1 in depth.
Teeth about one-third narrower than in the more slender form.	
Body more compressed.	

120. ARCHOSARGUS POURTALESII.

Sargus pourtalesii Steindachner, Fische Afrikas, 39, 1881 (Galapagos Islands).
Archosargus pourtalesii, Jordan & Bollman, Proc. U. S. N. M. 1889, 186 (Chatham Island of the Galapagos).

Habitat: Galapagos Islands.

Etymology: To Louis F. de Pourtalès, a friend and associate of Agassiz, who was with him on the Hassler expedition, by which this fish was discovered.

This species is known to us from the description and excellent figure given by Dr. Steindachner and from a specimen obtained by the *Albatross* on Chatham Island. The differences between *pourtalesii* and *unimaculatus* are very slight, and might be ignored were it not for the remote and restricted habitat of the Pacific form.

121. ARCHOSARGUS TRIDENS.

Sargus tridens Poey, Enumeratio Pisc. Cub., 57, 1875 (Cuba).
Archosargus tridens Eigenmann & Hughes, l. c., 1887, 70 (copied).

Habitat: Cuba.

Etymology: *Tres*, three; *dens*, tooth.

This species is known to us only from the description of Prof. Poey. Its distinctive characters need verification, it being perhaps an abnormal specimen of *Archosargus unimaculatus*.

122. ARCHOSARGUS PROBATOCEPHALUS.

(Sheepshead; Sargo Raiado.)

Sparus Sheepshead, Schöpf, "Schriften der Gesellsch. Natf. Freunde, VIII, 152," 1788 (New York).

Sparus probatocephalus Walbaum, Artedi, Pisc., 295, 1792 (based on Schöpf).

Archosargus probatocephalus, Gill, Cat. Fish. East Coast North America, 27, 1873; Uhler & Lugger, Fishes of Maryland, 103, 1874 (Maryland); Jordan & Gilbert, Proc. U. S. N. M. 1878, 379 (Beaufort); Goode & Bean, Proc. U. S. N. M. 1879, 133 (Pensacola); Jordan, Proc. U. S. N. M. 1880, 22 (St. Johns River); Bean, Proc. U. S. N. M. 1880, 95 (St. Johns River); Goode & Bean, Proc. U. S. N. M. 1885, 208; Eigenmann & Hughes, loc. cit., 1887, 68.

Diplodus probatocephalus, Jordan & Gilbert, Proc. U. S. N. M. 1882, 278 (Pensacola); Jordan & Gilbert, Proc. U. S. N. M. 1882, 605 (Charleston); Jordan & Gilbert, Syn. Fish. North America, 558, 1883; Bean, Internat. Fish. Exhib. London, 57, 1883 (Matanzas River Inlet, Florida); Jordan, Proc. U. S. N. M. 1884, 128 (Key West); Jordan & Swain, Proc. U. S. N. M. 1884, 232 (Cedar Keys); Jordan & Meek, Proc. U. S. N. M. 1884, 237 (Jacksonville, Fla.); Henshall, Florida, 239, 1884 (east and west coast, Florida Keys); Jordan, Cat. Fish. N. A., 91, No. 1066, 1885; Gill, Standard Nat. Hist., III, 220, fig. 125, 1885; Goode, Hist. Aquat. Animals, 381, plates 130 and 131, 1886; Jordan, Proc. U. S. N. M. 1886, 27 (Beaufort, N. C.).

Sparus ovicephalus Bloch & Schneider, Syst. Ichth., 280, 1801 (based on Schöpf).

Sargus ovicephalus, Gill, Proc. Acad. Nat. Sci. Phila. 1860, 20 (name only); Gill, Cat. Fish. East Coast, 31, 1861 (name only).

Sargus ovis, Mitchill, Trans. Lit. and Phil. Soc. N. Y., I, 392, plate 2, fig. 5, 1814 (New York); Cuv. & Val., Hist. Nat. Poiss., VI, 53, 1830 (New Orleans); DeKay, Fishes, New York, 89, pl. 8, fig. 23, 1842 (New York); Storer, Synopsis Fishes North America, 332, 1846 (copied); Günther, Cat. Fish. Brit. Mus., I, 447, 1859 (North America); Holbrook, "Ichth. S. Carolina, 54, plate 8, fig. 2," 1860 (South Carolina); Storer, Fishes Mass., 126, plate 10, fig. 1, 1867 (New Bedford).

Habitat: Atlantic and Gulf coasts of the United States; Cape Cod to Florida Keys and Texas.

Etymology: *πρόβατον*, sheep; *κεφαλή*, head.

The numerous specimens examined by us are chiefly from Florida. The species is one of the most common and most valuable of the food-fishes of our Atlantic coast.

123. ARCHOSARGUS ARIES.

Sargus aries Cuv. & Val., Hist. Nat, Poiss., VI, 58, 1830 (Rio Janeiro, Maracaibo); Günther, Cat. Fish. Brit. Mus., I, 449, 1859 (copied); Günther, Fishes Cent. America, 386, 1864 (Belize).

Archosargus probatocephalus aries Eigenmann & Hughes, l. c., 1887, 69.

Etymology: *Aries*, the ram.

This species is unknown to us except through the published descriptions above referred to, and through the manuscript notes of Dr. Jordan on the type of Cuv. & Val. It would appear to be closely allied to *D. probatocephalus*, distinguishable only by the slightly narrower teeth and possibly larger scales. It is probably to be regarded as a geographical variety or southern representative of the common sheepshead.

XXVIII. DIPLODUS.

Diplodus Rafinesque, Indice d'Ittiologia Siciliana, 54, 1810 (*annularis*).
Sargus Cuvier, Règne Animal, 1817, ed. 1, 272 (*sargus;* name preoccupied in Insects).

Type: *Sparus annularis* Gmelin.

Etymology: διπλόος, double; ὀδούς, tooth, from the two forms of teeth.

The name *Diplodus* should of course supersede *Sargus*, both from the fact that it is prior in date and because the latter name was earlier used for a genus of insects. The genus *Diplodus*, as it is here understood, differs from *Archosargus* chiefly in the absence of a procumbent dorsal spine. Most of the species of *Diplodus* are European, as those of *Lagodon*, *Archosargus*, and *Stenotomus*—the genera which have the procumbent dorsal spine are American. The skull in *Diplodus* resembles that of *Archosargus*, but the cavernous or honeycombed structure of the interorbital area is still more prominent.

ANALYSIS OF AMERICAN SPECIES OF DIPLODUS.

a. Scales, 7–56–14; depth in adult, 2⅛ in length; black bar extending entirely across caudal peduncle; body regularly elliptical, moderately compressed; head, 3⅜ in length; profile regularly rounded, not as steep as in *argenteus;* eye, 1¾ in preorbital, 1½ in snout, 4½ in head; mouth large, almost horizontal; maxillary, 3⅓ in head; incisors, $\frac{4}{4}$, inserted obliquely; molars in three series above and two below; longest dorsal spine, 2⅔ in head; caudal deeply forked; second anal spine little larger than third, 3½ in head; ventrals reaching half way to the anal fin; pectorals not reaching to first anal spine; steel-blue above, paler below, a broad black border on the operculum; a black spot on upper part of base of pectoral; D. XII, 14 or 15; A. III, 13 .... HOLBROOKI, 124.

aa. Scales, 8–62 to 65–16; black bar not extending entirely across caudal peduncle.

b. Eye, 3½ in head, 1 in snout; second anal spine, 2⅔ in head; body much compressed; dorsal outline greatly elevated; depth, 1⅞ in length; head, 3½ in length; profile almost straight, very steep; eye large, 1¼ in preorbital; mouth moderate, almost horizontal; maxillary, 3⅓ in head; incisors, $\frac{4}{4}$, placed as in *holbrooki;* molars as in *holbrooki.* Longest dorsal spine, 2½ in head; caudal long, forked; second anal spine much stouter and ⅓ longer than third; ventrals reaching half way to second anal ray; pectorals reaching to first anal spine; steel-blue above, silvery below; a blackish border on the operculum; a black spot on the upper part of the base of pectorals; five or six very narrow, oblique blackish crossbars; D. XII, 14; A. III, 13; scales, 8–62–16. ARGENTEUS, 125.

bb. [Eye, 4⅓ in head, 1½ in snout; second anal spine, 3½ in head; depth, about 2 in length; incisors, rather broad, implanted obliquely; three series of molars above, two below; eye, 1⅓ in interorbital; crown of head convex, a protuberance above the anterior angle of the orbit; preorbital not entirely covering maxillary; pectoral fin extending to origin of anal; ventrals nearly to vent; silvery or shining golden, with many narrow longitudinal dusky stripes (8 or 9 above lateral line, 15 or 16 below), and with four or five narrow blackish crossbands, the first between the origin of the dorsal and the axil; D. XI or XII, 12 to 15; A. III, 13 or 14; scales, 8–65–16.] (*Günther*) .... SARGUS, 126.

124. DIPLODUS HOLBROOKI.

Sargus holbrooki Bean, Forest and Stream, June 13, 1878 (Charleston); Bean, Proc. U. S. N. M. 1878, 198 (Charleston); Jordan & Gilbert, Proc. U. S. N. M. 1878, 379 (Beaufort); Bean, Proc. U. S. N. M. 1880, 95 (Charleston, New York market).

Diplodus holbrooki Jordan & Gilbert, Proc. U. S. N. M. 1882, 605 (Charleston); Jordan & Gilbert, Syn. Fish. N. A., 559, 1883; Jordan & Swain, Proc. U. S. N. M. 1884, 232 (Cedar Keys); Jordan, Cat. Fish. N. A., 91, No. 1067, 1885; Goode, Hist. Aquat. Anim., 386, fig. 132, 1886; Jordan, Proc. U. S. N. M. 1886, 27 (Beaufort, N. C.); Eigenmann & Hughes, l. c., 1887, 72 (Cedar Keys, Pensacola, Beaufort).

Diplodus caudimacula Jordan & Gilbert, Syn. Fish. N. A., 559, 1883 (young, not *caudimacula* of Poey).

Habitat: South Atlantic and Gulf coasts of the United States; Cape Hatteras to Cedar Keys.

Etymology: Named for John Edwards Holbrook, author of the Ichthyology of South Carolina.

The specimens examined are from Cedar Keys and Pensacola, Fla., and from Beaufort, N. C. This species has not yet been found in the West Indies, though it probably occurs there. It may be considered as the northern representative of *argenteus*, but is unquestionably a different species.

125. DIPLODUS ARGENTEUS.

Sargus argenteus Cuv. & Val., Hist. Nat. Poiss., VI, 60, 1830 (Brazil); Günther, Cat. Fish. Brit. Mus., I, 444, 1859 (Rio Janeiro); Goode, Bull. U. S. N. M., V, 75 (Bermudas); Günther, Shore Fishes, 5-7, 1880 (Island of Ascension, Bermudas).

Diplodus argenteus Eigenmann & Hughes, l. c., 1887, 73 (New Smyrna, Fla.).

Sargus caudimacula Poey, Memorias de Cuba, II, 198, 1860 (Cuba); Poey, Syn. Pisc. Cub., 310, 1868 (Cuba); Poey, Enumeratio Pisc. Cub., 57, 1875 (Cuba).

Habitat: West Indies, Florida and the Bermudas to Rio Janeiro.

Etymology: *Argenteus*, silvery.

The specimen examined is from New Smyrna, Fla., where it was obtained by Mr. William P. Shannon. This is the only specimen yet recorded from the United States. The account of *Sargus argenteus* Cuv. & Val. agrees well with our specimen from New Smyrna, which is certainly the *Sargus caudimacula* of Poey. We have therefore substituted the name *argenteus* for the current name *caudimacula*. The types of *S. argenteus* in the Museum at Paris are also identified by Dr. Jordan as belonging to the same species as the types of *Sargus caudimacula* which are in the National Museum.

126. DIPLODUS SARGUS. (Sargo.)

Sparus No. 13, Artedi, Genera, 37; No. 2, Sueci, Descr., 58, 1738.
Sparus sargus Linnæus, Syst. Nat., ed. x, 278, 1758 (Mediterranean), and of early European authors.
Sargus variegatus Lacépède, Hist. Nat. Poiss., iv, 207, 1803 (Mediterranean); Goode, Bull. U. S. N. M., v, 52, 1876 (Bermuda); Goode, Cat. Fish. Bermuda, Am. Jour. Science and Art, 292, 1877 (Bermuda).
Sargus raucus Geoffroy St. Hilaire, Descr. de l'Egypte, Poiss., 1813, pl. xviii, fig. i.
Sargus rondeleti Cuv. & Val., Hist. Nat. Poiss., vi, 14, pl. cxli, 1830 (Mediterranean), and of European writers generally.
Sargus vetula Cuv. & Val., l. c.

Habitat: Coast of southern Europe; Bermudas.

Etymology: *σαργός*, *sargus*, the ancient name of a species of this genus.

This species is known to us only from descriptions. It is included in the American fauna on the record of Dr. Goode of its occurrence in the Bermudas.

The remaining European species of the genus are the following:

127. DIPLODUS VULGARIS (Geoffroy St. Hilaire). (**Sargo Seifia.**) Mediterranean Sea and neighboring islands.

128. DIPLODUS ANNULARIS (Gmelin). (**Mojarra.**) Mediterranean Sea and neighboring islands.

129. DIPLODUS FASCIATUS (Cuv. & Val.). Western Mediterranean and shores of northwestern Africa.

This species is intermediate between *Diplodus* and *Charax*, and, according to Steindachner, its existence makes the latter genus untenable.

XXIX. CHARAX.

Charax Risso, Europe Méridionale, iii, 1826, 353 (*acutirostis=puntazzo*) not *Charax* of Gronow, which is pre-Linnæan).
Puntazzo Bleeker, Systema Percarum Revisum, 1875, 284 (*puntazzo;* substitute for *Charax*, regarded as preoccupied).

Type: *Sparus puntazzo* Gmelin.

Etymology: *Charax*, *χάραξ*, an ancient name given "on account of the row of teeth which continues without interruption on each jaw."

This genus is very close to *Diplodus*, from which it differs only in the presence of a single row of very small molars instead of two or more rows of larger ones. The snout is slender and projecting, giving the species a somewhat peculiar physiognomy. The genus is of slight value, but may be retained for the present, although, as Steindachner has already noticed, *Diplodus fasciatus* with two rows of small molars marks the transition from *Diplodus* to *Charax*. The generic name *Puntazzo* is unnecessary if the pre-Linnæan and prebinomial names of Gronow (1754) are not to be considered. *Charax* of Gronow is based on species of *Characinidæ*. A single species is known:

130. CHARAX PUNTAZZO (Gmelin). Mediterranean Sea and islands of the Eastern Atlantic.

Subfamily VII.—BORIDIINÆ.

XXX. BORIDIA.

Boridia Cuv. & Val., v, 154, 1830 (*grossidens*).

Type: *Boridia grossidens* Cuv. & Val.

Etymology: Unexplained; possibly from *βόξ* and *εἶδος*.

This genus is based on a single species once brought from Brazil, but not seen by any recent collector. It is certainly very different from any other known fish. It resembles a *Xenichthys* with the teeth of a *Calamus*. Bleeker places it near *Hoplopagrus*, which is certainly not its natural position.

ANALYSIS OF SPECIES OF BORIDIA.

a. Body rather elongate, covered with moderate scales, which are ranged in series parallel with the lateral line; mouth small, the maxillary reaching front of eye; teeth all blunt and molar, in about three rows in each jaw, the front teeth enlarged; eye rather large; preorbital very narrow; nostril small, near eye; dorsal fin divided to base, the first and second spines very short, the third longest, about $\frac{2}{5}$ head; soft dorsal and anal low; second anal spine longer and stronger than third, but still short; caudal well forked; pectorals quite short, shorter than ventrals; soft fins scaleless; depth about equal to length of head and about 4 in body; D. XI–I, 13; A. III, 11; color nearly plain, scales dotted with black. (*Cuv. & Val.*) .... GROSSIDENS, 131.

131. BORIDIA GROSSIDENS.

Boridia grossidens Cuv. & Val., v, 154, pl. 114, 1830 (Brazil).

Habitat: Coast of Brazil.

Etymology: *Grossus*, thick; *dens*, tooth.

This species is known from Cuvier's description of a single individual, 14 inches long, brought from Brazil by De Lalande.

Subfamily VIII.—MÆNINÆ.

XXXI. MÆNA.

Mænas Klein, 1749 (nonbinomial).
Mæna Cuvier, Règne Animal, ed. II, 1828 (*mæna*).
Mæna, Bleeker, Systema Percarum Revisum, 1875, 273 (*mæna*).

Type: *Sparus mæna* Gmelin.

Etymology: *μαινίς*, an old name of some small fish.

This genus is very closely related to the next, with which it is united by Dr. Bleeker, the chief difference being in the presence of rudimentary vomerine teeth in *Mæna*. Two species are commonly recognized, besides two doubtful ones, *Mæna vomerina* Cuv. & Val. and *Mæna usculum* Cuv. & Val. All belong to the Mediterranean fauna.

132. MÆNA MÆNA (Gmelin).

133. MÆNA ZEBRA (Brünnich).

XXXII. SPICARA.

Spicara Rafinesque, Caratteri, etc., 1810, 51 (*flexuosa* = *smaris*).
Smaris Cuvier, Règne Animal, ed. I, 1817, 269 (*smaris*).

Type: *Spicara flexuosa* = *Sparus smaris* L.

Etymology: *Spicara*, a local name, probably from *spica*, a spike.

This genus is chiefly confined to the Mediterranean and neighboring waters. The name *Spicara* has priority over the commonly used name *Smaris*.

Two species are now recognized on the European coasts. These are:

134. SPICARA SMARIS (Linnæus). (Picarel.)

135. SPICARA ALCEDO (Risso).

Besides these, a single species has been* doubtfully recorded from the West Indies—*Spicara martinica*.

XXXIII. CENTRACANTHUS.

Centracantus (by misprint) Rafinesque, Caratteri, etc., 1820, 42 (*cirrus* = *insidiator*).

Type: *Centracanthus cirrus* Rafinesque = *Smaris insidiator* Cuv. & Val.

Etymology: κέντρον, point; ἄκανθα, spine.

This genus contains one species found in the Mediterranean fauna and another in the Indian seas. The European species has been usually referred to *Spicara* (*Smaris*), but the form of its dorsal and various minor characters sufficiently distinguish it. Its specific name *cirrus* is derived from a Sicilian name, "*cirrú*."

136. CENTRACANTHUS CIRRUS Rafinesque. Coasts of southern Europe.

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* ANALYSIS OF SUPPOSED AMERICAN SPECIES OF SPICARA.

a. [Allied to *Spicara smaris*, but with the body rounded, compressed, the suborbital narrower and more notched. Color apparently plain, a small black spot on the side; D. XII, 11; A. III, 9.] (*Cuv. & Val.*) ....MARTINICA.

SPICARA MARTINICA.

Smaris martinicus Cuv. & Val., VI, 1830, 424 (Martinique).

Habitat: West Indian fauna.

Etymology: From Martinique.

The type of this species, 4 inches long, is reputed to have been sent to Paris from Plée, in Martinique. Very likely it is the common European picarel, *Spicara smaris*, and it may have come from the coasts of France. Errors of locality are common in museums, and the "Cabinet du Roi" has not been exempt from them.

XXXIV. ERYTHRICHTHYS.

Erythrichthys Temminck & Schlegel, Fauna Japonica, Poiss., 117, 1840–50 (*schlegeli*).
Emmelichthys Richardson, Voyage Erebus and Terror, Fishes, 47, 1846 (*nitidus*).
Boxaodon Guichenot, in Gay, Hist. Chili, II, 208, 1847 (*cyanescens*).
Dipterygonotus Bleeker, Contr. Ichth. Celebes, 1848 (*leucogrammicus*).
Inermia Poey, Memorias, II, 1860, 193 (*vittata.*)

Type: *Erythrichthys schlegeli* Günther.

Etymology: ἐρυθρός, red; ἰχθύς, fish; true only of the typical species.

This genus contains about five species, bright-colored fishes, inhabiting rather deep water. The species are not well known, and each one of them has been made the type of a distinct genus by writers who have failed to detect their association with each other. None of the species have been studied by us.

ANALYSIS OF AMERICAN SPECIES OF ERYTHRICHTHYS.

a. [Color greenish, with a broad band of yellowish green from the eye to the tail; three narrower streaks of darker green on the back; snout yellowish, dorsals pale yellow; caudal violet, its upper and lower edge white; pectoral rose; lower fins pale. Body fusiform, oval in section; maxillary reaching beyond eye; no teeth in jaws; preopercle with soft teeth at the angle; nostril small; no pores on lower jaw; dorsal fins separate; pectorals short; fins low, with slender spines; caudal deeply forked; D. XIV, 10; A. III, 9; scales, 100.] (*Poey.*) VITTATUS, 137.

aa. [Uniform bluish green; D. XIII–10; A. III, 12]. (*Günther* from *Guichenot.*) CYANESCENS, 138.

137. ERYTHYRICHTHYS VITTATUS. (Boga.)

Inermia vittata Poey, Memorias, II, 193, 1860 (Havana).
Emmelichthys vittatus Poey, Synopsis, 320, 1868.
Erythrichthys vittatus Poey, Enumeratio, 49, 1875.

Habitat: Coasts of Cuba.

Etymology: *Vittatus*, striped.

This little fish reaches a length of about 8 inches. According to Poey it is generally rare on the Cuban coast, occasionally appearing in great numbers.

138. ERYTHRICHTHYS CYANESCENS.

Boxaodon cyanescens Guichenot, in Gay, Hist. Chili, 209, Atlas, lam. 5, f. 1, 1847.
Erythrichthys cyanescens Günther, I, 395 (copied).

Habitat: Coast of Chile.

Etymology: *Cyanescens*, bluish.

This species is known only from the scanty and incorrect account given by Guichenot. We have not seen the original account, and copy our diagnosis from Günther.

Subfamily IX.—SCATHARINÆ.

XXXV. BOX.

Box Cuv. & Val., VI, 346, 1830 (*boops*).

Type: *Sparus boops* L.

Etymology: *βόξ*, *box*, an old name of the typical species, still called Bogue or Boga in southern Europe.

This genus contains one very well known species abundant in the seas of southern Europe. It has been commonly referred to the same genus as the next species, but the elongate form of the body, the much larger eye, and especially the presence of 14 or 15 dorsal spines instead of 11, seem sufficient for its generic separation. The name *Box* has been almost universally used for both species, but that of *Boops* is older, and must take its place, as Bleeker has shown, if the two are placed in one genus. Under *Boops*, *B. salpa* is the first species mentioned by Cuvier, and Bleeker has made this the type of the genus *Boops*. It is evident however, that *B. boops* was regarded by Cuvier & Valenciennes as the type of *Box*. This fact may justify us in retaining both names, *Boops* and *Box*, rather than to invent a new generic or subgeneric name for *Box boops*.

139. BOX BOOPS (L.).

Besides the well known *Box boops*, another species* of *Box* has been erroneously accredited to the West Indies. The type of *Box carabaica** came, however, from St. Vincent of the Cape Verde group and not from the West Indian island of the same name.

XXXVI. BOOPS.

Cynædus Gronow, Zoophyl., 1763 (*salpa*) (non-binomial).

Boops Cuvier, Règne Animal, ed. 1, 1817, 270 (*salpa*, *melanurus*, *boops*; restricted by Bleeker, Systema Percarum Revisum, to *Boops salpa*, the first species mentioned by Cuvier).

Cynædus Gronow, Syst. Ed. Gray, 1854, 55 (*onias* = *salpa*; not *Cynædus* Swainson, 1839 = *Crenilabrus*).

Type: *Sparus salpa* L.

Etymology: *Βοώψ*, *boops*, large-eyed, a name applied by Rondelet to *Box boops*. It is probably an error for *βόξ*.

This genus as here understood contains one common European species.

140. BOOPS SALPA (L.). Mediterranean Sea and neighboring islands.

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* *Box vulgaris* var. *carabaica* Günther, I, 419, 1859 (St. Vincent).

This species is said to differ from *Box boops* in the slightly smaller scales, and by the presence of 15 dorsal spines instead of 14. As already noted (*Parapristipoma viridense*) there is an island called St. Vincent in the Cape Verde Archipelago as well as in the West Indies. There is no doubt, as already shown, that the type of *Box carabaica* came from the other St. Vincent, and it is doubtless identical with the common *Boga* of Europe.

XXXVII. OBLADA.

Oblada Cuvier, Règne Animal, ed. 2, 1829 (*melanura*).
Oblata Cuv. & Val., VI, 1830, 366 (*melanura*).

Type: *Sparus melanurus* L.

Etymology: From *Oblado* or *Blade*, the common name of *Oblada melanura* at Marseilles.

This genus contains a single species common in the Mediterranean. We here restore the older orthography of the name.

141. **OBLADA MELANURA** (L.). Mediterranean Sea and neighboring waters.

XXXVIII. SCATHARUS.

Scatharus Cuv. & Val., VI, 375, 1830 (*græcus*).

Type: *Scatharus græcus* Cuv. & Val.

Etymology: *ασκάθαρος* or *σκάθαρος*, a name now used by the Greeks for *Scatharus græcus* and *Spondyliosoma cantharus*.

This genus contains a single species, abundant on the coasts of Greece.

142. **SCATHARUS GRÆCUS** Cuv. & Val. Eastern Mediterranean.

XXXIX. SPONDYLIOSOMA.

Cantharus Cuvier, Règne Animal, ed. 1, 1817, 278 (*cantharus;* name preoccupied in Mollusks and in Polypi).
Spondyliosoma Cantor, Catal. Malayan Fishes, 1850, 50 (*cantharus:* substitute for *Cantharus*, preoccupied).

Type: *Sparus cantharus* Gmelin.

Etymology: *σπονδύλιον*, spindle; *σῶμα*, body.

This genus contains some half a dozen old-world species, well characterized by the presence of a band of lanceolate teeth in each jaw. It is remarkable that the generic name *Cantharus*, although twice preoccupied, should have been almost universally used for this group, while Cantor's substitute name of *Spondyliosoma* has been entirely overlooked. The recognized species of *Spondyliosoma* in European waters are:

143. **SPONDYLIOSOMA CANTHARUS** (Gmelin). Southern Europe north to England.

144. **SPONDYLIOSOMA ORBICULARE** (Cuv. & Val.). Mediterranean Sea.

Subfamily X.—GIRELLINÆ.

XL. GIRELLA.

Girella Gray, Illustrations of Indian Zoölogy, about 1840 (*punctata*).
Melanichthys Temminck & Schlegel, Fauna Japonica, Poissons, 75, 1850 (*punctatus*).
Camarina Ayres, Proc. Cal. Acad. Nat. Sci. 1860, 81 (*nigricans*).

Type: *Girella punctata* Gray.

Etymology: From the French "*Girelle*," which is a derivative of *Julis*, and is applied to the smaller labroids.

This genus contains several species found in the western Pacific and a single species characteristic of the rocky shores of California. They are herbivorous fishes, feeding on seaweeds.

ANALYSIS OF AMERICAN SPECIES OF GIRELLA.

a. Body oval, compressed, with very deep caudal peduncle; snout thick, its profile evenly rounded; mouth small, subinferior, the maxillary reaching nearly to front of orbit; a minute patch of palatine teeth; each jaw with a series of flat, tricuspid, movable incisors, behind which is a broad band of smaller ones; no teeth on vomer or tongue; cheeks with very small scales; opercles and top of head naked; preopercle minutely serrulate at its angle; preorbital as broad as eye. Gill-rakers numerous, rather long. Scales firm, weakly ctenoid, those on thorax and front of back smaller. Dorsal spines lower than soft rays, with an imperfect sheath of scales at their base; anal spines small, graduated, the soft rays higher than those of the dorsal; caudal lunate; pectorals short and broad, not reaching vent; ventrals short. Air bladder with two posterior horns; intestinal canal very long; pyloric cœca numerous; peritoneum black. Color dusky green, paler below; young with a large yellowish blotch on each side of dorsal. Head, 4 in length; depth, 2¼; D. XIV, 14; A. III, 12. Scales, 50. NIGRICANS, 145.

145. GIRELLA NIGRICANS. (Bluefish.)

Camarina nigricans Ayres, Proc. Cal. Acad. Nat. Sci. 1861, 81, f. 22 (California).

Girella nigricans, Gill, Proc. Acad. Nat. Sci. Phila. 1862, 244; Jordan & Gilbert, Proc. U. S. N. M. 1880, 27 (San Diego); Jordan & Gilbert, Proc. U. S. N. M. 1880, 456 (Monterey Bay, Santa Barbara, San Pedro, San Diego); Jordan & Jouy, Proc. U. S. N. M. 1881, 12 (Wilmington, Cal., Santa Barbara); Jordan & Gilbert, Proc. U. S. N. M. 1881, 47 (Monterey, Santa Barbara); Jordan & Gilbert, Proc. U. S. N. M. 1882, 363 (Cape San Lucas); Jordan & Gilbert, Syn. Fish. N. A., 1883, 560; Rosa Smith, Proc. U. S. N. M. 1883, 234 (Todos Santos Bay); Rosa Smith, Proc. U. S. N. M. 1884, 553 (San Cristobal); Jordan, Fish. Indus. U. S., I, 394, 1884 (Monterey, Santa Barbara); Jordan, Proc. U. S. N. M. 1885, 380 (Cape San Lucas); Jordan, Fish. Indus. U. S., II, 596, 1887 (Santa Catalina); Evermann & Jenkins, Proc. U. S. N. M. 1891, 154 (Guaymas).

Girella dorsomacula Gill, Proc. Acad. Nat. Sci. Phila. 1862, 244 (Cape San Lucas); Jordan & Gilbert, Proc. U. S. N. M. 1882, 363.

Habitat: Pacific coast from Monterey to the Gulf of California.

Etymology: *Nigricans*, blackish.

This fish is very common on the coast of southern California, reaching the length of about a foot. It is a food-fish of fair quality.

XLI. DOYDIXODON.

Doydixodon Valenciennes, Voyage de la Venus, v, 318, 1855 (*freminvillei*).

Type: *Doydixodon freminvillei* Valenciennes.

Etymology: *Doy*, meaning unexplained; δίξοος, forked; ὀδών, tooth.

This genus contains two species, both as yet imperfectly described. It is certainly closely allied to *Girella* and may prove to be inseparable from that genus. The only important difference would seem to be in the smaller spinous dorsal of *Doydixodon*.

ANALYSIS OF SPECIES OF DOYDIXODON.

a. [Color, uniform dark green, or banded with darker; D. XII, 15; A. III, 12. Scales about 60. Form, squamation, and dentition of *Girella nigricans*.] (*Valenciennes.*) FREMINVILLEI, 146.

aa. [Color, uniform dark brown. D. XIII, 18; A. III, 12.] .... LÆVIFRONS, 147.

146. DOYDIXODON FREMINVILLEI.

Doydixodon freminvillei Valenciennes, Voyage Venus, 323, pl. 5 (Galapagos Islands).
Doydixodon fasciatum Kner & Steind., Sitzb. Akad. Wien, LIV, 358, f. 2 (Iquique, Peru).

Habitat: Galapagos Islands, and coast of Peru.

Etymology: Named for Freminville, an early French naturalist and explorer.

This species is known to us only from the poor figure of Valenciennes, which closely resembles *Girella nigricans*, but the number of dorsal spines is smaller.

147. DOYDIXODON LÆVIFRONS.

Pimelepterus lævifrons Tschudi, Fauna Peruana, 1844, 18 (Huacho, Peru).

Habitat: Coast of Peru.

Etymology: *Lævis*, smooth; *frons*, forehead.

This imperfectly known species is probably to be referred to *Doydixodon*. It is probably close to *D. freminvillei*, but if correctly described it cannot be the same. The following is Tschudi's description:

PIMELEPTERUS LÆVIFRONS Tsch.

D. XIII, 18. V. I, 5; A. III, 12. P. 16.

Verhältniss der Höhe zur Länge 1: 2, 8, des Kopfes zum Körper 1:3. Auge kreisrund, nahe am convexen obern Stirnrand; 1, 6 seines Durchmessers vom Vordeckelrande und zweimal sein Durchmesser vom Unterkieferrande. Nasenlöcher sehr nahe am Auge.

Maul klein, nicht ganz bis unter das Auge gespalten. Zähne des Ober- und Unterkiefers in zwei hechelförmigen Massen zusammengedrängt; die einzelnen Zähne leicht nach hinten gebogen.

Die verticale Deckelrand schwach nach hinten geschweift, der horizontale leicht nach unten gebogen; der Winkel abgerundet.

Der Vordeckeldorn stumpf; nach dem obern Winkel zu ist der Vordeckelrand ausgeschnitten. Stirn unbeschuppt, Nacken, Deckel und Brust so wie die Basis der Flossen mit kleinen, der übrige Körper mit grossen Schuppen besetzt. Die Seitenlinie verläuft dem Rückenprofil parallel, beinahe in der Mitte des Körpers.

Die Rückenflosse beginnt der Bauchflosse gegenüber und endet nach hinten so weit wie die Afterflosse. Die Stacheln sind beinahe gleichlang und ziemlich kurz, der 13te der längste, die ersten Flossenstrahlen noch einmal so lang als dieser. Schwanzflosse gerade abgeschnitten. Die Afterflosse beginnt dem ersten Rückenflossenstrahle gegenüber; die drei Stacheln sind kurz; der erste der spitzigste und längste. Die Bauchflosse beginnt hinter der Brustflosse und reicht nicht ganz bis zur Afterflosse; ihr Flossenstachel ist ziemlich lang. Die Brustflosse sitzt am weitesten nach vorn und endet dem 8ten Rückenflossenstachel gegenüber.

Färbung.—Auf dem ganzen Körper braun-grau; der Kopf, besonders auf der Stirn, olivenbraun, die Seiten mehr in's Graue übergehend, der Bauch weisslich braun. Länge 9″.

Vorkommen.—Bei Huacho, nördlich von Lima.

Subfamily XI.—KYPHOSINÆ.

XLII. HERMOSILLA.

Hermosilla Jenkins & Evermann, Proc. U. S. N. M. 1888, 144 (*azurea*).

Type: *Hermosilla azurea* Jenkins & Evermann.

Etymology: *Hermosilla*, name of the capital city of Sonora, along the coasts of which state the typical species was taken, derived from Spanish *hermosa*, beautiful (Latin, *formosa*).

This genus contains a single species, an ally of *Kyphosus*, found in the Gulf of California.

ANALYSIS OF SPECIES OF HERMOSILLA.

a. Top of head from posterior margin of eyes, snout, preorbitals, chin, and preopercles naked. Body ovate, compressed; head short; snout blunt, 3 in head; maxillary about equal to eye, which is 3⅘ in head, and reaching front of eye; both jaws with one series of close-set, equal, narrow, rounded incisors; no teeth on vomer; gill-rakers slender, 3+12, about equal to eye; preorbital 1½ in eye; preopercle entire; fins except spinous dorsal finely scaled; seventh dorsal spine longest; second anal spine longest, 1½ diameter of eye; pectorals shorter than ventrals, 1½ in head; spinous dorsal about half longer than soft. Head, 3⅗; depth, 2; D. XI, 11; A. III, 10. Scales, 11–55–17. Color, dark steel-blue, paler below; body with about 12 nearly vertical blackish crossbands about as wide as the eye; below eye silvery, with a dark streak from maxillary to angle of opercle; opercular blotch black; a black blotch in the axil; fins mostly dark. AZUREA, 148.

148. HERMOSILLA AZUREA.

Hermosilla azurea Jenkins & Evermann, Proc. U. S. N. M. 1888, 144 (Guaymas).

Habitat: Gulf of California.

Etymology: *Azureus*, sky-blue.

This beautiful species is known from two examples, taken by Jenkins & Evermann at Guaymas, in Sonora.

XLIII. KYPHOSUS.

Kyphosus Lacépède, Hist. Nat. Poiss., III, 114, 1802 (*bigibbus* = *fuscus*).
Pimelepterus Lacépède, Hist. Nat. Poiss., IV, 429, 1803 (*bosqui* = *sectatrix*).
Dorsuarius Lacépède, Hist. Nat. Poiss., V, 482, 1803 (*nigrescens* = *fuscus*).
Xyster Lacépède, Hist. Nat. Poiss., V, 484, 1803 (*fuscus*).
? **Opisthistius** Gill, Proc. Acad. Nat. Sci. Phila. 1862, 245, (*tahmel*).
Sectator Jordan & Fesler, subgen. nov. (*ocyurus*).

Type: *Kyphosus bigibbus* Lacépède.

Etymology: κυφός, a hump, the word more correctly written *cyphus*, and referring to a deformed specimen with hump back.

This genus contains some ten species, all but one confined to the Pacific Ocean, and most of them found in the East Indies. One of the species, *Opisthistius tahmel*, usually referred to this group, is probably the type of a distinct genus, distinguished by its elevated soft dorsal and anal.

ANALYSIS OF AMERICAN SPECIES OF KYPHOSUS.

a. Soft dorsal and anal moderately elevated.

b. Incisor teeth well developed, each with a conspicuous horizontal process or root; caudal fin moderate, about as long as the head, the outer rays not 3 times as long as middle rays; junction of gill-membranes forming an angle (*Kyphosus*).

c. Soft dorsal with 14 rays; anal with 14; teeth 25 to 30; color bluish, sides with about 12 dark longitudinal streaks; longest spine about 2½ in head; D. XI, 14; A. III, 14.

d. Soft part of anal fin low, its longest ray 4 in base of fin and 4 in head; scales smaller, about 85; depth more than half length; eye nearly 4 in head. ANALOGUS, 149.

dd. Soft part of anal fin somewhat elevated in front, its longest ray 2¼ in head, 2¼ in base of fin; scales 12–70–22; depth 2 in length; eye 3½ in head; snout very blunt .... ELEGANS, 150.

cc. Soft dorsal with 11 or 12 rays; anal rays III, 11; teeth 35 to 40; color grayish or yellowish, with darker lengthwise streaks.

e. Scales 10–55–16; soft dorsal and anal fin moderate, the longest ray of anal about 2¼ in head; longest anal spine 2¼ in head. Body ovate, compressed, its depth 2½ in length; head, 3⅘. D. XI, 12; A. III, 11. Color dusky, with about 25 pale streaks following the rows of scales, those near middle of body broadest; a silver streak along preorbital........ SECTATRIX, 151.

ee. Scales 12–67–22; anal fin high in front, its longest soft ray about 1¾ in head; longest anal spine about 2 in head; depth of body 2¼ in length; head, 3⅘; D. XI, 11; A. III, 11 .... LUTESCENS, 152.

bb. Incisor teeth small, with inconspicuous roots; caudal much longer than head, the lobes falcate, the outer 5 times length of middle rays; gill-membranes not forming an angle at junction. (*Sectator* Jordan & Fesler.)

f. Anal low, its last ray longest, its middle rays shorter than eye; longest dorsal spine about 3¼ in head; scales 11–78–19; color olivaceous, with blue and golden spots and stripes; depth, 2⅘; head, 3⅚; D. XI, 13; A. III, 14. OCYURUS, 153.

149. KYPHOSUS ANALOGUS.

Pimelepterus analogus Gill, Proc. Acad. Nat. Sci. Phila. 1862, 245 (Cape San Lucas); Jordan & Gilbert, Proc. U. S. N. M. 1881, 232 (Porto Escondido); Jordan & Gilbert, Bull. U. S. F. C. 1881, 328; Jordan & Gilbert, Bull. U. S. F. C. 1882, 107 (Mazatlan, no description); Jordan & Gilbert, Bull. U. S. F. C. 1882, 110 (Panama, no description); Jordan & Gilbert, Proc. U. S. N. M. 1882, 353, 363 (Cape San Lucas, no description).

Cyphosus analogus, Jordan & Gilbert, Proc. U. S. N. M. 1882, 626 (Panama, no description).

Kyphosus analogus, Jordan, Cat. Fish. N. A., 1885, 92 (Pacific coast, no description); Jordan, Proc. U. S. N. M. 1885, 380 (Mazatlan, Panama, no description); Evermann & Jenkins, Proc. U. S. N. M. 1891, 154 (Guaymas).

Habitat: Pacific coast of tropical America, from Panama to Gulf of California.

Etymology; *Analogus*, analogous (to *Kyphosus sectatrix*).

This species is generally common along the Pacific coast of tropical America, where it represents the closely allied *K. sectatrix*. The specimens examined by us are from Guaymas, Cape San Lucas, Porto Escondido, and Mazatlan.

150. KYPHOSUS ELEGANS. (Chopa.)

Pimelepterus elegans Peters, Berliner Monatsberichte, 707, 1869 (Mazatlan).
Kyphosus elegans, Evermann & Jenkins, Proc. U. S. N. M. 1891, 155 (Guaymas).

Habitat: Gulf of California.

Etymology: *Elegans*, elegant.

This species is very closely related to the more abundant *K. analogus*, from which it differs chiefly in the form of the anal fin and of the snout. The specimens seen by us are the original type from Mazatlan and the specimen obtained by Evermann & Jenkins from Guaymas.

151. KYPHOSUS SECTATRIX.

(Razor-fish; Chub; Bream; Rudder-fish; Bermuda-chub.)

Perca marina sectatrix, the Rudder-fish, Catesby, Nat. Hist. Car., 1738.
Perca saltatrix Linnæus, Syst. Nat., ed. x, 293, 1758 (incorrectly copied from Catesby, who called it *sectatrix*); Goode & Bean, Proc. U. S. N. M. 1885, 201.
Perca sectatrix Linnæus, Syst. Nat., ed. xii, 486, 1766; Jordan, Proc. U. S. N. M. 1884, 193, 198.
Kyphosus sectatrix Jordan, Cat. Fish. N. A., 92, 1885 (West Indies, no description); Jordan, Proc. U. S. N. M. 1886, 28 (Beaufort, no description); Jordan, Proc. U. S. N. M. 1886, 585 (West Indies, no description).
Pimelepterus bosci Lacépède, Hist. Nat. Poiss., iv, 429, 1803 (North Atlantic); Cuv. & Val., vii, 258, pl. 187, 1831 (Charleston, S. C.); Valenciennes, in Webb & Berthelot, Hist. Nat. Îles Canar., Poiss, pl. 19, 1836 (Canary Islands); De Kay, New York Fauna, Fishes, 100, pl. xx, f. 56, 1842 (New York, copied from Cuvier); Storer, Syn. Fishes N. A., 88, 1845 (copied from Cuvier); Günther, i, 497, 1859 (Jamaica, Cuba, Madeiras); Poey, Syn. Pisc. Cubens., 323, 1868; Baird, Rep't Comm. Fish and Fisheries, 824, 1873 (Woods Holl, no description); Bleeker, Syst. Percarum, ii, 6, 1875; Goode, Fishes of the Bermudas, 52, 1875; Jordan & Gilbert, Proc. U. S. N. M. 1878, 378 (Beaufort); Goode, Proc. U. S. N. M. 1879, 113 (east coast Florida); Bean, Proc. U. S. N. M. 1880, 94 (Bermuda, no description); Goode & Bean, Proc. U. S. N. M. 1882, 238 (Gulf of Mexico, no description); Jordan & Gilbert, Syn. Fish. N. A., 561, 1883.
Cyphosus bosci Goode, Fish Indust. Exh. 1884, 394 (Gulf of Mexico).
Cyphosus bosqui Jordan, Proc. U. S. N. M. 1884, 128 (Key West).
Pimelepterus oblongior Cuv. & Val., vii, 264, 1831 (locality unknown).
Pimelepterus incisor Cuv. & Val., vii, 266, 1831 (Brazil); Valenciennes in Webb & Berthelot, Hist. Poiss., Canaries, 47, 1838 (Canaries).
Pimelepterus flavolineatus Poey, Repertorio, i, 319, 1866; Poey, Syn. Pisc. Cubens 324, 1868.
Pimelepterus bosci var. *sicula* Doderlein, Bull. Soc. Sci. Nat. (Palermo).

Habitat: Atlantic coast of the United States from Cape Cod, crossing the ocean to the Canary Islands; accidental in the Mediterranean.

Etymology: *Sectator*, one that follows. According to Catesby, the species follows ships, hence the name of "Rudder-fish."

This species is not rare off our Atlantic coasts, becoming rather common southward. The specimens before us are from Key West. It has been once taken at Palermo, where it has been named var. *sicula.*

152. KYPHOSUS LUTESCENS.

Pimelepterus lutescens Jordan, Proc. U. S. N. M. 1881, 229 (Braithwaite Bay, Socorro Island); Jordan, Bull. U. S. F. C. 1881, 328.
Kyphosus lutescens Jordan, Proc. U. S. N. M. 1885, 380 (Socorro Island, no description).

Habitat: Revillagigedo Archipelago.

Etymology: *Lutescens*, growing yellow.

This species is known only from the original type taken on Socorro Island and from another taken at Clarion Island by Dr. Gilbert.

153. KYPHOSUS OCYURUS.

Pimelepterus ocyurus Jordan, Bull. U. S. F. C. 1881, 327, 328 (Bay of Panama); Jordan & Gilbert, Bull. U. S. F. C. 1882, 110 (Panama, no description).
Kyphosus ocyurus Jordan, Proc. U. S. N. M. 1885, 380 (Panama, no description).

Habitat: Panama.

Etymology: *ὠκύς*, quick; *οὐρά*, tail.

This species is known only from the original types, from Panama It is a strongly marked species, perhaps the type of a distinct subgenus or even genus, *Sectator*, characterized by the little development of the roots of the teeth and by the deeply forked caudal.

XLIV. MEDIALUNA.*

Medialuna Jordan & Fesler, *gen. nov.* (*californiensis*).

Type: *Scorpis californiensis* Steindachner.

Etymology: Spanish *medialuna*—half moon, the vernacular name of the typical species in California.

This genus contains a single species which belongs to the Californian fauna. Its nearest relative seems to be the Australian genus *Atypichthys* Günther, which has a different fin formula (D. XI, 15; A, III, 15) and the middle dorsal spines much longer, about half of head. The two genera are apparently distinct; certainly neither belongs to the *Chætodontidæ*.

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* The genera lately subtracted from *Scorpis* (type *S. georgianus*, an Australian species) may be defined as follows:

a. Anal fin long, 2½ in length of body, its rays, III, 25 to 27; dorsal spines gradually increasing in height posteriorly (teeth said to be conical, but probably compressed).
b. Soft dorsal and anal falcate, the longest ray 1¼ in base of rayed part; dorsal spines 9....... SCORPIS.
bb. Soft dorsal and anal not falcate, the longest ray 2⅜ in base of rayed part; dorsal spines 10. CÆSIOSOMA (*Kaup*).
aa. Anal fin short, its base 3⅝ in length of body, its rays III, 19; dorsal spines gradually increasing in height to the sixth, decreasing posteriorly; soft dorsal and anal not falcate, the longest ray 1½ in base of rayed part; preoperculum serrated at angle; teeth compressed, incisor-like, but narrow.. MEDIALUNA.

ANALYSIS OF SPECIES OF MEDIALUNA.

a. Body ovate-elliptical, its outlines regular; head bluntish, rounded, the profile strongly convex; maxillary narrow, not reaching front of eye; preorbital narrow; eye small, 1⅓ in snout, 5 in head; mouth small, terminal, horizontal; jaws with broad bands of slender teeth, the outer compressed, narrowly lanceolate, without evident roots behind; outer teeth similar, growing smaller backward, all somewhat movable; vomer, palatines, and tongue with patches of minute teeth; gill-rakers slender, rather long; preoperele entire. Dorsal spines low, the middle spines highest, scarcely longer than eye; soft dorsal low, not elevated in front, little higher than spines; anal low; caudal lunate, the upper lobe slightly longer; pectorals short and narrow; ventrals rather small; scales thinnish, adherent, with smaller ones intermixed; sides, top of head, and jaws closely sealed; head 3⅗ in length, depth 2⅓; D. IX, I, 22; A. III, 19 Scales 9–58–12. Color blackish, with steely luster, paler, and often mottled below; sides with faint oblique vertical lines of spots; fins blackish.

CALIFORNIENSIS, 154.

154. MEDIALUNA CALIFORNIENSIS. (Medialuna.)

Scorpis californiensis Steind., Ichth. Beitr., III, 19, 1875 (San Diego); Jordan & Gilbert, Syn. Fish. N. A., 1883, 562, and elsewhere.
Cæsiosoma californiense Jordan, Cat. Fish. N. A., 1885, 92.

Habitat: Coast of southern California, from Point Concepcion southward.

Etymology: From California.

This handsome fish is abundant on the rocky coasts of southern California. It reaches a length of about a foot, and is a food-fish of good quality.

XLV. CÆSIOSOMA.

Cæsiosoma (Kaup) Bleeker, Systema Percarum Revisum, II, 11, 1875 (*æquipinnis*).

Type: *Scorpis æquipinnis* Richardson.

Etymology: *Cæsio*, an allied genus; *σῶμα*, body.

This genus is based on an Australian species which differs from the type of *Scorpis* (*Scorpis georgianus*) in having the soft dorsal and anal low and not falcate. The generic value of this character is at least open to question. In the form of the soft dorsal, *Cæsiosoma* resembles *Medialuna*, but in the latter genus the soft dorsal and anal are proportionately much shorter and the dorsal spines are not graduate. We refer to *Cæsiosoma* a South American species we have not seen, but which seems to have the same generic characters. In all these species the incisors have been described as cylindrical or conic, but they will probably be found to have a flattened form, as in *Medialuna*, and to be really lanceolate.

ANALYSIS OF AMERICAN SPECIES OF CÆSIOSOMA.

a. [Body deep, the outlines strongly arched; mouth very oblique, the maxillary reaching front of eye; snout shorter than eye; both margins of preopercle finely toothed; nostrils round, close together; preorbital finely toothed; head completely scaled, except the snout, lips, and part of each jaw; dorsal spines growing steadily longer to the last, which is about half head; second soft ray of dorsal highest; third anal spine slightly longer than eye; pectoral, 1¼ in head; ventral 2½; caudal deeply notched, its lobes slender; soft rays of vertical fins closely scaled. Color, dusky violet above, silvery gray below; fins yellowish; body sometimes irregularly mottled with darker. Head 4 in length; depth 2½; eye 3½ in head. D. x, 27; A. III, 25. Scales, 70.] (*Steindachner*)..CHILENSE, 155.

155. CÆSIOSOMA CHILENSE.

Scorpis chilensis Gay, "Hist. Chil. Zoology, II, 220; Ictiol., lam. 6, f. 1." (Juan Fernandez); Günther, II, 64 (copied); Steindachner, Ichth. Beiträge, II, 14, 1875 (Juan Fernandez).

Habitat: Islands of Chile.

Etymology: From Chile.

This species is known to us only from the scanty account copied by Günther from Gay and from the detailed description given by Steindachner. According to Steindachner, the species reaches a length of a foot, and is very common on the coasts of Juan Fernandez.

Subfamily XII.—APLODACTYLINÆ.

XLVI. APLODACTYLUS.

Aplodactylus Cuv. & Val., VIII, 476, 1831 (*punctatus*).
Haplodactylus Günther, I, 434, 1859 (corrected orthography, same type).

Type: *Aplodactylus punctatus* Cuv. & Val.

Etymology: ἁπλόος, simple; δάκτυλος, finger, from the unbranched pectoral rays.

This genus contains some half dozen herbivorous fishes of the South Pacific. The three species accredited to the coast of Chile are scantily described, and none of them have been examined by us.

ANALYSIS OF AMERICAN SPECIES OF APLODACTYLUS.

a. [Body and fins everywhere finely spotted with black, the ground color brownish-red; body moderately elongate; the head bluntish, formed as in *Girella*; scales very small; caudal lunate; soft dorsal higher than spinous; anal fin short and high; incisors tricuspid; simple pectoral rays 6; D. XVI–21; A. III, 8; cœca 2.] (*Günther; Cuv. & Val.*)....PUNCTATUS, 156.

aa. Body not everywhere spotted with black.

b. Color brownish gray, vermiculated with brown; fins brown-spotted; incisors tricuspid. D. XV–I, 20; A. III, 8. (*Gay* fide *Günther.*) VERMICULATUS, 157.

bb. Color yellowish, dotted all over with white. D. XV–I, 20; A. III, 7. (*Gay* fide *Günther*)....GUTTATUS, 158.

156. APLODACTYLUS PUNCTATUS.

Aplodactylus punctatus Cuv. & Val., VIII, 477, pl. 242, 1831; Jenyns, Zoöl. Beagle, 15, 1842; Gay, Hist. Chile, II, 156.
Haplodactylus punctatus Günther, I, 434.
Aplodactylus reginæ (Valenciennes) Gay, l. c., "II, 158, lam. I, f. 2."

Habitat: Coast of Chile.

Etymology: *Punctatus*, speckled.

This species is known to us from descriptions.

157. APLODACTYLUS VERMICULATUS.

Aplodactylus vermiculatus Gay, l. c., II, 159, lam. I, f. 1 (Valparaiso).

Habitat: Coast of Chile.

Etymology: *Vermiculatus*, with markings like worm tracks.

A doubtful species, known only from Gay's description.

158. APLODACTYLUS GUTTATUS.

Aplodactylus guttatus Gay, l. c., 160 (Chile).

Habitat: Coast of Chile.

Etymology: *Guttatus*, with spots like raindrops.

A scarcely known species, apparently to be recognized by its coloration.

RECAPITULATION.

The following is a list of the species of sparoid fishes recognized by us as occurring in the waters of America and Europe. Species not seen by the authors are marked with an asterisk. The general distribution of each species is indicated by the use of the following letters:

E, Europe.
I, Islands of eastern Atlantic; Azores, etc.
N, Atlantic coast of United States, Cape Cod to Cape Hatteras.
S, South Atlantic and Gulf coast.
K, Florida Keys.
W, West Indies.
C, Southern California (Point Concepcion to Cerros Island).
P, Pacific coast of tropical America.
G, Galapagos Islands.
V, Pacific coast of South America.
B, Brazil.

Family SPARIDÆ.

Subfamily I. HOPLOPAGRINÆ.

Genus I. **Hoplopagrus** Gill.

1. *Hoplopagrus güntheri* Gill. P.

Subfamily II. LUTJANINÆ.

Genus II. **Lutjanus** Bloch.

§ Evoplites Gill.

2. *Lutjanus viridis* (Valenciennes). G, P.

§ Genyoroge Cantor.

3. *Lutjanus caninus** (Steindachner). B. Doubtful species.

§ Dipterodon Lacépède.

4. *Lutjanus novemfasciatus* Gill. P.
5. *Lutjanus cyanopterus* (Cuvier & Valenciennes). W, B.
6. *Lutjanus griseus* (L.). S, K, W, B.
7. *Lutjanus jocú* (Bloch & Schneider). K, W, B.
8. *Lutjanus caxís* (Bloch & Schneider). K, W, B. Perhaps to be called *Lutjanus apoda.*
9. *Lutjanus argentiventris* (Peters). P.
10. *Lutjanus lutjanoides** (Poey). W. Probably a hybrid; *chrysurus-jocú.*
11. *Lutjanus buccanella* (Cuvier & Valenciennes). W.
12. *Lutjanus vivanus* (Cuvier & Valenciennes). W.
13. *Lutjanus aya* (Bloch). S, K, W, B.
14. *Lutjanus analis* (Cuvier & Valenciennes). K, W, B.
15. *Lutjanus colorado* Jordan & Gilbert. P.
16. *Lutjanus brachypterus* Cope. W. Probably a hybrid; *synagris-griseus.*
17. *Lutjanus guttatus* (Steindachner). P.
18. *Lutjanus synagris* (L.). W, K, B.
19. *Lutjanus ambiguus* Poey. W. Certainly a hybrid, *chrysurus-synagris.*
20. *Lutjanus mahogoni* (Cuvier & Valenciennes). W.

§ Rabirubia Jordan & Fesler. New subgenus based on *L. inermis.*

21. *Lutjanus inermis* (Peters). P.

§ Raizero Jordan & Fesler. New subgenus based on *L. aratus.*

22. *Lutjanus aratus* (Günther). P.

Genus III. **Ocyurus** Gill.

23. *Ocyurus chrysurus* (Bloch). S, W, K, B.

Genus IV. **Rhomboplites** Gill.

24. *Rhomboplites aurorubens* (Cuvier & Valenciennes). S, K, W, B.

Genus V. **Apsilus** Cuvier & Valenciennes.

25. *Apsilus dentatus* Guichenot. W.

Subfamily II. **LUTJANINÆ**—Continued.

Genus VI. **Aprion** Cuvier & Valenciennes.

26. *Aprion macrophthalmus* (Müller & Troschel). W.

Genus VII. **Etelis** Cuvier & Valenciennes.

27. *Etelis oculatus* (Cuvier & Valenciennes). W.

Genus VIII. **Verilus** Poey.

28. *Verilus sordidus* Poey. W.

Subfamily III. **XENICHTHYINÆ.**

Genus IX. **Xenocys** Jordan & Bollmann.

29. *Xenocys jessiæ* Jordan & Bollman. G.

Genus X. **Xenistius** Jordan & Gilbert.

30. *Xenistius californiensis* (Steindachner). C.

Genus XI. **Xenichthys** Gill.

31. *Xenichthys agassizii* (Steindachner). G.
32. *Xenichthys xanti* Gill. P.

Subfamily IV. **HÆMULINÆ.**

Genus XII. **Hæmulon** Cuvier.

§ Hæmulon.

33. *Hæmulon sexfasciatum* Gill. P.
34. *Hæmulon album* Cuvier & Valenciennes. W, K, B.
35. *Hæmulon macrostoma* Günther. W, K.
36. *Hæmulon bonariense* Cuvier & Valenciennes. W, B.
37. *Hæmulon parra* (Desmarest). W, K, B.
38. *Hæmulon scudderi* Gill. P.
39. *Hæmulon carbonarium* Poey. W, B.
40. *Hæmulon schranki* Agassiz. W, B, P.
41. *Hæmulon melanurum* (L.). W.
42. *Hæmulon sciurus* (Shaw). K, W, B.
43. *Hæmulon plumieri* (Lacépède). S, K, W, B.
44. *Hæmulon flavolineatum* Cuvier & Valenciennes. K, W, B.

§ Brachygenys Scudder.

45. *Hæmulon chrysargyreum* Günther. K, W, B.

§ Bathystoma Scudder.

46. *Hæmulon rimator* Jordan & Swain. S, K, W.
47. *Hæmulon aurolineatum* Cuvier & Valenciennes. K, W, B.
48. *Hæmulon striatum* (L.). W, B.

§ Lythrulon Jordan & Swain.

49. *Hæmulon flaviguttatum* Gill. P.

§ Orthostæchus Gill.

50. *Hæmulon maculicauda* (Gill). P.

Genus XIII. **Anisotremus** Gill.

51. *Anisotremus pacifici* (Günther). P.
52. *Anisotremus cæsius* Jordan & Gilbert. P.
53. *Anisotremus dovii* (Günther). P.
54. *Anisotremus surinamensis* (Bloch). W, B, P.
55. *Anisotremus bicolor* (Castelnau). B, W.
56. *Anisotremus scapularis* (Tschudi). V.
57. *Anisotremus davidsoni* (Steindachner). C.
58. *Anisotremus tæniatus* Gill. P.
59. *Anisotremus virginicus* (L.). K, W, B.
60. *Anisotremus catharinæ* * (Cuvier & Valenciennes). B. Doubtful species; probably identical with *A. virginicus*.
61. *Anisotremus serrula* * (Cuvier & Valenciennes). W. Doubtful species; perhaps identical with *Genyatremus luteus*.

Genus XIV. **Conodon** Cuvier & Valenciennes.

62. *Conodon nobilis* (L.). S, W, B.
63. *Conodon serrifer* Jordan & Gilbert. P.

Subfamily IV. HÆMULINÆ—Continued.

Genus XV. **Pomadasis** Lacépède.

§ POMADASIS.

64. *Pomadasis humilis* Kner & Steindachner. P.
65. *Pomadasis productus* * (Poey). W.
66. *Pomadasis macracanthus* (Günther). P.
67. *Pomadasis crocro* (Cuvier & Valenciennes). W, B.
68. *Pomadasis branicki* (Steindachner). P.
69. *Pomadasis ramosus* (Poey). W, B. Synonymy uncertain.

§ PSEUDOPRISTIPOMA Sauvage.

70. *Pomadasis panamensis* (Steindachner). P.

§ BRACHYDEUTERUS Gill.

71. *Pomadasis axillaris* (Steindachner). P.
72. *Pomadasis nitidus* (Steindachner). P.
73. *Pomadasis corvinæformis* (Steindachner). B.
74. *Pomadasis leuciscus* (Günther). P.
75. *Pomadasis elongatus* (Steindachner). P. Doubtful species; perhaps a form of the preceding.

Genus XVI. **Orthopristis** Girard.

§ ORTHOPRISTIS.

76. *Orthopristis bennetti* (Cuvier & Valenciennes). E, I.
77. *Orthopristis ruber* (Cuvier & Valenciennes). B.
78. *Orthopristis chalceus* (Günther). P, G.
79. *Orthopristis chrysopterus* (L.). S.
80. *Orthopristis poeyi* Scudder. W.
81. *Orthopristis cantharinus* (Jenyns). P, G, V.

§ ISACIELLA Jordan & Fesler. G.

82. *Orthopristis lethopristis* Jordan & Fesler. G.
83. *Orthopristis brevipinnis* (Steindachner). P.

§ MICROLEPIDOTUS Gill.

84. *Orthopristis inornatus* (Gill). P.

Genus XVII. **Isacia** Jordan & Fesler.

85. *Isacia conceptionis* (Cuvier & Valenciennes). V.

Genus XVIII. **Parapristipoma** Bleeker. Genus perhaps inseparable from *Plectorhynchus*.

86. *Parapristipoma mediterraneum* (Guichenot). E.
87. *Parapristipoma viridense* * (Cuvier & Valenciennes). E, I.

Genus XIX. **Genyatremus** Gill.

88. *Genyatremus luteus* (Bloch). W, B.

Subfamily V. DENTICINÆ.

Genus XX. **Dentex** Cuvier.

89. *Dentex macrophthalmus* (Bloch). E.
90. *Dentex dentex* (L.). E.
91. *Dentex maroccanus* Cuvier & Valenciennes. E.
92. *Dentex filosus* Valenciennes. I.

Genus XXI. **Nemipterus** Swainson. Doubtful genus; perhaps inseparable from *Dentex*.

93. *Nemipterus macronemus* Günther. B. Doubtful species; probably from the East Indies instead of South America.

Subfamily VI. SPARINÆ.

Genus XXII. **Stenotomus** Gill.

94. *Stenotomus aculeatus* Cuvier & Valenciennes. S.
95. *Stenotomus chrysops* (L.). N, S.
96. *Stenotomus caprinus* Bean. S.

Subfamily VI. SPARINÆ—Continued.

Genus XXIII. **Calamus** Swainson.

97. *Calamus calamus* (Cuvier & Valenciennes). K, W, B.
98. *Calamus proridens* Jordan & Gilbert. K, W.
99. *Calamus pennatula* * Guichenot. W.
100. *Calamus bajonado* (Bloch & Schneider). W, K.
101. *Calamus brachysomus* (Lockington). P.
102. *Calamus leucosteus* Jordan & Gilbert. S.
103. *Calamus macrops** Poey. W.
104. *Calamus taurinus* Jenyns. G.
105. *Calamus penna* Cuvier & Valenciennes. S, K, W, B.
106. *Calamus arctifrons* Goode & Bean. S, K.
107. *Calamus medius* Poey. W.

Genus XXIV. **Sparus** (Artedi) Linnæus.

§ SPARUS.

108. *Sparus aurata* Linnæus. E.
109. *Sparus cæruleostictus** (Cuvier & Valenciennes). E.

§ PAGRUS Cuvier.

110. *Sparus pagrus* Linnæus. E, S.
111. *Sparus ehrenbergi** Cuvier & Valenciennes. E.
112. *Sparus bertheloti** Valenciennes. E.

Genus XXV. **Pagellus** Cuvier & Valenciennes. Perhaps inseparable from *Sparus*.

113. *Pagellus erythrinus* (L.). E.
114. *Pagellus acarne* Cuvier & Valenciennes. E.
115. *Pagellus centrodontus* (De la Roche). E.
116. *Pagellus bogaraveo** (Brünnich). E.
117. *Pagellus mormyrus* (L.). E. Ascribed probably by error to the coast of Brazil.

Genus XXVI. **Lagodon** Holbrook.

118. *Lagodon rhomboides* (L.). N, S, W.

Genus XXVII. **Archosargus** Gill.

119. *Archosargus unimaculatus* (Bloch). K, W, P. Includes two forms or varieties: *unimaculatus* and *flavolineatus*.
120. *Archosargus pourtalèsii* (Steindachner). G. Perhaps a variety of *unimaculatus*.
121. *Archosargus tridens** (Poey). W. (Perhaps a variation of *unimaculatus*.)
122. *Archosargus probatocephalus* (Walbaum). N, S.
123. *Archosargus aries* (Cuvier & Valenciennes). W, B. Perhaps a southern variety of the preceding.

Genus XXVIII. **Diplodus** Rafinesque.

124. *Diplodus holbrooki* (Bean). S.
125. *Diplodus argenteus* (Cuvier & Valenciennes). S, W, B.
126. *Diplodus sargus** (L.). E, W.
127. *Diplodus vulgaris* (St. Hilaire). E, I.
128. *Diplodus annularis* (Gmelin). E, I.
129. *Diplodus fasciatus** (Cuvier & Valenciennes). E, I.

Genus XXIX. **Charax** Risso. Perhaps inseparable from *Diplodus*.

130. *Charax puntazzo** (Gmelin). E, I.

Subfamily VII. BORIDIINÆ.

Genus XXX. **Boridia** Cuvier & Valenciennes.

131. *Boridia grossidens** Cuvier & Valenciennes.

Subfamily VIII. MÆNINÆ.

Genus XXXI. **Mæna** Cuvier.

132. *Mæna mæna* (Gmelin). E.
133. *Mæna zebra** (Brünnich). E.

Genus XXXII. **Spicara** Rafinesque.

134. *Spicara smaris* (L.). E. Recorded, probably by error, from Martinique, as S. *martinica* (Cuvier & Valenciennes).
135. *Spicara alcedo* (Risso). E.

Genus XXXIII. **Centracanthus** Rafinesque.

136. *Centracanthus cirrus* Rafinesque. E.

Genus XXXIV. **Erythrichthys** Temminck & Schlegel.

137. *Erythrichthys vittatus* * (Poey). W.
138. *Erythrichthys cyanescens* * (Guichenot). V.

Subfamily IX. SCATHARINÆ.

Genus XXXV. **Box** Cuvier & Valenciennes. Perhaps indistinguishable from *Boops*.

139. *Box boops* (L.). E, I.

Genus XXXVI. **Boops** Cuvier.

140. *Boops salpa* (L.). E, I.

Genus XXXVII. **Oblada** Cuvier.

141. *Oblada melanura* (L.).

Genus XXXVIII. **Scatharus** Cuvier & Valenciennes.

142. *Scatharus græcus* Cuvier & Valenciennes. E.

Genus XXXIX. **Spondyliosoma** Cantor.

143. *Spondyliosoma cantharus* (Gmelin). E.
144. *Spondyliosoma orbiculare* (Cuvier & Valenciennes). E.

Subfamily X. GIRELLINÆ.

Genus XL. **Girella** Gray.

145. *Girella nigricans* (Ayres). C, P.

Genus XLI. **Doydixodon** Valenciennes. Genus perhaps not distinguishable from *Girella*.

146. *Doydixodon freminvillei* * Valenciennes. G.
147. *Doydixodon lævifrons** (Tschudi). V.

Subfamily XI. KYPHOSINÆ.

Genus XLII. **Hermosilla** Jenkins & Evermann.

148. *Hermosilla azurea* Jenkins & Evermann. P.

Genus XLIII. **Kyphosus** Lacépède.

§ KYPHOSUS.

149. *Kyphosus analogus* (Gill). P
150. *Kyphosus elegans* (Peters). P.
151. *Kyphosus sectatrix* (L.). S, W, K, B, E.
152. *Kyphosus lutescens* Jordan & Gilbert. P.

§ SECTATOR Jordan & Fesler.

153. *Kyphosus ocyurus* Jordan & Gilbert. P.

Genus XLIV. **Medialuna** Jordan & Fesler.

154. *Medialuna californiensis* (Steindachner). C.

Genus XLV. **Cæsiosoma** Kaup. Perhaps inseparable from *Scorpis*.

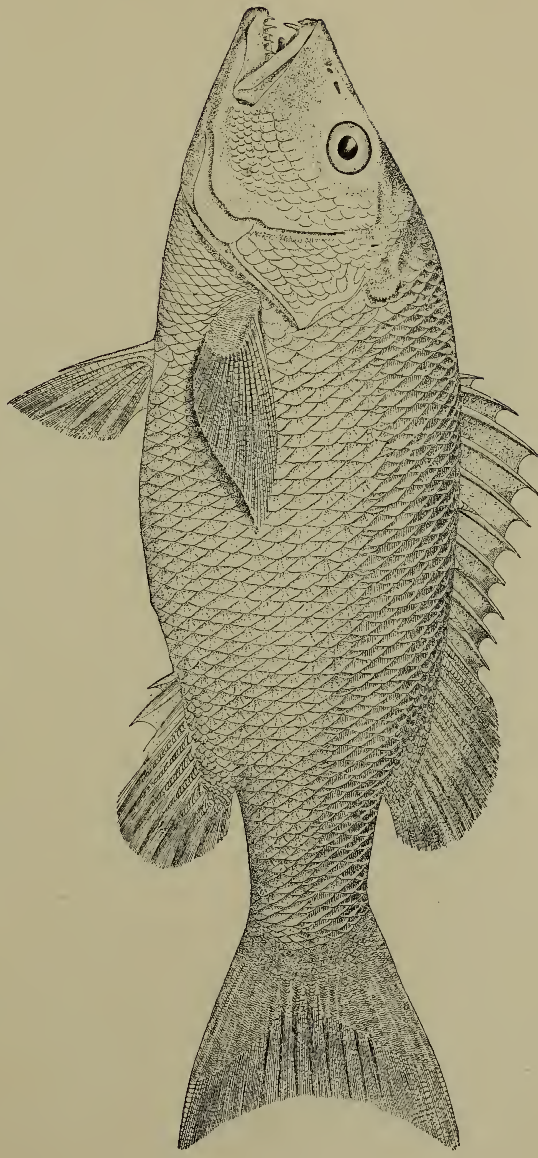
155. *Cæsiosoma chilense* * (Gay). V.

Subfamily XII. APLODACTYLINÆ.

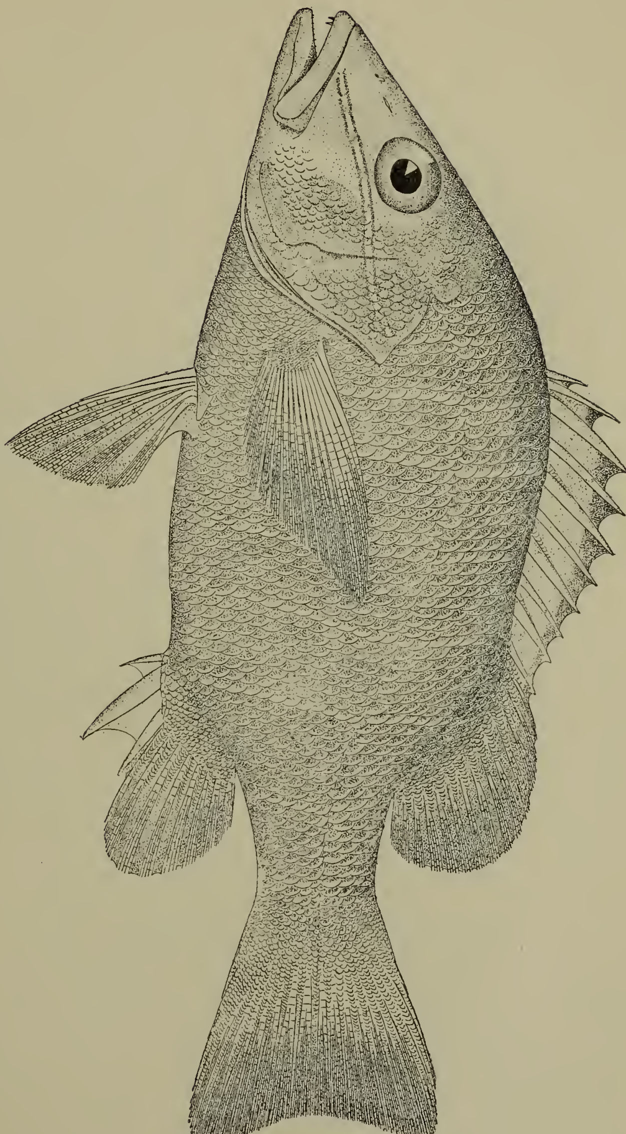
Genus XLVI. **Aplodactylus** Cuvier & Valenciennes.

156. *Aplodactylus punctatus* * Cuvier & Valenciennes. V.
157. *Aplodactylus vermiculatus* * Gay. V.
158. *Aplodactylus guttatus* * Gay. V.

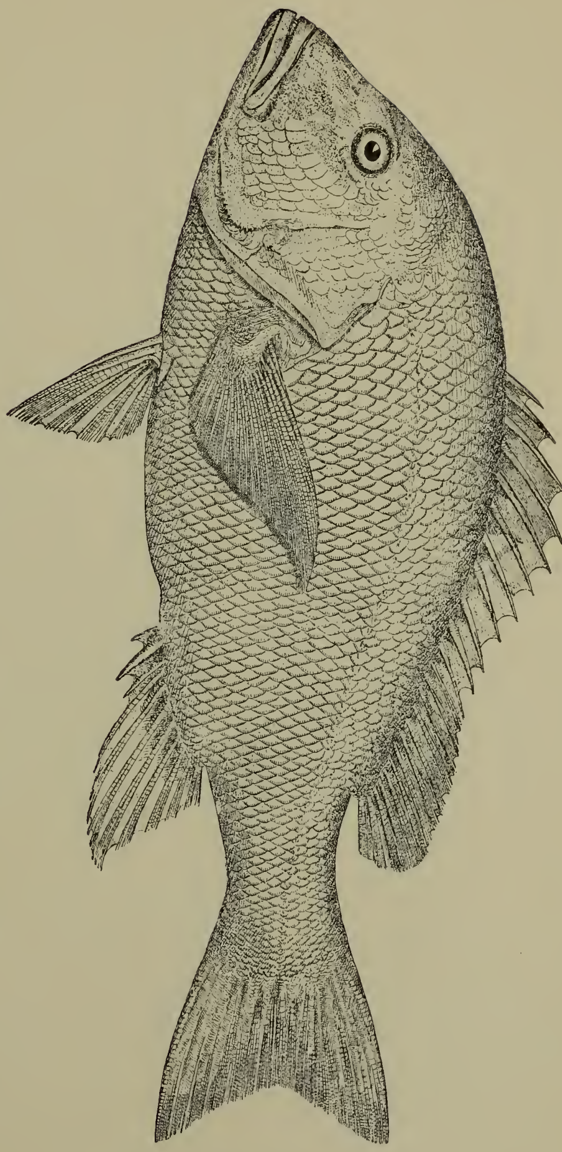
PALO ALTO, CAL., *March 20, 1892.*



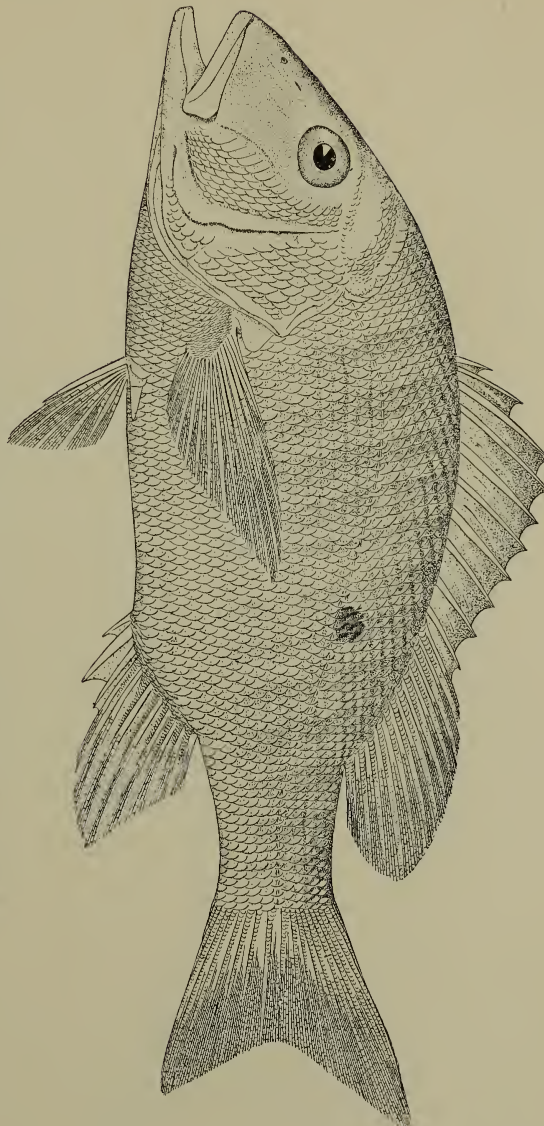
LUTJANUS GRISEUS (Linnæus). *The Gray Snapper or Mangrove Snapper.*



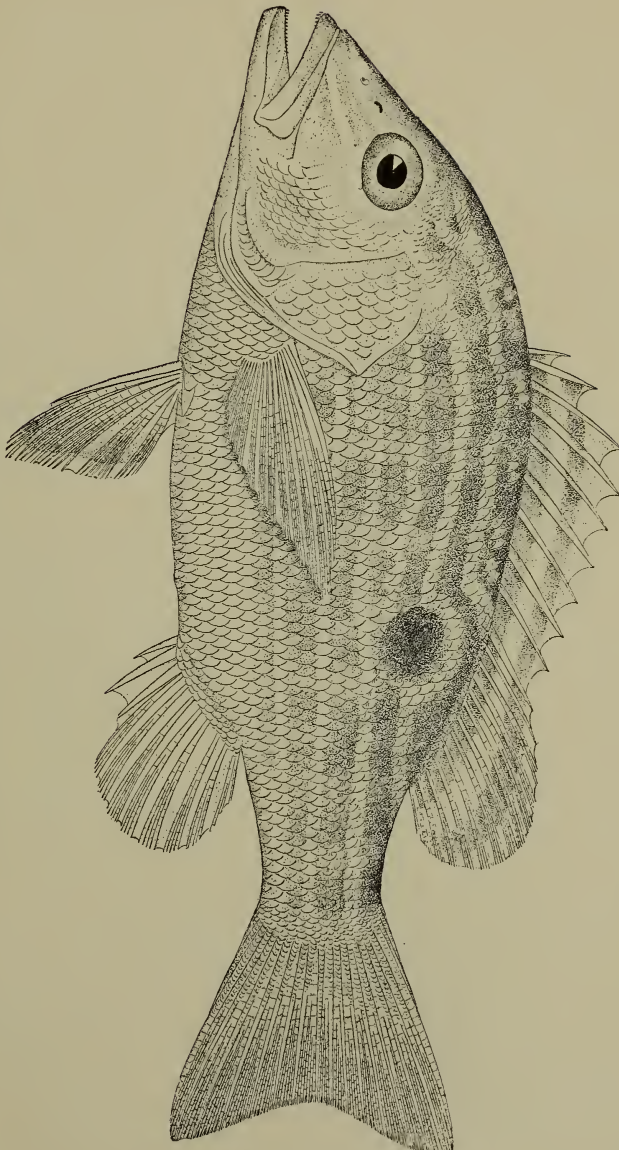
LUTJANUS CAXIS (Bloch and Schneider). *The Schoolmaster.*



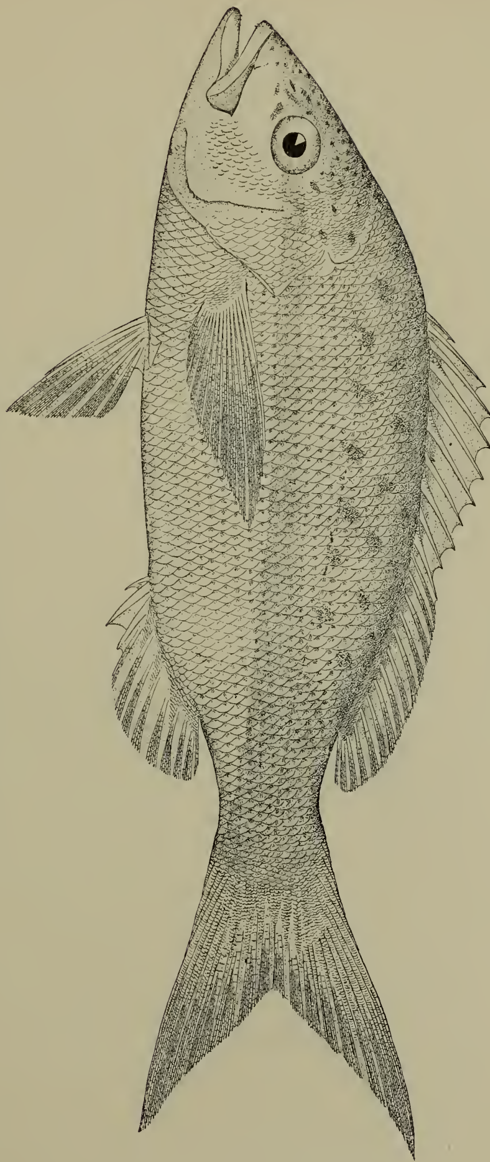
LUTJANUS AYA (Bloch). *Red Snapper.*



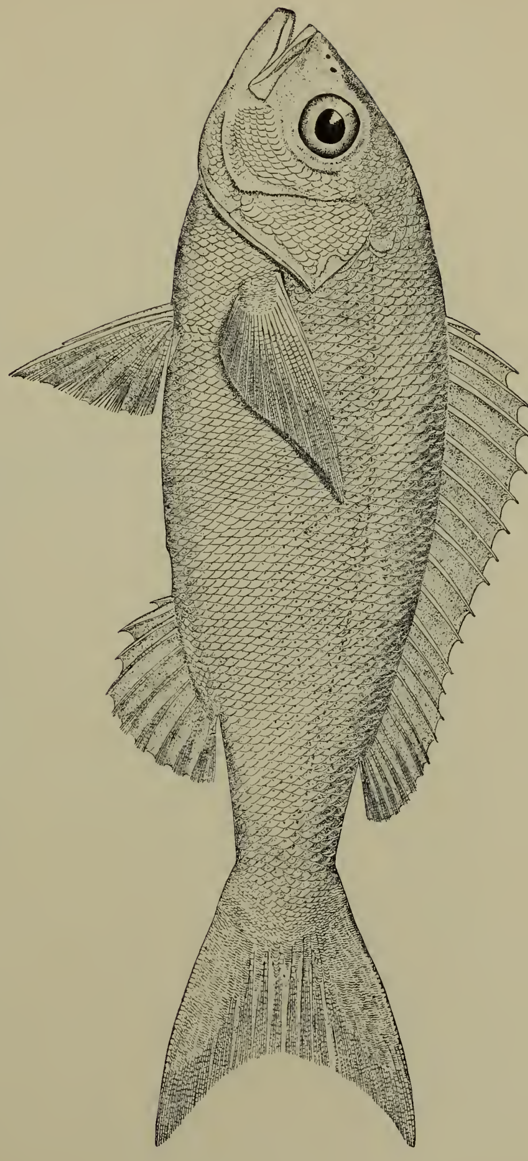
LUTJANUS ANALIS (Cuvier and Valenciennes). *The Mutton-fish or Pargo Criollo.*



LUTJANUS SYNAGRIS (Linnæus). *The Lane Snapper or Biajaiba.*

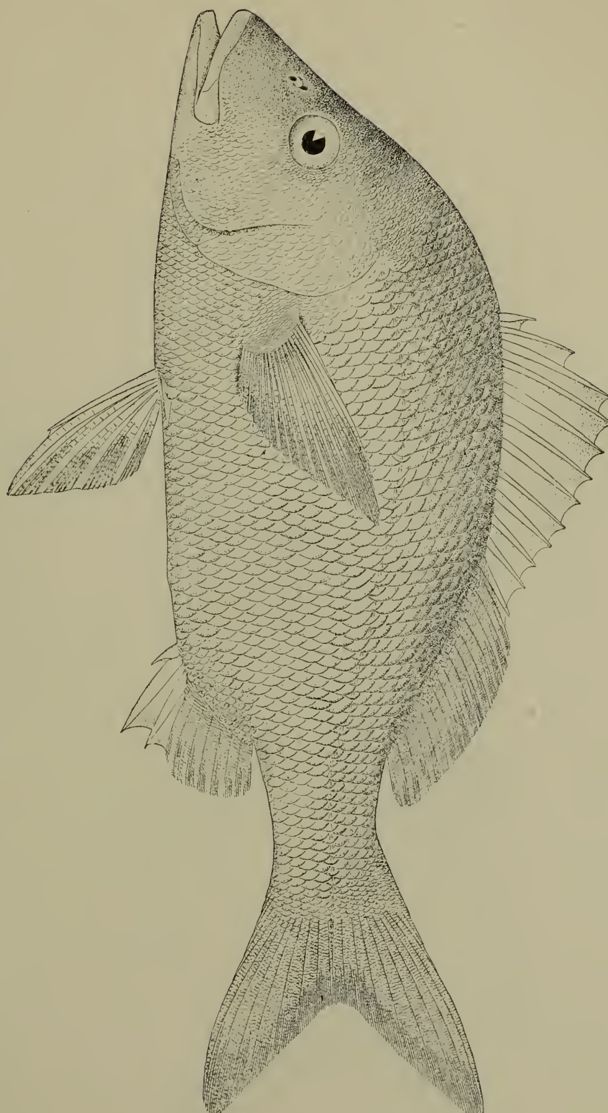


OCYURUS CHRYSURUS (Bloch). *The Yellow-tail Snapper or Rabirubia.*

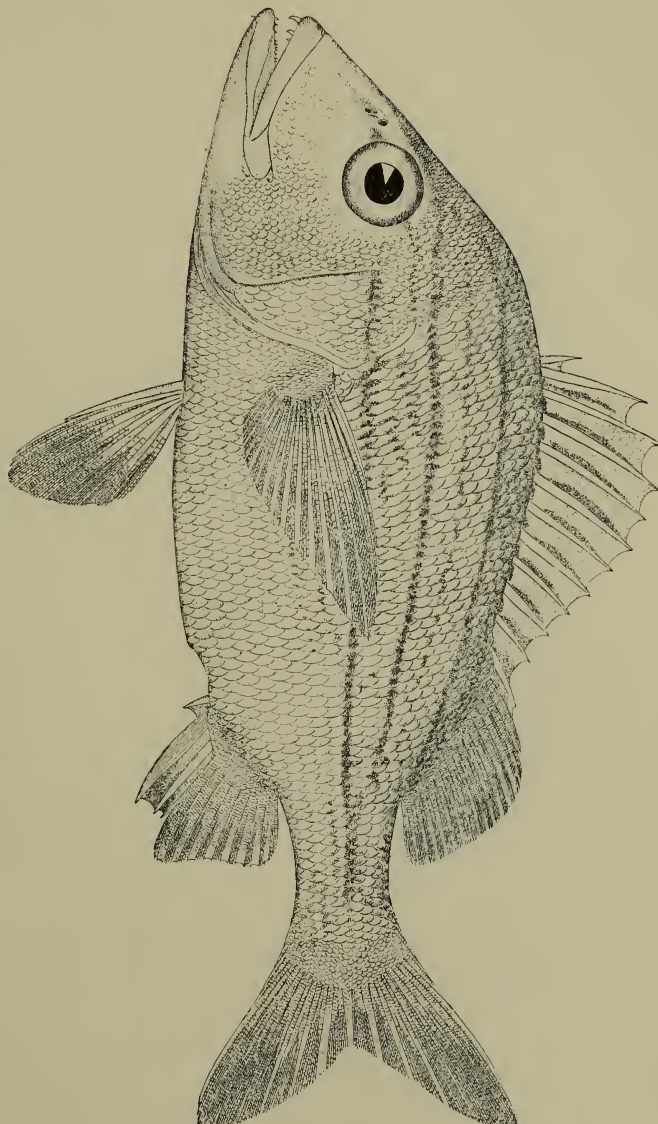


RHOMBOPLITES AURORUBENS (Cuvier and Valenciennes). *The Cagon.*

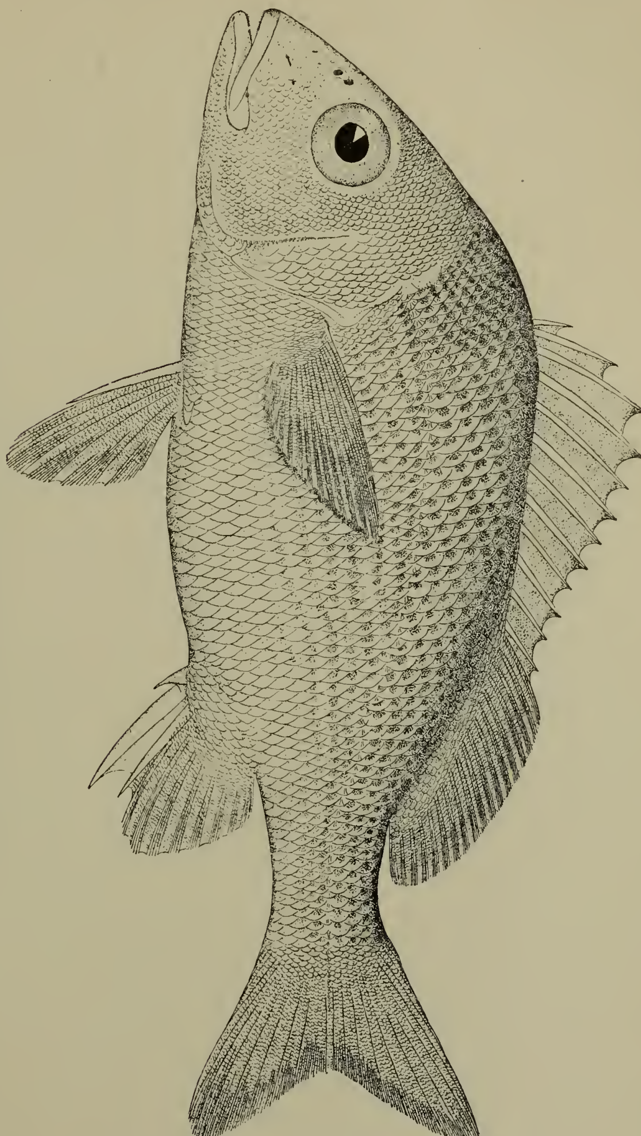
PLATE 35.



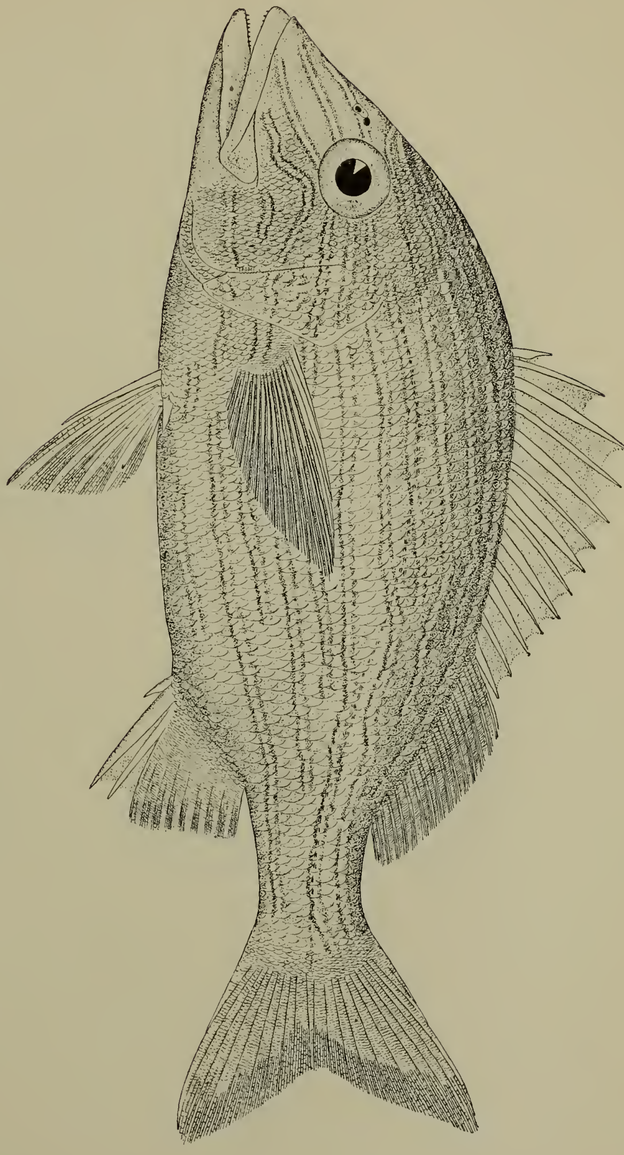
HÆMULON ALBUM Cuvier and Valenciennes. *The Margate-fish or Jallao.*



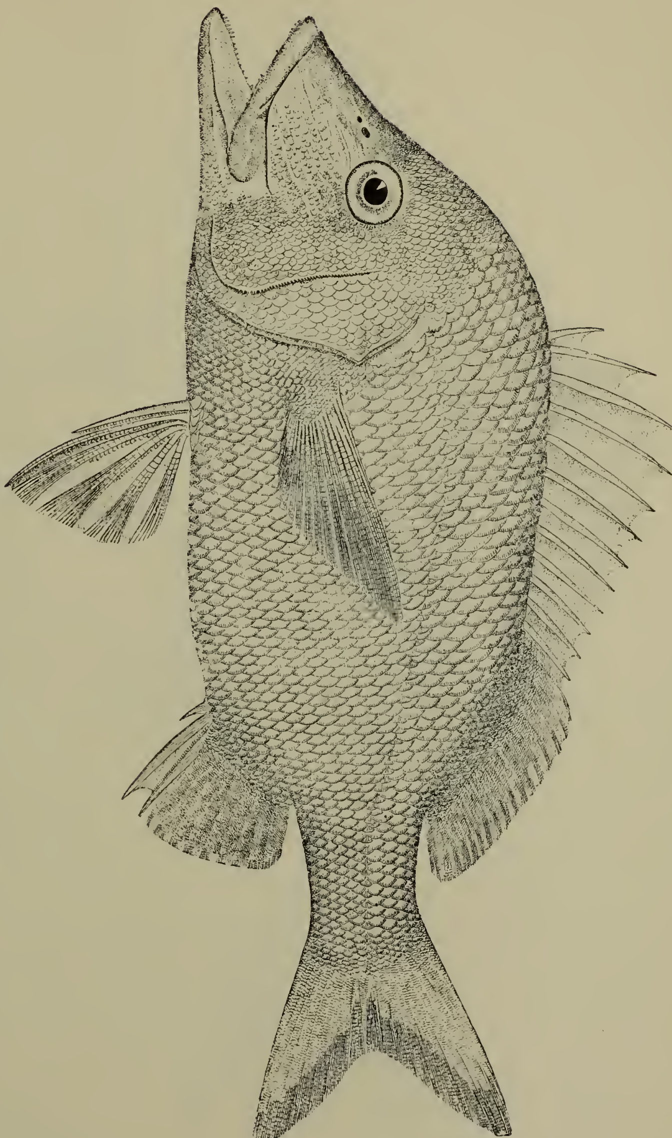
HÆMULON MACROSTOMA Günther. *The Striped Margate-fish.*



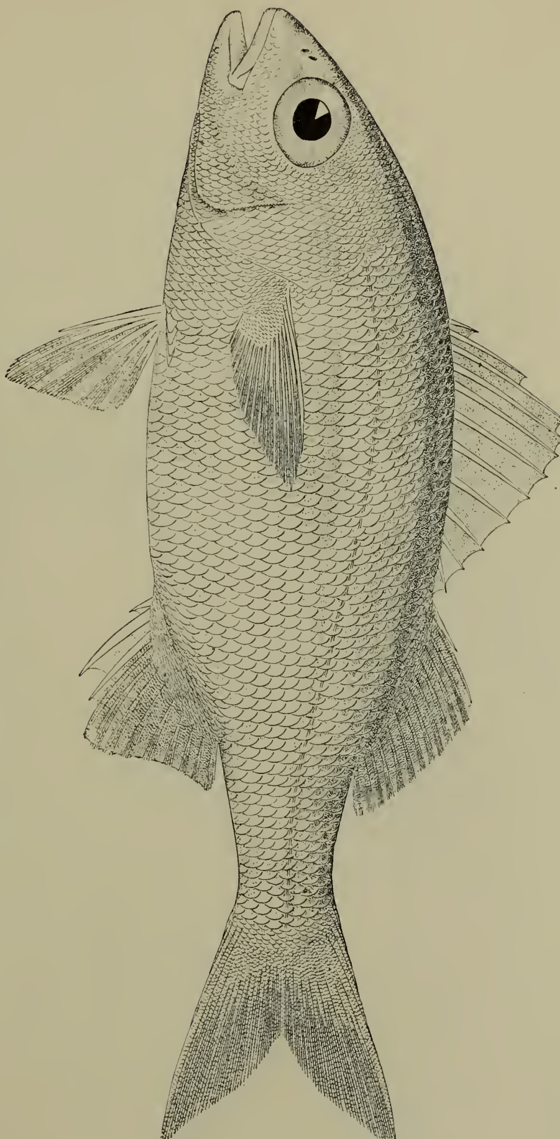
HÆMULON PARRA (Desmarest). *The Sailor's Choice or Ronco Blanco.*



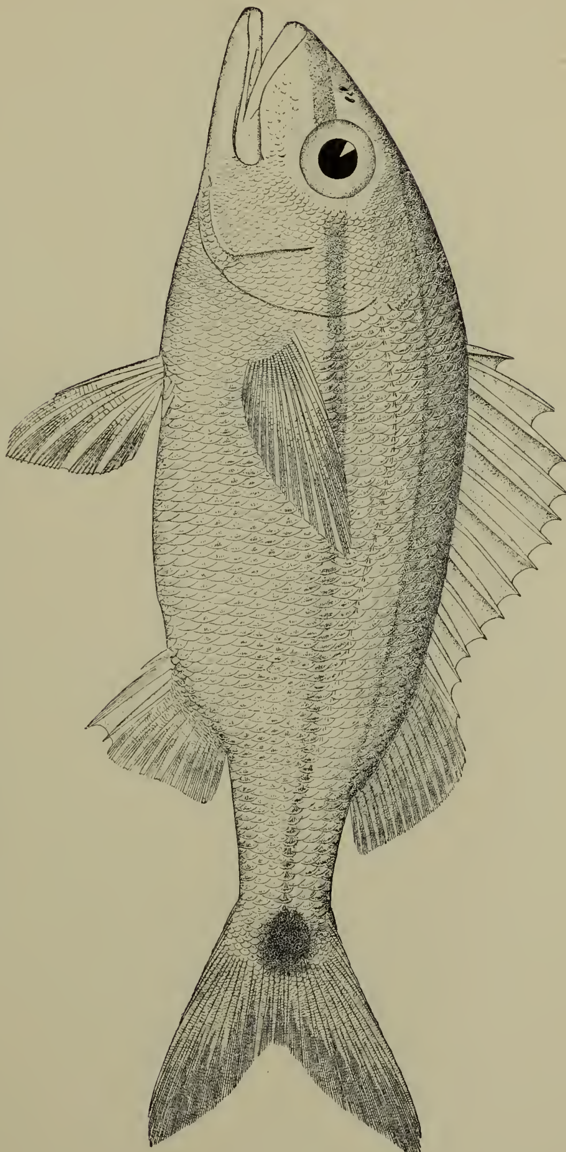
HÆMULON SCIURUS (Shaw). *The Yellow Grunt or Ronco Amarillo.*



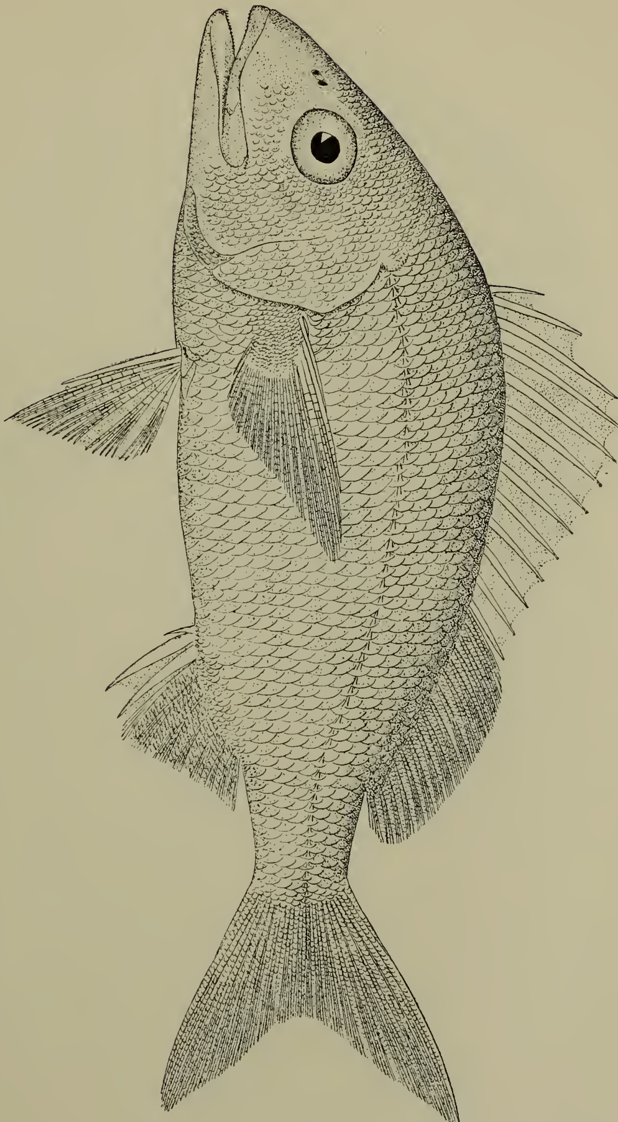
HÆMULON PLUMIERI (Lacépède). *The Common Grunt or Ronco Ronco.*



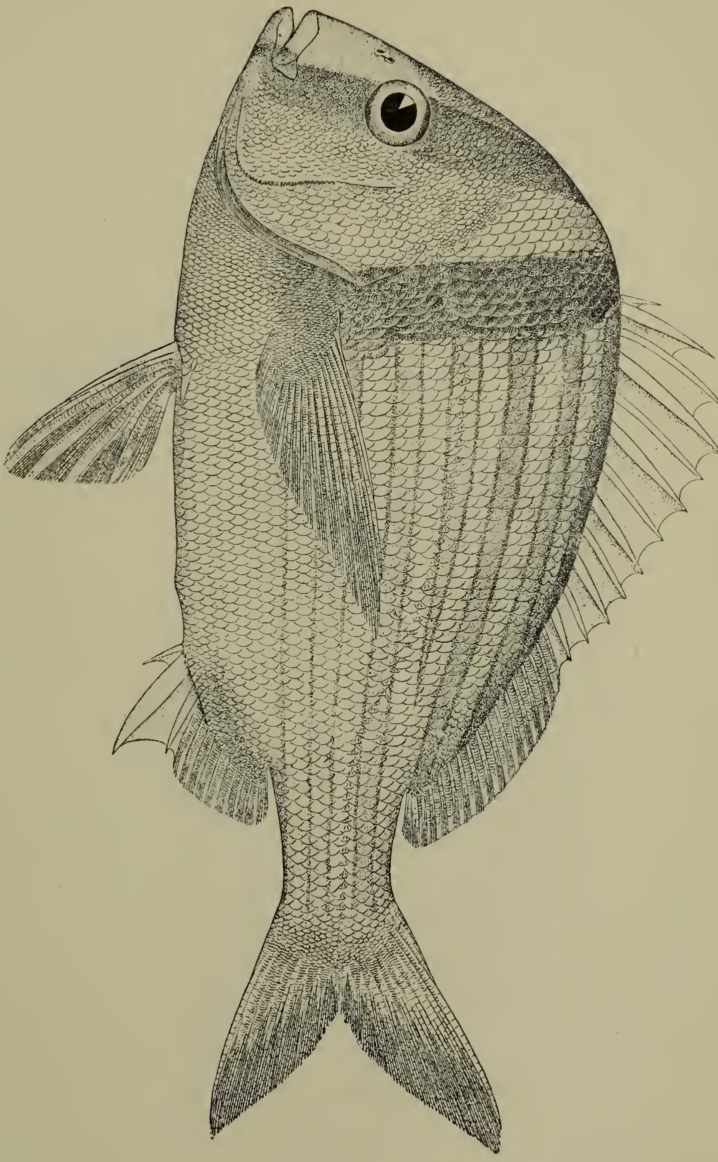
HÆMULON CHRYSARGYREUM Günther. *The Small-mouthed Grunt.*



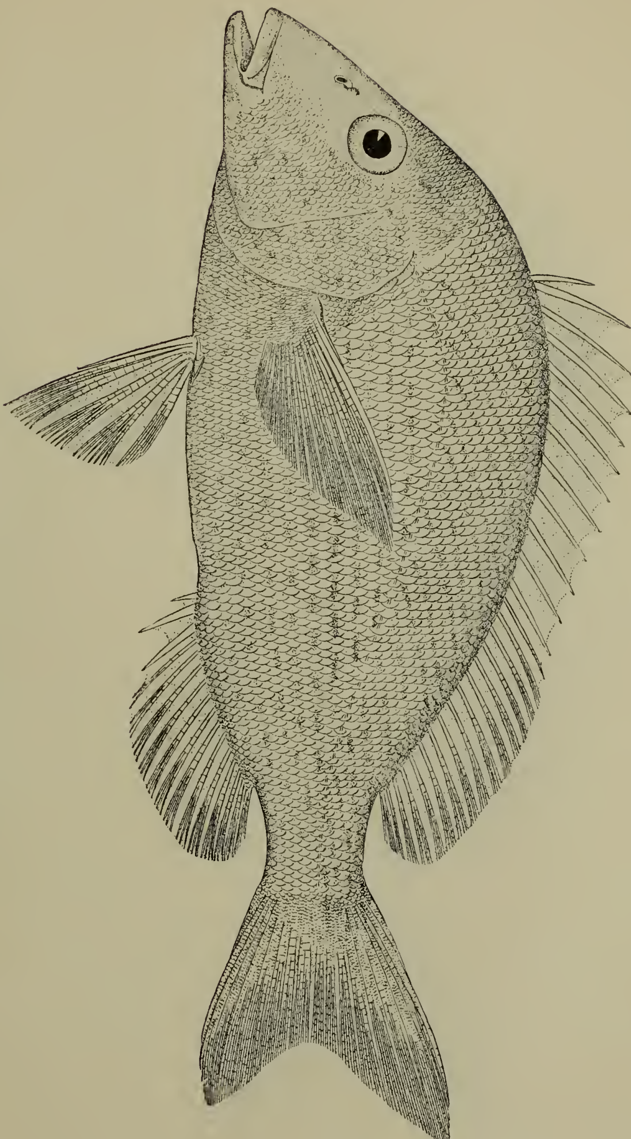
HÆMULON RIMATOR Jordan and Swain. Young. *The Tom-tate or Flannel-mouthed Grunt.*



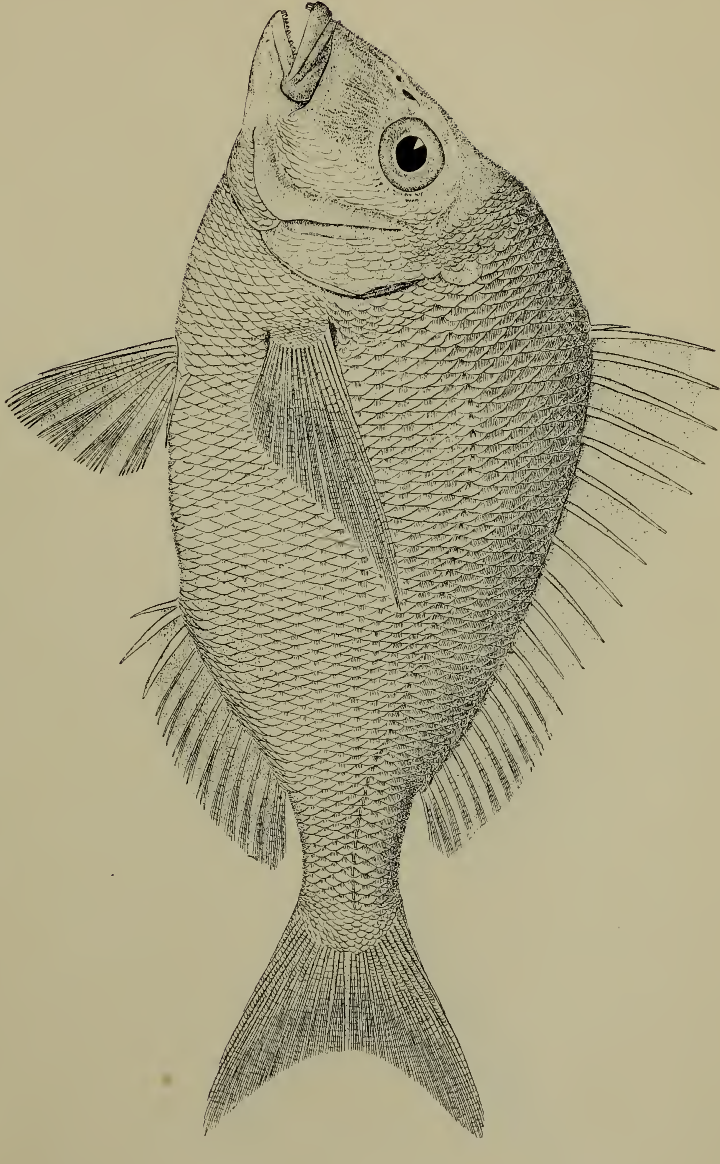
HÆMULON RIMATOR Jordan and Swain. Adult. *The Tom-tate or Flannel-mouthed Grunt.*



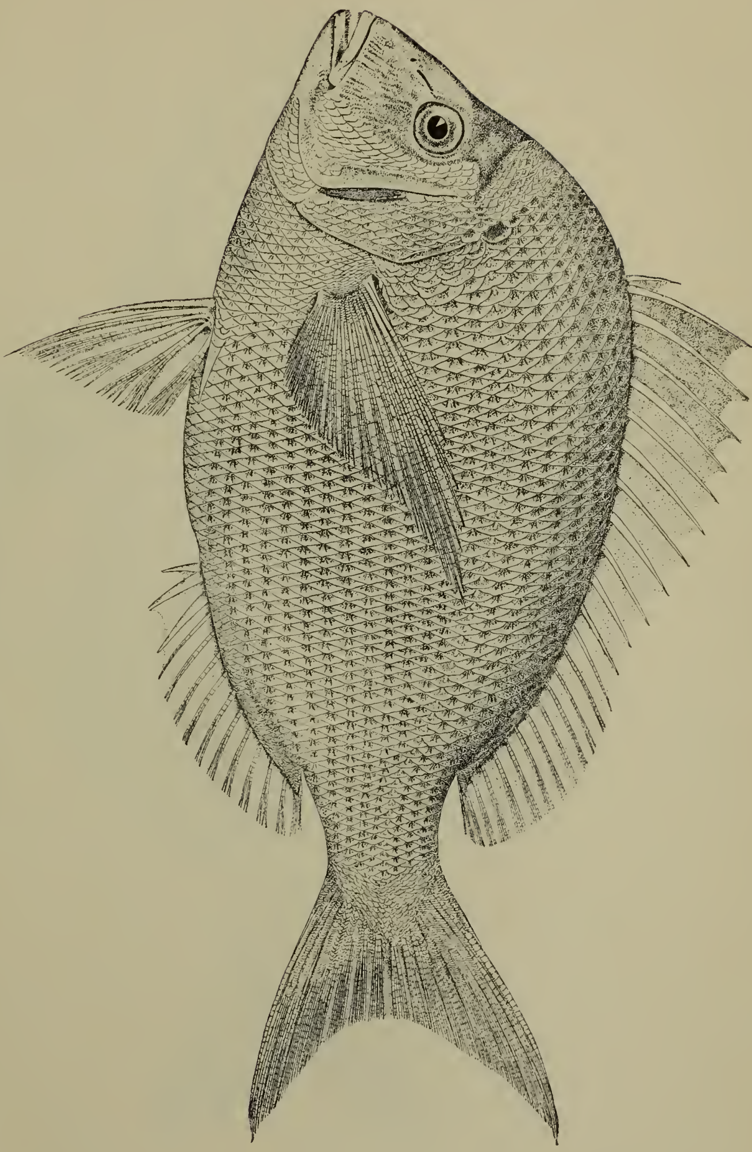
ANISOTREMUS VIRGINICUS (Linnæus). *The Pork-fish or Catalineta.*



ORTHOPRISTIS CHRYSOPTERUS (Linnæus). *The Pig-fish.*

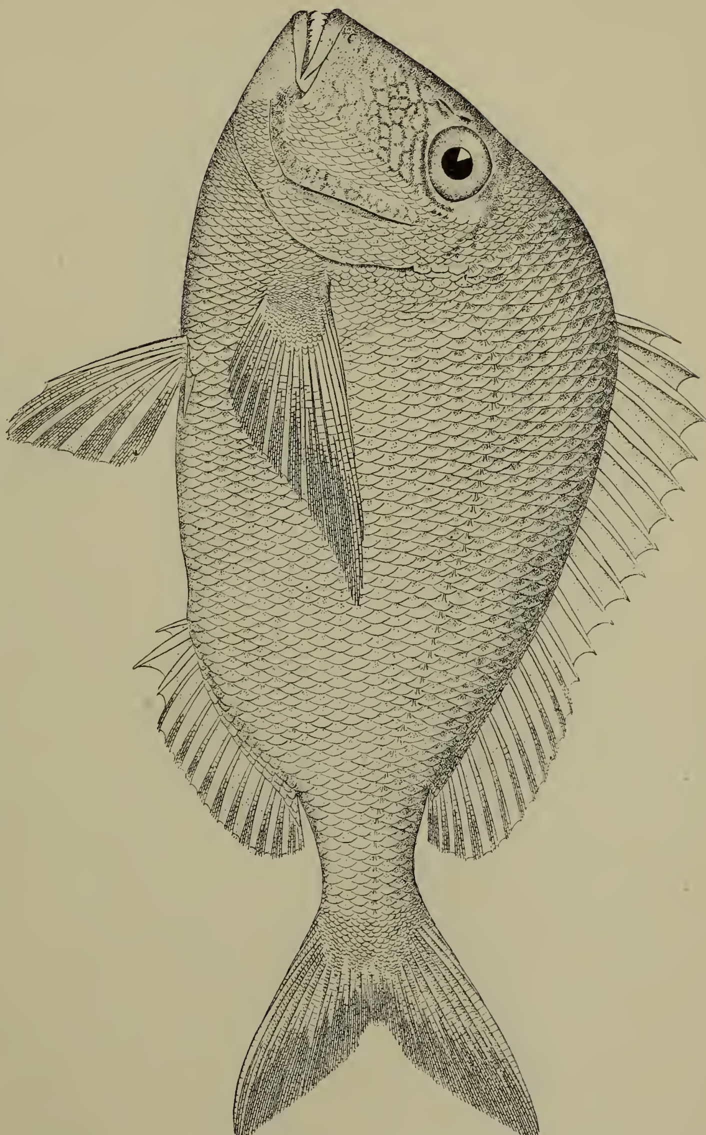


STENOTOMUS ACULEATUS (Cuvier and Valenciennes). *The Southern Porgy.*

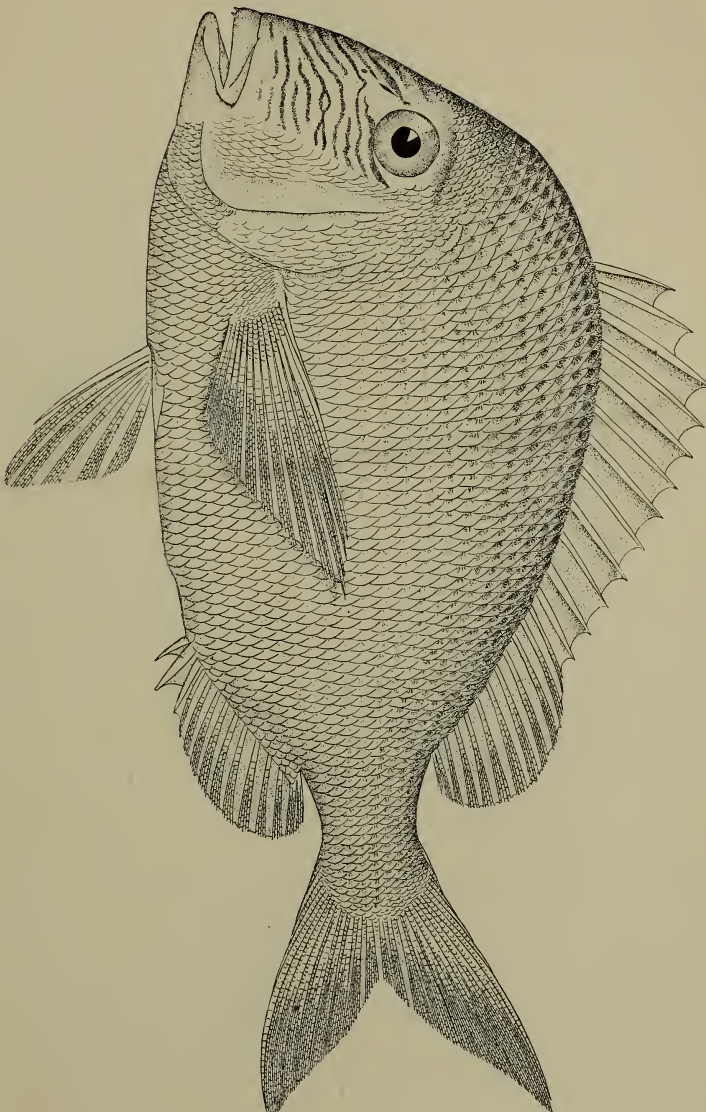


STENOTOMUS CHRYSOPS (Linnæus). *The Scup.*

STENOTOMUS CAPRINUS Bean. *The Goat-head Scup.*

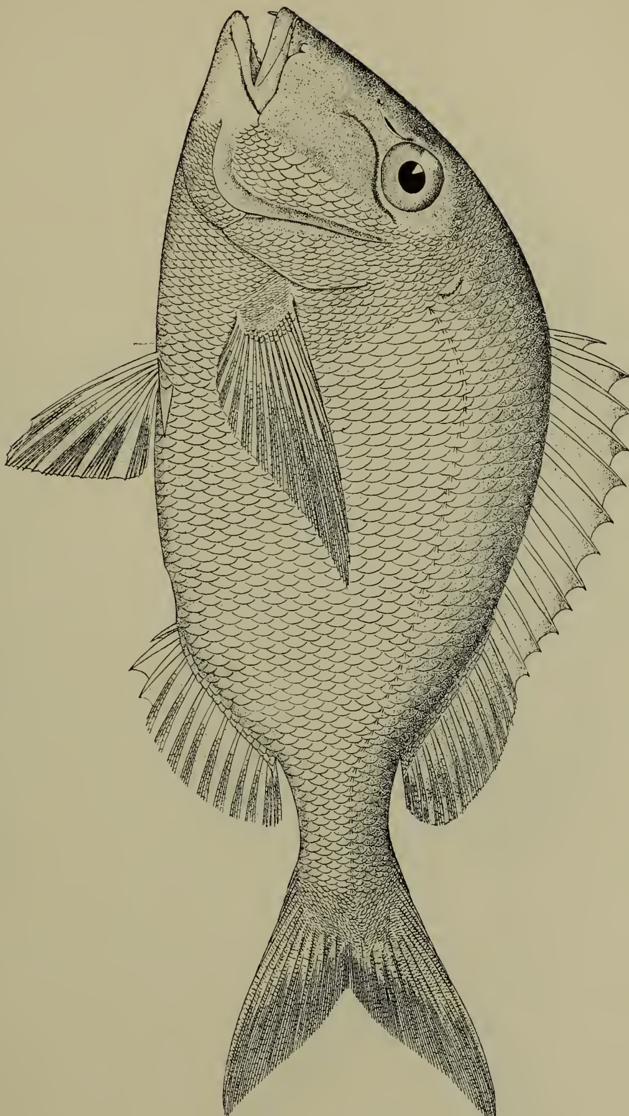


CALAMUS CALAMUS (Cuvier and Valenciennes). *The Saucer-eye Porgy.*

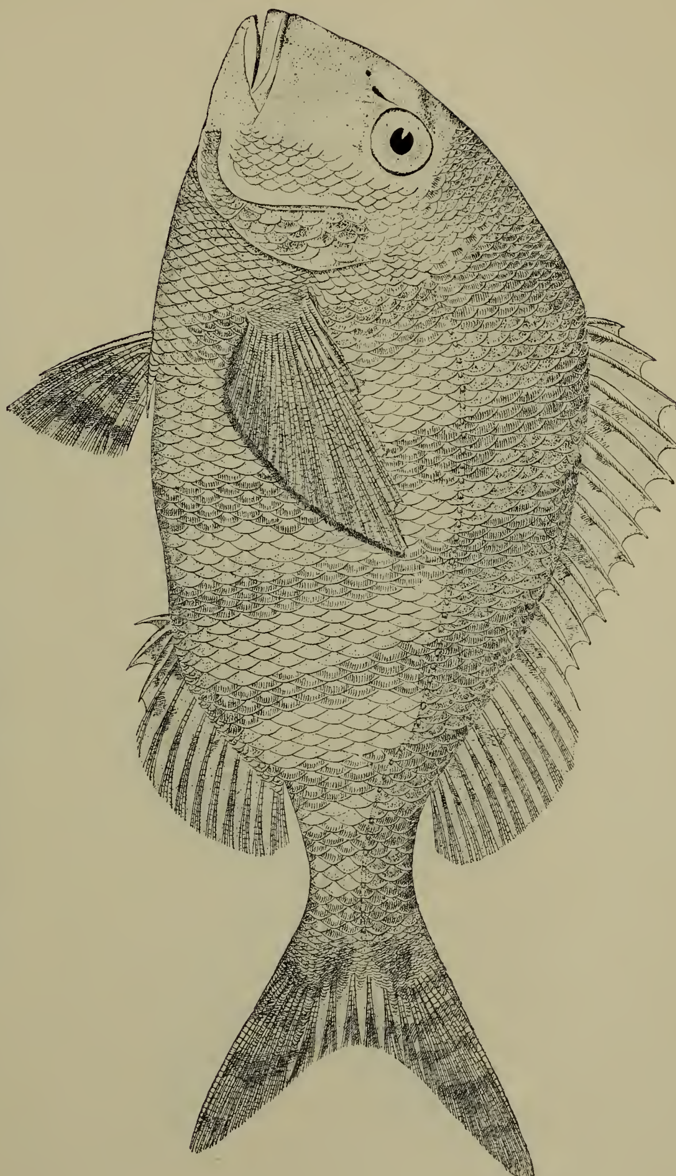


CALAMUS PRORIDENS Jordan and Gilbert. *The Little-head Porgy or Pez de Pluma.*

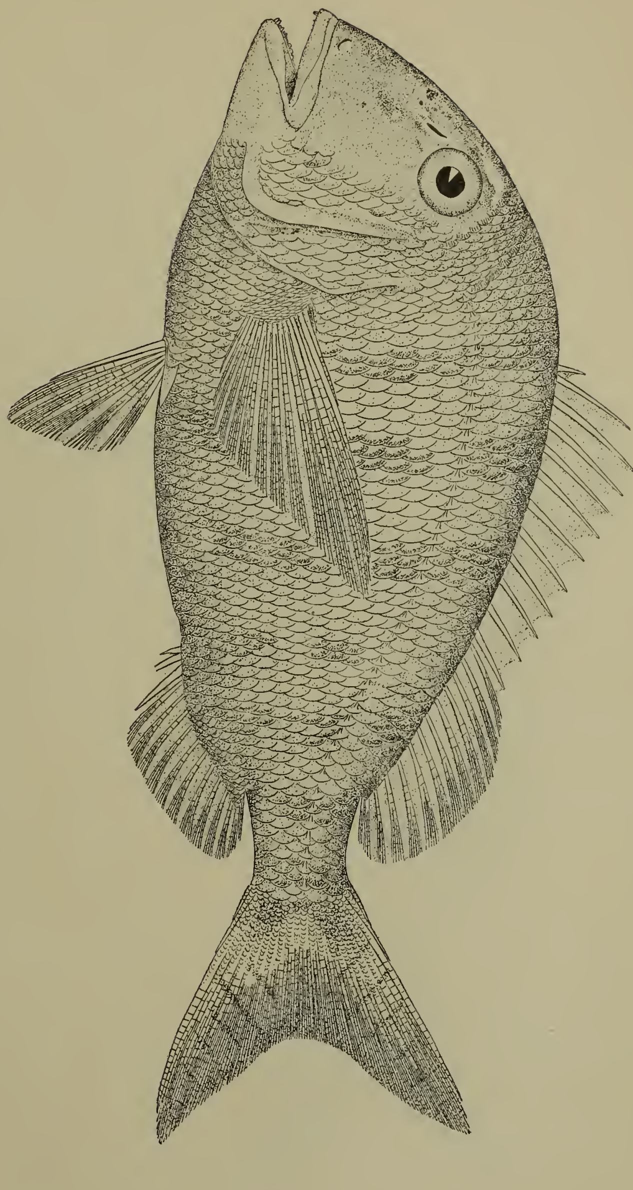
PLATE 50.



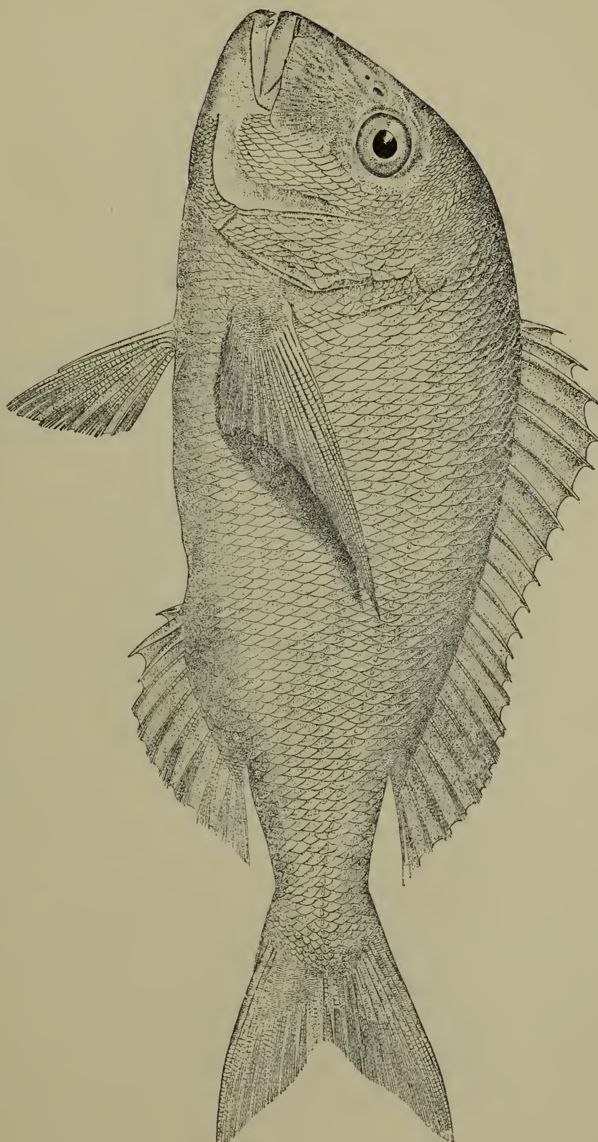
CALAMUS BAJONADO (Bloch and Schneider). *The Jolt head Porgy or Bajonado.*



CALAMUS PENNA Cuvier and Valenciennes. *The Little-mouth Porgy or Sheepshead Porgy.*

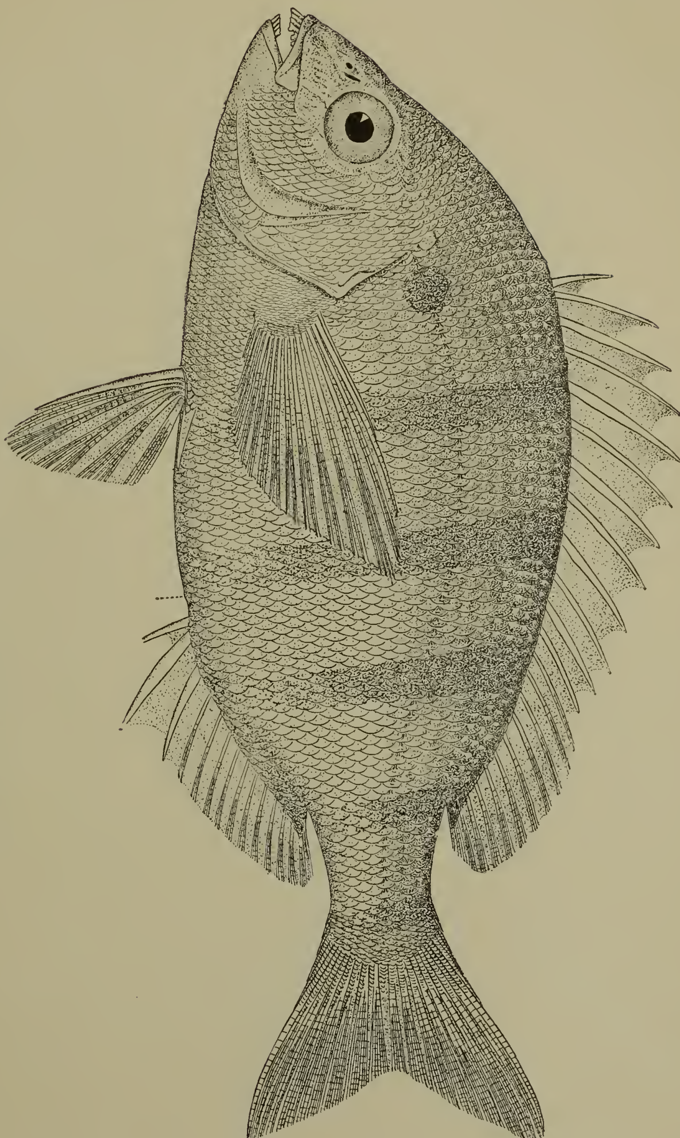


CALAMUS ARCTIFRONS Goode and Bean. *The Grass Porgy.*

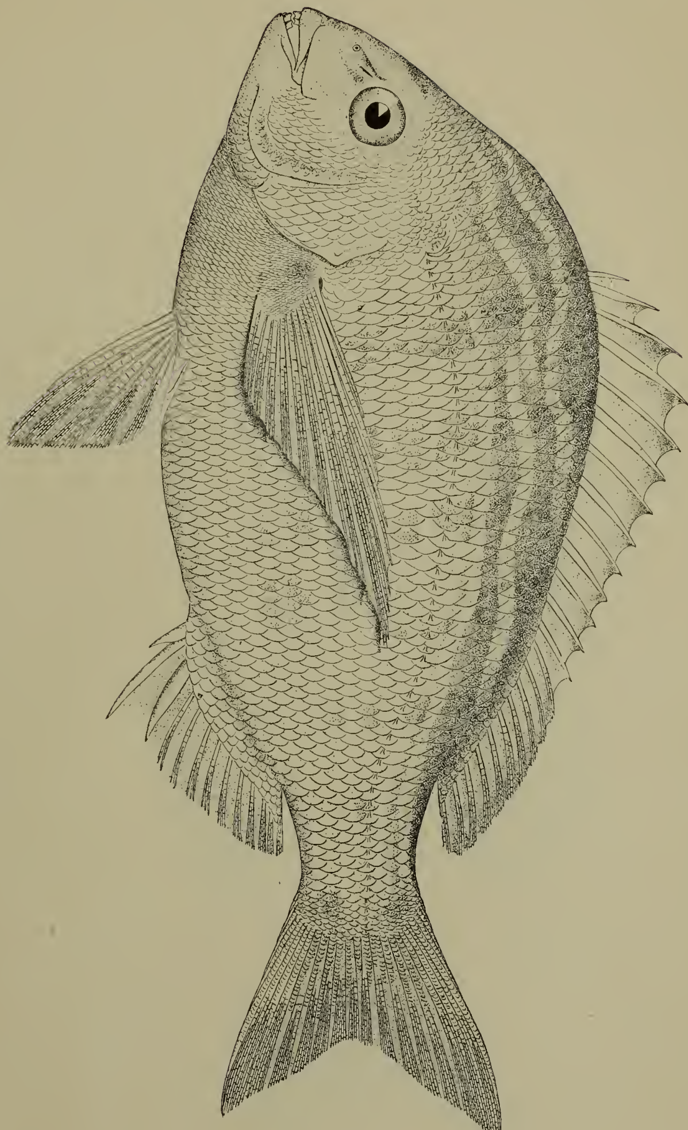


SPARUS PAGRUS Linnæus. *The Red Porgy (the true Porgy or Pargo of Europe.)*

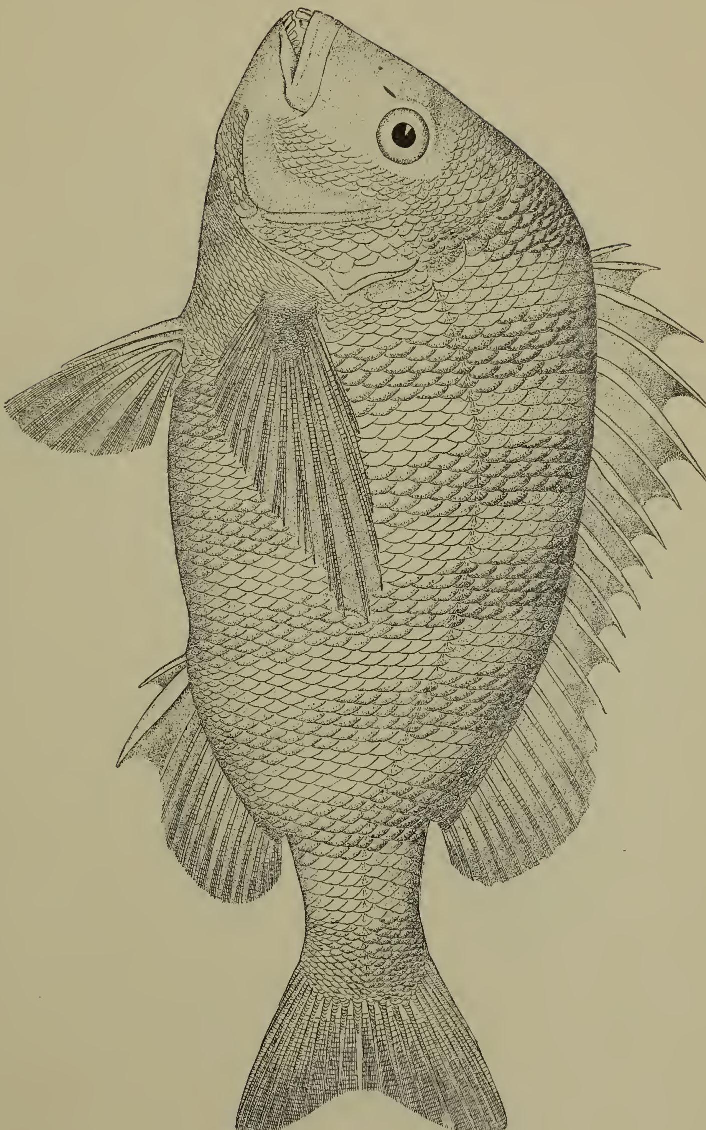
PLATE 54.



LAGODON RHOMBOIDES (Linnæus). *The Pin-fish or Chopa Spina.*

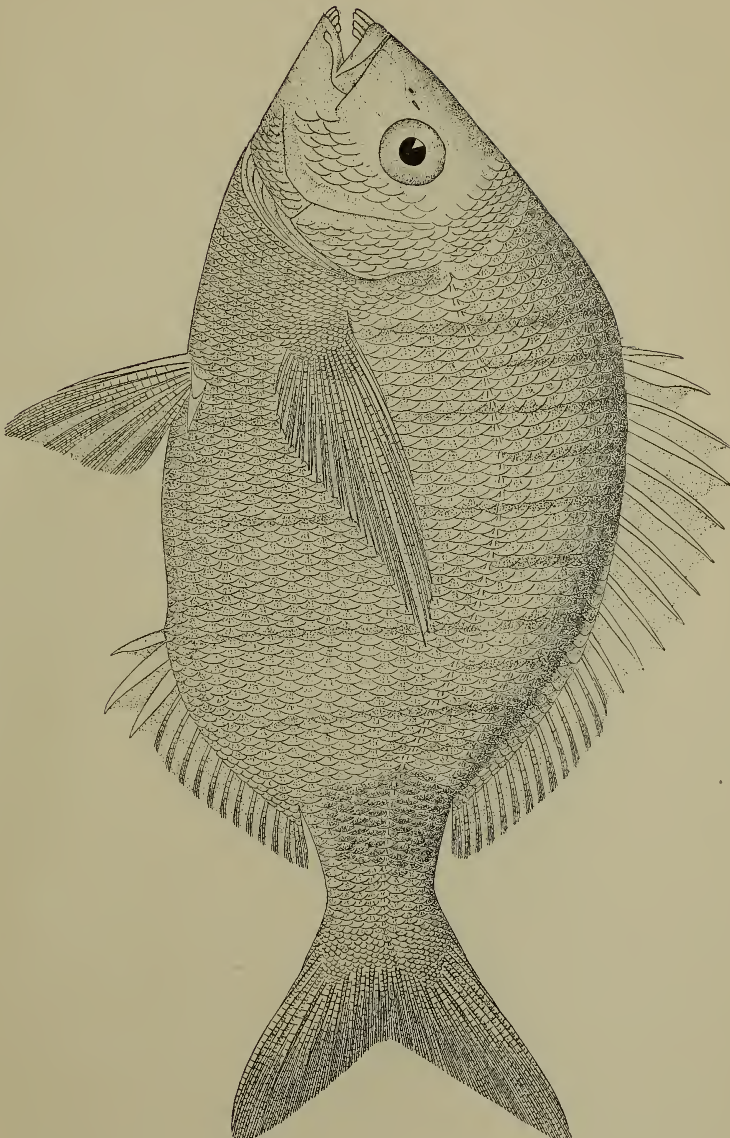


ARCHOSARGUS UNIMACULATUS (Bloch). *The Salema.*

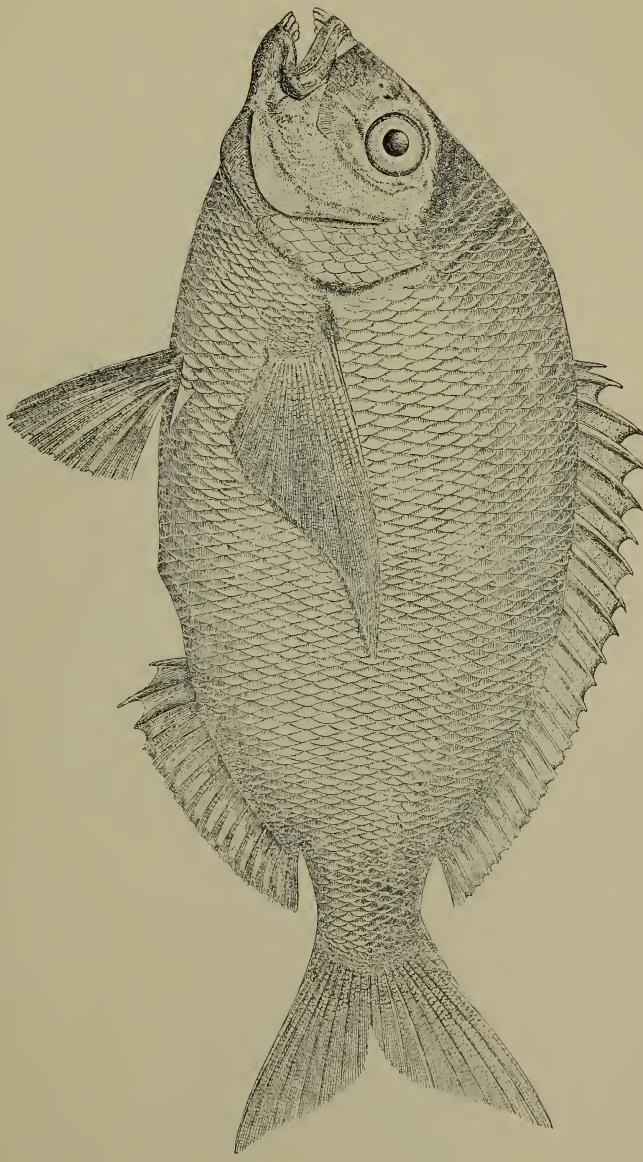


ARCHOSARGUS PROBATOCEPHALUS (Walbaum). *Sheepshead.* Adult. Third anal spine too slender.

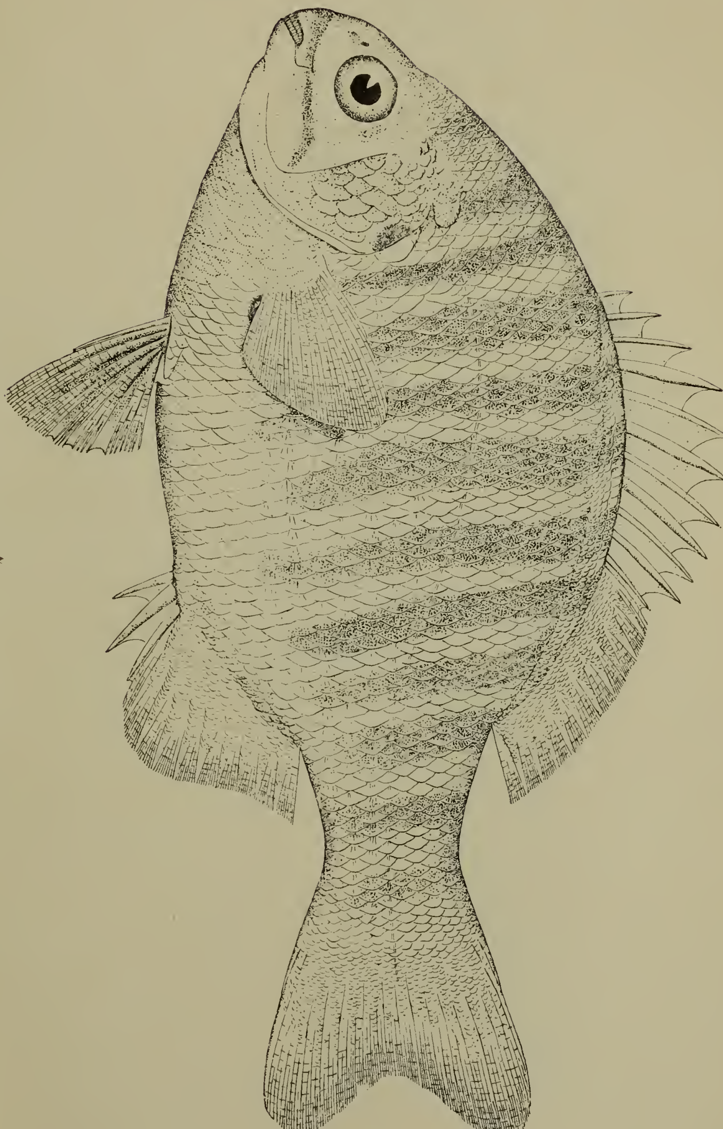
ARCHOSARGUS PROBATOCEPHALUS (Walbaum) *The Sheepshead.* Young.



DIPLODUS HOLBROOKI (Bean). *Ring-tailed Bream.* Young.

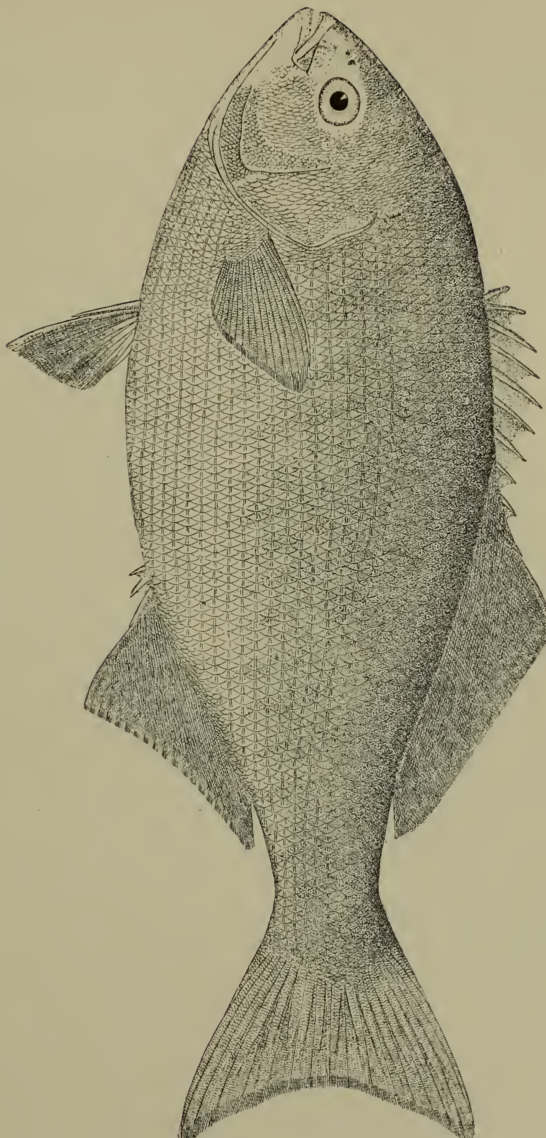


DIPLODUS HOLBROOKI (Bean). *Ring-tailed Bream.* Adult.



HERMOSILLA AZUREA Jenkins and Evermann. *The Hermosilla.*

KYPHOSUS SECTATRIX (Linnæus). *The Rudder-fish.*



MEDIALUNA CALIFORNIENSIS (Steindachner). *The Medialuna.*

5.—ON FISH ENTOZOA FROM YELLOWSTONE NATIONAL PARK.

By EDWIN LINTON, PH. D.,
Professor of Zoölogy in Washington and Jefferson College.

This paper makes the third which the author has prepared for the U. S. Fish Commission on entozoa collected in the Yellowstone National Park. The first of these papers contained a report on two species of larval cestods, *Ligula catostomi* from the sucker (*Catostomus ardens*), and *Dibothrium cordiceps* from the trout (*Salmo mykiss*), collected by Dr. David S. Jordan in September and October, 1889. The second paper was a special report on the life history of *Dibothrium cordiceps*, being the result of the author's investigations, in July and August, 1890, into the cause of the excessive parasitism among the trout of Yellowstone Lake. The present paper contains descriptions of other fish entozoa which were obtained incidental to the inquiry into the life history of *D. cordiceps*.

Aside from the trout parasite (*D. cordiceps*), perhaps the most interesting form encountered was the monobothrium from the sucker; this appears to be an undescribed species, and I have given it the name *Monobothrium terebrans*, from its habit of boring a pit in the mucous membrane of its host. I have thought it best also to give a brief account of the anatomy of this singular worm. Some additional notes on the ligula of the sucker have been given. These are based on observations made in July, 1890. That part of the report which relates to the nematods is necessarily imperfect, owing to the fact that, with the exception of the species *Dacnitis globosa* from the trout, the specimens were all immature and for the most part few in number.

CESTODA.

Ligula catostomi Lt., Bull. U. S. F. C., IX, for 1889, pp. 66–72, pl. XXIII–XXV.

An account of this parasite, based upon specimens found by Dr. David S. Jordan in the sucker (*Catostomus ardens*), of Witch Creek, a tributary of Heart Lake, Wyoming, was published in the Bulletin of the United States Fish Commission, cited above. It is not proposed to give any further account of the anatomy of this species here, but simply to record a few notes and observations.

On July 28, 1890, I found in a young sucker, captured in a small warm stream near our camp on Heart Lake, a ligula, in the abdominal cavity. The length of the fish was about 75 mm., that of the parasite 400 mm. The greatest breadth, near the anterior end, was 6 mm. For the first 75 mm. it was thick and stout, the remainder was slender and tapered slowly to the posterior end, near which the breadth was about 2 mm. Several large suckers from the lake were examined, but no ligulæ were found in them. The water of the lake is quite cold, the temperature 40° F. having been found at a depth of 124 feet.

On July 29, I examined a number of suckers collected in Witch Creek. The fish were taken in a seine from a warm branch of the main stream. The temperature of the water in which the fish were swimming was 95° F. A school of fish were observed in the warm stream where it joined with a cold stream, 46° F. The fish showed no tendency to enter the cold water, even when frightened by the presence of the seine. Two species of fish were secured from this school, viz: *Catostomus ardens* and *Leuciscus atrarius*. The specimens were all young or half grown. No trout were seen in the warm water, although they appeared to be rather abundant in the cold stream.

The larger suckers were nearly all infested with these parasites; the smaller ones not so much, and the smallest scarcely at all. Of 30 fish, ranging from 14 to 19 centimeters in length, only one or two were without parasites. Of 45 specimens averaging about 10 centimeters in length, 15 were infested and 30 were not. Of 65 specimens, averaging about 9 centimeters in length, 10 were infested and 55 were not. Of 62 specimens less than 9 centimeters in length, 2 were infested and 60 were not.

I insert the following notes made at the time of collecting:

1. Fish 19 cm. long, contained 1 parasite, length 39.5 cm., broadest at anterior end, where it measured 15 mm.
2. Fish 17 cm. long, 1 parasite 27 cm. long, 13 mm. broad near anterior end.
3. Fish 15 cm. long, 4 parasites, 12, 13, 13, and 20 cm. long, respectively.
4. Fish 13.7 cm. long, no parasites.
5. Fish 13 cm. long, 3 parasites.
6. Two fish 13 and 14 cm., respectively, no parasites.
7. Fish 11 cm. long, abdominal region flabby and collapsed, a hole beside and a little in front of vent from which a parasite had apparently escaped. One free ligula was found with the fish when they were brought in. The fish may have been injured in seining. The intestine was congested.
8. Two fish 10 and 11 cm. long, respectively, more than one parasite in each; put in alcohol entire.
9. Fish 10 cm. long, no parasites.
10. Two fish 10 cm. long, no parasites, intestine and peritoneum congested.
11. Fish 10 cm. long, no parasites; intestine and peritoneum black and unhealthy looking.
12. Fish 10 cm. long, one parasite 39 cm. long.
13. Three fish each 10 cm. long, two with 2 and one with 3 parasites.
14. Two fish, 8 and 9 cm., respectively, one with 3 and the other with 4 parasites.

The parasitized fish are perhaps a little lighter in color than the non-parasitized ones.

The admirable researches of Donnadieu on the ligula of the European tench show that the time during which the parasite lives in the abdominal cavity of the fish is variable, but is generally limited to two years. Most frequently it attains its maximum development at the end of the second year.

The fact that the specimens of *L. catostomi* showed comparatively slight difference in apparent age points to the conclusion that the period of infection is brief. It is probable that the final host is one, or possibly more than one, of the migratory aquatic birds, such as the heron, pelican, larus, merganser, etc., which are summer residents or visitors in this region. The abundance of the parasites is doubtless due to the warm water in the streams fed by thermal springs, which furnishes conditions favorable to the development of the embryos from the egg. If these parasites ever normally make their escape from their intermediate host the fish, as stated by European observers, the chances of their being swallowed by a bird are very few, since they are eaten with avidity by fish, in whose intestine, however, they do not mature.

On the evening of July 29 I threw into the lake a large number of these parasites, and on the following day, about noon, caught a chub (*Leuciscus atrarius*) near the place where the ligulæ had been thrown. The alimentary canal of the chub was filled from one end to the other with ligulæ in various stages of digestion. In the intestine they were reduced to a white chyle with recognizable fragments, and even in the stomach they were corroded and fragmental.

Dibothrium cordiceps Leidy.

A description of this species by Dr. Joseph Leidy was published in the Preliminary Report of the U. S. Geological Survey of Montana and adjacent territory (Hayden, 1871, pp. 381, 382). Some account of the anatomy of the larval stage was given in my paper entitled, "On two species of Larval Dibothria from the Yellowstone National Park (Bull. U. S. Fish Commission, IX, for 1889, pp. 72–76, pls. XXV–XXVII); and of the adult stage in "A contribution to the life history of *Dibothrium cordiceps*," etc. (Bull. U. S. Fish Commission, IX, for 1889, pp. 337–358, pls. CXVII–CXIX.)

Larval stage: In the rocky mountain trout (*Salmo mykiss*), in cysts and free in the abdominal cavity; also often migrating into the flesh of these trout in the Yellowstone Lake.

Adult stage: Intestine of the American white pelican (*Pelecanus erythrorhynchus*).

MONOBOTHRIUM TEREBRANS sp. nov.

[Plates 63, 64, 65; Figs. 1 to 21.]

Body elongated, somewhat flattened, linear, slightly enlarged at the extremities, which terminate in blunt points, opaque, white. Head variable, subsagittate, wedge-shape or bluntly rounded, a little broader and thicker than the body, somewhat depressed dorso-ventrally but without distinct bothria, translucent white with more delicate cuticle than body. Posterior end of the body with irregular prominences due to the development of ova in the uterus. Genital aperture ventral about the posterior fifth; testes in front of genital aperture occupying the greater part of the body; female genitalia behind the genital aperture. Largest specimen 28 mm. in length. Sometimes several with heads buried in common pit in mucous membrane of host.

Habitat: Intestine of *Catostomus ardens*, Heart Lake, Wyoming, July 28, 1890.

Diesing makes this genus the type of his family *Monobothria*. The genera included are *Caryophyllæus* Gmelin, *Monobothrium* Diesing, and *Diporus* Diesing. These cestods are peculiar in that the body is not segmented and contains but one set of genitalia. In other words a single individual corresponds to one proglottis of an ordinary tapeworm. The members of the group thus serve, in a measure, to connect the cestods and trematods.

Several large suckers which had been taken in a trammel net were examined and about a dozen specimens of this parasite were obtained from two of the fish. They were associated with *Echinorhynchus tuberosus*, and in each instance several of the individuals were found to be attached to the intestinal wall with their heads buried in a common pit in the mucous membrane. Some of these clusters were preserved entire with a portion of the intestine. Upon examining the alcoholic specimens one was found 7 mm. in length, which was wholly inclosed in a pit in the mucous membrane. The walls of the pit were thick and gristly and the head end of the parasite had nearly perforated the intestinal wall.

The longest living specimen measured 28 mm.; as an alcoholic specimen it measured nearly the same, presenting the following dimensions in millimeters: Length, 27; breadth, median, 2, expanding near anterior end to 2.5, and near the posterior end tapering rather abruptly to 1; thickness about 1, but increasing to 1.5 at the posterior end where there are two or three moderately swollen or nodular places.

The following observations are based on alcoholic specimens: A small specimen measured 17 mm. in length; median breadth, 25 mm.; breadth near extremities, 2 mm. The anterior end of this specimen was sagittate and thicker than the body, posterior end bluntly tapering, thicker than body, and somewhat swollen or nodular. Each end of the larger specimens is rather sharply marked off from the body for a distance of 3 mm. or more. The anterior end is somewhat lighter colored than the body and suggests the head of some species of *Dibothrium*, but there are no bothria. The body, especially toward the posterior end, is yellowish-white.

ANATOMY.

The sections upon which the following account of the anatomy is based were made from specimens stained *in toto* in borax carmine.

Structure of the head.—Upon examining transverse and longitudinal sections of the head it is seen to consist of somewhat spongy tissue, in which there are a few longitudinal muscular and connective fibers and numerous protoplasmic granules and granular masses contained in a mesh of transverse connective fibers. There are also numerous small open spaces shown in the sections which are doubtless the fine and irregular branchings of the vessels of the water-vascular system. Figs. 9 and 10 show the structure of the head of a small specimen. In them it is seen that the cuticular layer is very thin and the subcuticular granulo-fibrous layer, which is clearly defined toward the middle of the body, is but faintly foreshadowed. The longitudinal muscular fibers are not collected into any definite area, but are distributed pretty uniformly among the other tissues. There is no indication of layers of any kind. If the entire section, from which Fig. 10 was sketched, had been figured it would have shown no peculiarities of structure that are not shown in the small portion which is represented.

No calcareous bodies were found in any of the sections. One of the smallest specimens was placed in hydrochloric acid, but no evidence of the presence of calcareous particles was educed.

Structure of the body.—There is a rather abrupt transition between the head and the body. When transverse sections made through the anterior part of the body immediately back of the head are compared with those of the head several differences may be observed. The cuticle is thicker and more sharply defined. In the center of the section the connective fibers assume a parallelism, especially in a direction from margin to margin, which is in marked contrast with the irregular course which they pursue in the head. The open spaces, which indicate the situation of longitudinal vessels, are collected towards the periphery. The protoplasmic granules in the center soon begin to collect into clusters, which represent the beginnings of the testes.

In a small specimen about 5 mm. long, which was cut into transverse sections, it was not until the middle, or a little back of the middle, counting from the head, that the longitudinal muscles began to collect into bundles to form a somewhat discontinuous layer surrounding the inner space.

In sections made in the vicinity of the reproductive aperture, back of the posterior fourth of the body, the cuticle was found to consist of two layers (Fig. 20, *c*, *c*). The outer or epidermal layer appears to be sloughing off from the inner, uniform cuticular layer. Within the cuticle is a very thin layer of fine longitudinal fibers. This is succeeded by a thick granulo-fibrous layer, which contains numerous granules and nuclear bodies, which latter stain deeply in carmine. There are also, especially in the older specimens, small clusters of longitudinal muscular fibers in this layer (Fig. 16, *l*). The inner portion of this layer is somewhat open or areolar. The water vascular system consists of an indefinite number of vessels not clearly defined and of various sizes, which, in the posterior part of the body, in the vicinity of the reproductive aperture, lie in the inner portion of the subcutaneous granulo-fibrous layer (Fig. 16, *w*). This characteristic branching of the water-vascular system appears to be identical with that observed by G. R. Wagener (Natuurk. Verh. Haarlem, XIII, 96; Tab. VII, 2). Next within the granulo-fibrous layer is a layer of longitudinal muscular fibers (Figs. 16, 17, 18, 20, *lm*). This does not constitute an unbroken layer, but consists of numerous clusters of longitudinal fibers which lie in the midst of the connective tissue and surround the central space. The latter contains the genital organs. A terminal pore leading into a short duct with thick walls was observed in transverse sections through the posterior end of a small specimen. The duct enters posteriorly from near one margin and not from the extreme tip, and continues anteriorly to the posterior vitelline gland. The same was observed in transverse sections of larger specimens, where it appeared first in the posterior sections as a pore entering one of the margins, and was soon seen, in succeeding anterior sections, toward the middle of the sections as an elongated opening with strong walls of connective tissue of irregular thickness. In the smaller specimens strong connective fibers run from the anterior end of this cul-de-sac. This organ is doubtless the terminal pulsating organ common to larval cestods.

Genital organs.—The testes begin a short distance back of the head. In a young specimen they began about the anterior third; in an older specimen they began almost immediately behind the head. They consist of globular masses (testicules) of granular protoplasm in the younger specimens. In the older specimens they are irregular in shape and relatively smaller. The granules are collected into minute globular clusters and appear in the sections as circular or oval nests of nuclei. The testes extend posteriorly nearly to the reproductive aperture, which is about the posterior fourth or fifth of the body.

In front of the genital aperture there is a voluminous tube which, after making numerous convolutions, communicates with the cirrus bulb. This tube is evidently the vas deferens (*vide* Figs. 13, 14, 15, 16). In sections of a large specimen it was seen to contain numerous masses of minute, short filaments felted together (Fig. 21, *s*). These, when isolated, appear as slender filaments with a black speck at one end. They are presumably spermatozoa. I was not able to demonstrate any communication between the testes and the vas deferens from my sections. The wall of the cirrus-bulb is thick and well supplied with circular muscular fibers, and within there are numerous retractile muscular fibers. The cirrus was retracted in all the specimens. The aperture of the cirrus, as seen in section through the retracted organ, is quite irregular, with puckered walls and its longer axis transverse to the long axis of the body (Fig. 19, *c i*).

The germ gland or ovary lies transversely across the body about midway between the genital aperture and the posterior end (Figs. 13, 14, 15, *g*). It is a single organ, though comprising two marginal lobes with a narrower connecting part. The latter disappears in specimens which have become replete with ripe ova, while the marginal lobes still remain (Fig. 14, *g*). In such cases there appear to be two ovaries. In Fig. 13 there appear to be two ovaries. The sketch was made from a section which passes on the dorsal side of the part which connects the marginal lobes. It is thus seen that the marginal portions of the ovary extend farther toward the dorsal side than the part which connects them. The ovaries are made up of nucleated cells closely and uniformly packed together. They do not lie in clusters or nests like the granular nuclei of the testes and the vitelline glands. In the older specimens, however, the ovary appears to be broken up into lobular portions (Fig. 14, *g*). The ovary as a whole lies nearest the ventral face of the body.

The vitellaria (Figs. 13, 14, 15, *vg*) in the younger specimens are seen to consist of two marginal glands which connect with a posterior gland lying behind the ovary. In the adult specimens this organ may be divided into at least three distinct glands, one posterior and two marginal. The vitellarian gland differs from the ovary in being lobulated, and in the lobules there are numerous clusters of granules, appearing in section as circles or oval nests of nuclei. This organ is well developed along each margin in the vicinity of the cirrus bulb, extending forward of the cirrus bulb for a short distance and overlapping the testes. I observed small ducts leading from the marginal glands, but found nothing corresponding to the conspicuous marginal ducts noticed by Van Beneden in his account of the anatomy of the related genus *Caryophyllæus*.

The ducts from the vitellaria were in some cases crowded with small globular masses, which apparently originate from the disintegration of the nests of nuclei in the vitellaria. The exact relation of these ducts to the duct from the germ gland was not certainly made out, but they were so far traced as to show that they unite with that duct near the median line on the dorsal side of the germ gland not far from its posterior border.

The duct from the germ gland leaves that organ on its postero-dorsal side. Soon after leaving the gland it enlarges for a short space and appears to be lined in the enlarged portion with cilia.

The vagina opens immediately behind the cirrus in a common genital pore. In longitudinal sections parallel with the ventral surface and near the exterior it appears as a simple transverse slit smaller than the male orifice. The vagina pursues a somewhat tortuous course for a short distance behind the external opening, during which time it lies near the ventral surface. It then dips into the central region of the body and passes along the median region on the dorsal side of the germ gland. It enlarges at one point into a kind of seminal receptacle (Fig. 13, *v*). It appears to unite with the germ duct near the posterior edge of the germ gland and on its dorsal side.

The common duct formed by the union of the germ duct and vagina soon receives ducts from the vitelline glands. The common duct thus formed, and which is the beginning of the uterus, functions as a shell gland. In Fig. 13, *o*, *o* are ova which lie in the vicinity of the shell gland. See also Fig. 14 *u′* and the ideal sketch, Fig. 15 *sg*.

The product of the vitelline glands is added in the shape of small globules of protoplasmic matter. These masses do not, at least immediately, unite, and on that account the ova, even in the beginning of the uterus, have the appearance of undergoing segmentation. In some cases I observed ova that appeared to be in the process of formation. The shell was exceedingly thin and weak, and among the numerous non-nucleated masses, products of the vitelline gland, could be distinguished the nucleated germ cell (Fig. 12 *a*).

The uterus lies dorsally in the posterior part of the body. It is a voluminous organ and when full of eggs occupies the greater part of the body behind the cirrus bulb (Fig. 14 *u*). It is on account of the accumulation of eggs in the uterus that the posterior surface of the body is raised into irregular elevations (Figs. 1, 3, 7, 8). The uterus begins behind the ovary and appears to originate from the confluence of the vagina, germ duct, and vitelline ducts. The first folds in section present a reticulated appearance and contain numerous ova which have thin and membranous shells. These ova are very irregular in in their outline and are invariably collapsed. Both shell and contents stain deeply with carmine. The perfect ova have shells that resist the action of the staining fluid.

From its origin on the postero-dorsal side of the germ gland the uterus proceeds by numerous folds anteriorly in the direction of the cirrus bulb. It appears to terminate, in the older specimens, in a pore immediately behind the cirrus, in close proximity with the vagina.

The ova are comparatively large, being 0.06 to 0.065 mm. in length and 0.03 to 0.035 mm. in breadth. The globular masses of which their protoplasmic contents are for the most part made up are 0.01 mm. and over in diameter.

TREMATODA.

Encysted Distoma from Leuciscus atrarius.

[Plate 65, Figs. 22–25.]

On July 30 I examined several small chubs (*Leuciscus atrarius*) from a warm branch of Witch Creek, and some larger fish of the same species from Heart Lake. In these fish the mesentery and serous covering of the viscera generally were thickly specked with minute white granules, which upon examination proved to be cysts containing larval trematods. In most cases each cyst contained but one larva, but in one instance, among cysts from a large chub, three larvæ were observed in one cyst, and in several others two. The larvæ lay in a transparent fluid which was inclosed in an oval sac with pellucid walls. The sac collapses when the larva is liberated. It is then seen to consist of interlacing fibers, the interstices of which are filled with granular parenchyma. The parasites are too immature to make their identification certain. I record, however, the following characters:

The average length of the cysts appears to be about 0.5 mm. An alcoholic cyst measured 0.7 mm. in length and 0.5 mm. in breadth, and contained a larval distomum 0.4 mm. long and 0.25 mm. broad. Another larva, liberated from a somewhat smaller cyst, measured 0.32 and 0.16 mm., and another 0.35 and 0.26 mm. in length and breadth, respectively. Another was 0.4 mm. long and 0.15 mm. thick.

These distoma are elliptical, oblong, or oval in outline when viewed dorsally or ventrally, but in marginal view are convex dorsally and concave ventrally. The two suckers have made their appearance, and also the muscular pharynx. These organs have about the same relative positions and proportions as the similar organs in *Distomum laureatum*, but there is no indication of the head papillæ of that species. The body is somewhat longitudinally striated behind the ventral sucker, an appearance which seems to be due to the branches of the water-vascular system. There is a posterior emargination which marks the position of the terminal pore of the water-vascular system. From a short median vessel connecting with the terminal pore a number of marginal vessels branch like the arms of a candelabra. The ventral sucker is well developed, the oral imperfectly so.

Distomum laureatum Zeder.

Rudolphi Entozoa Hist., II, 413; id., Synops., 113, 413; Diesing, Syst. Helminth., 380; Dujardin, Hist. Helminth., 435; Olsson, Bitrag till Skandinaviens Helminthfauna, 1876, 24, Taf. IV, Figs. 52, 53, 54.

Body unarmed, depressed, oblong, with short neck. Head with four low, blunt, dorsal papillæ and two ventro-marginal lobes on oral sucker. Ventral sucker larger than mouth, sessile but prominent, with transverse cleft-like aperture. Pharynx globose near the mouth, with short œsophagus. Intestinal crura continued almost to the posterior end. Vitelline glands numerous, not only occupying the margins of the body as far as the middle of the neck, but also all the region behind the testes. Transverse duct with vitelline receptacle in front of the testes. Testes two, subglobose, median, approximate with each other. Ovary globular, one-half the size of a testis, remote. Gyri of uterus few, situated in front of the testes. Genital apertures apposed in middle of neck. Bursa of penis long, smooth, cylindrical. Excretory vessel a median cæcum, desisting in front of testes and opening in a posterior caudal pore. Length 6 mm., breadth 1.5 mm.

This description is adapted, with a few changes, from Olsson, cited above.

Habitat: *Salmo mykiss*, rectum. Heart Lake and Yellowstone Lake, July and August.

A distomum which I have found frequently in the Rocky Mountain trout appears to be identical with *D. laureatum*, a parasite which infests several European fishes, *e. g.*, *Thymallus vulgaris*, *Coregonus oxyrhynchus*, and *Salmo fario*.

The dimensions given by Dujardin for this species are: Length, 2 to 3.35 mm.; breadth, 1 to 1.22 mm.

My specimens, alcoholic, measure from 1.5 to 4 mm. in length and 0.5 to 1.5 mm. in breadth. The length is in most cases three or four times the breadth. The diameter of the ventral sucker is about twice that of the oral sucker. The transverse diameter of the aperture of the ventral sucker is three times its axial diameter. The eggs are yellow, elliptical, usually collapsed in alcoholic specimens from 0.07 to 0.085 mm. in length and 0.04 to 0.045 mm. in breadth.

In life the color is yellowish-white; with transmitted light the eggs, which are large and not numerous, appear golden-brown. In the living specimens there appeared to be about five low, blunt papillæ on the dorsal half of the circumference of the oral sucker. Subsequent study revealed the number and disposition given above and in the sketches. This parasite was noticed on several occasions, but usually there were but few—a dozen or two—in each host.

Detailed measurements of the specimen figured in Fig. 26 are as follows:

	Millimeters.
Length	3.50
Greatest breadth	1.00
Diameter of anterior sucker, interior, lateral	0.17
Diameter of anterior sucker, interior, axial	0.15
Diameter of anterior sucker, exterior	0.33
Diameter of ventral sucker, interior	0.30
Diameter of ventral sucker, exterior	0.43

ACANTHOCEPHALA.

Echinorhynchus globulosus Rud.

[Plate 65, Figs. 31, 32.]

A fragment of an echinorhynchus from a trout (*Salmo mykiss*) collected by Dr. Jordan in Yellowstone Lake, in September, 1889, appears to belong to this species, or at least near it. The fragment is the anterior end of a female broken a short distance back of the proboscis sheath. The length of the fragment is 3 mm.; the length of the proboscis is 0.6, and of the sheath 1.2 mm.; the diameter of the proboscis at base is 0.27, at apex 0.16 mm.; length of hooks, 0.05 to 0.06 mm. There are about ten rows of hooks and about the same number in each spiral visible on a side, and about sixteen hooks in a vertical row. The specimen was put in glycerin to study, and the peculiar shape of the proboscis may be in part due to a collapse of its walls. The proboscis is cylindrical at base, tapers abruptly about the middle, and becomes cylindrical again towards the apex. The hooks on the slender part of the proboscis were somewhat distorted. This feature appears in the two upper right-hand hooks in Fig. 32. The lemnisci were not clearly made out, but they appear to be shorter than the sheath.

Echinorhynchus tuberosus Zeder.

[Plate 66, Figs. 33–39; Plate 67, Fig. 40.]

Zeder, Naturg., 163; Rudolphi, Entoz. Hist., II, 257; Synops., 65 and 312; Westrumb, Acanthoceph., 9; Creplin, Obs., 26; Wiegmann's Arch., 1846, 150, 152, 154, and 155; Dujardin, Hist. Nat. des Helminth., 538; Diesing, Syst. Helminth., II, 33; Revision der Rhyngodeen, 29.

Proboscis short, clavate, or subglobose, with about three series of hooks; about six large hooks in outer series, hooks in other series diminishing in size and number toward base of proboscis. Hooks long, slender, recurved, but with slight outward curve toward the point. No neck. Proboscis sheath short. Lemnisci very long and slender, in the males sometimes equal to more than one-half the length of the body. Body elongated, attenuate at each end. Males with copulatory bursa. Length of males from 4 to 9 mm., of females from 10 to 15 mm.

Habitat: *Catostomus ardens*, *Leuciscus atrarius*, intestine; July 28, 1890; Heart Lake, Wyoming.

I refer to this species a lot of 75 echinorhynchi from the intestine of the sucker (*Catostomus ardens*). Eight large fish were examined and echinorhynchi were found in most of them. I also refer to the same species a single specimen from the intestine of a chub (*Leuciscus atrarius*). The majority of the specimens of the first lot were translucent white or cream color, a few were lemon-yellow, and a few orange-yellow. The specimen from the chub was a male 6 mm. in length and of a rusty yellow color. In a few cases external pores, with elevated thickened borders, were observed, similar to what I have recorded in *E. agilis* (Report of Commissioner of Fish and Fisheries, 1886, p. 490). One of these is shown in Fig. 40. The bodies of the alcoholic specimens are arcuate; the proboscis is usually inclined nearly at right angles to the body; the terminal aperture of the female is lateral near the posterior end. The lemnisci are proportionally longer in the males than in the females. The length is not well shown in Fig. 38, which was sketched from a specimen in glycerin, in which the lemnisci did not show plainly. They frequently extend far beyond the first testis, and are, moreover, often more or less folded. The testes are large, oblong, and approximate. The vas deferens is large; the prostatic sacs appear to be represented by a single elongated gland lying parallel with the vas deferens; the ejaculatory duct and bursa are both relatively large.

The ovarian masses are ellipsoidal. The dimensions of a typical mass were, length .14 mm., other diameters about .07 mm. The fusiform embryos were .035 mm. in length, and .015 mm. in breadth. The outer cells of the ovarian masses are the largest and are nucleated.

The body wall near the anterior end is thin, as shown in Fig. 36. Towards the median and posterior region the subcuticular fibrous layer thickens greatly and contains the relatively large branching vessels of the water-vascular system. Some of the latter may be seen in optical section in Fig. 38.

The following measurements were obtained from typical alcoholic specimens:

Measurements.	Male.	Female.
	mm.	*mm.*
Length	6.00	10.00
Length of proboscis	0.25	0.15
Diameter of proboscis	0.20	0.15
Length of proboscis sheath	0.50	0.40
Length of lemnisci	3.00	1.50
Length of largest hooks on proboscis	0.07	....

NEMATODA.

The nematods infesting the fishes of the National Park do not appear to be very numerous either as to species or individuals. Moreover, the specimens which were found on the expedition were, with the exception of those of one species, encysted or otherwise immature forms. Since there is much consequent uncertainty attending their proper identification I shall refer to them somewhat cursorily under the head of the several hosts.

SALMO MYKISS.

A parasite which is found rather frequently in greater or less abundance, usually in the vicinity of the pyloric cœca of the trout; agrees very closely with *Dacnitis globosa* Dujardin, from *Salmo fario*.

The species *D. globosa* is not recognized by Von Linstow in his "*Compendium der Helminthologie*," but is apparently regarded by him as identical with *Cucullanus globosus* Zeder. On account of its close agreement with Dujardin's description of *D. globosa*, I have used that name in the explanation of the figures (Pl. 67, Figs. 41 to 46).

There appear to be two varieties of this worm, or at least of the females. In one the body is slender, almost filiform, the female being twice as long as the male. In the other the body is not so slender and there is not much difference between the sexes with respect to the length of the body. This feature, however, may be accidental.

This worm may be described as follows:

Body, white, usually slender, nearly linear, anteriorly narrowing into a neck, which expands into a head that is wider than the neck, marked with longitudinal striæ and with indistinct transverse striæ. Head subglobose, with two rather thin and corneous lips, the mouth a triangular slit narrowing dorsally. The head is usually deflected dorsally by a curve in the neck, which resembles a crosier. There is a small nodular eminence on the dorsal side of the head. Œsophagus with thick, strong walls. Female with body usually twice the length of the male; reproductive aperture with border raised into prominent folds, situated about the posterior third; posterior end acuminate. Male usually about half the length of the female, posterior end strongly recurved ventrally with a pair of sabre-shaped spicules and a short, blunt process behind the pair of spicules and a broad sucker-like depression in front of the spicules bearing the anal aperture near its anterior end.

Length of females, 8 to 15 mm.; of males, 7 mm.

One of the long, slender females was 12 mm. long and 0.2 mm. in diameter; one of the shorter kind was 8 mm. long and 0.3 mm. in diameter. A male, corresponding in appearance with the latter, was 7 mm. long and 0.27 mm. in diameter. These dimensions are of alcoholic specimens. The following additional measurements were made, also on alcoholic specimens. The dimensions are given in millimeters: Male, length

7.00; greatest diameter, 0.25; diameter of head, 0.20; diameter of neck, 0.13; length of neck, 1.00; length of caudal spine, 0.15. Female, length 15.00; greatest diameter, 0.40; diameter of head, 0.25; diameter of neck, 0.17; length of neck, 1.20. Genital pore, 5 mm. from posterior end.

These parasites were met with frequently in the trout of Heart Lake and in those of Yellowstone Lake and the river. Their favorite resting-place is in the alimentary canal in the vicinity of the pyloric cœca.

ENCYSTED SPECIMENS OF D. GLOBOSA.

This worm was also found in cysts which usually appeared as pediculated tumors within the body cavity of the trout. It frequently happened that among the cysts of *Dibothrium cordiceps*, found in the body cavity of the trout, there would be a few cysts which differed somewhat in appearance from the former. These, when opened, collapsed on account of the liberation of a thin, watery, granular fluid, in which there was invariably a small nematod worm. These proved, upon subsequent examination, to be specifically identical with the worms from the alimentary canal which I have referred to *D. globosa*.

These cysts are easily distinguished from the dibothrium cysts by their difference in color and resistance to pressure. The cysts of *Dibothrium cordiceps* are white, firm, and resistant. The nematod cysts are yellowish or flesh-colored, and are soft and yielding. Moreover, they are usually suspended by a peduncle and are covered by a layer of the peritoneum, which is richly supplied with blood vessels. The worm which is liberated from the cyst is altogether disproportionate in size to the containing cyst. The worm, even from a cyst 10 mm. in diameter, may be so small as to be easily overlooked amidst the granular fluid which escapes when the wall of the cyst is ruptured. These cysts usually occur on the rectum or along the course of the lower intestine. They are sometimes found, however, in the vicinity of the pyloric cœca.

A cyst measuring 15 by 9 by 7 mm. in its three dimensions, which had been preserved in alcohol, was opened. The walls were 0.5 mm. thick, and the contents were granular and whitish. The cyst was covered by a layer of peritoneum, which contained capillary blood vessels. The worm which was liberated was 8 mm. in length. Another cyst, 4 by 5 by 3 mm. in its three dimensions, contained a small male worm 4 mm. long. The nematods obtained from these cysts were all immature and belonged to the same species, *Dacnitis globosa*. Sections of these cysts show that their walls are made up of a number of concentric layers, rather loosely connected and often poorly defined, and with numerous nuclear granules in and among the layers.

In addition to *Dacnitis globosa*, and associated with it, I found a few forms that I have not been able to identify. One of these, a single specimen of which was found, is an immature form of a rather stout nematod, length 14 mm., breadth 0.5 mm. It tapers gradually toward the anterior end and a little more rapidly toward the posterior end. The body is marked by five longitudinal striæ and a broad longitudinal stripe on each side; there are a few transverse wrinkles for a distance of about 0.3 mm. from the anterior end. The mouth appears to be simple and there is no œsophagus. Another is a fragment, the posterior end of a female, length 11 mm., breadth 0.5 mm. This fragment is cylindrical; posterior end rather blunt. In optical section the body appears to be crenulated, owing to the deep transverse striæ. The intestine is dark brown and the anal aperture nearly terminal.

Another species, which bears some resemblance to *Ascaris tenuissima* Zeder, was found in the trout (Figs. 47–51). These are slender, white worms, tapering gradually towards the anterior end from about the posterior third; posterior end larger except at the extremity, where it tapers rather abruptly to a blunt, slightly-curved point, behind the anal aperture (Fig. 49). Head small, truncate, mouth apparently trilobed. Body marked by regular transverse striæ, making serrate margins in optical sections near anterior end, the serrations becoming crenulate posteriorly. The œsophagus is short, with what I take to be a chitinous ring at base. The few specimens which I have found are small. The following measurements were obtained from a female, dimensions given in millimeters: Length, 7; diameter of anterior end, 0.03; post anal diameter, 0.04; diameter immediately in front of anal aperture, 0.06; greatest diameter of body about 0.12; ova, 0.04 by 0.02 in diameter. The length of a male was found to be 4 mm. Spicules, 2, diverging. Genital aperture of female about posterior third, vulva prominent. My specimens do not present many characteristic details of structure, and I am not able, without more careful examinations of sections, to reach a satisfactory conclusion with regard to their classification.

Some small nematods encapsuled in the muscular walls of the intestine of the trout were found, some of which appear to be immature forms of the foregoing. These worms are very small, hardly exceeding 3 mm. in length, and many of them not more than 2 mm. long. One of them, which measured 2 mm. in length, was 0.06 mm. in diameter, and for the greater part of its length was filled with polygonal nucleated cells about 0.02 mm. in diameter. The body tapers abruptly at the posterior end, but more gradually towards the anterior end. The mouth appears to be three-lobed and surrounded by about five minute papillæ. The chitinous cuticle is uniformly and minutely marked with transverse striæ. This feature in optical section produces serrate margins, the teeth of which are about 0.01 mm. apart. In one the anal aperture was found to be 0.2 mm. from the posterior end. In another of these encapsuled nematods, which was stouter than the ones just described, the polygonal cells were present and also minute cells about 0.002 mm. in diameter, which filled a large part of the body. The length of this specimen was 3 mm., the diameter 0.2 mm. In this specimen the margins in optical section are crenulate and the body tapers towards each end. I can not refer this specimen to any species with any degree of certainty. The former encapsuled specimens are evidently young forms of those which I have referred provisionally to *Ascaris tenuissima*, although they present some resemblance to *Ascaris capsularia* Rudolphi.

LEUCISCUS ATRARIUS.

The nematods secured from this fish were few in number. They were found only in the body cavity, where they were coiled up under the external tunic of the viscera. They are all apparently larval ascaridæ, although on account of their rudimentary condition I have not been able to identify them with certainty.

One specimen obtained from the serous coat of the intestine of its host appeared to be near the stout nematod from *S. mykiss* mentioned above. It was 17 mm. in length. Its greatest breadth was 0.6 mm. near the posterior end. Its diameter at the anterior end was 0.25 mm. The living worm was for the most part brownish red in color. When the alcoholic specimen was examined it was found to be partly enveloped in a thin, transparent, chitinous investment, which, when removed, revealed a smooth cuticle, with a broad, prominent lateral line. The breadth of the lateral lines was about 0.07 mm. at the anterior end, increasing to 0.1 mm. toward the posterior end. The surface, except along the lateral regions, presented a reticulated or squamose appearance. When the specimen was placed in glycerin the reticulations were no longer visible. Fine transverse fibers and strong longitudinal fibers, however, became visible in the cuticle.

The neck is continuous with the body, the head narrow, truncate, mouth terminal, with rudimentary lips. The body is gradually attenuate anteriorly, but tapers abruptly and somewhat unequally on opposite sides to the rather blunt posterior end; anal aperture terminal. At the posterior end there is a minute, bluntly rounded, papillary spine, 0.012 mm. in length. Nothing could be made out with regard to the œsophagus or genital organs.

In addition to the above, some small white nematods were obtained from the mesentery. These were about 7 mm. long and 0.35 mm. in the greatest diameter. The anterior end is nearly truncate and 0.1 mm. in diameter. The body tapers nearly uniformly to each extremity, but in some more abruptly towards the posterior end. The lateral lines are prominent. The surface of the body is smooth, the longitudinal muscles well developed, giving a longitudinally striated appearance when magnified; transverse striæ are not visible in alcoholic specimens, but become visible when treated with glycerin. The number of oral lobes is not definite, but there are several small oral papillæ. The genital organs are rudimentary, the anal aperture terminal. These specimens resemble the larger specimen closely, but in life were white, while the larger specimen was brownish red. They are also much like the specimens mentioned below from the sucker.

CATOSTOMUS ARDENS.

But one species of nematod was found in this fish. These were slender white worms, found in the intestine of their host, where they were associated with *Echinorhynchus globulosus* and *Monobothrium terebrans*. They were from 6 to 8 mm. long and about 0.3 mm. in diameter. They taper toward each end alike. The body in alcoholic specimens appears to be marked with fine longitudinal striæ. The lateral lines are prominent. When treated with glycerin fine transverse striæ became visible. The lips are not well defined, but are apparently three in number, with several minute papillæ. The reproductive organs are rudimentary.

In the absence of distinct characters, it is of necessity impossible to refer these larval nematods to established species.

WASHINGTON AND JEFFERSON COLLEGE,
Washington, Pa., April 3, 1891.

EXPLANATION OF PLATES.

PLATE 63.

Monobothrium terebrans sp. nov.

Fig. 1. Adult; *a*, head; *b*, posterior end; *c*, genital pore, × 3½.
Fig. 2. Smaller specimen, dorsal view, × 18.
Fig. 3. Posterior end of adult, ventral view; *a*, genital pore, × 14.
Fig. 4. Small specimen, dorsal view, × 14.
Fig. 5. Anterior end of adult, marginal view, × 14.
Fig. 6. Anterior end of adult, dorsal view, × 14.
Fig. 7. Posterior end of adult, dorsal view, × 14.
Fig. 8. Posterior end of adult, marginal view, × 14.
Figs. 5 to 8 are sketched from the same specimen.
Fig. 9. Median longitudinal section of anterior end of small specimen, parallel with a dorsal surface, × 200.
Fig. 10. Transverse section near apex, of small specimen; *c*, cuticle; *w*, vessel of water-vascular system, × 200.
Fig. 11. Egg, sketched from section of young specimen, showing eggs in the uterus, × 375.
Fig. 12. Egg, from one of the posterior convolutions of the uterus of a young specimen; *a*, germ cell; the remainder of the contents consists of globular masses from the vitelline gland, × 375.
Fig. 13. Longitudinal section through the posterior region of a small specimen; *c*, cuticle; *ci*, cirrus and cirrus-pouch; *e*, epidermis; *g g*, marginal lobes of germ gland; *lm*, longitudinal muscles; *o o*, eggs in posterior convolutions of the uterus; *sc*, subcuticular fibro-granular layer; *t*, testes; *u u*, uterus; *v*, seminal receptacle of vagina; *vd*, vas deferens; *vg vg vg*, marginal and posterior vitelline glands, × 300.

PLATE 64.

Monobothrium terebrans sp. nov.

Fig. 14. Longitudinal section through the posterior region of an adult specimen, × 60; *u*, shell gland; other letters as in Fig. 13.
Fig. 15. Diagrammatic sketch showing position of genitalia; *v*, vagina; *v'*, seminal receptacle; *g*, shell gland; other letters as in Fig. 13.
Fig. 16. Transverse section through body in region of cirrus bulb of adult, × 54; *l*, longitudinal muscles in subcutaneous fibro-granular layer; *w*, vessels of water-vascular system; other letters as in Fig. 13.
Fig. 17. Transverse section of body-wall in front of cirrus, × 210; *l*, longitudinal subcutaneous fibers; other letters as in Fig. 13.
Fig. 18. From transverse section in front of germ gland, × 210; *v*, ciliated duct vagina; *g*, germ gland; *lm*, longitudinal muscles; *o*, egg in uterus; *u*, uterus.
Fig. 19. Longitudinal section near ventral surface; *ci*, cirrus; *v*, vagina, × 300.

PLATE 65.

Monobothrium terebrans sp. nov.

Fig. 20. Longitudinal section of body wall near posterior end; *e*, epidermis; *c*, cuticle; *l*, longitudinal subcuticular fibers; *sc*, subcuticular fibro-granular layers; *n*, nucleated cell; *lm*, longitudinal muscle layer; *g*, nucleated cells of germ gland, × 300.

Fig. 21. Longitudinal section through vas deferens; *vd*, vas deferens; *s*, masses of spermatozoa, × 375.

Encysted distomum from Leuciscus atrarius.

Fig. 22. Young distomum in cyst, from body cavity of *Leuciscus atrarius*, × 60.

Fig. 23. Same liberated from cyst, × 60; *w*, terminal pore of water vascular system.

Fig. 24. Cyst with three distoma, from same host.

Fig. 25. Cyst with two distoma, from same host.

Distomum laureatum Zeder.

Fig. 26. Ventral view of specimen in carbolic acid and turpentine; × 24, *a*, mouth and anterior sucker; *ph*, pharynx; *c*, cirrus; *b*, ventral sucker; *o*, eggs in uterus, walls of latter organ not clearly defined in specimen; *ov*, ovary; *vd*, vitelline duct; *t*, testes; *vg*, vitelline glands.

Fig. 27. Marginal view of another specimen, × 22.

Fig. 28. Ventral view of anterior end.

Fig. 29. Dorsal view of same specimen figured in No. 28.

Fig. 30. Ventral view of anterior end of specimen 4.5 mm. in length, × 45.

Echinorhynchus globulosus ? Rud.

Fig. 31. Sketch of a fragment, the anterior end of an echinorhynchus from *Salmo mykiss;* length of fragment, 3 mm. Specimen in glycerin when sketched; anterior end of proboscis apparently collapsed.

Fig. 32. Hooks of same near base of proboscis.

PLATE 66.

Echinorhynchus tuberosus Zeder.

Fig. 33. *a*, Anterior end of ♀ × 12; *á*, posterior end of same, × 12; *b*, hooks of proboscis; *c*, same, specimen in caustic potash, showing basal supports, highly magnified.

Fig. 34. Portion of proboscis of ♀ in glycerin.

Fig. 35. Anterior end of ♀, optical section, *l*, lemnisci; *s*, sheath of proboscis; *a*, cuticular pore; *o*, eggs; *ó*, ovarian masses, × 14; ova × about 30.

Fig. 36. Transverse section through anterior end, *c*, cuticle; *l*, longitudinal subcuticular fibers; *s c*, subcuticular granulo-fibrous layer; *cm*, circular muscles; *lm*, longitudinal muscles forming a sheath for the lemnisci; *ll*, lemnisci; *v*, longitudinal vessel of same; *s*, wall of proboscis sheath; *ng*, nerve ganglion; *r*, retractor muscle of proboscis.

Fig. 37. Transverse section through nerve ganglion, more highly magnified than Fig. 36; *n g*, nerve ganglion.

Fig. 38. Optical section of ♂ in glycerin; *a*, *b*, *c*, hooks of proboscis. Other specimens were observed in which the lemnisci were relatively considerably longer than shown in this sketch. × 9.

Figs. 33 to 38 sketched from specimens from *Catostomus ardens.*

Fig. 39. Head of ♂ from *Leuciscus atrarius.*

PLATE 67.

Echinorhynchus tuberosus Zeder.

Fig. 40. Anterior end of ♂ from *Catostomus ardens*.

Dacnitis globosa Dujardin.

Fig. 41. ♂ and ♀ × 3½.
Fig. 42. Side view of head of ♂, optical section; *o*, mouth; *ph*, pharynx, × 60.
Fig. 43. Anterior end of ♀; *a*, front view of head, × 60.
Fig. 44. Posterior end of ♂; *v*, vent; *st*, anal spines, × 60.
Fig. 45. Same, optical section, × 60.
Fig. 46. Vulva of ♀, highly magnified.

Undetermined species of Nematods.

Fig. 47. Small nematod, ♀, from *Salmo mykiss*, × 12.
Fig. 48. Anterior end of same, × 185.
Fig. 49. Posterior end of same, × 185.
Fig. 50. Same species, ♂, × 12.
Fig. 51. Posterior end of same, × 185.
Fig. 52. Small nematods from *Catostomus ardens*, × 3½.
Drawings by the author from alcoholic specimens.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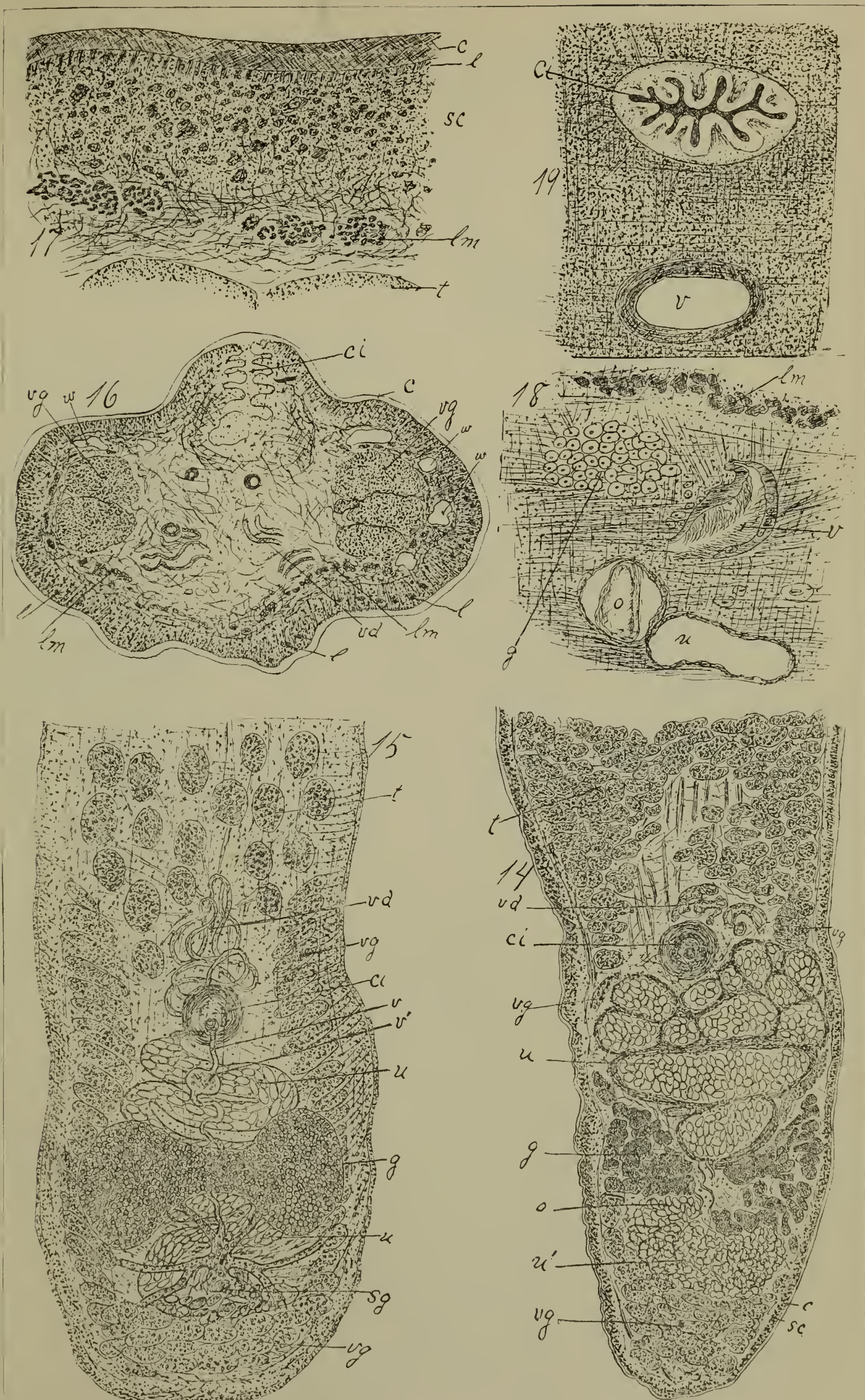
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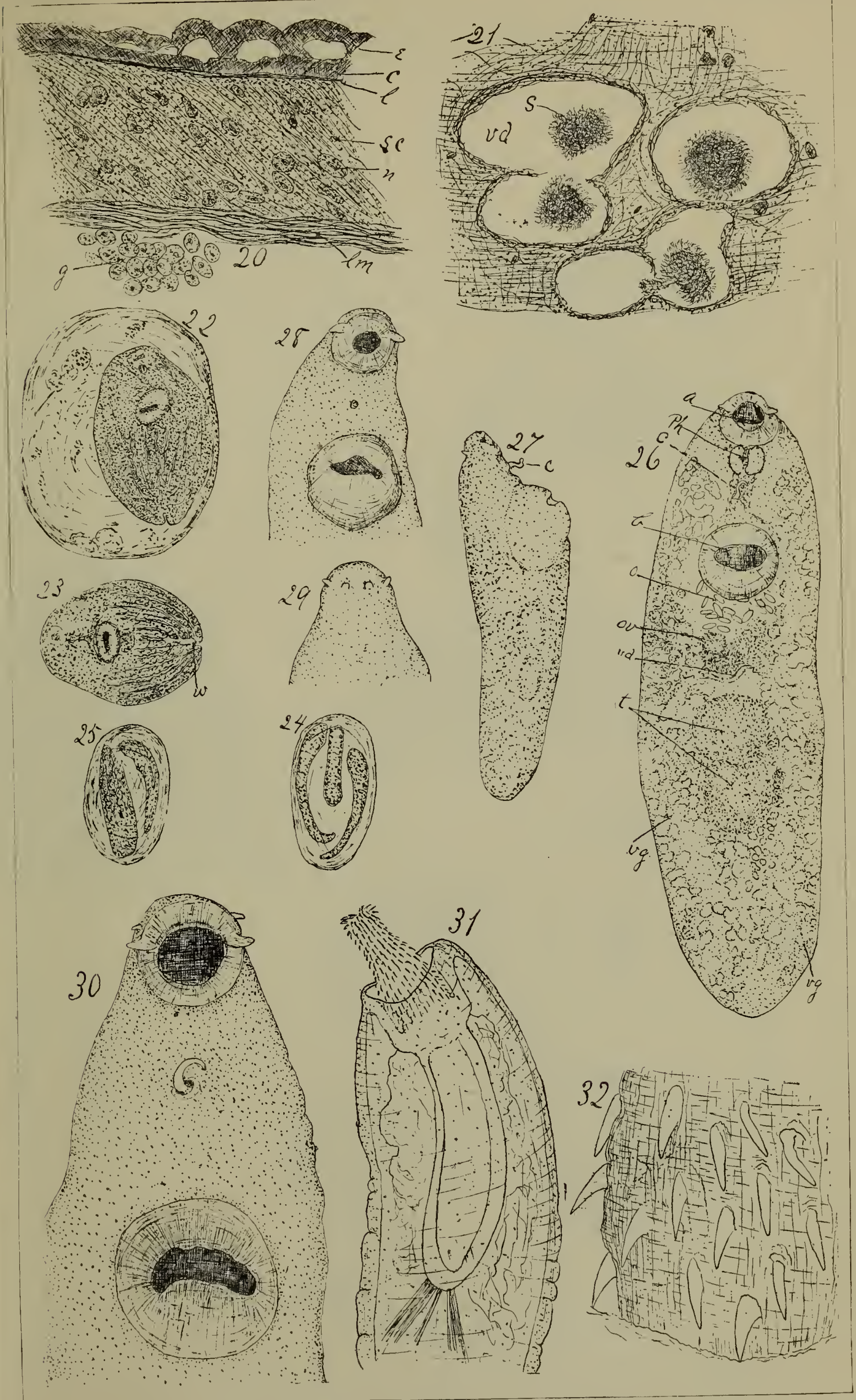
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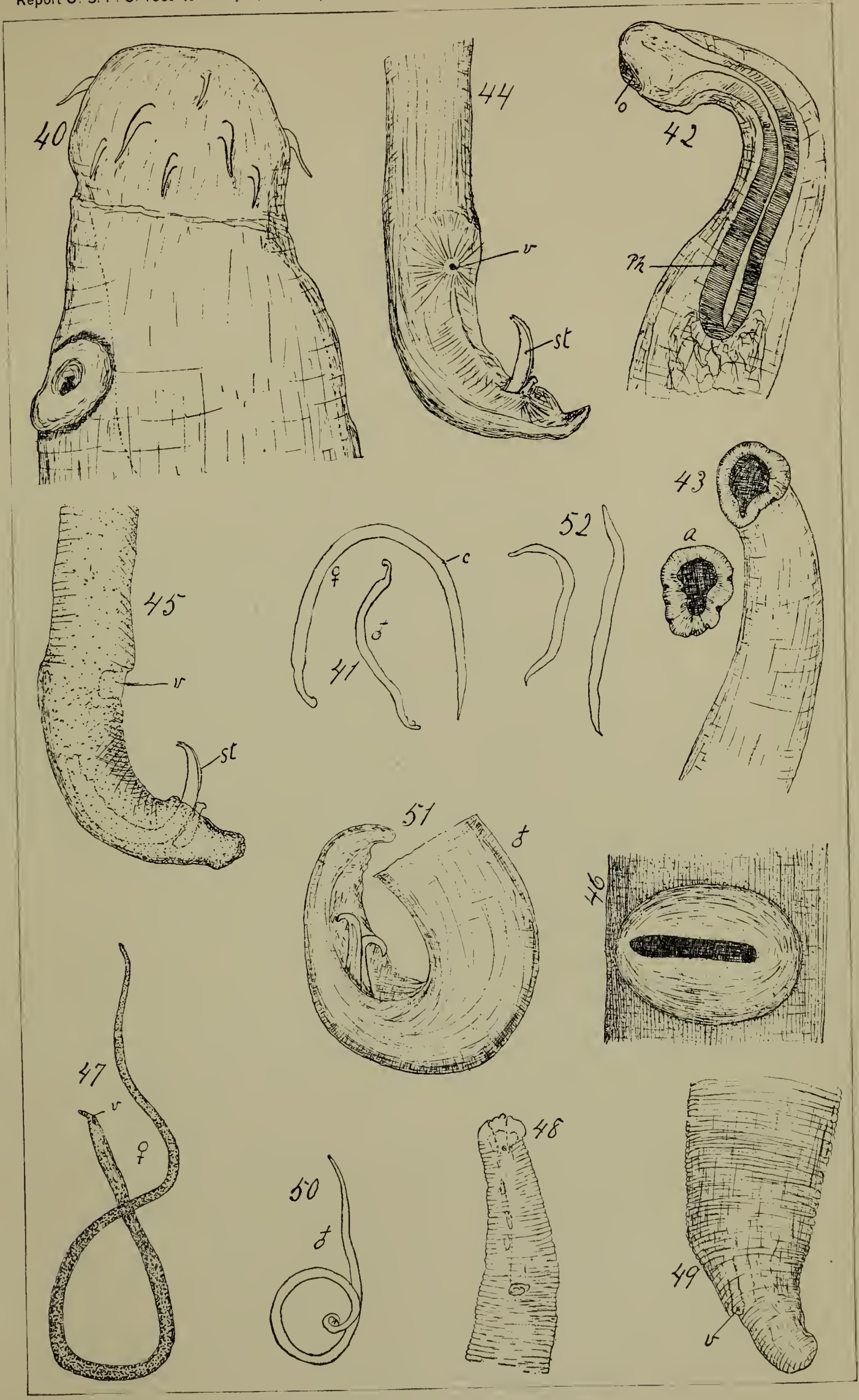
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6.—PLANKTONIC STUDIES: A COMPARATIVE INVESTIGATION OF THE IMPORTANCE AND CONSTITUTION OF THE PELAGIC FAUNA AND FLORA.

By Ernst Hæckel.

[Translated by George Wilton Field.]

TRANSLATOR'S PREFACE.

Prof. Hæckel's "Plankton-Studien" first appeared in the *Jenaische Zeitschrift*, vol. XXV, first and second parts, 1890. It was immediately published in separate form by Gustav Fischer, of Jena, and attracted much attention on the Continent and in England. The subject, "a comparative study of the importance and constitution of the marine fauna and flora," is presented in Prof. Hæckel's usual pleasing style, and the work can not fail to be of value to all interested in the biological sciences, to the general reader as well as to the specialist. It derives especial interest in connection with the work of the Fish Commission, from its broad discussion of those many important elements which enter into the food supply of all pelagic fishes, such as the mackerel and menhaden, and, considering the extensive physical investigations now being conducted in our coast waters by the schooner *Grampus*, its publication at the present time will prove exceedingly advantageous.

The terminology used by Prof. Hæckel may at first seem formidable, but this difficulty is more fancied than real. The terms are formed upon correct analogies, and most of them will probably find a permanent place. The definite restriction of the meaning of terms is a fundamental necessity in every science, and for the lack of this the branch of biology here considered is in a very unsatisfactory condition. The author, first of all, proposes certain terms with a definite meaning. The word "plankton," from the Greek πλαγκτός, *wandering*, *roaming*, was, I believe, first employed by Hensen in place of the German "Auftrieb," to designate all plants and animals found at the surface of the ocean which are carried about involuntarily in the water. Hæckel adopts this term, but objects somewhat to the meaning at present attached to it.

Particularly valuable for us is the general review which the author gives of the discovery and growth of our knowledge of this branch, which he names "planktology"; the distinctions which he points out between the varied constituents and distribution of the plankton; and finally his extremely valuable suggestions for further work in the field which he so justly terms "a wonder-land."

In the translation the liberty of omitting a few personal references was taken, for the reason that we in this country know very little of the facts which have called them forth.

In the case of several German words it has been found necessary for the sake of clearness to use a circumlocution. For instance, I can recall no English equivalent for "*Stoffwechsel des Meeres*," which would convey its meaning in a single word. The "cycle of matter in the sea," *i. e.*, the change of inorganic matter into vegetable and animal organic matter, and this finally again into inorganic matter, seemed the best rendering, though even this does not include all which the German term implies.

I.—HISTORICAL EXPLANATIONS.

For the great progress made in the last half century in our knowledge of organic life, we are indebted—next to the theory of development—in a great measure to the investigation of the so-called "pelagic animal world." These wonderful organisms, which live and swim at the surface of the sea and at various depths, have long aroused the interest of seafarer and naturalist, by the wealth of the manifold and strange forms, as well as by the astonishing number of individuals—these have been referred to in many old as well as in recent narratives. A considerable number of these, especially of the larger and more remarkable forms, were described and figured in the last, or in the first half of the present, century. The new and comprehensive investigation of the "pelagic world" began in the fifth decade of our century, and is therefore not yet 50 years old.

Into this, as into so many other regions of biology, the great Johannes Müller, of Berlin, equally distinguished in the realms of morphology and physiology, entered as a pioneer. He was the first who systematically and with great results carried on the "pelagic fishery by means of a fine net." In the autumn of 1845, at Helgoland, he began his celebrated investigations upon the development of echinoderms, and obtained the small pelagic larvæ of the echinoderms, and other small pelagic animals living with them, as sagitta, worm larvæ, etc., at first by "microscopical examination of the sea water, which was brought in" (1). This wearisome and thankless method was soon displaced by the successful use of the "fine pelagic net." In the treatise "on the general plan in the development of the echinoderms,"

NOTE.—Citations inclosed in parentheses which occur in the text refer to the list of publications at the end of this paper (pp. 640, 641).

Müller compares the different methods of obtaining them, and chooses, above all, "fishing with a fine net at the surface of the sea." He says:

> I have used this method for many years with the best results; for the advanced stages of the swimming larvæ and for the time of maturity and metamorphosis it is quite indispensable, and in no way to be replaced.

The students who, in 1845–46, as well as in the following years, accompanied Johannes Müller to Helgoland and Trieste (Max Müller, Busch, Wilms, Wagener, and others) were introduced into this method of "pelagic fishery" and into the investigation of "pelagic tow-stuff" (*pelagische Auftrieb*) obtained thereby. It was soon employed at sea with excellent results by other zoölogists—by T. H. Huxley, by Krohn, Leuckart, Carl Vogt, and others, and especially by the three Würtsburg naturalists, A. Kolliker, Heinrich Müller, and C. Gegenbaur, who in 1852 examined with such brilliant success the treasures of the Straits of Messina. At this time, in the beginning of the second half of our century, the astonishing wealth of interesting and instructive forms of life which the surface of the sea offers to the naturalist first became known, and that long series of important discoveries began which in the last forty years have filled so many volumes of our rapidly increasing zoölogical literature. A new and inexhaustibly rich field was thus opened to zoötomical and microscopical investigation, and anatomy and physiology, organology and histology, ontogeny and systematic zoölogy have been advanced to a surprising degree. The investigation of the lower animals has since then been recognized as a wide field of work, whose exploration is of great significance for all branches of science and to which we owe numberless special and the most important general conclusions.

The general belief of zoölogists regarding the extent of this rich pelagic animal world arose as the result of the discovery that a special "pelagic fauna" exists, composed of many characteristic forms, fundamentally different from the littoral fauna. This pelagic fauna is made up of animals (some floating passively, others actively swimming) which remain at the surface of the sea and never leave it, or only for a short time descend to a slight depth. Among such true "pelagic animals" are the radiolaria, peridinia, noctiluca, medusæ, siphonophores, ctenophores, sagitta, pteropods, heteropods, a greater part of the crustacea, the larvæ of echinoderms, of many worms, etc.

Important changes were first made in the prevailing idea of the "pelagic fauna" by the remarkable discoveries of the epoch-making *Challenger* expedition (1873–1876). The two leaders of this, Sir Wyville Thompson and Dr. John Murray, did not limit themselves to their chief object, the general physical and biological investigation of the deep sea, but studied with equal care and perseverance the conditions of organic life at the surface of the ocean and in zones of various depths. As the most significant general result Murray, in his "Preliminary Report" (1876), says:

Everywhere we have found a rich organic life at and below the surface of the ocean. If living individuals are scarce at the surface, below it the tow net commonly discloses numerous forms, even to a depth of 1,000 fathoms and more (5, p. 536).

In 1875, on the journey through the North Pacific Ocean (from Japan to the Sandwich Islands), the extremely important fact was established that the pelagic organisms in oceanic zones of different depths belong to different species; fine pelagic nets (or tow nets) "on many occasions were let down even to depths of 500, 1,000, and 2,000 fathoms, and thereby were discovered many swimming organisms which had never been captured hitherto, either at the surface of the ocean or at slight depths (up to 100 fathoms below the surface)" (6, p. 758). The most characteristic forms of these zones of different depths belong chiefly to the class of the *Radiolaria*, especially to the order of the *Phæodaria*.

Through the investigation of the *Challenger* radiolaria, which occupied for ten years the greater part of my time and attention, I was led to study anew these conditions of distribution; and I reached the conviction that the differences discovered by Murray in the pelagic fauna, at different depths of the ocean, were still more significant than he assumed, and that they had the greatest significance, not merely for the radiolaria, but also for other groups of swimming oceanic organisms. In 1881, in my "*Entwurf eines Systems der Challenger Radiolarien*," p. 422, I distinguished three groups: (*a*) pelagic, living at the surface of the calm sea; (*b*) zonary, living in distinct zones of depth (to below 20,000 feet); and (*c*) profound (or abyssal) animals living immediately above the bottom of the deep sea. In general, the different characteristic forms correspond (to below 27,000 feet) to the different zones.

In my "General Natural History of the *Radiolaria*" (4, p. 129) I have established this distinction, and have expressed my conviction that it is possible, by the aid of a suitable bathygraphic net, to demonstrate many different faunal belts overlying one another in the great deep-sea zones.

The existence of this "intermediate pelagic fauna," discovered by Murray, inhabiting the zones of different depths of the ocean between the surface and the deep-sea bottom, which I have briefly called "zonary fauna," has been decidedly contradicted by Alexander Agassiz. He claimed, on the ground of "exact experiments" carried on during the *Blake* expedition, in 1878, that the greater part of the ocean contains absolutely no organic life, and that the pelagic animals go down no deeper than 100 fathoms. "The experiments finally show that the surface fauna of the sea is actually limited to a relatively thin layer, and that no intermediate zone of animal life, so to speak, exists between the fauna of the sea bottom and of the surface" (15, pp. 46, 48).

Although these negative conclusions from the so-called "exact experiments" of Agassiz are contradicted by the foregoing results of the *Challenger* investigator, yet against the latter, with some show of right, Agassiz might have raised the objection that the "tow net" used could establish no safe conclusion.* This objection could only be finally removed by the construction of a new tow net, which could be let down closed to a certain depth, and then opened and closed again. The merit of inventing such a closible net, and of the immediate successful use of it, belongs to two distinguished Italian naval officers: G. Palumbo, commander of the Italian war corvette *Vettor Pisani*, first constructed such a closible pelagic net or "bathygraphical zone net;" and Naval Lieutenant Gætano Chierchia, who during the three years' voyage of the *Vettor Pisani* around the world made a very valuable collection of pelagic animals, used the new closible net with fine results, even at a depth of upwards of 4,000 meters (8, p. 83).

Chierchia's first trial with this "deep-sea closible net" was June 5, 1884, in the East Pacific Ocean, directly under the equator, 15° west of the Galapagos Islands. Fourteen days later, June 19, midway between the Galapagos and the Sandwich Islands, this closible net was sunk to 4,000 meters. In this and in many other trials these Italian naval officers captured an astonishing wealth of new and interesting zonary animals, whose description has for a long time busied zoölogists. The collections brought back to Naples by the *Vettor Pisani* are, next to those of the *Challenger*, the most important materials from the region under consideration.

A few faults which pertained to Palumbo's net were soon done away with by improvements, for which we are indebted to the engineer Petersen and to Prof. Carl Chun, of Breslau. The latter, in 1886, made trials in the Gulf of Naples with the improved closible net which showed "a still more astonishing richness of pelagic animals in greater

* The "tow nets" used by the *Challenger* were the ordinary Müller's net (or the "fine pelagic net" of Joh. Müller), a round bag of Müller gauze or silk mull, the mouth being kept open by a circular metallic ring. This ring is in ordinary pelagic fishing fastened to a handle 2 or 3 meters long (like the ordinary butterfly net). While the boat moves along, the opening of this net is held at the surface in such a way that the swimming animals are taken into the bag. They remain hanging in the bottom of this, while the water passes through the narrow meshes of the net. After a time the net is carefully inverted and the tow stuff (*Auftrieb*) is emptied into a glass vessel filled with sea water. If one wishes to fish below the surface, the ring of the net is fastened by means of three strings, equally distant from one another, which at a point (about 1 meter distant from the opening of the net) are joined to a longer line which is sunk by weights to a definite distance, corresponding to the desired depth. When Murray fastened such a tow net to the deep-sea sounding line or to the long line of the deep-sea dredge, he first obtained the inhabitants of the "intermediate ocean zones," but he could not thereby avoid the objection that, since this tow net always remained open, the contents might come from very different depths or even only from the surface. For in drawing up the open tow net animals from the most different zones of depth might occasionally be taken in.

depths, and completely overthrew the assumption that an azoic layer of water exists between the surface and the sea bottom" (15, p. 2). Chun embraced the general results of his important bathypelagic investigations under the four following heads:

(1) The portion of the Mediterranean investigated showed a rich pelagic fauna at the surface as well as at all depths up to 1,400 meters.

(2) Pelagic animals which during the winter and spring appear at the surface seek deep water at the beginning of summer.

(3) At greater depths occur pelagic animals which have hitherto been seldom or never observed at the surface.

(4) A number of pelagic animals also remain at the surface during the summer, and never sink into deep water (15, p. 44).

Among the remarks which Chun made on the vertical distribution of the pelagic fauna and the astonishing planktonic wealth of the depths of the sea (at 1,000 to 2,000 meters), he justly throws out the question, "Who knows, whether in the course of time our views will not undergo a complete reversal, and whether the depths will not show themselves as the peculiar mother earth of pelagic life, from which, for the time being, swarms are sent out to the surface as well as to the sea bottom! There are only a few forms which can so completely adapt themselves to the changing conditions of existence at the surface that they no more seek the deeper levels" (15, p. 49). In consequence of his observations on the periodic rising and sinking of pelagic animals, Chun "can not resist the impression that from the abundance of animal life in the depths the surface fauna represents relatively only an advance guard of the whole, which sometimes to a greater, sometimes to a less extent, and occasionally completely, withdraws itself into more protected regions. Facts plainly speak for this, that the periodical wandering of pelagic animals in the vertical direction is especially conditioned by the changes in temperature. Only a few pelagic animal groups can endure the high temperature of the surface water during the summer; the majority withdraw from the influence of this by sinking, and, finally, whole groups pass their life in the cool deep regions without ever rising to the surface" (15, p. 54).

The general ideas which Chun had obtained by this deep-sea investigation of the Mediterranean he was able to confirm for the Atlantic Ocean on a trip made in the winter of 1887–88 to the Canary Islands (16, p. 31). At this time he made the observation that the periodical wandering of pelagic animals in a vertical direction was influenced in great part by ocean currents (at the surface as well as in deep water), and that among other things the occurrence of the full moon exerted a significant action (16, p. 32). Chun's special observation in the sea of Orotava, upon the poverty of the Canary plankton in November and December and the sudden appearance of great numbers and many species of pelagic animals in January and February, agrees completely with the observations which I myself made twenty years before at the Canary island Lanzarote. I also entirely agree with Chun in regard to his general views upon the chorology of the plankton, and consider his investigations upon the pelagic animal world and its relation to the surface fauna as the most important contribution which planktology has received since the pioneer discoveries of the *Challenger* and of the *Vettor Pisani*.

Entirely new aspects and methods have been introduced into pelagic biology in the last three years by Dr. Victor Hensen, professor of physiology at Kiel (9 and 22). He has for a number of years thoroughly studied the conditions of life of the fauna and flora of the bay of Kiel, and as a member of the commission for the scientific investigation of the German Ocean (at Kiel) has endeavored to improve and extend the fisheries there, and by counting the fish eggs collected to get an approximate idea of the number of fish in corresponding districts (9, p. 2). This investigation led him to the conclusion that it was necessary and possible to come nearer to the fundamental food supply of marine animals and to determine this quantitatively. For solving this problem Hensen invented a new mathematical method (2, p. 33). He constructed a new pelagic net (p. 3), and in July, 1884, in company with three other naturalists of Kiel, undertook a nine-day excursion in the North Sea and Atlantic Ocean, which was extended to the Hebrides and to the Gulf Stream (57° 42′ N. Lat.) (p. 30). In 1887 he published the results of this investigation in a comprehensive work containing many long numerical tables, "On the Determination of the Plankton, or the Animal and Vegetable Material found in the sea" (9). He used the term "plankton" in place of "*Auftrieb*," the word hitherto commonly used, because this name is not sufficiently comprehensive and suitable (9, p. 1). To be sure, the German term "*Auftrieb*" or "*pelagischer Mulder*," introduced by Johannes Müller forty years ago, was in general use and has many times been used in English, French, and Italian works. But I agree with Hensen that in this, as in other scientific terms, a Greek *terminus technicus*, capable of easier flexion, is preferable. I adopt the term Plankton in place of "*Auftrieb*," and form from it the adjective planktonic (*planktonisch*). The whole science which treats of this important division of biology is briefly called planktology.

Hensen regards the *mathematical determination of the plankton* as the chief aim of planktology from a physiological standpoint. By it he hopes to solve the somewhat neglected question of the cycle of matter in the sea. For the purpose of solving this, and to make a trial of his new method on a larger scale, Hensen, in the summer of 1889, arranged a more extensive expedition in the Atlantic, which was most liberally supported by the German government and by the Berlin Academy of Sciences. The German Emperor furnished 70,000 marks; the Berlin

Academy gave, from the income of the Humboldt fund, 24,600 marks, and by further contributions the entire sum at the disposal of the expedition was raised to 105,600 marks—a sum never before made available in Germany for a biological expedition. The new steamer *National*, of Kiel, was chartered for three months, and was fitted out "with all the admirable contrivances for obtaining plankton, for deep-sea fishing, and for sounding." Besides the leader of the expedition, Prof. Hensen, five other naturalists participated: the zoölogists Brandt and Dahl; the botanist Schütt; the bacteriologist Fischer; the geographer Krümmel; and the marine artist Richard Eschke. The voyage of the *National* lasted 93 days (July 7 to November 15). The course was westward through the north Atlantic (Gulf Stream, Sargasso Sea), then southward (Bermudas, Cape Verde, Ascension) to Brazil, and eastward back by the Azores. During this voyage 400 casts were made, 140 with the plankton nets, 260 with other nets.

Our German navy has been but little used for scientific, still less for biological, investigations; much less than the navies of England, France, Italy, Austria, and the United States. The remarkable services which many distinguished German zoölogists have rendered in the last half century for the advancement of marine biology have been carried on almost entirely without government aid. The German government has hitherto had very little means available for this branch of science. Therefore, great was the satisfaction when, by the liberal endowment of the plankton expedition of Kiel, the first step was taken for the more extensive investigation, with better apparatus, of the biology of the ocean, and for emulation of the results which the English *Challenger* and the Italian *Vettor Pisani* had lately obtained in this region.

Accounts have been published of the results of the plankton expedition of Kiel, by Victor Hensen (22), Karl Brandt (23), E. du Bois Reymond (21), and Krümmel. The essential details of these accounts have been repeatedly published in the German newspapers, to the general effect that the proposed goal was reached and the most important question of the plankton was happily solved. I very greatly regret that I can not agree with this favorable verdict. (1) The most important generalizations which the plankton expedition of Kiel obtained on the composition and distribution of the plankton in the ocean stand in sharp contradiction to all previous experience; one or the other is wrong. (2) It seems to me that Hensen has incautiously founded a number of far-reaching erroneous conclusions on very insufficient premises. Finally, I am convinced that the whole method employed by Hensen for determining the plankton is utterly worthless, and that the general results obtained thereby are not only false, but also throw a very incorrect light on the most important problems of pelagic biology. Before I establish this dissenting opinion let me give an account of my own planktonic studies and their results.

II.—PLANKTONIC STUDIES.

My own investigations on the organisms of the plankton were begun thirty-six years ago, when I got my first conception of the wonderful richness of the marine fauna and flora in the North Sea. Accepting the kind invitation of my ever-remembered teacher, Johannes Müller, I accompanied him in the autumn of 1854 on a vacation trip to Helgoland, and was introduced by him personally into the methods of plankton fishery and the investigation of the pelagic fauna. There, during August and September, I accompanied him daily on his boating trips, and under all conditions of the rich planktonic captures I received from him the most competent instruction, and pressed with corresponding eagerness into the mysteries of this wonderful world. Never will I forget the astonishment with which I first beheld the swarms of pelagic animals which Müller emptied by inversion of his "fine net" into a glass jar of sea water—a confused mass of elegant medusæ and glistening ctenophores, swift-darting sagittas and snake-like tomopteris, copepods and schizopods, the pelagic larvæ of worms and echinoderms. The important stimulus and instruction of the founder of planktonic investigation has exercised a constant influence on my entire later life, and has given me a lasting interest in this branch of biology.*

Two years later (in August and September, 1856), while at Würtzburg, I accepted the invitation of my honored teacher, A. Kölliker, to accompany him to Nizza, and, under his excellent guidance, became acquainted with the zoölogical treasures of the Mediterranean. In company with Heinrich Müller and K. Kupffer, we investigated especially the rich pelagic animal life of the beautiful bay of Villafranca. There, for the first time, I met those wonderful forms of the pelagic fauna which belong to the classes of the siphonophores, pteropods, and heteropods. I also there first saw living polycyttaria, acanthometra, and polycystina, those phantasmic forms of radiolaria, in the study of which I spent so many later years.

Johannes Müller, who was at this time at Nizza, and had already begun his special investigation of this latter order, called my attention to the many and important questions which the natural history of these enigmatical microscopical organisms present. These valuable suggestions resulted some years later in my going to Italy and spending an entire year in pelagic fishing on the Mediterranean coast. Dur-

* When at Helgoland, investigating the wonders of the plankton with the microscope, Johannes Müller, pleased with the care and patience with which his zealous students tried to study the charming forms of medusæ and ctenophores, spoke to me the ever-memorable words, "There you can do much; and as soon as you have entered into this pelagic wonderland you will see that you can not leave it."

ing the summer of 1859, at Naples and at Capri, I endeavored to gain as wide a knowledge as possible of the marine fauna. In the following winter, at Messina, I devoted my entire attention to the investigation of the radiolaria, and thus obtained the material which forms the basis of my monograph of this class (1862). Daily boat trips in the harbor of Messina made me acquainted with all the forms in the pelagic fauna which make this classic spot, in consequence of the combination of uncommonly favorable conditions, far richer for planktonic study and investigation than any other point on the Mediterranean (3, pp. v, 25, 166, 170).

For a full generation, since that time, the study of plankton has remained my most pleasant occupation, and I have hardly let a year pass without going to the seacoast and, by means of the pelagic net, getting new material for work. Various inducements were offered to me in addition; on the one hand the radiolaria, on the other the siphonophores and medusæ, to which I had already given some attention while at Nizza in 1864. The results of these studies are given in my monographs of these two classes (1879 and 1888). In the course of these three decades I have by degrees become acquainted with the entire coast of the Mediterranean and its fauna. I have already made reference, in the preface to my "System of Medusæ," p. XVI, to the places where I have studied this subject. In addition to the Mediterranean I have continued my planktonic studies on the west coast of Norway (1869); on the Atlantic coast of France (1878); on the British coast (1876 and 1879); at the Canary Islands (1866–67); in the Red Sea (1873), and in the Indian Ocean (1881–82).

By far my richest results and my deepest insight into the biology of the plankton were vouchsafed me during a three months' residence at Puerto del Arrecife, the seaport of the Canary island Lanzarote (in December, 1886, and in January and February, 1887). The pelagic fauna in this part of the Atlantic is so rich in genera and species; the fabulous wealth of life in the wonderful "animal roads" or Zain currents (18, p. 309) is, every day, so great, and the opportunities for investigation on the spot are so favorable that Lanzarote afforded me greater advantages for planktonic study than all the other places ever visited by me (excepting perhaps Messina). Every day the pelagic net brought to me and to my companions (Prof. Richard Greeff and my two students, N. Miklucho-Maclay and H. Fol) such quantities of valuable tow-stuff (*Auftrieb*) that we were able to work up only a very small part of it. At that time I concentrated my chief interest on the medusæ and siphonophores, and the larger part of the new material which is worked up in my monographs of these two classes was collected at Lanzarote. All my observations "On the Development of the Siphonophores" (1869) were made there.

The excursion to the coral reefs of the Red Sea (1873), which is recounted in my "Arabic Corals," and the trip to Ceylon, about which I have written in my "Indian Journal" (*Indische Reisebriefe*, 1882), were extremely valuable to me, because I thereby gained an insight into the wonders of the Indian fauna and flora. On the journey from Suez to Bombay (in November, 1881), as well as on the return from Colombo to Aden (in March, 1882), I was able to make interesting observations on the pelagic fauna of the Indian Ocean, as well as during a six weeks' stay at Belligam and in the pelagic excursions which I made from there. I obtained thereby a living picture of the oceanic and neritic fauna of the Indo-Pacific region, which differs in so many respects from that of the Atlantic-Mediterranean region. The special results of my experience there are, with the kind consent of Dr. John Murray, for the most part embraced in my report on the Radiolaria (1887), and on the Siphonophora (1888), which form parts XVIII and XXVIII of the *Challenger* Report. These two monographic reports also contain many observations on plankton, which I had made in earlier journeys and had not yet published.

The extensive experience which I had gained through my own observations of living plankton during a period of three decades was well filled out by the investigation of the large and well-preserved planktonic collections placed at my disposal from two different sources by Capt. Heinrich Rabbe, of Bremen, and by the *Challenger* directors of Edinburgh. Capt. Rabbe, with very great liberality, turned over to me the valuable collection of pelagic animals which he had obtained on three different trips (with the ship *Joseph Haydn*, of Bremen) in the Atlantic, Indian, and Pacific oceans, and which he had carefully preserved according to my directions and by approved methods. This extraordinarily rich and valuable material, contained in numerous bottles, embraced planktonic samples from the most diverse localities of the three oceans, chiefly in the southern hemisphere. Like the much more extensive collection of the *Challenger*, it gives (though to a smaller degree) a complete summary of the complexity of the composition of the plankton and the difference in its constituents. Rabbe's collection supplements that of the *Challenger* in a most welcome manner, since the course of the *Challenger* was southward from the Indian Ocean through the Antarctic region, and between the Cape of Good Hope and Melbourne was always south of 40° south latitude. The course of the *Joseph Haydn*, on the other hand, on the repeated voyages through the Indian Ocean, was much more northerly, and between Madagascar, the Cocos Islands, and Sumatra included a number of points where the pelagic net obtained a very rich and peculiarly constituted capture. I hope to be able to publish soon in detail the special results which I have obtained by investigation of Rabbe's plankton collection, with the aid of the carefully kept journal which Capt. Rabbe made of his observations. The discoveries of new radiolaria, medusæ, and siphonophores which I owe to these are already embraced in my monographs on these three classes in the *Challenger* Report, and in the preface I have expressed to Capt. Rabbe my sincere thanks for his very valuable aid.

Of all expeditions which have been sent out for investigating the biology of the ocean, that of the *Challenger* was, without doubt, the greatest and the most fruitful, and I recognize it with additional gratitude since I was permitted for twelve years to take part in working up its wonderful material. When, after the return of the expedition, I was honored by its leader, Sir Wyville Thompson, by being summoned to work up the extensive collection of radiolaria, I believed, after a hasty survey of the treasures, that I could complete their investigation in the course of three to five years; but the further I proceeded in the investigation the greater seemed the assemblage of new forms (4, p. XV), and it was a whole decade before the report on the radiolaria (part XVIII) was completed. Three other reports were also then finished—on deep-sea horny sponges (part LXXXII), on the deep-sea medusæ (part XII), and on the siphonophores (part XXVIII) collected by the *Challenger*. The comparative study of these extremely rich planktonic treasures was highly interesting and instructive, not only on account of the daily additions to the number of new forms of organisms in these classes, but also because my general ideas on the formation, composition, and importance of the plankton were enriched and extended. I am sincerely thankful for the liberality with which Sir Wyville Thompson, and after his untimely death (1882) his successor, Dr. John Murray, placed these at my entire disposal.

A record of the 168 stations of observations of the *Challenger* expedition, whose soundings, plankton results, and surface preparations I have been able to investigate, has been given in § 240 of the report on the radiolaria (4, p. CLX). The number of the bottles containing plankton (from all parts of the ocean) in alcohol amounts to more than a hundred, and in addition there are a great number of wonderful preparations which Dr. John Murray finished at the different observation stations, stained with carmine and mounted in Canada balsam. A single such preparation (for example, from station 271) contains often 20 to 30 and sometimes over 50 new species. Since the material for these preparations was taken with the tow net, not only from the surface of all parts of the sea traveled by the *Challenger*, but also from zones of different depths, they make important disclosures in morphology as well as in physiology and chorology. To the study of these station preparations I am indebted for many new discoveries. I have been able to examine over a thousand (4, p. 16).

If I here refer to the development and extension of my own plankton studies, it is because I feel compelled to make the following brief summary of results. I am not now in a position to give the proofs in detail, and must defer the thorough establishment of the most weighty series of observations for a later and more detailed work. But since, to my regret, I am compelled to decidedly contradict the far-reaching assertions made by Hensen (22), it is only to justify and prove these that I refer to my extended experience of many years. I believe I do not err in the assumption that among living naturalists I am one of those who by extensive investigation on the spot have become most thoroughly acquainted with the conditions of the plankton and have worked deepest into these intricate problems of marine biology. If I had not for so many years had these continually in mind, and at each new visit to the sea begun them anew, I would not dare to defend with such determination the assertions expressed in the following pages.

III.—CHOROLOGICAL TERMINOLOGY.

The science of the distribution and division of organic life in the sea (marine chorology) has in the last decade made astonishing progress. Still this new branch of biology stands far behind the closely related terrestrial chorology, the topography and geography of land-dwelling organisms. We have as yet no single work which treats distinctly and comprehensively of the chorology of marine plants and animals in a manner similar to Griesbach's "Vegetation of the Earth" (1872) for the land plants, and Wallace's "Geographical Distribution of Animals" (1876) for the land animals.

How much there is still to be done is shown by the fact that not one of the simplest fundamental conceptions of marine chorology has yet been established. For example, the most important conception of one subject, that of the pelagic fauna and flora, is now employed in three different senses. Originally, and through several decades, this term was used only in the sense in which Johannes Müller used it, for animals and plants which are found swimming at the surface of the sea. Then the term was extended to all the different animals and plants which are found at the surface of fresh-water basins. It was so used, for example, by A. Weismann in his lecture upon "the animal life at the sea-bottom" (1877), in which he "distinguishes the animal world living on the shore from the 'pelagic or oceanic company living in the open sea.'" To a third quite different meaning has the conception of the pelagic living world been widened by Chun (1887), who extends it from the surface of the ocean down to the greatest depths (15, p. 45). In this sense the conception of the pelagic organisms practically agrees with the "plankton" of Hensen.

Errors have already arisen from the varied use of such a fundamental conception, and it seems necessary to attempt to clear this up, and to establish at least the most important fundamental conception of marine chorology. In the use of words I will, as far as possible, conform to the usage of the better authors.

MARINE FLORA AND FAUNA.

Since the old mooted question about "the limits of the animal and vegetable kingdom" comes anew into the foreground in the planktonic studies, a few words must first be devoted to its consideration. In the plankton, those organisms (for the most part microscopic) which stand on the boundary line and which may be regarded as examples of a neutral "Protista realm," play a conspicuous part—the unicellular diatoms and murracytes, dictyochea and palmellaria, thalamophora and radiolaria, dinoflagellata and cystoflagellata. Since it is still asserted that for replies to this boundary question we need new researches, "more exact observations and experiments," I must here express the opposing belief, that the desired answer is not to be obtained by this empirical and inductive method, but only by the philosophic and deductive method of more logical definite conception (*logischer Begriff-Bestimmung*). Either we must use as a definite distinction between the two great organic realms the physiological antithesis of assimilation, and consider as "plants" all "reducing organisms" (with chemical-synthetic functions) and as "animals" all "oxidizing organisms" (with chemical-analytical functions) or we may lay greater weight on the morphological differences of bodily structure and place the unicellular "*Protista*" (without tissues) over against the multicellular *Histona* (with tissues).*

For the problem before us, and with more particular reference to the important questions of the fundamental food supply (*Urnahrung*) and the cycle of matter in the sea (*Stoffwechsel des Meeres*), it is here more suitable to employ the first method. I regard the diatoms, murracytes, and dinoflagellates as *Protophytes*, the thalamophores, radiolarians, and cystoflagellates as *Protozoa*.

For a term to designate the totality of the marine flora and fauna, the expression *halobios* seems to be suitable, in opposition to *limnobios* (the organic world of fresh water) and to *geobios* (as the totality of the land-dwelling or terrestrial plant and animal world). The term *bios* was applied by the father of natural history, Aristotle, "to the whole world of living" as opposed to the lifeless forms, the *abion*. The term biology should be used only in this comprehensive sense, for the whole organic natural science, as opposed to the inorganic, the abiology. In this sense, zoölogy and botany on the one side, and morphology and physiology on the other, are only subordinate parts of biology, the general science of organisms. But if (as is frequently done to-day even in Germany) the term biology is used in a much narrower sense, instead of *œcology*, this narrowing leads to misunderstandings. I mention

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* *Protista* and *Histona* may both again be divided into two groups, on the ground of the different assimilation, into an animal and a vegetable group, the *Protista* into *Protophyta* and *Protozoa*, the *Histona* into *Metaphyta* and *Metazoa*. Compare my "Natural History of Creation" (*Natürliche Schöpfungsgeschichte*), 8th edition, 1889, pp. 420 and 453.

this here because in planktology the interesting and complex vital relations of pelagic organisms, their manner of life and economy, are very often called biological instead of œcological problems.*

PLANKTON AND BENTHOS.

If under the term *Halobios* we embrace the totality of all organisms living in the sea, then these, in œcological relation, fall into two great chief groups, *benthos* and *plankton.* I give the term *benthos*† (in opposition to *plankton*) to all the non-swimming organisms of the sea, and to all animals and plants which remain upon the sea bottom either fixed (sessile) or capable of freely changing their place by creeping or running (vagrant). The great œcological differences in the entire mode of life, and consequently in form, which exist between the benthonic and planktonic organisms, justify this intelligible distinction, though here as elsewhere a sharp limit is not to be drawn. The *benthos* can itself be divided into littoral and abyssal. The *littoral-benthos* embraces the sessile and vagrant marine animals of the coast, as well as all the plants fixed to the sea-bottom. The *abyssal-benthos*, on the other hand, comprises all the fixed or creeping (but not the swimming) animals of the deep sea. Although as a whole the morphological character of the *benthos*, corresponding to the physiological peculiarities of the mode of life, is very different from that of the *plankton*, still these two chief groups of the *halobios* stand in manifold and intimate correlation to one another. In part these relations are only phylogenetic, but also in part at the present day of an ontogenetic nature, as, for example, the alternation of generations of the benthonic polyps and the planktonic medusæ. The adaptation of marine organisms to the mode of life and the organization conditioned thereby may in both chief groups be primary or secondary. These and other relations, as, well as the general characteristics of the pelagic fauna and flora, have already been thoroughly considered by Fuchs (12) and Moseley (7).

PLANKTON AND NEKTON.

The term *plankton* may be used in a wider and in a narrower sense; either we understand it as embracing all organisms swimming in the sea, those floating passively and those actively swimming; or we may exclude these latter. Hensen comprehends under *plankton* "everything which is in the water, whether near the surface or far down, whether dead or living." The distinction is, whether the animals are driven involuntarily with the water or whether they display a certain degree of independence of this impetus. Fishes in the form of eggs

* The terms biology and œcology are not interchangeable, because the latter only forms a part of physiology. Comp. my "Generelle Morphologie," 1866, Bd. I, p. 8, 21; Bd. II, p. 286; also my "Ueber Etwickelungsgang und Aufgabe der Zoölogie," Jena. Zeitsch. fur Med. u. Nat., Bd. V, 1870.

† *βένθος*, the bottom of the ocean; hence the organisms living there.

and young belong in the highest degree to the plankton, but not when mature animals. The copepods, although lively swimmers, are tossed about involuntarily by the water, and, therefore, must be reckoned in the plankton (9, p. 1). If, with Hensen, we thus limit the conception of *plankton*, then we must distinguish the *actively* swimming *nekton* from the *passively* driven *plankton*. The term thus loses its firm hold, and becomes dependent on quite variable conditions; upon the changing force of the current in which the animal is driven, by the momentary energy of voluntary swimming movements, etc. A pelagic fish or copepod, which is borne along by a strong current, belongs to the plankton; if he can make a little progress across this current, and if, besides this, he can voluntarily and independently define his course, then he belongs also to the nekton. It therefore seems to me advisable, as preliminary, to regard the term plankton in the wider sense, in opposition to benthos.

Still, for the chief theme which Hensen has set up in his plankton studies, for the physiological investigation of the cycle of matter in the sea (*Stoffwechsel des Meeres*), this limitation of the plankton conception will not hold; for a single large fish which daily devours hundreds of pteropods or thousands of copepods exerts a greater influence on the economy of the sea than the hundreds of small animals which belong to the plankton. I will return to this in speaking of the vertebrates of the plankton. If with Hensen we could, on practical grounds, separate those animals of the plankton which are carried involuntarily from those following their own voluntary swimming movements (independent of the current), we might distinguish the former as *ploteric*,* the latter as *necteric*.*

HALIPLANKTON AND LIMNOPLANKTON.

Although the swimming population of fresh water shows far less variety and peculiarity than that of the sea, still among the former as among the latter similar conditions are developed. Already the study begins to take a joyous flight to the pelagic animals of the mountain lakes, etc. Therefore, it will be necessary here also to fix limits, as has been already done for the marine fauna; but since the term "pelagic" should only be used for marine animals, it becomes advisable to designate as *limnetic* the so-called "pelagic" animals of fresh water. Among these we can again distinguish *autolimnetic* (living only at the surface), *zonolimnetic* (limited to certain depths), and *bathylimnetic* (dwellers in the deep waters). The totality of the swimming and floating population of the fresh water may be called *limnoplankton*, as opposed to the marine *haliplankton* (9, p. 1), which we here briefly call *plankton*.

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* Πλωτήρ = drifting; νηκτής = swimming.

OCEANIC AND NERITIC* PLANKTON.

The manifold differences which the character of the plankton shows according to its distribution in the sea, lead first, with reference to its horizontal extension, to a distinction between oceanic and neritic plankton. *Oceanic plankton* is that of the open ocean, exclusive of the swimming *bios* of the coast. The region of oceanic plankton may from a zöological point of view be divided into five great provinces: (1) the Arctic Ocean; (2) the Atlantic; (3) the Indian; (4) the Pacific; (5) the Antarctic. In each of these five great provinces the characteristic genera of the plankton are apparent through the different species, even if the differences in general are not so significant as in the different provinces of the neritic and still more of the littoral fauna.

The neritic plankton embraces the swimming fauna and flora of the coast regions of the continents as well as the archipelagos and islands. This is in its composition essentially different from the oceanic plankton, and is quantitatively as well as qualitatively richer. For along the coast there develop, partly under protection of the littoral *bios*, or in genetic relation with it, numerous swimming animal and vegetable forms which do not generally occur in the open ocean, or there quickly die; but the floating organisms of the latter may be driven by currents or storms to the coast and there mingled with the neritic plankton. Aside from this the richness of the neritic plankton in genera and species is much greater than that of the oceanic. The complicated and manifold relations of the latter to the former, as well as the relations of both to the benthos (littoral as well as abyssal), have been but little investigated and contain a fund of interesting problems. One could designate the neritic plankton also as "littoral plankton" if it were not better to limit the conception of the littoral bios to the non-swimming organisms of the coast, the vagrant and sessile forms.

PELAGIC, ZONARY, AND BATHYBIC PLANKTON.

I keep the original meaning of the *pelagic plankton* as given forty-five years ago by Johannes Müller, and used since by the great majority of authors. I also limit the meaning of the pelagic fauna and flora to those actively swimming or passively floating animals and plants, which are taken swimming at the surface of the sea, no matter whether they are found here alone or also at a variable depth below the surface. These are the *superficial* and *interzonary* organisms of Chun (15, p. 54). On the other hand, I distinguish the *zonary* and *bathybic* organisms; I call *zonary plankton* those organisms which occur only in zones of definite depths of the ocean, and above this (at the surface of the sea) or below (at the sea bottom) are only found occasionally, as for example many phæodaria and crustacea; also the deep-sea siphonophores dis-

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* Νηρίτης, son of Nereus.

covered by Chierchia, which were taken by him in great numbers and in great vertical and horizontal extension, but never higher than 1,000 meters below the surface and never deeper than 1,000 meters above the sea bottom (8, p. 85). The deepest part of this zonary fauna forms the *bathybic plankton* (or the profound tow-stuff, *Auftrieb*), *i. e.*, animals of the deep sea, which only hover over the bottom but never touch it, whether they stand in definite relation to the abyssal benthos or not. One might also call them "*abyssal plankton*," if it were not more practicable to limit the term "abyssal" to the (vagrant and sessile) benthos of the deep sea. To the bathybic plankton belong many phæodaria, some medusæ and siphonophores, many deep-sea crustacea, *Tomopteris euchæta*, *Megalocercus abyssorum*, etc. (15, pp. 55–57).

In each of these vertical parts of the plankton, distinctions may be made which apply to the *horizontal* distribution. We may also distinguish oceanic and neritic forms in the pelagic fauna as in the zonary and bathybic fauna.

AUTOPELAGIC, BATHYPELAGIC, AND SPANIPELAGIC PLANKTON.

If, following the old custom, we limit the term "pelagic *bios*" to those organisms which, at some time, swim or float at the *surface* of the sea—if we do not with Chun (15, p. 45) extend this term to the zonary and bathybic animals—it still is necessary to further distinguish by different terms those forms of life which constantly, temporarily, or only exceptionally live at the surface of the sea. I suggest for these the terms autopelagic, bathypelagic, and spanipelagic. *Autopelagic* are those animals and plants which are constantly found only at the surface (or in stormy weather at slight depths below it), the "superficial" of Chun (15, pp. 45, 60). To this "constant superficial fauna" belong, for example, many polycyttaria (most sphærozoids), many medusæ (*e. g.*, *Eucopidæ*), and many siphonophores (*e. g.*, *Forskalidæ*); further, the lobate ctenophores (*Eucharis*, *Bolina*), particular species of *Sagitta* (*e. g.*, *bipunctata*), and many copepods (*e. g.*, *Pontellina*, 15, p. 27).

I call *bathypelagic* all those organisms which occur not merely at the surface, but also extend down into the depths, and often fill the deep layers of the ocean in not less astonishing multitudes than the surface layers. Chun designates such bathypelagic animals as "interzonary pelagic animals" (15, p. 45). Here belongs properly the chief mass of the plankton; for through the agreeing researches of Murray (5, 6), Moseley (7), Chierchia (8), and Chun (15, 16), as well as from my own wide experience, it becomes highly probable that the great number of pelagic animals and plants only pass a part of their lives at the surface; swimming at different depths during the other part. Among the bathypelagic animals there are farther to be distinguished: (*a*) *Nyctipelagic*, which arise to the surface only at night, living in the depths during the day; very many medusæ, siphonophores, pyrosoma, most pteropods, and heteropods, very many crustacea, etc.; (*b*) *Chimopelagic*, which appear at the surface only in winter and in summer are hidden in the depths—radiolaria, medusæ, siphonophores, ctenophores, a part of the pteropods and heteropods, many crustacea, etc.; (*c*) *Allopelagic*, which perform irregular vertical wanderings, sometimes appearing at the surface, sometimes in the depths, independently of the changes of temperature, which condition the change of abode of the nyctipelagic and chimopelagic animals; the final cause of these wanderings ought to be found in different œcological conditions, as of reproduction, of ontogeny, of food supply, etc.

Finally one may call *spanipelagic* those animals which always live in the ocean depths (zonary or bathybic), and come to the surface only exceptionally and rarely. This does not apply to a few deep-sea animals which once every year ascend to the surface, but only for a short time, for a few weeks or perhaps for a single day, *e. g.*, *Athorybia* and *Physophora* among the siphonophores, *Charybdea* and *Periphylla* among the medusæ. The final cause of this remarkable spanipelagic mode of life must lie chiefly in the conditions of reproduction and ontogeny. These animals must be much more numerous than present appearances show.

HOLOPLANKTONIC AND MEROPLANKTONIC ORGANISMS.

Numerous organisms pass their whole life and whole cycle of development hovering in the ocean, while with others this is not the case. These rather pass a part of their life in the benthos, either vagrant or sessile. The first group we call *holoplanktonic*, and the second *meroplanktonic.* To the holoplanktonic organisms, which have no relation whatever to the benthos, belong the greater part of the diatoms and oscillaria, all murracytes and peridinea; further all radiolaria, many globigerina, the hypogenetic medusæ (without alternation of generations), all siphonophores and ctenophores, all chætognathæ, pteropods, the copelata, pyrosoma, and thalidia, etc. Among these we find "purely pelagic, zonary, or bathybic" forms.

The *meroplanktonic* organisms, on the other hand, which are found swimming in the sea only for a part of their life, passing the other part vagrant or sessile in the benthos (either littoral or abyssal), are represented by the following groups: A part of the diatoms and oscillaria, the planktonic *fucoids*, the metagenetic medusæ (*Craspedota* with hydroid nurse, *Acraspeda* with scyphistoma nurse), some turbellarians and annelids, etc; further, the "pelagic larvæ" of hydroids and corals, many helminths and echinoderms, acephala and gasteropods, etc.

IV.—SUMMARY OF THE PLANKTONIC ORGANISMS.

A.—Protophytes of the Plankton.

The *unicellular plants* (*Protophyta**) have very great importance in the physiology of the plankton and the cycle of matter in the sea (*Stoffwechsel des Meeres*), for they furnish by far the greater part of the fundamental food (*Urnahrung*). The inconceivable amount of food which the countless myriads of swimming marine animals consume daily is chiefly derived, directly or indirectly, from the planktonic flora, and in this the unicellular protophytes are of much greater importance than the multicellular metaphytes. Nevertheless the natural history of these small plants has thus far been very much neglected. As yet no botanist has attempted to consider the planktonic flora in general, and its relation to the planktonic fauna. Only that single class, so rich in forms, the diatoms, has been thoroughly investigated and systematically worked up; as regards the other groups, not a single attempt at systemization has been made; and many simple forms of great importance have lately been recognized for the first time as unicellular plants. I must, therefore, limit myself here to a brief enumeration of the most important groups of the plankton flora. Its general extent and quantitative development have in my opinion hitherto been much undervalued, and with reference to the cycle of matter in the sea (*Stoffwechsel des Meeres*) deserve a thorough consideration. I find masses of various protophytes everywhere in the plankton, and suspect that they have been neglected chiefly because of their small size and inconspicuous form. Many of these, indeed, have been regarded as protozoa or as eggs of planktonic metazoa.

As a foundation for a most important province of botany, the classification of the protophytes, we must keep in the foreground the following considerations: (1) The kind of reproduction, whether by simple division (*Schizophyta*) into two, four, or many parts, or by formation of motile swarm-spores, *Mastigophyta;* (2) the constitution of the phytochroms, of yellow, red, or brown pigment, which is distributed in the protoplasm of the cell (usually in the form of granules), and has great significance in assimilation (chlorophyll, diatomin, erethrin, phæodin, etc.); (3) the morphological and chemical constitution of the *cell-membrane* (cellulose, siliceous, capsular, or bivalvular, etc.). So long as we hold to the present view of the vegetable physiologists, that for the fundamental process of vegetal assimilation, for the synthesis of protoplasm and amylum, the presence of the vegetal pigment matter is necessary, we can regard as true protophytes only such unicellular organisms as are provided with such a phytochrom, but we will have to

*The separation of the *Protophyta* from the *Metaphyta* is as justifiable as that of the *Protozoa* from the *Metazoa*. The latter form tissues, the former do not. (Compare Naturl. Schöpfungsgeschichte, VIII Aufl., 1889, pp. 420–453.)

include here a great number of protista, which have hitherto been reckoned as protozoa, *e. g.*, the *Murracyteæ*, *Dictyocheæ*, *Peridineæ*. As characteristic and important protophytes of the plankton I here mention seven groups: (1) *Chromaceæ*, (2) *Calcocyteæ*, (3) *Murracyteæ*, (4) *Diatomeæ*, (5) *Xanthelleæ*, (6) *Dictyocheæ*, (7) *Peridineæ*.

1. *Chromaceæ* (30, p. 452).—In this lowest vegetable group is probably to be placed a number of small "unicellular algæ" of simplest form, which occur in great abundance in the plankton, but on account of their minute size and simple spherical shape have for the most part been overlooked, or possibly regarded as germ cells of other organisms. They may here be provisionally distinguished as *Procytella primordialis*. The diameter of the spherical cells in the smaller forms is only about .001 to .005 mm., in the larger .008 to .012 mm, seldom more. Usually each cell contains only one phytochrom granule of greenish color, sometimes approaching a yellow or red, sometimes a blue or brown. Whether there is also a diminutive nucleus is doubtful. Increase takes place simply by division into two or four parts, and appears to go on with excessive rapidity, but swarm spores do not appear to be formed. Hundreds or thousands of such green spheres may be united in a mass of jelly. The decision whether these simplest *Chromaceæ* belong to the *Chlorcocceæ* or *Protococceæ*, or to some other primitive protophytic group, must be left to the botanist for further investigation, as well as the question whether these diminutive *Procytellæ* are actually true nucleated cells or only unnucleated cytodes. For our plankton studies these are of interest only so far as they develop in astonishing quantities in many (the colder) regions of the ocean, like the diatoms; and with the latter form a great part of the fundamental food (*Urnahrung*). Over wide areas the sea is often colored brown or green, and they form the chief food (described as *Protococcus marinus*) of inconceivable myriads of copepods, as Kükenthal has mentioned in his "Contributions on the Fauna of Spitzbergen."

2. *Calcocyteæ*.—In the eighth edition of the "*Naturliche Schopfungsgeschichte*" (30, p. 437) I have designated as *Calcocyteæ* or "unicellular calcareous algæ" those important minute organisms which, as "*Coccosphæra*, *Cyathosphæra*, and *Rhabdosphæra*, play a great rôle in oceanic life. They are found abundantly in the plankton of the tropical and subtropical seas, less abundantly in colder zones, and are never absent where pelagic *Thalamophora* occur in great numbers. Like the latter, they are bathypelagic. The ball of protoplasm which completely fills the interior of the small calcareous-shelled plastid seems, when stained red with carmine or brown with iodine, to be unnucleated, and therefore a cytode. The beautiful calcareous plates which compose the shell (*Coccolitha*, *Cyatholitha*, *Rhabdolitha*), and which in the *Rhabdosphæra* bear a radial spine, fall apart after death and are found in great numbers in all parts of the warmer oceans and in the globigerina ooze of the bottom. Murray (5, p. 533; 6, p. 939) and Wyville Thompson (14, I, p. 222)

were the first to demonstrate the wide distribution and innumerable abundance of this unicellular calcareous alga, and I agree with them in the supposition that these play a significant part in the biology of the ocean and in the formation of its globigerina ooze.

3. *Murracyteæ.*—Under this name I may here refer to the very important but hitherto neglected group of planktonic protophytes, which were first discovered by John Murray and described under the name *Pyrocystis* (5, p. 533, plate XXI; 6, pp. 935–938). These "unicellular algæ" are transparent vesicles, from 0.5 to 1 or 1.5 millimeters in diameter, and spherical, oval, or spindle-shaped in form. Their simple continuous cell membrane is very thin and fragile, like glass. It is stained blue by iodine and sulphuric acid, and seems to contain a small quantity of siliceous earth. The contents of the vesicle is a vacuolated cell, whose protoplasmic network contains many yellow granules of diatomin. The spherical form (*Pyrocystis noctiluca* Murray) is very similar in size and form to the common *Noctiluca miliaris* and probably is very often mistaken for it. I saw these thirty years ago (1860) at Messina, and later (1866) at Lanzarote, in the Canary Islands.

When John Murray published in 1876 the first figures and careful description, he at first placed them with the diatoms, but later (6, p. 935) he has, with justice, separated them. He there says of *Pyrocystis noctiluca:*

This organism is everywhere present, often in enormous masses, at the surface of the tropical and subtropical oceans, where the temperature is not more than 20° to 21° C., and the specific gravity of the oceanic water is not diminished by the presence of coast and river water. *Pyrocystis* shines very brightly; the light comes from the nucleus and is *the chief source of the diffuse phosphorescence of the equatorial oceans* in calm weather.

Since these unicellular vegetable organisms do not have the characteristic bivalve shell or siliceous case of the diatoms, but their cell membrane forms a completely closed capsule, they can not be reckoned with the latter, but must be regarded as representatives of a different group of protophytes, for which I propose the name *Murracyteæ* or "glass bladders" (*Murra*, a name given by the Romans to a glasslike mineral—fluospar (?)—from which costly articles are made.)*

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*In the Atlantic and Indian oceans I have seen great masses of *Murracyteæ*, and have distinguished many species, which may be regarded as representatives of four genera: (1) *Pyrocystis noctiluca* Murray; spherical. (2) *Photocystis ellipsoides* Hkl; ellipsoid. (3) *Murracystis fusiformis* Hkl (*Pyrocystis fusiformis* Murray); spindle-shaped. (4) *Nectocystis murrayana* Hkl; cylindrical. The *Murracytes* multiply, as it appears, only by simple division (commonly into two parts, less frequently into four). After the nucleus, lying eccentrically or against the cell wall, has divided, there follows division of the soft cell body, which is separated from the firm capsulelike membrane by a wide space (filled with a jelly). Then the membrane bursts, and around the two halves or four tetrads there is immediately formed a new covering. Considered phylogenetically, the *Murracytes* appear as very old oceanic *Protophytes* of very simple structure. Perhaps they ought to be regarded as the ancestral form of the diatoms, for the bivalvular shell of the latter could have arisen by a simple halving of the capsule of the former.

4. *Diatomeæ.*—The inconceivable quantities in which the diatoms populate the whole ocean and the extraordinary importance which they possess as one of the most important constituents of the "fundamental food supply" (*Urnahrung*) in the cycle of matter in the sea has been considered so many times that it is sufficient here to point to the comparatively recent accounts of Murray (5, p. 533; 6, p. 737, etc.), Fuchs (12, p. 49), Castracane (6, p. 930), and Hensen (9, p. 80). Earlier the chief attention was paid to the benthonic diatoms which everywhere cover the seacoast and the shallow depths of the sea bottom in astonishing quantities; in part fixed on stalks, in part slowly moving among the forests of seaweed and the fixed animal banks (*festsitzenden Thierbanken*) of the coast. The importance of the planktonic diatoms was recognized much later, those abounding in the open ocean as well as in the coast waters furnishing one of the most important sources of food for the pelagic animals. The *oceanic diatoms*, which often cover the surface of the open sea as a thick layer of slime, form another flora, very insufficiently studied and characterized by many forms of colossal size (several millimeters in diameter), peculiarly regular in form, and with extremely thin-walled siliceous shells (species of *Ethmodiscus*, *Coscinodiscus*, *Rhizosolenia*, etc., discovered in such numbers by the *Challenger*). The *neritic diatoms*, on the other hand, which, swimming free in no small numbers, populate the coast waters, are less in diameter and with thicker walls, and stand on the whole between the oceanic and littoral forms. The absolute and relative quantity of the planktonic diatoms seems to increase gradually from the equator towards both poles.

In the tropical zone the pelagic diatoms are much less developed than in the temperate zone, and here again much less than in the polar zone. Wide stretches of the Arctic Ocean are often changed by inconceivable masses of diatoms into a thick dark slime, the "black water," which forms the feeding-ground of whales. The pteropods and crustaceans, upon which these cetaceans live, feed upon this diatom slime, the "black water" of the Arctic voyager. Not less wonderful are the vast masses of diatoms which fill the Antarctic Ocean south of the fiftieth degree of latitude, and whose siliceous shells, sinking to the bottom after the death of the organism, form the diatom ooze (*Challenger*, stations 152–157). The tow nets here were quickly filled with such masses of diatoms (for the most part composed of *Chætoceros*) that these when dried in the oven formed a thick matted felt (6, p. 920).

5. *Xanthelleæ.*—A highly important share in the cycle of matter in the sea belongs to the remarkable *xanthelleæ* or "yellow cells," which live in *symbiosis* in the bodies of many marine animals, in the plankton as well as in the benthos. I first proved that these "yellow cells," which were observed by Huxley (1851) and by Johannes Müller (1858) in the calymma of radiolarians, were "undoubted cells," and also described their structure and increase by division (3, p. 84), and later (1870) showed that they constantly contained amylum (4, § 90). But Cien-

kowski first advanced the view that the yellow cells are independent unicellular organisms, parasitic algæ, which for a time live in the bodies of the radiolarians, but after the death of the latter come forth and multiply by division. This supposition was confirmed experimentally by Karl Brandt (24, p. 65) and Patrick Geddes, who explained further the nature of their symbiosis, and finally showed the wide distribution of the *xanthelleæ* in the bodies of numerous marine animals, as well as their production of zoöspores (*Zoöxanthella*, *Philozoön*). Whether these are ontogenetically connected with certain "yellow unicellular algæ" which live free in the plankton, remains to be farther investigated. Perhaps also in this group belong the *Xanthidea* which were described by Hensen (9, p. 79) and Möbius (10, p. 124) as species of *Xanthidium* and as "spiny cystids," spherical cells which reach 1 millimeter in diameter, contain yellow diatomin granules, and multiply by division. Their thick hyaline shell, which seems to consist of slightly silicified cellulose, armed with simple or star-shaped radial spines, is characteristic. I find these *Xanthideæ* very numerous in the oceanic plankton. Perhaps the siliceous-shelled *Xanthidia*, which Ehrenberg has found so abundantly as fossils, also belong here.

6. *Dictyocheæ.*—The ornamented latticed cases of the *Dictyochidæ*, formed of hollow siliceous spicules, are often found in great numbers in the plankton, pelagic as well as zonary. Although these have long been known, both living and as fossils, to microscopists, two very different views as to their true nature are entertained.*

In a preliminary contribution "On the Structure of *Distephanus* (*Dictyocha*) *speculum*" Zoöl. Anzeiger, No. 334, one of my earlier students, Adolf Borgert, briefly showed that each single case contains an independent ciliated cell. He therefore considered it a new group of *Flagellata* (or *Mastigophora*), for which he proposed the term *Silicoflagellata*. The "twin parts" described by me (4, p. 1549) he regarded as a double case which had arisen through the conjugation of two individual *flagellata*. To my mind this new interpretation seems to have very considerable probability, although I do not regard it as settled that the ciliated cells are the swarm-spores of the *Phæodarium*. In case

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*Ehrenberg, who in 1838 and 1841 first described the ornamented siliceous skeletons of *Dictyocha* and *Mesocena*, called them diatoms and distinguished no less than 50 species of them, some living, some fossil. Later, at Messina (1859), I noticed, inclosed within the ornamented hat-shaped latticed shell a small cell, and on that account referred it to the *Radiolaria*, with reference particularly to the similar siliceous skeletons of some *Nassellaria* (*Acanthodesmida*). Twenty years later R. Hertwig found a spherical *Phæodarium*, the surface of whose calymma was covered with numerous *Dictyocha* little hats (*Dictyocha-Hütchen*), and he therefore believed that they must belong to this legion. He compares the single siliceous little hats (*Hütchen*) with the scattered spicules of the *Sphærozoida*. In my *Challenger* report (4, p. 1558) I agreed with this interpretation; so much the more when I myself saw numerous similar *Phæcystina* (*Dictyocha stapedia*) living among a similar *Phæodaria* in Ceylon, and found specimens in several bottles of the *Challenger* collections, especially from Station 144, from the Cape of Good Hope (4, p. 1561, pl. 101, Figs. 10–12).

the greenish-yellow pigment granules in the protoplasm of the *Dictyochidæ* are chlorophyll or phytochrom, they must be placed with "unicellular algæ." If, as I believe, the supposition of Borgert is correct, then the masses of *Dictyochidæ* shells found so abundantly in the calymma of *Phæodariæ* can be regarded only as the empty shells of *Silicoflagellata*, which the skeletonless *Phæodina* has taken in as food. This supposition is much more probable since these, together with siliceous scales of diatoms and tintinnoids, have been found in great numbers in the calymma of other radiolarians. This case would then be analogous to two similar appearances which I myself have previously described, *Myxobrachia pluteus* (4, p. 22) and *Dalcaromma calcarea* (4, p. 70, § 102).

7. *Peridineæ* (*Dinoflagellata or Dinocytea, earlier Cilioflagellata*).—This group of *Flagellata* (or *Mastigophora*) earlier placed with the *Infusoria*, has lately, with more certainty, been recognized as a protophytic group with vegetable metabolism. They are represented in the plankton by numerous and, in part, remarkable and beautiful forms, a part of which have been lately figured by Stein under the name *Arthrodele flagellata.* Many such forms occur in the neritic, fewer in the oceanic plankton, and often in such masses that they take a great part in the formation of the fundamental food supply. Hensen correctly points out the great importance of these *Protista*, of whose quantity he attempted to give a conception by counting (9, p. 71). Many of these participate in a prominent way in the marine population (*Ceratium*, *Prorocentrum*, etc.). John Murray very often found chains of *Ceratium tripus* (each composed of eight cells) floating in the plankton of the open ocean, without ciliary movements, while the ciliated single cells inhabited the neritic plankton in vast numbers close to the shore. Sometimes these crowds of *Peridineæ*, like the diatoms, appeared so abundantly as to fill the tow net with a yellow slime (6, p. 934).

B.—Metaphytes of the Plankton.

The only class of metaphytes which occurs in the plankton are the algæ. The great majority of this class, so rich in forms, belong to the littoral benthos; only a few forms have adopted the pelagic mode of life, and of these only two, from their great abundance, are of any considerable importance in the oceanic fundamental food supply, the *Oscillatoriæ* which live in the depths, and the *Sargassa* which grow at the surface. A third group, the *Halosphæreæ*, is much less abundant and important, but of considerable interest in many relations.*

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* The *Oscillatoriæ* must be regarded as true algæ, since their characteristic "jointed threads" ("*Glieder-faden*") form an actual *Thallus*, and indeed a thread-like thallus, as in the *Confervæ*. But on the same grounds also we must regard as *algæ* the *Volvocineæ* and *Halosphæreæ* with spherical thallus; they are also multicellular *Metaphytes*, which show the simplest form of tissue (*Histones*, 30, p. 420). The foregoing prototypes, on the other hand, have no tissue, since the entire organism is only a simple cell (*Protista*, 30, p. 453).

1. *Halosphæreæ.*—Under the name *Halosphæra viridis*, Schmitz (1879) first described a new genus of green algæ from the Mediterranean, which appear floating in the plankton of the Gulf of Naples in great numbers from the middle of January until the middle of April. They form swimming hollow spheres, from 0.55 to 0.62 mm. in diameter, whose thin cellulose wall is covered within by a single layer of chlorophyll containing cells analogous to the blastoderm of the metazoic egg. Each of these epithelial cells divides later into several daughter cells, each of which forms four cone-shaped swarm-spores with two ciliated cells. I have known this green ball for thirty years. In February, 1860, I found them numerous in the plankton of Messina. I observed a second kind in February, 1867, at Lanzarote, in the Canary Islands. The hollow spheres found in the Atlantic are twice as large, and reach a diameter of 1 to 1.2 mm. They have pear-shaped swarm-spores. I named them *Halosphæra blastula.* Morphologically these hollow spherical algæ are of great interest, since they are directly comparable to the blastula (or blastosphere stage) of the metazoic embryo. As the latter is to be regarded as the simplest type of the metazoon, so *Halosphæra* (like *Volvox*) can be looked upon as the primitive ancestral form of the *Metaphyta* (4, p. 499). Hensen has lately found numerous living specimens of *Halosphæra viridis* in five hauls from a depth of 1,000 to 2,000 meters (10, p. 521). The light of the bathybic luminiferous animals may possibly be sufficient for their metabolic activity.

2. *Oscillatoriæ.*—Like the diatoms in the cold regions of the ocean, the oscillatoriæ (*Trichodesmium* and its allies) are found in the warm regions in inconceivable quantities. It is very certain that the latter, as well as the former, belong to the most important source of the "fundamental food supply." Ehrenberg in 1823 observed in the Red Sea, at Tur, such large quantities of *Trichodesmium erythræum* that the water along the shore was colored blood-red by them. Möbius has recently carefully described the same thing anew, and has (quite correctly) traced from it the name of the Red Sea (26, p. 7). Later, I myself found just as great numbers as these in the Indian Ocean at Maledira and Ceylon (25, p. 225). In Rabbe's collections are several bottles of plankton (from the Indian and Pacific oceans) entirely filled with them.* The *Challenger* found great quantities of *Trichodesmium* in the Arafura Sea and Celebes Sea (6, p. 545, 607), and also in the Guinea stream (6, p. 218); and between St. Thomas and the Bermudas (6, p. 136) wide stretches of the sea were colored by it dark red or yellowish brown. Murray found it only in the superficial, never in the deeper layers of the ocean.

3. *Sargasseæ.*—The higher algæ are represented in the planktonic flora only by a single group, the *Sargasseæ*, and these again are com-

*In the collection of *Radiolaria*, which may be purchased from the famulus Franz Pohle, at Jena, preparation No. 5; from Madagascar, contains many flakes of this *Oscillatoria.*

monly only of a single species, *Sargassum bacciferum*; but this has the greatest importance, since, as is known, it alone forms the floating sargasso banks, which cover such extensive portions of the ocean. Besides this very important species, other fucoids are found floating in the ocean, especially species of *Fucus* (*F. vesiculosus*, *F. nodosus*, and others). Still they never appear in such masses as the familiar "berry weed." The floating sargasso banks are well known to have their characteristic animal life, which Wyville Thompson accurately described and fittingly termed nomadic (14, II, pp. 9, 339).

This remarkable sargasso fauna bears the same character in both the Atlantic and the Pacific oceans and consists partly of benthonic animals, which live sessile or creeping on the sargasso weed, partly of planktonic organisms which swim among the weeds; the latter are more neritic than oceanic. Hensen has lately described this fauna as remarkably poor, and could only find 10 species of animals in it (9, p. 246). The *Challenger* found more than five times as many species in this same Atlantic sargasso, namely, 55 (6, p. 136). It is obvious that the remarkable negative results of Hensen on this as on other planktonic questions can have no value against the positive results of other investigators.

C.—Protozoa of the Plankton.

The two great chief groups of unicellular animals, *Rhizopoda* and *Infusoria*, occur in the ocean in very different proportions, in the reverse condition to that in fresh water.

The *Infusoria* (*Flagellata* and *Ciliata*), which chiefly form the protozoic fauna in the latter, are indeed represented in the sea by a great number of species, but the most belong to the littoral benthos, and only a few swimming species occur in such quantities that they are of importance in the plankton, the *Noctilucidæ* among the *Flagellata*, the *Tintinnoidæ* among the *Ciliata*. Much greater is the wealth of the ocean in *Rhizopoda*, calcareous-shelled *Thalamophora* and siliceous-shelled *Radiolaria*. The accumulated masses of these shells form the most important sediment of the ocean, while their unicellular soft bodies constitute the chief food supply for many planktonic animals.

Infusoria.—As is known, the *Infusoria* do not play so great a rôle in the life of the ocean as in that of the fresh water. It is true that a great number of *Flagellata* and *Ciliata* occur in the neritic or littoral fauna, but neither on account of the number of individuals nor the richness of forms are they elsewhere of importance, and only a few small groups extend out into the open sea. It seems as if these tender and for the most part uncovered *Protozoa* are not suited for the contest which the wild "struggle for existence" offers here. The armored rhizopods take their place. Still two small and very peculiar groups of *Infusoria* are found in very great numbers in the plankton, and sometimes in such quantities as to form the chief bulk; the *Noctiluca* among the *Flagellata*, and the *Tintinna* among the *Ciliata*. Both groups, and particularly the *Noctilucidæ*, belong to the neritic plankton. They occur in the oceanic only where the coast water flows in (6, pp. 679, 750, 933).

The common *Noctiluca miliaris* and some related species sometimes cover the surface of the coast waters in such masses as to form a thick reddish-yellow slime, often like "tomato soup," and at night are brightly luminous. The *Tintinnoidæ* (*Tintinnus*, *Dictyocysta*, *Codonella*) appear in smaller quantities, but often in great numbers. Some forms of these elegant *Ciliata* are oceanic.

Thalamophora (*Foraminifera*).—The *Thalamophora*, often and very properly called *Foraminifera*, were once generally regarded as benthonic. New observations first showed that a part of these are planktonic, and through the comprehensive series of observations by the *Challenger* the abundant occurrence of these pelagic *Foraminifera* and their great part in the formation of that most important sediment, the *Globigerina* ooze, was first established. All these *Thalamophora* of the plankton belong to the peculiar perforated *Polythalamia*, to the family of the *Globigerinidæ;* only *Orbulina* (provided it is independent) to the *Monothalamia*. The number of their genera (8–10) and species (20–25) is relatively small, but the number of individuals is inconceivably great. By far the most important and numerous belong to the genera *Globigerina*, *Orbulina*, and *Pulvinulina*; after these *Sphæroidina* and *Pullenia*. They occur everywhere in the open ocean in numberless myriads. J. Murray could often from a boat scoop up thick masses of them with a glass, and never fished with the tow net in 200 fathoms without obtaining some (5, p. 534). A few forms (*Hastigerina* and *Cymbalopora*) show more local increase in numbers, while others are rare everywhere (*Chilostomella*, *Candeina*). In the equatorial countercurrents of the Western Pacific, between the equator and the Caroline Islands, the *Challenger* found "great banks of pelagic foraminifera. On one day an unheard-of quantity of *Pulvinulina* was taken in the tow nets; on the following day they were entirely absent, and *Pullenia* was extraordinarily abundant." These important observations by Murray I can confirm from my own experience in the Atlantic and Indian oceans* (comp. 3, pp. 166, 188).

*The important relations of these pelagic *Polythalamia* to the rest of the fauna of the plankton on the one side, as well as its importance in the formation of the "*Globigerina* ooze" on the other, has been expressly stated by Murray (6, p. 919). I agree completely with him in the view that these oceanic *Globigerinidæ* are true pelagic rhizopods, which in part are found swimming only at the surface or at slight depths (autopelagic), in part at zones of different depths (zonary), but they are not benthonic. The enormous sediment of "*Globigerina* ooze" is composed of the sunken calcareous shells of the dead pelagic animals. On the other hand, the benthonic thalamophores, living partly abyssal, on the bottom of the deep sea, partly littoral, creeping among the forests of seaweed on the coasts, are of other species and genera. They develop a much greater variety of form. The neritic thalamophores found swimming in the coast waters are in part again characterized by various forms.

Radiolaria.—No class of organisms has remained so long unknown to us, and by the brilliant discoveries of the last decade has been suddenly placed in so clear a light, as the *Radiolaria* (comp. 4, § 251–260). For half a century we knew next to nothing of these wonderful rhizopods; to-day they appear as one of the most important planktonic classes.* These, the most varied in form of all the unicellular organisms, form a *purely oceanic class*, and live and swim in all seas, especially in the warmer ones. Numerous species are also found near the coasts, yet these are not distinguishable from those of the open sea. They constitute no separate neritic fauna.

Vast crowds of *Radiolaria* occur at the surface of the ocean, as well as at different depths. Long ago Johannes Müller remarked:

> It is a great phenomenon that *Acanthometra* can be taken daily by thousands in a calm sea and independently of storms; and that of many species of *Polycystina*, hundreds of individuals were seen during my last residence at the seashore (2, p. 25).

I have tried myself, on the hundreds of voyages to different coasts which I have made since 1856, to thoroughly study the natural history of the *Radiolaria*. The incomparable collections of the *Challenger* afforded me by far the richest material for observation. The results obtained therefrom are embodied in the report (1887). Among other references to the conditions of the plankton there mentioned, it brought up the following propositions: (1) *Radiolaria* occur abundantly in all seas which contain a medium amount of salt, and which do not (like the Baltic) receive a strong influx of fresh water. (2) In the colder seas only a few species occur (chiefly *Acantharia*), but immense quantities of individuals; towards the equator the variety in form gradually increases (horizontal distribution, comp. 4, § 226–231). (3) The chief groups of *Radiolaria* are distributed unequally in the five *bathyzones* or girdles of depth of the open ocean. The subclass *Porulosa* (the two legions of *Spumellaria* and *Acantharia*) inhabit especially the two upper zones. On the other hand, the subclass *Osculosa* (*Nasselaria*

*After Ehrenberg, in 1847, had described the siliceous shells of some hundred species from the Barbados, we obtained in 1858 the first description of their organization through Johannes Müller. In the work with which this great master closed his renowned life he described 50 species which he had observed alive in the Mediterranean Sea (2). When in continuation of this I devoted a winter's residence in Messina to their further investigation, I was able in 1862, in the monograph consequent thereupon, to distinguish 144 new species, in all 113 genera and 15 families (3). But this rich *Radiolaria* fauna of Messina still gave no promise of the immense quantities of these delicately ornamented creatures peopling the open ocean, and whose variously formed siliceous shells, sinking to the bottom after death, formed that wonderful sediment, the "*Radiolaria ooze.*" This was first discovered thirteen years later by the *Challenger*. The investigation of the fabulous radiolarian treasures (chiefly from the Pacific) which this expedition brought home has led to the discrimination of 20 orders, 85 families, 739 genera, and 4,318 species (4, § 256). Further study of the *Radiolaria* slime of the deep sea will bring to light many new forms from this inexhaustibly rich mine.

and *Phæodaria*) move in the three lower zones (vertical distribution, 4, § 232–239). The dependence of their appearance upon the various conditions of life has been investigated by Brandt (24, p. 102).

D.—Cœlenterates of the Plankton.

The ancestral group of the *cœlenterates* has important significance and manifold interest for the natural history of the plankton; still this applies in very varied degrees to the different principal groups of this numerous circle (comp. 30, p. 522). The great class of the *sponges*, which belongs exclusively to the benthos, has never acquired a pelagic habit of life. The phylum of the *platodes* also needs no further reference here. We know, to be sure, a small number of pelagic turbellarians and trematodes. Arnold Lang, in his monograph on the sea-planarians or polyclads (1884, p. 629), mentions as "purely pelagic" or oceanic 8 species and 4 genera (*Planocera*, *Stylochus*, *Leptoplana*, *Planaria*). Parasitic trematodes are occasionally found as "pelagic parasites" in medusæ, siphonophores, and ctenophores; but these trematodes and turbellarians are usually found only individually; they never appear in such quantities as are characteristic of the majority of the plankton animals. Much more important for us is the third type of the cœlenterates, the diversified chief group of the nettle animals or *Cnidaria* (30, p. 524).

Cnidaria.—With reference to the mode of life and the form conditioned thereby, one may divide the whole group of *Cnidaria* into two great principal divisions, polyps and acalephs, which since the time of Cuvier have lain at the foundation of the older systems. The polyps (in the sense of the older zoölogists) embrace all nettle animals, which are fixed to the bottom of the sea, hydropolyps as well as scyphopolyps (*Anthozoa*). They belong exclusively to the benthos. Only a few forms have acquired the pelagic mode of life (*Minyadæ*, *Arachanactis*, larvæ of *Actiniæ*, *Cerinthidæ*, and some other corals). The second principal division of the nettle animals, the *Acalepha*, embraces, in the sense of their first investigator Eschscholtz (1829), the three classes of medusæ, siphonophores, and ctenophores; all swimming marine animals, which, from their richness in forms, their general distribution in the ocean, and their abundant occurrence, possess much importance for plankton study. Since the above-mentioned pelagic polyps (*Minyadæ*, etc.) on the whole are rare, and never appear in great quantities, we need make no further reference to them here. Much more important are the *Acalephs*, which offer a fund of interesting problems for plankton study. Commonly, all these animals are roughly termed "pelagic," but a new consideration shows us that they are so in a very different sense, and that the distinction which we have made above in reference to their chorological terminology here finds its complete justification. We will first consider the medusæ, then the siphonophores and ctenophores.

Medusæ.—The great interest which I have felt in this wonderful class of animals since my first acquaintance with living medusæ, in 1854, and which has been increased by my numerous sea voyages, led me to the monographing of them (1879). I immediately gained thereby a number of definite chorological and œcological ideas, which have been of permanent influence in the further course of my plankton studies. By it was definitely fixed the knowledge that the whole race of the medusæ is *polyphyletic*, and that on the one side the *Craspedota* (or *Hydromedusæ*) have arisen independently from the *Hydropolyps*, just as on the other side the *Acraspedota* (or *Scyphomedusæ*) from the *Scyphopolyps.* In both analogous cases the transition to the pelagic, free-swimming mode of life has led to the formation, from a lower, sessile, very simply organized benthic animal, of a much higher planktonic metazoön, with differentiated tissues and organs—a fact which is of great significance for our general understanding of the phylogeny of tissues.

I have in that monograph broadly distinguished two principal forms of ontogeny or individual developmental history among the medusæ, *metagenesis* and *hypogenesis.* Of these I regard metagenesis, the alternation of generations with polyps, as the primary or *palingenetic* form; on the other hand, *hypogenesis*, the "direct development" without alternation of generations, as the secondary abbreviated or *cenogenetic* form. This distinction is of great importance in the chorology, in so far as the great majority of the *oceanic* medusæ are *hypogenetic;* the *neritic*, on the other hand, are *metagenic.* To the oceanic medusæ in the widest sense I refer the *Trachylinæ* (*Trachymedusæ* and *Narcomedusæ*) among the *Craspedota;* to the neritic, the *Leptolinæ* (*Anthomedusæ* and *Leptomedusæ*: comp. 29, p. 233). While the former have lost their relation to the benthonic polyps, the latter have retained it through heredity. The same seems to obtain also for the majority of the *Acraspedota*, namely the *Discomedusæ.* Among these there are only a few oceanic genera with *hypogenesis*, *e. g.*, *Pelagia.* The development of the smaller but very important acraspedote orders, which I have distinguished as *Stauromedusæ*, *Peromedusæ*, and *Cubomedusæ*, is, I am sorry to say, as yet quite unknown. The first is to be regarded as neritic and metagenic; the two latter, on the other hand, oceanic and hypogenic. That the majority of the large *Discomedusæ* are neritic and not oceanic is shown from their limited local distribution.

Although ten years ago the *Medusæ* were generally held to be purely pelagic animals, it has now been found that a certain (perhaps considerable) part of them are zonary or bathybic. Among the 18 deep-sea *medusæ* which I have described in part XII of the *Challenger* Report (1881) there are, however, some forms which occur also at the surface, and a few which perhaps were accidentally taken in the tow net while drawing it up. But others are certainly true deep-sea dwellers, as the *Pectyllidæ* among the *Craspedota*, the *Periphyllidæ* and *Atollidæ* among the *Acraspedota*. Some *Medusæ* have partly or entirely given up the swimming mode of life, as *Polyclonia*, *Cephea*, and other *Rhizostoma*, which lie with the back towards the sea bottom, the many-mouthed bunch of tentacles directed upwards. The *Lucernaridæ* have completely passed over to the benthos. Many *Medusæ* are spanipelagic, rise to the surface only during a few months (for the purpose of reproduction?), and pass the greater part of the year in the depths; thus in the Mediterranean the beautiful *Cotylorrhiza tuberculata*, *Charybdea marsupialis*, *Tima flavilabris*, and *Olindias mülleri*. These bathybic forms are sometimes brought up in great numbers with the bottom net (19, p. 122). Many cling with their tentacles to *Algæ* and other objects (20, p. 341).

The immense swarms in which the *Medusæ* sometimes appear, millions crowded thickly together, are known to all seafaring naturalists. Thus in Arctic waters, *Codonium princeps*, *Hippocrene superciliaris;* in the North Sea, *Tiara pileata*, *Aglantha digitalis;* in the Mediterranean, *Liriantha mucronata*, *Rhopalonema velatum;* in the tropics, *Cytæis nigritina;* in the Antarctic Ocean, *Hippocrene mocloviana* and others. Hensen (9, p. 65) in the North Sea found a swarm of *Aglantha*, the number of which he estimated at twenty-three and one-half billions. The extent of the multitude was so great that "the thought of approximately estimating the animals in this swarm must be given up." In such cases the whole sea for a few days, or even weeks, seems everywhere full of *Medusæ;* and then again weeks, or even months, may pass without finding an individual. The *uncertainty* of appearance, the "capriciousness of these brilliant beauties," in other words, the dependence upon many different, and for the most part unknown causes, is in this interesting animal group remarkably impressed upon us. I will, therefore, in another place, refer to it on the ground of my own experience.

Siphonophores.—What I have said above concerning the unequal distribution of the medusæ applies also to their wonderful descendants, the purely *oceanic* class of the siphonophores. This highly interesting class was, up to a few years ago, also regarded as purely pelagic; but of these, too, it is now known that they are in great part bathypelagic, in part also zonary and bathybic. The new and very peculiar group of the *Auronectæ* (*Stephalidæ* and *Rhodalidæ*), taken by the *Challenger* at a depth of 200 to 600 fathoms, is described in my "Report of the Siphonophores of H. M. S. *Challenger*" (1888, p. 296). The *Bathyphysa* taken by Studer, and some of the *Rhizophysidæ* (*Aurophysa*, *Linophysa*) captured by the *Gazelle*, were taken at a depth of 600 to 1,600 fathoms (l. c.). But that such deep-sea siphonophores (probably mostly *Rhizophysidæ*) inhabited the ocean in great masses was first shown by Chierchia (8, p. 84–86). Previously, in numerous soundings which the *Vettor Pisani* had made in the Atlantic and Pacific oceans, the line of the deep-sea lead when drawn up was found to be wound around with the torn-off stinging tentacles of great siphonophores. By means of the new closible net invented by Palumbo, he was enabled to bring up the entire animals from definite depths. From these experiments Chierchia concluded "that certain characteristic species of siphonophores live in great numbers at certain depths, from 1,000 meters above the bottom upwards, the strongest and most resistant in the depths, the weaker higher up" (8, p. 86). Other siphonophores, which belong to the forms most numerous at the surface, extend down to considerable depths, as *Diphyes sieboldii* (15, p. 12). The larvæ of *Hippopodius luteus*, which are very numerous in winter and spring, have quite disappeared in summer, and, according to Chun, live in greater depths, even to 1,200 meters (15, p. 14). Other forms are spanipelagic and come to the surface only for a short time, only a few weeks in the year, like so many *Physonectæ*. From these and other grounds the participation of the siphonophores in the plankton, like that of their ancestors, the *Hydromedusæ*, is extremely irregular, and their appearance at the surface of the sea is subject to the most remarkable changes.

Ctenophores.—This *Cnidarian* class also, like the preceding, is purely oceanic, not neritic. They also show the same phenomena of pelagic distribution as the *Siphonophores* and *Medusæ*, frequent appearance in great swarms, sudden disappearance for long periods, unaccountable irregularity in their participation in plankton formation. The tables which Schmidtlein has given on the basis of three years' observations, on their periodical appearance in the Gulf of Naples, are very instructive for all three classes of the planktonic *Cnidaria* (19, p. 120). The ctenophores also, up to a short time ago, were regarded as autopelagic animals; but of them also it has been discovered that they extend in abundance to various, somewhat definite depths. Chun, in his monograph of the ctenophores of Naples (1880, p. 236–238) has pointed out that these most tender of all pelagic animals have just as definite vertical as horizontal migrations. Many ctenophores, which in the spring are found as larvæ at the surface, later sink, pass the summer in the cooler depths, and rise to the surface in the autumn in crowds, as mature animals. The irregularity of their appearance is also mentioned by Graeffe (20, p. 361).

E.—Helminths of the Plankton.

The race of the helminths or "worms" (the cross of suffering for systematic zoölogy) obtains a more natural unity and more logical definition, if one removes therefrom the platodes and annelids, placing the former with the cœlenterates, the latter with the articulates. The justice of this limitation and also the grounds for regarding the worms as the common ancestral group of the higher animals, I have set forth already in the "Gastrea Theory" (1873), and many times at later opportunities, last in the eighth edition of my "Natural History of Creation" (1889, p. 540). There remain then as helminths, in the narrower sense, four divisions with about 12 classes, namely, (1) the *Rotatoriæ*

(*Trochosphæra*, *Ichthydina*, *Rotifera*); (2) the *Strongylariæ* (*Nematoda*, *Acanthocephala*, *Chætognatha*); (3) the *Rhynchocœla* (*Nemertina*, *Enteropneusta*), and (4) the *Prosopygiæ* (*Bryozoa*, *Brachiopoda*, *Phoroneæ*, *Sipunculeæ*). The larvæ of many of these worms have acquired the pelagic mode of life, but most of them are too small and too scattered in the plankton to be of any considerable importance in its composition.

Chætognatha.—In its mature condition only a single class of helminths plays an independent and indeed an important rôle in the plankton—the small and peculiar class of arrow-worms or *Chætognatha* (*Sagitta*, *Spadella*, etc.). These, together with the copepods, salpae, pteropods, and radiolarians belong to the most substantial, most generally distributed, and usually unfailing constituents of the plankton. Hensen (9, p. 59) has made some calculations of the immense numbers in which they appear. He reckons them in the "perennial plankton," yet does not find "everywhere the regularity which one might expect." He is astonished at the "highly remarkable variations" in their numbers, and finds this very unequal distribution very puzzling (9, p. 60). Chun has lately shown that the troops of *Sagitta* not only populate the surface of the sea, but also "in common with the *Radiolaria*, *Tomopteridæ*, *Diphyidæ*, *Crustacea*, constitute the most numerous and most constant inhabitants of the greater depths. In countless multitudes they are taken in the open as well as in the closible net, from 100 meters down to 1,300 meters" (15, p. 17). It seems that *Sagitta*, as a whole purely *oceanic*, is represented by pelagic as well as zonary and bathybic species.

F.—Mollusks of the Plankton.

The race of mollusks play a very important rôle in the plankton. Although the great majority of the genera and species belong to the benthos, yet there are a few families which have become adapted to the pelagic mode of life, of great importance on account of the great swarms in which they often appear. The three chief classes which we distinguish in this race (30, p. 546) live very differently. The *Acephala*, entirely benthonic, can take part only as swarming larvæ in the composition of the plankton; so also the swimming larvæ of many meroplanktonic *Gastropoda*. Of these latter only a very few genera have adopted completely the pelagic mode of life, like *Ianthina* among the prosobranchs, *Glaucus* and *Phyllirrhæ* among the opisthobranchs.

Pteropods and Heteropods.—These two groups of snails are holoplanktonic, chiefly nyctipelagic animals, which come to the surface of the sea, preferably during the night, in vast numbers (14, pp. 121–125). Chun has lately discovered that many of them are found at considerable depths (15, p. 36). Some kinds of pteropods (*e. g.*, *Spirialis*) seem to belong to the zonary and bathybic fauna. The heteropods are on the whole of less importance. They occur in great swarms less frequently and only in certain parts of the warmer seas. The pteropods on the other hand surpass the former, not only by a great diversity of genera and species, but particularly from their enormous development in all parts of the ocean. *Clio* and *Limacina* are known to occur in the Arctic and Antarctic ocean in schools so vast as to form the chief food supply of the whales; the swarms of *Creseis*, *Hyalea*, and others which appear in the seas of the warmer and temperate zones, are also so considerable that these fluttering "sea butterflies (*Farfalle di mare*)" often play a very important part in the "cycle of matter in the sea" (*Stoffwechsel des Meeres*"). The irregularity of the distribution and phenomena is also shown by the fact that Hensen, during his plankton expedition through the North Sea (July and August, 1887), completely missed the pteropods (9, p. 59; 10, p. 116). On the other hand, when in August, 1879, I fished at Scoury, on the northwest coast of Scotland, we found such immense quantities of *Limacina* (during the forenoon in still weather) that these pteropods certainly formed more than nine-tenths of the entire plankton, and with a bucket we could scoop up many thousands. The mass of the swarm had the same density for a depth of two fathoms and for more than a square kilometer in horizontal extent.

Cephalopods.—Although entirely swimming animals, these highly developed mollusks for the most part do not fall under the term plankton, if with Hensen we limit this to those "animals floating involuntarily in the sea" (9, p. 1). They must then be included in the "nekton;" but naturally it depends in some cases entirely on the strength of the current whether the small cephalopods should be included in the former or in the latter. In any case this highest developed class of mollusks is of very great importance in the physiology of the plankton, the question of the "cycle of matter in the sea." On the one hand they daily consume vast masses of pteropods, crustacea, sagitta, medusæ, and other planktonic animals; on the other, they furnish the most important food for fishes and cetaceans. From recent investigations it is found that the cephalopods are partly pelagic, partly zonary or bathybic (*Spirula*, *Nautilus*, etc.). Characteristic small, transparent *Decolenæ* (*Loligopsidæ*) are known as partly pelagic, partly bathybic species (15, p. 36). The same is true also of some *Octolenæ* (*Philonexidæ*). Young forms of cephalopods are captured swimming in the plankton at the surface as well as in the depths.

G.—Echinoderms of the Plankton.

The rayed animals in their significance in the plankton, as also in many other morphological and physiological relations, show highly peculiar and varied conditions. Although all echinoderms are without exception purely marine animals, and no single form of this great group inhabits fresh water, still not a single species has completely adopted the planktonic life. Not a single echinoderm in its full-grown and sexually mature condition can be called pelagic. The few forms which temporarily swim about (*Comatulidæ*) belong only to the neritic fauna and do not occur in the ocean. They also are found in such limited numbers that they are without importance for the plankton.

Much more important for us are the free-swimming echinoderm larvæ, which often play a great part in the neritic plankton. Indeed they are classical objects in the history of plankton investigation; for to their study their discoverer, Johannes Müller, forty-five years ago first applied the method of "pelagic fishery with the fine net," which soon led to such remarkable and brilliant results. The distribution and number of the larval rayed animals is naturally dependent upon that of their benthonic parents; but in addition also partly upon chorological, partly œcological causes. According to Sir Wyville Thompson (14, II, pp. 217–245; 6, p. 379), the remarkable metamorphosis, discovered and described in a masterly way by Müller, is the rule only among the littoral forms, chiefly in the temperate and warm zones; on the other hand, it is the exception in the case of the majority, for star animals of the deep sea and cold zones, in the Arctic as well as in the Antarctic, develop directly. Therefore, great troops of pelagic larvæ of these animals occur commonly only in the *neritic plankton* of the temperate and warm zones, not in the open ocean. They seem to visit the depths (below 100 meters) very seldom (15, p. 17). Besides, their appearance is naturally connected with the time of year of this development; often only during a few months (9, p. 62). The variation in the constitution of the "periodic plankton" is here very remarkable.

H.—Articulates of the Plankton.

Of the three chief divisions which we distinguish in the group of articulated animals (30, p. 570) two, the *Annelids* and *Tracheates*, take no part in the constitution of the plankton. Both are represented only by a few pelagic genera, and these have a limited distribution. Much greater in importance is the third chief division, the *Crustacea*. It is the only animal class which is never lacking in the tow-net collections (or only very exceptionally), and which commonly appears in such numbers that their predominant position in the animal world of the sea is evident at the first glance. This applies as well to the oceanic as to the neritic fauna, to the littoral as to the abyssal benthos.

Annelids.—The great mass of this group, so rich in forms, belongs to the benthos, and is represented in the abyssal as well as in the littoral fauna by numerous creeping and sessile forms. Only very few ringed animals have acquired the pelagic mode of life and have assumed the characteristic hyaline condition of the oceanic glasslike animals, the swimming *Tomopteridæ* and *Alciopidæ*. Both families are represented in the plankton only by a few genera and species, and as a rule their number of individuals is not very considerable. Chun has lately shown by means of the closible net that both forms, *Tomopteris* as well as *Alciope*, are represented in the different depths, from 500 to 1,300 meters, by peculiar zonary and bathybic species, which are distinguishable from the pelagic species of the surface by characteristic marks. "The wealth in such *Alciopidæ* (and *Tomopteridæ*) at all depths of 100 meters or over is very surprising, and it requires a careful scrutiny, for the beautiful transparent worms often press actively by dozens in serpentine course through the crowd of other forms in the dishes" (15, p. 24).

Crustacea.—In their general œcological importance, in their universal distribution over all parts of the ocean, and especially in their incomprehensible fertility and the abundance of their appearance conditioned thereby, the *Crustacea* surpass all other classes of animals. In the physiology of the plankton the first rank in the animal kingdom belongs to them, as to diatoms in the vegetable kingdom. On the whole, in the organic life of the ocean they have the same predominant importance as the insects for the fauna and flora of the land. In a similar way, as the complicated "struggle for existence" has called up for the latter a quantity of remarkable œcological relations and morphological differences conditioned thereby within the insect class, so has the same occurred in the ocean within the crustacean class. Meanwhile the numerous orders and families of this class, so rich in forms, participate in very different degrees in the constitution of the plankton. The order of copepods by far surpasses all other orders. Next to these follow the ostracods and schizopods, then the phyllopods, amphipods and decapods. The other orders of crustaceans participate in the constitution of the plankton in a much less degree—part of them very little. It is to be added that larvæ of all orders may appear in great numbers therein. Thus, for example, the pelagic larvæ of the sessile benthonic cirripeds often appear in the neritic plankton so numerously that they constitute four-fifths to nine-tenths or even more of the entire mass.

The chorology of the *Crustacea* offers to the plankton investigator one of the most important and interesting fields of work, the elaboration of which has yet scarcely been begun. The same applies also to the geography and topography of the oceanic and neritic *Crustacea*, both in their horizontal and vertical distribution, to their relations to the benthonic *Crustacea* as well as to the marine fauna and flora in general. As a very important result of the recent discoveries, particularly of the *Challenger*, the fact must here as elsewhere be brought up that in the different groups of *Crustacea* (just as in the *Radiolaria*) *the vertical divisions of the planktonic fauna* can be very plainly distinguished. Pelagic, zonary, and bathybic forms are found here in quite definite relations.

Copepoda.—As the *Crustacea* are on the whole the most important and influential among the planktonic animals in their œcological relations, so are the copepods among the *Crustacea*. Only one who has seen with his own eyes can gain a conception of the innumerable masses in which these small crustaceans crowd the surface of the ocean as well as the zones of different depths. For days the ship may sail through wide stretches of ocean whose surface always remains covered with the same yellowish or reddish "animal mush," composed in by far the greater part of copepods. In the journal which I kept in the winter of 1866–67, at Lanzarote, in the Canary Islands, of the varying constitution of the plankton, for many days there is only the remark: "almost pure buckets of copepods," or "the collection consisted almost entirely of *Crustacea*, by far the greater part of copepods." That these small crustaceans form the chief food supply for many of the most important food-fishes (*e. g.*, the herring) has long been known. In the Arctic as well as the Antarctic Ocean *Calanus finmarchicus* and a few related species form in general the chief bulk of the plankton, and furnish food for pteropods and cephalopods, for the divers and penguins, for many fishes and whales. On the voyage from Japan to Honolulu the *Challenger* sailed through wide stretches of the North Pacific Ocean which were covered with red and white patches, caused by great accumulations of two species of small copepods, the red being *Calanus propinquus* (8, p. 758). In many other regions, from the Polar Circle to the Equator, the ship passed through white bands many miles wide, composed solely of copepods (8, p. 843). That their appearance is *very irregular* and dependent on many conditions is true of this very important group of plankton animals as for all others. For two days the *Challenger* went through thick shoals of *Corycaeus pellucidus*. For the next three days the copepods had entirely disappeared.

Hensen has made statistical statements upon the appearance of the copepods of the North and Baltic seas (9, p. 45). Chun has lately shown that this order plays a highly significant rôle, not only at the surface, but also at considerable depths (600 to 1,300 meters), (15, p. 25). "Their abundance and richness in forms in greater depths is absolutely astonishing. Larval forms of species sessile or living upon the bottom mingle in confusion with the young forms and sexually mature stages of eupelagic species. Many species hitherto regarded as varieties are numerously represented in the depths." On the other hand, the order seems to be very poorly represented at very great depths. The *Challenger* found only one very characteristic deep-sea species in 2,200 fathoms—*Pontostratioides abyssicolla* (8, p. 845). Some genera never leave the surface and are autopelagic, *e. g.*, *Pontellina* (15, p. 27).

Ostracoda.—The ostracods are, next to the copepods, the most important *Crustacea* of the plankton, and are represented at the surface as well as in different depths by masses of many species. In the œcology of the ocean they play a similar rôle, as do the near-related cladocerans (*Daphnidæ*) in the fresh water. The *Challenger* collected 221 species of ostracods. Of these 52 were found below 500 fathoms, 19 below 1,500, and 8 below 2,000 fathoms in depth. Many ostracods, like many copepods and other crustaceans, belong to the most important luminous animals of the ocean. On my journey to Ceylon (in the beginning of November, 1881), as well as on the return trip (middle of March, 1882), I admired as never before the oceanic light in its splendor. "The whole ocean, so far as the eye could reach, was a continuous shimmering sea of light." Microscopical investigation of the water showed that the luminous animals were for the most part small *Crustacea* (*Ostracoda*), to a less extent *Medusæ*, *Salpæ*, worms," etc. (25, pp. 42, 372). Chierchia, three years later, in the same region and in the same month, saw the same brilliant phenomenon: "The most brilliant emerald-green light was produced by an infinitude of ostracods" (8, p. 108).

Schizopoda.—Not less important in the planktonic life than the ostracods (sometimes even more important) are the schizopods. They also occur in wide stretches in immense swarms at the surface, as well as in greater and lesser depths. They also play a great rôle in the cycle of matter in the sea (*Stoffwechsel des Meeres*); on the one side since they devour great quantities of protozoa and planktonic larvæ, and on the other because they serve as food for the cephalopods and fishes. Many schizopods, like many ostracods and copepods, belong to the most brilliantly luminous animals, and, like the latter, furnish very interesting problems for the bathygraphy of the plankton. G. O. Sars, who has worked up the rich material collected by the *Challenger*, distinguished 57 species, and found that 32 of these lived only at the surface, 6 from 32 to 300 fathoms, and 4 extended down below 2,000 fathoms (as far as 2,740 fathoms), (6, p. 739). Chun also has discovered in the Mediterranean a number of new zonary and bathybic schizopods very different from the pelagic varieties of the surface, *Stylochiron*, *Arachnomysis*, etc. (15, p. 30).

The phyllopods (*Daphnidæ*), the amphipods (*Phronimidæ*, *Hyperidæ*), and the decapods (*Miersidæ*, *Sergestidæ*) are indeed represented in the plankton by a number of interesting forms, partly oceanic, partly neritic; and some of these occasionally appear in considerable quantities. But as a whole they are of far less importance than the copepods, ostracods, and schizopods. The same applies also to the other groups of *Crustacea*, although many of them in their larval state take a great part in the constitution of the plankton. Also in regard to these multiformed and often abundant *pelagic crustacean larvæ*, as well as for the mature crustacean animals, the advancing plankton study has still to establish and explain a fund of facts; namely, in relation to their pelagic, zonary, and bathybic distribution; their migrations, and the relations in which this planktonic fauna stands to the benthic fauna.

Insecta.—That important branch the *Tracheata*, the most numerous in forms of all the principal divisions of the animal kingdom, has in the sea no representatives whatever. The *Protracheata*, *Myriapoda*, and *Arachnidæ* are exclusively inhabitants of the land and in small part of the fresh water, except the pycnogonids or pantopods (in case these really belong to the *Arachnidæ*). Among the *Insecta* there is only a single small group of true marine animals, the family of the *Halobatidæ*. These small insects, belonging to the *Hemiptera*, have completely acquired a pelagic mode of life, and run about in the tropical ocean just as our "water-runner" (*Hydrometra*) on the surface of fresh water.

Both of the genera belonging there (*Halobates* and *Halobatodes*, with about a dozen species) are limited to the tropical and subtropical zone. The *Challenger* found them in the Atlantic between 35° north latitude and 20° south latitude; in the Pacific between 37° north latitude and 23° south latitude. I myself observed *Halobates* numerously in the Indian Ocean, and on one day in crowds in the neighborhood of Belligam. Although they can dive, they never go into the depths.

J.—TUNICATES OF THE PLANKTON.

The tribe of mantle animals falls into two chief divisions, according to their mode of life. The *ascidians* belong to the *benthos;* all other *tunicates* to the *plankton.* The *Copelata* (or *Appendicularidæ*) are morphologically the oldest branch of the stem, and are to be regarded as the nearest of the now living relatives of the *Prochordiniæ*, the hypothetical common ancestor of the tunicates and vertebrates (30, p. 605). The near relationship of the *Copelata* and the ascidian larva makes it very probable that the whole class of ascidians has sprung from the primarily pelagic *Copelata*, and has diverged from this through the acquirement of a sessile mode of life. The *Lucidiæ* or *Pyrosomidæ*, on the other hand, are probably secondarily pelagic animals, and sprang from the *Cœlocormidæ*, a benthonic synascidian group. The *Thalidiæ* (the *Doliolidæ* as well as the *Salpidæ*) are to be regarded as primarily pelagic animals. These conditions are doubly interesting, because the tunicates in an exemplary manner demonstrate the peculiarities which the transition on one side to a sessile mode of life in the benthos (in case of the ascidians), and on the other to a free-swimming mode of life in the plankton (in the case of all other tunicates), has brought about. All the latter are transparent and luminous fragile animals, poor in genera and species, but rich in numbers of individuals. The ascidians, on the other hand, fastened to the bottom, in part littoral on the coast, in part abyssal in the deep sea, are much richer in genera and species, in many ways adapted to the manifold local conditions of the bottom, and mostly opaque. The few hyaline forms (*e. g.*, *Clavellina*) may be regarded as the remnant of the old ascidian branch, which diverged from the pelagic *Copelata*.

All planktonic tunicates are exquisite *oceanic* animals and all may appear in immense swarms of astonishing extent. Murray (6, pp. 170, 521, 738, etc.) and Chierchia (8, pp. 32, 53, 75, etc.) met with great swarms of *Appendicularia*, *Pyrosoma*, *Doliolum*, and *Salpa* in the middle of the open ocean, both in the Atlantic and Pacific, particularly in the equatorial zone. I observed the same in the Indian Ocean, between Ceylon and Aden. Further, I have whole bottles full of closely pressed *Thalidiæ*, which Captain Rabbe collected in the middle of the Atlantic, Pacific, and Indian oceans, far removed from all coasts. In many log books also these swimming and luminous crowds of *Salpa* and *Pyrosoma* on the open sea, far from all coasts, are spoken of. On the other hand we know of no *neritic* tunicates, no other forms of swimming mantled animals which are found only on the coasts, except the omnipresent ascidian larva.

Lately Chun has established the interesting fact that the planktonic tunicates occur in numbers not only at the surface and in slight depths, but also during the summer extend down into greater depths (15, pp. 32, 42). He discovered further in the Mediterranean new *Copelata*, which are only zonary or bathybic, never coming to the surface and characterized by peculiar organization as well as difference in size (*Megalocereus abyssorum*, 3 centimeters long, 15, p. 40).

The small, delicate *Copelata* and *Doliola*, from their small size, are naturally more difficult to see than the large luminous *Salpæ* and *Pyrosoma*. Whoever has carefully examined great quantities of oceanic plankton can readily testify that the former also occur almost everywhere and occasionally take an important part in the constitution of the mixed plankton. Among the *Salpæ* there are for example the smaller species which form extensive swimming shoals. From the three-year observations of Schmidtlein it is learned that the salpas belong to the perennial plankton and are numerous throughout the whole year (19, p. 123).

K.—Vertebrates of the Plankton.

The vertebrates of the sea are in their mature condition for the most part too large and have too powerful voluntary movements to be reckoned in the true plankton in Hensen's sense, as "animals carried involuntarily with the water." The sea fishes, as well as the aquatic birds and mammals of the sea, overcome more or less easily the impetus of the currents, and thereby prove their independence by voluntary movements, which is not commonly the case with the floating invertebrate animals of the plankton. Meanwhile I have already shown above that this limitation of the *plankton* against the *nekton* is very arbitrary and at any moment may be changed in favor of the latter through diminution of the strength of the current. For the chief point of Hensen's plankton investigation, for the question of the "cycle of matter in the sea," the vertebrates are of greatest importance, since they, the largest of the rapacious animals of the sea, daily consume the greatest quantity of plankton, no matter whether directly or indirectly. A single sea fish of medium size may daily consume hundreds of pteropods and thousands of crustacea, and in case of the giant cetaceans this quantity may be increased ten or a hundred fold. In a comprehensive consideration of the plankton conditions, and particularly in its physiological, œcological, and chorological discussion, a thorough investigation of the vertebrates swimming in the sea, the marine fishes, the aquatic birds, seals, and cetaceans, is not to be undertaken. We can then turn from it here, since it has no further relation to the purpose of this plankton study. We can here in Hensen's sense (9, p. 1) provisionally limit ourselves to the vertebrates of the sea "carried involuntarily with the water," and as such (apart from a few small pelagic fishes) only the pelagic eggs, young brood, and larvæ of the marine fishes come into consideration. Some few teleosts (*Scopelidæ*, *Trichiuridæ*, *et al.*) occur sometimes in schools in the plankton and are partly autopelagic, partly bathypelagic. The remarkable *Leptocephalidæ* are possibly planktonic larvæ (of *Murænoidæ*), which never become sexually mature (7, p. 562).

Fish eggs.—The planktonic fish eggs, found in great numbers at the surface of the sea, as well as the young fish escaped from them, play without doubt a great rôle in the natural history of the sea. Hensen, whose planktonic investigation started from this point, had thereupon "based the hope to obtain a far more definite conclusion upon the supply of certain species of fishes than had hitherto seemed to be possible" (9, p. 39). But the assumption from which he starts is wholly untenable. Hensen says (*loc. cit.*):

It is scarcely to be doubted that an opinion upon the relative wealth of various kinds of fish in the Baltic or in any other part of the ocean whatever can be obtained through the determination of the quantity of eggs in the area under consideration.

Brandt also characterizes this proposition as very lucid and weighty (23, p. 517).

This standard proposition of Hensen and Brandt, from which a series of very important and complicated computations are to be made, was disposed of in a brilliant manner thirty years ago by Charles Darwin. In the third chapter of his epoch-making "Origin of Species," treating of the "Struggle for Existence," Darwin, under the head of Malthus' theory of population, speaks of the conditions and results of individual increase, the geometric relation of their increase, and the nature of the hindrances to increase. He points out that "*in all cases* the average number of individuals of any species of plant or animal depends only indirectly on the number of seeds or eggs, but directly on the conditions of existence under which they develop." Striking examples of these facts are everywhere at hand, and I myself have mentioned a number of them in my "Natural History of Creation" (30, p. 143). Still, to draw a few examples from the life of the plankton, I recall in this connection many pelagic animals; *e. g.*, crustacea and medusæ. Many small medusæ, which belong to the most numerous animals of the pelagic fauna (*e. g.*, *Obelia* and *Lirope*) produce relatively few eggs; as also copepods, the commonest of all planktonic animals. Incomparably greater is the number of eggs produced by a single large medusa or decapod, which belongs to the rarer species. So, from the number of pelagic fish eggs *not the slightest conclusion* can be drawn as to the number of fish which develop from them and reach maturity. The major portion of the planktonic fish eggs and young are early consumed as food by other animals.

V.—COMPOSITION OF THE PLANKTON.

The composition of the plankton is in qualitative as well as quantitative relations very irregular, and the distribution of the same in place and time in the ocean also very unequal. These two axioms apply to the oceanic as well as to the neritic plankton. In both these important axioms, which in my opinion must form the starting-point and the foundation for the *œcology and chorology of the plankton*, are embodied the concordant fundamental conceptions of all those naturalists who have hitherto studied carefully for a long time the natural history of the pelagic fauna and flora.

The surprise was general when Prof. Hensen this year advanced an entirely opposite opinion, "that in the ocean the plankton was distributed so equally that from a few hauls a correct estimate could be made of the condition in a very much greater area of the sea" (22, p. 243). He says himself that the plankton expedition of Kiel, directed by him, started on this "*purely theoretical view*," and that it had "*full results* because this hypothesis was proven far more completely than could have been hoped" (22, p. 244).*

These highly remarkable opinions of Hensen, contradictory to all previous conceptions, demand the most thorough investigation; for if they are true, then all naturalists who many years previously, and in the most extensive compass, have studied the composition and distribution of the plankton are completely in error and have arrived at entirely false conclusions. If, on the other hand, these propositions of Hensen are false, then his entire plankton theory based thereon falls, and all his painstaking computations (on which in the last six years he has spent 17,000 hours, which he wishes to have number the individuals distributed in the plankton) are utterly worthless.

In the first place, the *empirical basis* upon which Hensen founded his assumptions must be proved, "starting from a purely theoretical point of view." The plankton expedition of Kiel was 93 days at sea, and in the months of late summer (July 15 to November 7) which, as is known, offer in the northern hemisphere the most unfavorable time of all for pelagic fishery (28, p. 16, 18). Hensen himself says that it bore the "character of a trial trip" (22, p. 10), and his companion Brandt names it a "reconnaissance" upon which they had come to investigate rapidly

* Hensen speaks of this in the following terms: "Hitherto it was the prevailing view that the inhabitants of the sea were distributed in schools, and that one, according to luck and chance, according to wind, current, and season, sometimes came upon thick masses, sometimes upon uninhabited parts. This in fact applies only in a certain degree for the harbors. For the open sea our knowledge teaches that normally regular distribution obtains there, which changes in thickness and ingredients only within wide zones corresponding to the climatic conditions. In any case one must seek the variation from such condition according to the cause which has produced it, and the occurrence of inequality is not to be taken as the given starting-point for relative investigation" (22, p. 244).

in succession as great areas as possible" (23, p. 525). In a more remarkable way he adds: "Thereby has resulted the furnishing of a fixed basis for a thorough quantitative and qualitative analysis of marine organisms." According to my view such "fixed basis" was obtained long ago, particularly by the widely extended investigations of the *Challenger* expedition (from January, 1873, to May, 1876), fitted out with all appliances. This embraced a period of forty months, and included "the whole expanse of the ocean." Their experience ought to lay claim to much greater value than that of the *National*, whose voyage of three months took in only a part of the Atlantic, and was in addition trammeled by bad weather, accidents to the ship, early loss of the large vertical nets, and other misfortunes in the carrying out of their plans. It is hardly conceivable how an "exact investigator," from so incomplete and fragmentary experience, can derive the "fixed basis" for new and far-reaching views, which stand in remarkable contradiction to all previous experience.

It would here lead too far, if, from the numerous old and new narratives of voyages, I should collect the observations of seafarers upon the remarkable inequality of the sea population, the different fauna and flora of the regions of currents, the alternation of immense swimming swarms of animals and almost uninhabited areas of sea. It is sufficient to point out the two works in which the most extensive and thorough knowledge up to this time is collected, the "Narrative of the Cruise of H. M. S. *Challenger*," edited by John Murray (6), and the "Collezioni della R. Corvetta *Vettor Pisani*" (8), published by Chierchia. Since the general chorological and œcological results in these two principal works agree fully with my own views gained from thirty years' experience, I pass immediately to a general exposition of these latter, reserving their proof for a later special work.

A.—Polymixic and Monotonic Plankton.

The constitution of the plankton of swimming plants and animals of different classes is exceedingly manifold. In this regard I distinguish first two principal forms, polymixic and monotonic plankton.*

The "mixed tow-stuff (*Auftrieb*), or the *polymixic plankton*," is composed of organisms of different species and classes in such a way that no one form or group of forms composes more than the one-half of the whole volume. The "*simple* tow-stuff, on the other hand, or the *monotonic plankton*," shows a very homogeneous composition, while a single group of organisms, a single species or a single genus, or even a single family or order, forms very predominantly the chief mass of the capture, at least the greater part of the entire volume of the plankton, often two-thirds or three-fourths of it, sometimes even more. Under this monotonic plankton one may again distinguish *prevalent plankton*, when the predominant group forms up to three-fourths of the total volume,

* Πολύμικτος = much mixed, complex; μονότονος = of a single form, simple.

and *uniform plankton* when this exceeds three-fourths and forms almost the whole mass.

In general the mixed plankton is more abundant than the simple, since as a rule the circumstances of the "struggle for existence" condition and vary in many ways the constitution of the planktonic flora and fauna. Still there are numerous exceptions to this rule, and at many points in the ocean (especially in the zoöcurrents) there occurs locally a development so numerous, and an accumulation of a single form or group of forms in such swarms, that these in the haul of the pelagic net form more than one-half the entire volume. This *monotonic plankton* appears in very different definite forms; for the difference of climate, the season, the oceanic currents, the neritic relation, etc., determine significant differences in the quantitative development of the plankton organisms, which simultaneously appear in vast numbers in a definite region. I will next briefly go over the single forms of the monotonic plankton known to me, passing over, however, the consideration of the extremely manifold composition of the *polymixic plankton*, since I am reserving that as well as a contribution of a number of mixture-tables for a later work.

1. *Monotonic Protophytic Plankton.*—Of the seven groups of pelagic *Protophytes*, at least three, the *Diatoms*, *Murracytes*, and *Peridineæ*, appear in such quantities in the ocean that they alone may constitute the larger part of the collection of the pelagic nets. The most important and most common is the *monotonic diatom-plankton*, particularly in brackish and coast waters. The siliceous-shelled unicellular *Protophytes* which compose this belong, often predominantly or almost entirely, to a single species or genus, as *Synedre* in the colder, *Chætoceros* in the warmer seas. The colossal masses of Arctic and Antarctic diatoms, which form the "black-water," the feeding-ground of whales, have been mentioned above. In the warmer tropical and subtropical parts of the ocean such accumulations of diatoms seldom or never occur. Here their place is taken by the *monotonic murracyte-plankton*, composed of immense swarms of nyctipelagic *Pyrocystidæ*. Less frequent is the *monotonic peridineæ-plankton.* Although these *Dinoflagellata* take a very significant part in the composition, especially of the neritic plankton, yet they do not often occur in such quantities as to form the greater part of the volume of the capture.

2. *Monotonic Metaphytic-Plankton.*—Among the pelagic *Metaphytes* there are only two forms, the *Oscillatoriæ* and the *Sargasseæ*, which appear so numerously that they form the greater part of the pelagic tow-stuff. The *monotonic oscillatoriæ-plankton*, as a rule formed of swimming bundles of fibers of a single species of *Trichodesmium*, appears in many regions of the tropical ocean in such masses that the quantity of the pelagic fauna is diminished on that account. The *monotonic sargassum-plankton*, formed of "swimming banks" of a single fucoid, *Sargassum bacciferum*, is the characteristic massive form of organic life in the *Halistasa* of the "Sargasso Sea."

3. *Monotonic Protozoic-Plankton.*—Among the unicellular *Protozoa*, three different groups, the *Noctiluca*, *Globigerina*, and *Radiolaria*, appear pelagically in such quantities that they form the greater part of the volume of the plankton. The *monotonic noctiluca-plankton* is neritic, and is composed almost exclusively of milliards of the common *Noctiluca miliaris.* It forms the reddish-yellow covering of slime upon the surface of the coast seas, and in the ocean always points out the littoral currents. On the other hand, the widely distributed *monotonic globigerina-plankton* is purely oceanic, the point of origin of the *globigerina* ooze of the deep sea. In different regions of the ocean it is composed of different genera of the above-mentioned pelagic thalamophores. Much more manifold is the *monotonic radiolaria-plankton*, also oceanic. Of these, one can distinguish the three following modifications:*

(1) *Polycyttaria-Plankton*, sometimes composed only of *Collozoum*, sometimes of *Sphærozoum*, sometimes of *Collosphæra*, most often of a mixture of these three forms; in the warmer seas, partly pelagic, partly zonary; very abundant.

(2) *Acantharia-Plankton*, commonly formed of milliards of a single or of a few species of *Acanthometron* (in the colder seas, *e. g.*, on the east and west coast of South America, south of 40° S. lat.; also north of 50° N. lat. on the coast of Shetland, Faroë-Orkney, and Norway); partly autopelagic, partly bathypelagic.

(3) *Phæodaria-Plankton*, zonary and bathybic, mostly composed of the larger species of *Aulosphæridæ* and *Sagosphæridæ*, *Cœlodendridæ* and *Cœlographidæ* (*e. g.*, *Cœloplegina murrayanum* from the Faroë-Orkney Channel, 4, p. 1757).

4. *Monotonic Cnidaria-Plankton.*—In the group of nettle animals there are numerous forms of medusæ, siphonophores, and ctenophores, which appear in immense schools. The *monotone medusa-plankton* is chiefly neritic, composed of very different local forms on the different coasts. Of the larger *Acraspedota*, in the warmer seas *Rhizostoma* (*Pilemidæ*, *Crambessidæ*) particularly occur; in the colder, *Semostoma* (*Aurelidæ*, *Cyanidæ*), which in schools fill the littoral bays and currents. Of the oceanic *Scyphomedusæ*, *Pelagia* seems to form similar schools. Among the *Craspedota*, monotonic medusa-plankton is especially formed of neritic *Cordonidæ*, *Margelidæ*, and *Eucopidæ*, of oceanic *Æquoridæ*, *Liriopidæ*, and *Trachynemidæ*. *Monotonic siphonophora-plankton* occurs only in the warmer seas, although *Diphyidea* are found abundantly in all parts of the ocean. The remarkable blue troops of the pelagic *Physalidæ*, *Porpididæ*, and *Velellidæ* have for a long time

*Radiolarian-plankton is contained in 13 preparations of the Radiolaria collection, which I have collected (1890) and which can be bought through the famulus Franz Pohle at Jena; 8 of these preparations contain polycyttaria-plankton, 2 acantharia-plankton, and 3 phædodaria-plankton. This collection (of 34 microscopical preparations) embraces in addition 17 preparations of the radiolarian-ooze of the deep sea, and 4 preparations of deep sea horny-sponges, whose pseudo-skeleton is composed of radiolarian slime. (Challenger Report, part LXXXII.)

in the tropical and subtropical seas attracted the attention of seafarers by their immense numbers as well as by the irregularity of their sudden appearance and disappearance. Rarer is a purely *physonectic* plankton chiefly composed of *Forskalia;* I have observed such repeatedly at Lanzarote. At that same place also occurred frequently a *monotonic ctenophora-plankton.* These delicate nettle animals also, as is well known, like the *Medusæ* and *Siphonophores*, appear in such closely packed crowds that there is scarcely room between them for other pelagic animals. Not infrequently the great accumulation of a single species of ctenophore imparts to the plankton a very remarkable character, and this is true in all oceans, in the cold as well as in the warm and temperate zones. More often it happens that the monotonic cnidaria-plankton is composed of several species of *Medusæ*, *Siphonophores*, and *Ctenophores,* while other classes of animals take only a very limited share in its constitution.

5. *Monotonic Sagittidæ-Plankton.*—The only form of monotonic plankton which the branch of *Helminthes* furnishes is made up by the class of the *Chætognatha*, various species of the genera *Sagitta* and *Spadella.* Although purely oceanic according to their mode of life, yet they occur numerously in the neritic tow-stuff (*Auftrieb*). Sometimes only a single species of these genera, sometimes several species close together, appear in such swarms as to make up more than half of the entire plankton. These phenomena have been observed in the colder as well as in the warmer seas. In the former the plankton is composed of the smaller, in the latter of the larger species. These forms occur also in the deep sea, and indeed the zonary *sagittidæ-plankton* is composed of different species from the pelagic.

6. *Monotonic Pteropoda-Plankton.*—Astonishing masses of oceanic pteropods are very widely distributed in all parts of the ocean, and in part are formed of characteristic genera and species in the different zones. The immense schools of *Clio borealis* and *Limacina arctica*, which inhabit the northern seas and (as "whale-food") furnish the chief food supply for many cetaceans, sea-birds, fishes, and cephalopods, have long been known. But no less immense are other swarms of pteropods, composed of different genera and species, which populate the seas of the temperate and tropical zones. These have often escaped the notice of seafarers, because most species are nyctipelagic. Of the immense quantities of these floating snails, direct evidence is furnished by the accumulated calcareous shells, which in many stretches of ocean (especially in the tropical zone) thickly cover the bottom at depths between 500 and 1,500 fathoms. Often the greater part of this "pteropod-ooze" is formed solely of them (6, pp. 126, 922). At Messina as well as at Lanzarote I found the pteropod-plankton often mixed with considerable numbers of heteropods. Still the latter never form the greater part of the volume.

7. *Monotonic Crustacea-Plankton.*—As the crustaceans surpass all other classes of the animals of the plankton in quantitative development, so they form monotonic plankton far more often than all other classes. Most commonly this simple crustacean-plankton is composed of copepods, not infrequently entirely of a single species (6, pp. 758, 843). Next to this I have more frequently found monotonic *ostracoda-plankton;* next *schizopoda-plankton.* Sometimes also there are in these two orders only numberless individuals of a single species, sometimes of many different species, which compose the monotonic plankton, often almost exclusively, and at other times mixed with additions of other *Crustacea*, *Sagitta*, *Salpa*, etc. The other above-mentioned orders of crustaceans, which also take a considerable part in the constitution of the plankton, the decapods, amphipods, and phyllopods, I have never found in such quantities that they formed more than half of the mass of tow-stuff. On the contrary, such quantities of *crustacean-larvæ* of one species (*e. g.*, of *Lepas* and other cirripeds) occasionally appear that they predominantly determine the character of the plankton.

8. *Monotonic Tunicata-Plankton.*—Next to the monotonic forms of plankton, which are composed of *Crustacea* and *Cnidaria*, that of the *Tunicata* is most numerous. Quite preponderant in quantity are the *Thalidiæ* or *Salpaceæ* (*Salpa* and *Salpella*), and among these, especially the smaller species (*Salpa democratica-mucronata*, *S. runcinata-fusiformis*, and related species). I have often taken such *monotonic salpa-plankton* in the Mediterranean, in the Atlantic and Indian oceans, and have received the same also through Capt. Rabbe from different parts of the Pacific Ocean. Masses of *Doliolum* and of *Copelata* (*Appendicularia*, *Vexillaria*, etc.) are also commonly mixed with this in greater or less quantities. Still these planktonic tunicates, on account of their small size, recede before the *Salpæ*. I know of no instance where they have by themselves formed a monotonic plankton. But this is the case with the nyctipelagic *pyrosoma.* The *Challenger* and the *Vettor Pisani* in the tropics, on dark nights, met with quantities of *monotonic pyrosoma-plankton* in the middle of the Atlantic and Pacific. By day not a single one of these "cones of fire" was to be seen, and as soon as the moon arose they went into the depths (8, pp. 32, 34).

9. *Monotonic Fish-Plankton.*—If, with Hensen, we limit the term plankton to the *halobios* floating passively in the sea, we can designate as "monotonic fish-plankton" only the schools of very young and small fishes, which often appear abundantly in the currents, occasionally so compact that very few other pelagic animals can find room between them. If one wishes to extend the term still farther, and wipe out the sharp distinction between *plankton* and *nekton*, all those sea fishes (oceanic as well as neritic) which appear in schools, and which play so significant an œcological rôle in the cycle of matter in the sea (*e. g.*, *Scopelidæ*, *Clupeidæ*, *Leptocephalidæ*, *Scomberoidæ*) will in general belong here (12, p. 51).

B.—Temporal Planktonic Differences.

The first and most remarkable phenomenon, known to every seafaring planktologist, is the varying constitution of the plankton and the variable mingling of its constituents. The remarkable differences of composition apply *qualitatively* and *quantitatively* to the *oceanic* as well as to the *neritic* plankton. They are just as important in the comparison of different places during the same time as at different times in one and the same place. We can therefore distinguish local and temporal variations, and will first of all consider the latter.

To obtain a complete and more certain survey of the temporary variations of plankton composition, there would be needed especially an unbroken series of observations, which had been carried on at one and the same place at least for the space of a full year—still better for several successive years—to obtain from the yearly and monthly oscillations a general average. Such complete *series of observations*, comparable to the meteorological (with which they stand in direct causal connection), have not hitherto been made. They belong to the most important tasks of the zoölogical stations now everywhere springing up.*

Meanwhile, a general conception of the considerable size of the yearly and monthly oscillations can be obtained from a comparative summary based upon the important series of observations extending over three years, which Schmidtlein has given upon the appearance of the larger pelagic animals in the Gulf of Naples, during 1875–77 (19, p. 120). The contributions of Graeffe upon the occurrence and time of appearance of marine animals in the Gulf of Trieste are also worthy of notice in this connection (20).

The considerable temporal variations which underlie the appearance of the pelagic organisms and which determine such great differences in the plankton composition, relative to quality and quantity, may be divided into four groups: (1) yearly, (2) monthly, (3) weekly, (4) hourly variations. Their causes are manifold, partly meteorological, partly biological. They are comparable to corresponding temporal oscillations of the terrestrial flora and fauna, on one side depending upon climatic conditions and meteorological processes, and on the other upon the changing mode of life, especially upon the conditions of reproduction and development. As the annual development of most terrestrial plants is connected with definite time conditions, as the period of budding and leaf development, of their blossoming and fructification, has

* My own extensive experience, I am sorry to say, is in this regard very insufficient, since I have never worked at a zoölogical station, and since usually I was only so fortunate as to go to the seacoast for a few months (or even only for a few weeks) during the academic vacation. Only once have I had the opportunity to extend my plankton studies at one and the same place to a half year (from October, 1859, to April, 1860, at Messina, 3, p. v, 166), and three times have I carried them on for three months at the same place—in the summer of 1859 at Naples, in the winter of 1866–67 at Lanzarote, and in the winter of 1881–82 in Ceylon.

become adapted to the meteorological conditions, the time of year and other conditions of life in the "struggle for existence," so also the annual development of most marine animals is governed by definite, inherited habits. With them also the influence of meteorological variations on the one side, of œcological relations on the other, are of the greatest importance for the periodical appearance. Most organisms appear in the plankton only periodically, and only very few can be reckoned as belonging to the "perennial plankton" in Hensen's sense (9, p. 1). This investigator also attaches great importance to the *temporal* "highly remarkable variations" in the plankton composition (9, pp. 29, 59); he explains it in part by "periods of famine" (p. 53).

Yearly oscillations.—The plankton literature has hitherto contained only a few reliable statements upon the yearly variations, which underlie the appearance of the pelagic animals and plants. Still there are a few contributions of high merit, extending over a series of years, namely those of Schmidtlein from Naples (19) and of Graeffe from Trieste (20). Even the first glance at the tables, those of the former relating to the appearance of the pelagic animals in the Gulf of Naples, shows us how remarkably different was the action of the majority of these in several successive years. As there are good and bad wine and fruit years, so there are rich and barren plankton years. But Schmidtlein correctly remarks that extensive observations extending through a long series of years are demanded to gain a deeper insight into the meaning of these yearly and monthly variations shown in the tables. The same view is also held by Chun, who, in his monograph of the ctenophores of the Gulf of Naples (p. 236), points out how very different was the number of these in five successive years.

Graeffe, resting on the basis of his observations for many years, says of *Cotylorhiza tuberculata*, that this beautiful acaleph has not for many years been found in the Adriatic, in other years only individually, but not at all rarely (yet always only in the three months of July, August, and September). Just as variable is the occurrence—"*according to the year*"—of *Umbrosa lobata* and other medusæ. Of the six species of ctenophores of the Gulf of Trieste, only one appears every year, the five others only now and then. Not only do the *quantities of individuals*, but also the "*time of appearance* of pelagic animals change according to the meteorological conditions of the time of year" (20, v, p. 361). I myself can fully establish this proposition on the ground of observations which I have made in the course of many years of medusa studies. Many of these "capricious beauties" occur in one and the same place on the Mediterranean coast (*e. g.*, in Portofino, in Villafranca), numerously in the first year, rarely in the second, and not at all in the third. When, in April, 1873, I fished in the Gulf of Smyrna, it was full of swarms of the great pelagic *Chrysaora hyoscella*. In April, 1887, when for the second time I sought the same gulf, I could not find a single individual of that beautiful medusa, but instead the gulf was filled by crowds of a new, hitherto undescribed, large medusa, *Drymonema cordelia.* Thousands of these *Cyaneidæ* lay cast upon the beach at Cordelio.*

Monthly oscillations.—The time of year is of just as great importance for the appearance of very many pelagic animals as for the flowering and fruit formation of land plants. Many of the larger planktonic animals, *Medusæ*, *Siphonophores*, *Ctenophores*, *Heteropods*, *Pyrosoma*, etc., appear only in one month or during a few months of the year. They form Hensen's "periodic plankton." In the Mediterranean many pelagic animals are numerous in the winter, while in the summer they are entirely wanting. This "periodical appearance of pelagic animals" has long been known and often mentioned; but not so the important fact that these ethoral periods themselves show considerable variations. For this the tables of Schmidtlein (19) and the notes of Graeffe (20) give important points of support. Especially the *Disconectæ* and other *Siphonophores*† behave very irregularly. The cause of the monthly variation lies on the one side in the conditions of reproduction and development; on the other in the varying temperature of the season, as Chun has lately shown (15, 16).

Daily oscillations.—Every naturalist who has observed and fished pelagic animals and plants in the sea for a long time, knows how unlike their appearance is on different days in the same period of the year or in the same month, when one may daily hope to find them. As a rule, the weather, and particularly the *wind*, conditions the remarkable difference of appearance. In long-continuing calms the surface of the sea becomes covered with swarms of various pelagic creatures. In long bands, smooth as oil, the most wonderful zoöcurrents appear. But as soon as a fresh wind stirs up lively waves, the majority sink into the quiet depths, and if a more violent storm churns up the deeper layers, all life vanishes from the surface for days. Many animals of the plankton (especially oceanic) are very susceptible to the influence of fresh water, and therefore disappear during violent rains. Warm sunshine entices the one to the surface, while it drives the other into the depths. This influence of the weather upon the quality and quantity of the planktonic composition is so well known that it is not necessary to give examples. Hensen (9) has even gone over his work many times, without thinking how the above endangers his "exact methods" and made their results illusionary.

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* *Drymonema cordelia,* whose milk-white umbrella reaches half a meter in diameter, I will describe hereafter. It differs in the formation of the gonads and oval tentacles, as in several other points, from the Adriatic species, which I have described as *Drymonema victoria* (=*dalmatinum*) (II, 29).

† Of the *Disconectæ* (*Porpita* and *Velella*) Chun during a 7 months' residence at the Canary Islands (1887–88) could find not a single specimen. According to him they should appear first in midsummer (July to September). On the other hand I saw at Lanzarote an isolated swarm of these *Disconectæ* in midwinter, in February, 1867.

Hourly oscillations.—Many pelagic animals appear at the surface of the sea *only at a definite hour* of the day, some in the morning, others at noon, still others towards evening. During the remainder of the day not a single individual of the species is to be found. Agassiz, thirty years ago, brought forward noticeable examples of this from the class of *Medusæ*, and I can from my own experience adduce a number of other examples. But many other pelagic animals also (*e. g.*, *Siphonophores*, *Heteropods*) come to the surface only for a few hours. We have long known that the swarms of the nyctipelagic *Pteropods*, *Pyrosoma* and many *Crustacea*, come to the surface only during the night and flee the light of day. Other groups act just reversely. But the late extensive observations, especially of Murray (6), Chierchia (8), and Chun (15) have taught us how great is the extent and importance of those hourly variations. That these are of great influence upon the composition of the plankton, and that this accordingly is very different at different times of day, needs no repetition. But we must allude once more to how all these temporal oscillations must be taken into consideration, if the *equality of plankton distribution* is to be proved by observation and estimation. In point of fact they all seem to tend to very remarkable *inequality*.

C.—Climatic Plankton Differences.

The numerous contributions which earlier and later observers have made upon the appearance of the swarms of the pelagic animals in different regions of the ocean, agree in pointing out the differences among them, corresponding to the climatic zones. Thus the Arctic oceans are characterized by masses of monotonic plankton of *Diatom*, *Beroidæ*, *Copepod*, and *Pteropod* groups, swarms which are often composed of milliards of single species. In the oceanic regions of the temperate zone we meet monotonic plankton of the *Fucoid*, *Noctiluca*, *Medusa*, *Ctenophore*, *Salpa*, *Schizopod*, etc., classes, sometimes composed of one, sometimes of several species. In the tropical ocean immense banks of monotonic plankton appear, in which the *Murracytes*, *Oscillatoriæ*, *Physalia*, *Pyrosoma*, *Ostracoda*, determine the character of the swimming oceanic population. Although these facts have long been known, up to this time no attempt has been made to arrange them chorologically or to define more closely the characteristic features of the plankton in the climatic zones. Yet I believe, partly upon the ground of the accounts referred to above (particularly of the *Challenger* and of the *Vettor Pisani*), partly on the ground of my own comparative investigations (of the *Challenger* as well as of the Rabbe collections), that even now an important proposition can be formulated.

The quantity of the plankton is little dependent upon the climatic differences of the zones, the quality very dependent; especially in this way, that the number of component species diminishes from the equator towards both poles. This proposition corresponds, on the whole, with the conditions which the climatic differences show in the terrestrial fauna and flora. Here as there the explanation of the facts is above all to be sought in the influence of the sun, that "all-powerful creator," which in the tropical zone conditions a much more lively interaction of the natural forces than in the polar zones. The "cycle of matter in the sea" (*Stoffwechsel des Meeres*) is no less influenced by the perpendicular rays of the sun than is the terrestrial fauna and flora; and as in the tropics the quantity and the complexity of the terrestrial organic living forms is by far most highly developed, so is it also the case with the marine forms.

Hensen places himself in remarkable opposition to this hitherto accepted view when in his account of the results of the *National* expedition he surprises us with the following statement:

Although we have found plankton everywhere, the amount of it under and near the tropics was relatively small, namely on an average 8 times less than in the north near the Banks of Newfoundland. Each one of these hauls contained upwards of a hundred different forms; but the poverty of the quantity is still a remarkably apparent established fact (22, p. 245).

In the notable account which E. du Bois-Reymond (on January 23, 1890) laid before the Berlin Academy upon the results of the *National* expedition, it was said concerning its scientific results that a complete account could not be given for three years, but then he added:

Only one chief result may here be assumed beforehand. Contrary to all expectations, established upon a theoretical basis, the quantity of plankton in the tropical waters is shown to be surprisingly small (21, p. 87).

Since Hensen with this "chief result" of the *National* expedition stands in strong opposition to the familiar experience of the *Challenger*, of the *Vettor Pisani*, and of many other expeditions, we must first of all again examine the *empirical foundations* upon which his assertions rest. For these he admits that he regards as such only the results of his "*trial trip" through a part of the Atlantic ocean*, in which the *residence in the tropics* embraced *scarcely two months.* The results which he here draws from his plankton fisheries, which obviously turned out remarkably poorly as a result of accidental conditions, may contradict the results which were set up by the *Challenger* and the *Vettor Pisani* during a residence in the tropics of altogether four years, in different parts of three great oceans. It is not indeed saying too much, if we declare this kind of conclusion by Hensen as hasty, and the "exact method" which he wishes to establish by *computation* as useless.

My own comparative study of the rich planktonic collections which Murray and Rabbe have brought in from the different parts of the three great oceans, has convinced me that the tropical ocean is not only qualitatively much richer (by the variety and number of planktonic species and genera) than the oceans of the temperate and cold zones, but that it also does not fall behind the latter quantitatively (in the abundant distribution and vast accumulations of individuals). To be sure, one ought not to take into consideration merely the *surface* of the tropical ocean (although this also is often extremely densely populated), but also the deeper zonary regions. For in the tropical zone there are numerous nyctipelagic organisms, which by day shun the glow of the perpendicular rays of the sun and betake themselves into the cooler, more or less deep layers of water; but at night these bathypelagic animals and plants appear at the surface in such immense crowds that they are not surpassed in quantity by the "immeasurable swarms" of pelagic organisms in the temperate and cold zones.

During my trip through the tropical region of the Indian Ocean, as well on the way to Ceylon (from Bombay) as on the return (from Socotora), I daily wondered at the great richness of pelagic life on the mirrored surface. At night the "whole ocean, as far as the eye could see, was a continuous shimmering sea of light" (25, p. 52). The luminous water, which at night we scooped up directly from the surface with buckets, showed a confused mass of nyctipelagic luminous animals (*Ostracods*, *Salpa*, *Pyrosoma*, *Medusæ*, *Pyrocystæ*), so closely packed that in a dark night we could plainly read the print in a book by the brightness of their pelagic light. The crowded mass of individuals was not less considerable than I have so often found in the Mediterranean in the currents of Messina. What quantities of food the plankton must here furnish to the larger animals was shown by the vast schools of great medusæ and flying-fish, which for days accompanied our vessel; and this mass covered large areas of the open Indian Ocean, midway between Aden and Ceylon. Just such plankton masses I have received through the kindness of Capt. Rabbe from other tropical parts of the Indian Ocean, between Madagascar and the Cocos Islands, and between these and the Sunda Archipelago. I encountered a wonderfully rich and thick planktonic mass in a pelagic current of the southwest monsoon drift, 50 nautical miles south of Dondra Head, the southern point of Ceylon.* I have referred to the richness of this in my "Indian Journal" (25, p. 275).

That the *tropical zone of the Atlantic Ocean* also possesses a vast wealth of plankton is shown by many older accounts, but especially from the experience of the *Challenger*. In the middle of the Atlantic, between Cape Verde and Brazil, Murray observed colossal masses of pelagic animals; and if by day they were scarce at the surface, he continually found them below the surface, in depths of 50 to 100 fathoms and more (6, pp. 195, 218, 276, etc.); at night they ascended to the surface and filled the sea far and wide with a brilliant glow (pp. 170, 195, etc.). "*On the whole cruise along the Guinea and equatorial currents, the pelagic life was exceedingly rich and varied*, in the quantities of individuals as well as of species, *much more than anywhere else in the northern or southern part of the Atlantic Ocean.* The greatest quantities were seen in the Guinea current during calms, *when the sea literally swarmed*

*A part of the new species of pelagic animals which I found in this astonishingly rich oceanic current are described in my "Reports on the Siphonophora and Radiolaria of H. M. S. *Challenger*."

with life" (p. 218). This astonishing wealth of plankton was observed in the whole breadth of the Atlantic tropical zone in August and September, 1873; but it was not less than that passed by the *Challenger* on her return in March and April, 1876, in the eastern part of the same region, between Tristan d'Acunha and Cape Verde. "When the water was calm, an extraordinary superabundance of pelagic life appeared at the surface. *Oscillatoriæ* covered the sea for miles, and vast quantities of *Radiolaria* (*Collozoün*) filled the nets" (p. 930). With those and other accounts by the *Challenger*, those of the *Vettor Pisani* quite agree. "*The zone of equatorial calms is out of all proportion rich in organic life.* Sometimes the water seems coagulated, jelly-like, even to the touch. It is impossible to describe the quantities of variously colored forms" (8, p. 31). Chierchia enthusiastically describes the wonderful spectacle which the luminous ocean furnishes at night—"a sea of light which extends to the whole horizon" (pp. 32, 53, etc.). The numerous plankton samples which I myself have investigated from the Atlantic tropical zone show for the most part an extraordinarily rich composition, particularly those between Ascension and the Canary Islands (*Challenger* stations 345 to 353), above all the two equatorial stations 347 and 348, which, like the *Canary currents*, which I studied for three months at Lanzarote, whose fabulous wealth I have already mentioned, also belong to the region of the *tropical* trades-drift.

The quantity and wealth of forms of the plankton in the *tropical zone of the Pacific Ocean* is not less than in the tropical region of the Atlantic and Indian oceans. In the most diverse parts of this region the *Challenger* sailed through "thick banks of pelagic animals." Between the New Hebrides and New Guinea "the surface of the water and its deeper levels swarmed with life. All the common tropical forms were found in great abundance. The list of genera of animals was about the same as in the Atlantic tropical region (pp. 218, 219), but it showed *considerable difference in the relative abundance of species*" (6, p. 521). Among the Philippines the water showed "a quite uncommon quantity and variety of oceanic surface animals" (p. 662). On the voyage from the Admiralty Islands to Japan the oceanic "fauna and flora of the surface was everywhere *especially rich and varied.* In the neighborhood of the equatorial countercurrents, between the equator and the Carolines, pelagic foraminifera and mollusks were taken in such quantities in the surface net that they surpassed all earlier observations," etc. (p. 738). On the voyage through the *central part of the tropical* Pacific, from Honolulu to Tahiti, between 20° N. lat., and 20° S. lat., "the catch of the tow net was everywhere very rich. *The superabundance of organic life in the equatorial current and countercurrent is very noticeable, as well with reference to the number of species as of individuals*" (p. 776). From this wonderfully rich region, which of all parts of the tropical ocean *is farthest removed from all continents*, came *the absolutely richest* plankton samples which I have ever studied, those which the *Challenger* brought from her stations 262–280. My astonishment was great when I first saw these planktonic masses, in the autumn of 1876; but it grew boundless when a year later I studied preparations taken from them and found in them hundreds of new species of pelagic animals.

The wonderfully rich *Radiolaria* ooze which the *Challenger* brought up at the central Pacific stations 263–274 (from depths of 2,000 to 3,000 fathoms) is only the siliceous remains of that planktonic mass, from which all organic constituents have vanished and the calcareous shells for the most part dissolved by the carbonic acid of the deep currents.* The numerous surface preparations which Murray finished upon the spot on this remarkable voyage of planktonic discovery through the central Pacific, and mounted in Canada balsam, are *absolutely the richest plankton preparations* which I have ever studied, especially those of stations 266–274, between 11° N. lat. and 7° S. lat. The richest of all stations is 271, lying almost under the equator (0° 33′ S. lat., 152° 56′ W. long.). I have since shown these preparations for microscopical studies to many colleagues and friends, and they have always expressed the liveliest astonishment over the new "wonder-world" concealed in them. They are jokingly called the "mira-preparations" (comp. 4, §§ 228–235).

The wonderful plankton wealth of the tropical Pacific is as well established by the manifold observations of Chierchia: "*The quantity and quality of the organisms which inhabit the tropical regions of the sea surpass all conception*" (8, p. 75). Inconceivable quantities of pelagic animals of all groups were seen in the middle of the tropical Pacific, between Callao and Hawaii, between Honolulu and Hongkong, not only at the surface, but in the most various depths up to 4,000 meters. The quantity of deep-sea siphonophores was here so enormous that the sounding lead was never drawn up without its being surrounded with torn-off tentacles (p. 85). During the forty days' voyage from Peru to Hawaii the pelagic fishery at the surface as well as in the depths brought to light "such a quantity of different organisms that it must seem almost impossible to one who did not follow the work with his own eyes" (8, p. 88). Similarly, in the Chinese sea and in the Sunda Archipelago immense masses of plankton were encountered.

It is my intention here to bring together the most general impressions of the relative planktonic wealth of the various oceanic regions, which I have gained from a comparative study of many thousand planktonic preparations. The pelagic fauna and flora of the tropical zone is richer in different forms of life than that of the temperate zone, and this again is richer than that of the cold zone of the ocean. This is true of the oceanic as well as of the neritic plankton. Everywhere the neritic plankton is more varied than the oceanic. The wealth of

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*Of this *Radiolaria* ooze there are 16 samples (embracing about 1,000 different species) contained in the "Radiolarian collection" (1890) above mentioned. The 8 richest of these (Nos. 20–27) belong to the *tropical central Pacific* (stations 265–274).

individuals can in none of these regions be called absolutely greater than in the others, since the quantitative development is very dependent upon local and temporal conditions and, according to time and place, is on the whole extremely irregular. Estimation of individuals can in this relation prove nothing.

D.—Currentic Planktonic Differences.

By far the most important of all the causes which determine the changing and irregular distribution of the plankton in the sea are the *marine currents.* The fundamental importance of these *currents* for all planktonic studies is generally recognized and has lately been mentioned many times and explained by Murray (6) and Chierchia (8). Even the zoölogists of the plankton expedition of Kiel have not been able to close themselves to this intelligence. Brandt calls special attention to "the importance of the marine currents as a means of, and limit to, the distribution of the planktonic organisms," so that in the various Atlantic currents numerous forms continually appear which were wanting in the regions previously traveled" (23, p. 518). Thus, Hensen mentions the "extraordinarily large plankton catches, which were transported by various currents."

I learned thirty years ago to recognize the great importance of the marine currents and their direct influence upon the composition of the plankton, when at Messina I went out almost daily in the boat for six months to secure the rich pelagic treasures of the strait (3, p. 172). The periodical strong marine current, which there is known to the Messinese under the name of the *current* or the *Rema*, enters the harbor twice daily and brings to it inexhaustible treasures of pelagic animals which since the time of Johannes Müller have aroused the wonder and desire for investigation of all naturalists tarrying there. Not less important did I find later the planktonic importance of the local marine currents (at Lanzarote), when the "Zain" current of the Canary Sea in like manner brought with it an extraordinary wealth of pelagic animals. My companion on the trip, Richard Greeff, has very vividly described these marine currents as "animal roads" (18, p. 307). During my numerous pelagic journeys on the Mediterranean it was always my first care to investigate the conditions of the currents, and on the most different parts of its coast (from Gibraltar to the Bosporus, from Corfu to Rhodos, from Nizza to Tunis, I have always been convinced of the determining influence which they exerted upon the composition and distribution of the plankton.

Although the fundamental importance of the marine currents for the diverse questions of oceanography are now generally recognized, still very little has been done to follow out in detail their significance for planktology. It seems to me, we must here, with reference to our theme, particularly distinguish (1) *halicurrents* (the great oceanic currents); (2) the *bathycurrents* (the manifold deep currents or undercurrents);

(3) the *nerocurrents* (the littoral currents or local coast currents); and (4) the *zoöcurrents* (the local planktonic streams or very crowded animal roads).

Halicurrents or ocean streams.—The unequal distribution of plankton in the ocean is in great part the direct result of the oceanic currents. In general the proposition is recognized as true that the great ocean streams, which we briefly designate as *halicurrents*, effect a greater accumulation of swimming organisms and thereby are richer in plankton than the *halistasa* or "still streams," the extensive regions which are inclosed by them and relatively free from currents. For a long time the richness in plankton which characterizes the Gulf Stream on the east coast of North America, the Falkland Stream on the east coast of South America, and the Guinea Stream on the west coast of Central Africa, has been known. Less understood and investigated than these Atlantic streams, but also very rich in varied plankton, are the great streams of the Indian and Pacific oceans, the Monsoon Stream on the south coast of Asia, the Mozambique Stream on the east coast of South Africa, the Black Stream of Japan, the Peru Stream on the west coast of South America, etc.

It is very difficult, from the numerous scattered accounts of the pelagic fauna and flora of these great ocean currents, to form a general picture of them, but it is now possible to draw from them the conclusion that generally the plankton of the *halicurrents*, qualitatively as well as quantitatively, is richer than the plankton of the *halistasa*, or the great oceanic sea basins around which flow the great streams and counter streams, and which meet the first glance on every recent map of the marine currents.*

In defending this proposition I rely especially upon the rich experience of the two most important plankton expeditions, of the *Challenger* (6) and of the *Vettor Pisani* (8), and also upon my own comparative study of several hundred plankton samples, which were collected in part by Murray, in part by Capt. Rabbe, in the most diverse parts of three great oceans. The planktonic wealth of the great halicurrents is most remarkable at the place where they are narrowest, when the masses of swimming animals and plants are most closely pressed together. Highly remarkable here is the opposition which the rich pelagic fauna and flora of the stream forms in qualitative and quantitative relation to the sparse population of the immediately adjacent halistase. As the temperature and often even the color of the sea

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* The systematic biological investigation of the *halistasa* seems to me to form one of the nearest and most pressing problems of planktology, and also of oceanography. Apart from the smaller and little investigated Arctic and Antarctic regions, in all five great areas of quiet water ought to be distinguished, namely: (1) the North Atlantic *halistase* (with the Sargasso Sea); (2) the South Atlantic (between Benguela and Brazil streams); (3) the Indian (between Madagascar and Australia); (4) the North Pacific (between California and China), and (5) the South Pacific *halistase* (between Chili and Tahiti).

water in two adjacent regions is remarkably different and often sharply contrasted, so also is the constitution of their animal and vegetable world. Thus Murray observed a strong contrast between the cool green coast streams and the warmer deep-blue ocean water when the *Challenger* neared the coast of Chili, between Juan Fernandez and Valparaiso, and correspondingly there occurred a sudden change of pelagic fauna, for the oceanic globigerina disappeared and the neritic diatoms, infusoria, and hydromedusæ appeared in greater abundance (6, p. 833).

This change was very remarkable when the *Challenger* (at station 240, June 21, 1875) left the warm "black stream" of Japan and entered the cold area of quiet water adjacent on the south (about 35° N. lat., 153° E. long.). Great polymixic masses of plankton, dwellers in the first area, were here killed by the sudden change of temperature and replaced by the monotonic copepodan fauna of the cold halistase (16, p. 758). Also, later, on the voyage through the Japan stream, the planktonic contents of the tow net plainly showed the proximity of two different currents. "In the cold streams there appeared a greater mass of small diatoms, noctiluca, and hydromedusæ than in the warmer streams where the richer pelagic animal world (*Radiolaria*, *Globigerina*) remained the same which the *Challenger* observed from the Admiralty Islands to Japan." Many similar cases occurred during the voyage, when proximity to the coast or the presence of coast currents was indicated by the contents of the tow net (6, p. 750).

Observations upon the plankton richness of the oceanic currents, similar to those of Wyville Thompson and Murray on the *Challenger* (6) were made by Palumbo and Chierchia on the *Vettor Pisani*. The latter calls attention especially to the great importance of these and the great accumulation of pelagic animals in limited regions of currents.

> It is a fact, that generally on a voyage through the ocean *great quantities of individuals of one species are found pressed together in relatively small spaces*, and this is true of organisms which, on account of their small size, are not capable of extensive movements. In addition, it is also a fact that when the ship is in the midst of the great oceanic currents, the pelagic fishery gives the most brilliant results (8, p. 109). *It is quite certain that the investigation of the distribution of the pelagic organisms can not progress unless accompanied by a parallel study of the currents, the temperature, and the density of the water* (8, pp. 109, 110).

Even the participators in the *National* expedition of Kiel could not avoid noticing the great irregularity of planktonic distribution in the ocean and the importance of the oceanic currents in this respect. During the voyage it was noticed that in different Atlantic currents numerous forms appeared continually which were absent in the regions previously traversed:

> The conditions are much more complicated (!) than we had hitherto supposed (23, p. 518).

But it is worthy of notice how Hensen, the leader of this plankton expedition, has noticed this abundant accumulation of pelagic organisms in single regions of currents, and has twisted it in favor of his theory of the *regular distribution of the plankton:*

The tests of the volume of the plankton show that, five times in the north, once north of Ascension, *extraordinarily large catches* (!) were made. These must have been caused by various *currents* in this region, and can therefore be left *out of consideration* (9, p. 249).

It seems to me that Hensen would have done better to take into consideration these and other facts observed by him relative to the unequal plankton distribution before he built up his fundamental, certainly *adequate*, theory of the equality of the same. This was to be expected, since he himself in his first oceanic plankton studies (1887) observed many "*remarkable inequalities*," and his own tables furnish proof of this. While he many times mentions the immense swarms of *Medusæ* and declares this "quite superabundant accumulation to be mysterious," he adds: "such places must be avoided in this fishery" (9, pp. 27, 65). When Hensen later, in comparing the different catches of copepods (one of the most important planktonic constituents), finds that the distribution of the plankton in the ocean is *very irregular* and that the constitution of this seems to very strongly contradict his general conceptions of natural life (9, p. 52), he holds it to be best that these catches, which are of "such a different kind, should be excluded from consideration" (pp. 51, 53). Also, in the case of *Sagitta*, which Hensen reckons with the copepods as belonging to the uniform perennial plankton, he finds "throughout not the equality which one might expect, but much more remarkable variations" (p. 59).

These "surprising inequalities," "variations even to tenfold," he finds in case of the *Daphnidæ* (pp. 54, 56) and *Hyperidæ* (p. 57), the pelagic larvæ of snails and mussels (pp. 57, 58), *Appendicularia* and *Salpa* (pp. 63, 64), the *Medusæ* and *Ctenophores* (64, 65), the *Tintinnoids* (p. 68), the *Peridiniæ* (p. 71), and even in the *Diatoms* (p. 82)—in brief, in all groups of pelagic organisms which by the numerous production of individuals are of importance for the plankton and upon which Hensen employs his painstaking method of calculation by quantitative planktonic analysis. If one freely "sets apart from consideration" all these cases of remarkable inequality (because they do not fall in with the theoretically preconceived ideas of the equality of planktonic composition), then finally the latter must be proved by counting.

Bathycurrents or deep streams.—Through recent investigations, particularly of Englishmen (Carpenter, Wyville Thompson, John Murray, *et al.*), we have become acquainted with the great importance of the submarine currents or deep streams. It has been demonstrated that the *epicurrents*, or the surface streams, furnish us no evidence relative to the understreams to be found below them, which we name *bathycurrents.* These undercurrents may in different depths of the ocean have a quite different constitution, direction, and force from the overcurrents. This is as true of the great oceanic as of the local coast currents. If the more accurate study of marine currents is a very difficult subject and great hindrances lie, as they do, in the way of exact determinations, the same applies especially to the deep currents. New ways and means must first be found for pressing into the dark labyrinth of very complicated physical transactions. Now we can only say that the bathycurrents are of great importance for the *irregular constitution and distribution of the plankton*. Since the time when, through the discoveries of Murray (1875), Chierchia (1885), and Chun (1887), we learned to recognize the existence and importance of the zonary and bathybic fauna, and particularly, through Chun, the *vertical migration* of the bathypelagic animals, the complicated conditions of the submarine currents must evidently have exerted an extraordinary significance for planktology. Although we have hitherto known so little about this subject, yet two points stand out clearly: First, that these are of great influence upon the local and temporal oscillations of planktonic composition; second, that it is an untenable illusion if Hensen and Brandt believe that, by means of their perfect-working vertical plankton net, "a column of water whose height and base area can be accurately determined has been completely filtered" (23, p. 515); for one can never certainly know what considerable changes in the plankton of this column of water one or more undercurrents have caused during the drawing up of the vertical net.

Nerocurrents or coast streams.—While the halicurrents or the great ocean streams are influenced in the first place by the winds and stand in immediate connection with the air currents of our atmosphere, it is only partly the case with the local coast currents, for here a number of local causes, which are to be sought in the climatic and geographical condition of the neighboring coast, work together. In the case of coasts which are much indented, in archipelagos with numerous islands, etc., the study of the littoral currents becomes a very complicated problem. The physical and geological natural condition of the coast mountains and of the beach, the number and force of the incoming rivers, the quality and quantity of the coast flora, etc., are here important factors. The fishermen, pilots, etc., are very well acquainted with these local coast currents, which we will briefly call *nerocurrents*, and are usually to be trusted in the details. Scientifically these currents should be studied more closely in smaller part and less quantity. For planktology they are of very high interest and not less important than the oceanic currents.

Next, the above-intimated *reciprocal relations of the neritic and oceanic plankton* are to be taken into consideration. He who for a long time has carried on the pelagic fishery at a definite point on the coast knows how very much the result of this is influenced by the natural condition of the coast, by the course and the extent of the coast currents. Straits like those of Messina and Gibraltar, harbors like those of Villafranca and Portofino, furnish uncommonly rich plankton results, because in consequence of the littoral currents a mass of swimming animals and plants are collected together in a limited space. The volume of this planktonic mass thus heaped up is often ten or many times greater than that in the immediately adjacent parts of the sea. On the contrary, the planktonic mass is extraordinarily poor in pelagic animals and plants, where by the emptying of great floods a quantity of fresh water is brought into the sea and its saltness diminished. Johannes Müller pointed out how very much the result of pelagic fishery was influenced thereby. Again, on the other hand, the rivers day by day bring into the sea a quantity of organic substances which serve as food for the benthonic organisms, and since the benthos again stands in manifold reciprocal relation to the plankton, since the meroplanktonic animals (like the medusæ, the pelagic larvæ of worms, echinoderms, etc.) are the means of a considerable interchange between the two, so is it easily understood how the distribution of the holoplanktonic animals is also influenced thereby and how irregular becomes the composition of the plankton.

Zoöcurrents, or planktonic streams.—Among the most noteworthy and important phenomena of marine biology is the great accumulation of swimming bodies which form long and narrow bands of thickened plankton. All naturalists who have worked at the seashore for a long period and have followed the irregular appearance of the pelagic organisms know these peculiar streams, which the Italian fishermen call by the name "*correnti*." Carl Vogt, in 1848, pointed out their great importance for pelagic fishery (17, p. 303). For their scientific designation and their distinction from the other marine currents I propose the term *Zoöcurrents* or *Zoörema*.*

The pelagic animals and plants are so numerous and so closely packed in these zoöcurrents as to resemble somewhat the human population in the busiest street of a great commercial city. But millions and millions of small creatures from all the above-mentioned groups of planktonic organisms are crowded confusedly together, and furnish a spectacle of whose charm a conception can be formed only by seeing it. If one directly scoops up a portion of this motley crowd with a tumbler, not infrequently "the greater part of the contents of the glass (an actual living animal broth) is composed of the volume of animals, the smaller of the volume of water" (3, p. 171). From a distance these "crowded sea-animal streets" are usually discernible from the smoothness which the surface of the sea presents, while close beside it the surface is more or less rippled. Often one can follow such an "oil-like animal stream," which usually has a breadth of 5 to 10 meters, for more than a kilometer without finding any diminution of the thick crowd of animals in it, while on both sides of it, right and left, the sea is almost vacant, or shows only a few scattered stragglers. At Messina, as at Lanzarote, the phenomena of the zoöcurrents were especially pronounced. My companion

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*Rema (used in Messina) is from the Greek ρεῦμα = current; comp. 3, p. 172 note.

on the trip, Richard Greeff, has described the Canary animal streams so vividly that I will here give his description verbatim:

Our gaze was directed to the highly peculiar long and narrow currents, which are of very especial importance for pelagic fishery with fine nets. If one looks at the calm sea, especially from an elevation over a wide expanse of water, here and there are seen strongly marked shining streaks, which intersect the surface as long narrow bands. Their course and place of appearance seem to be continually changing and irregular. Sometimes they are numerous, sometimes only few or entirely absent; to-day they appear here, to-morrow there; some have one direction, others the opposite or crossing the first. Occasionally they run along close to one another and unite in a single stream. If one approaches this streak it becomes evident that here in fact a current prevails different from the movements of the surrounding water, and that thereby is brought about the smooth band-like appearance. They give the impression of streams cutting through the rest of the ocean, with their own channel and banks, which, notwithstanding the great variations in the time and place of their appearance, yet during their existence, which is often brief, show a certain independence.

If one comes upon such streams, which are not too far distant from the coast, he sees that all the smaller, lighter objects which formerly scattered over the surface, floated about or cast upon the shore, were drawn into it. Pieces of wood and cork, straw, algæ, and tangle torn loose from the bottom, all in motley procession are carried along in this current. But in addition (and this is for us the most important phenomenon) all the animals belonging in the region of these currents are drawn in and fill it, often in such great quantities that one is tempted to believe it is not merely the mechanical influence of the narrow stream which has brought about such an accumulation of animals, but that the latter voluntarily seek out these smooth, quiet streams, perhaps in connection with certain vital expressions. A trip upon such a pelagic animal road furnishes a fund of very interesting observations. We can lean over the edge of the boat and review the countless brightly colored sea-dwellers, sometimes passing by singly, so that we can inspect them in their unique peculiarities, sometimes in such thickly massed hordes that they seem to form an unbroken layer of animals for a few feet below the surface. Yet these animal roads, where one meets them in the sea, will always form the most certain and richest mine for the so-called pelagic fauna, although naturally, from their changeableness and their dependence upon a calm sea, they can never be definitely counted upon. Likewise, the origin of these noticeable streams and their significance in the natural history of the sea is still almost completely dark, in spite of the fact that they can be observed in almost all seas and under favorable circumstances daily, and also are known to the fishermen of Arrecife under the name *Zain* (18, p. 307).

Although the zoöcurrents seem to occur in the most diverse parts of the ocean, and have often aroused the astonishment of observers, yet a recent investigation of them is wanting. What I know about them from my own experience and from the contributions of others is essentially the following:

The zoöcurrents occur in the open ocean as well as in the coast regions, particularly in the region of those nerocurrents which run in straits between islands or along indented coasts. They are dependent upon the weather, especially the wind, and appear as a rule only during calms. Although in the case of the neritic zoöcurrents the local course is more or less constant, still it is subject to daily (or even hourly) variations. Their breadth is usually between 5 and 10 meters, but sometimes 20 to 30 meters or more; their length is sometimes only a few hundred meters, and at others several kilometers. Oceanic animal streams reach much greater extension. Their constitution is sometimes polymixic, sometimes monotonic, often changing from day to day. Highly remarkable is the sharp boundary of the smooth, thickly populated animal roads, especially if the less inhabited and plankton-poor water on both sides is rippled by the wind. What combination of causes produces this vast accumulation is still quite unknown; certainly wind and weather play a rôle in it; often, also, the ebb and flow of the tide and other local conditions of the regions, especially local currents. As whirlwinds on land drive together the scattered masses of dust and smaller objects and raise a column of dust upwards, so may the submarine whirlwind press closely together the bathypelagic planktonic masses and carry them upward to the surface. But probably, also, in the same connection, complicated œcological conditions come into play, *e. g.*, sudden simultaneous development of quantities of eggs of one species of animal. A new study of the zoöcurrents is one of the most urgent problems of planktology.

VI.—METHODS OF PLANKTOLOGY.

The new aspects and methods which three years ago were introduced by Prof. Hensen into planktology, and of which I have already spoken, have for their main purpose the *quantitative analysis of the plankton*, *i. e.*, the most exact determination possible of the quantity of organic substance which the swimming organisms of the sea produce. To solve this subject and come nearer to the question connected with it of the "cycle of matter in the sea," Hensen devised a new mathematical method which aims chiefly at *the counting of the individuals of animals and plants* which populate the ocean. This new method we can briefly term *the oceanic population statistics* of Hensen. The high value which this indefatigable physiologist attributes to his new arithmetical method is shown by the special mention which he makes of it in his first contribution (9, pp. 2–33), from the wonderful patience with which he counted for months the single *Diatoms*, *Peridineæ*, *Infusoria*, *Crustacea*, and other pelagic individuals in a single haul of the Müller net, and from the long tables of numbers, the numerical protocols, and records of captures which he has appended to his first plankton volume which appeared in 1887.

Any ordinary pelagic haul with the Müller net or tow net brings up thousands of living beings from the sea; under most favorable circumstances hundreds of thousands and millions of individuals.* How much labor and time was involved in the counting of these organisms (for the greater part microscopic) is shown from the fact that "even the counting of one Baltic Sea catch, which is pretty uniform in its composition, required eight full days, reckoning eight working hours to the

* In a small catch, which filtered scarcely 2 cubic meters of Baltic Sea water, were found 5,700,000 organisms, including 5,000,000 microscopic peridineæ, 630,000 diatoms, 80,000 copepods and 70,000 other animals (23, p. 516).

day" (23, p. 516). Meanwhile Brandt, explaining the "highly original procedure" of Hensen ("turning attention to attacking a problem, the solution of which no one had ever thought of"), remarks, with reference to the foregoing quantitative analysis of the Atlantic plankton expedition of the *National* (1889), "that the very much more manifold ocean catches will consume presumably twice as much time, and since on the plankton voyage at least 120 such catches were made, then the working out of these (quite apart from the preliminary preparations) will fully occupy an investigator for 120 × 14 days, or about 6 years" (23, p. 516).*

Opinions respecting the significance and the value of the oceanic population statistics of Hensen are very different. E. du Bois-Reymond, in his paper before the Berlin Academy (21, p. 83),† attributes to it extraordinary importance, "wherefore the uncommon sacrifice made for it was justified." According to his opinion, the plankton expedition of the *National*, arranged for this purpose, within its definite limits, from the novelty and beauty of its well-described task, assumes a unique place, and the Humboldt fund ought to be proud at having been among the first to contribute to its execution" (21, p. 87). On the ground of this honorable recognition, as well as of the great hopes which the naturalist of Kiel himself based upon the results of the *National* expedition, numerous notices have appeared in German newspapers, disseminating the view that an entirely new field of scientific investigation had been thereby actually entered upon, and that a further extension of it was of great importance. I am sorry to say that I can not agree with this very favorable conception.

DISTRIBUTION OF THE PLANKTON.

The foundation upon which the entire planktonic conception and computation of Hensen rests is the view "that in the ocean the plankton must be regularly distributed; that from a few catches very safe estimates can be made upon the condition of very great areas of the sea" (22, p. 243). As Hensen himself says, he started with this "*purely theoretical view*," and he believes that a completely successful result is to be had, because these theoretical premises have been more fully

*According to this, the unfortunate plankton counter would in these 120 catches have to count for over 17,000 hours. How such an arithmetical Danaidæ work can be carried through without ruin of mind and body I can not conceive.

†In the introduction to this noteworthy paper Du Bois-Reymond says that since 1882 Hensen "had been mindful that, especially on the surface of the sea, there was found a more unequally numerous population of minutest living forms than had previously been supposed" (21, p. 83). This remark needs correction, because many times in the celebrated log book of the *National* plankton expedition this has been overlooked, and therefore it has wrongly been inferred that Hensen eight years ago was the first to discover the *existence* and *abundance* of the pelagic fauna and flora. In fact, for forty-five years they have been the object of wonder and study for numerous naturalists.

established than could have been hoped. I have already shown that this fundamental premise is entirely wrong. *The mass of plankton in the ocean is not perennial and constant, but of highly variable and oscillating size.* The biological composition is very diverse, dependent upon *temporal* variations—year, season, weather, time of day, upon *climatic* conditions and especially upon the complicated *currentic* conditions of the streams of the sea, of the oceanic and littoral currents, the deep currents, and the local zoöcurrents.

A comprehensive and fair estimation of all these œcological conditions must *a priori* lead to the conviction *that the distribution of the plankton in the ocean must be extremely irregular*, and we find this "purely theoretical view completely established" *a posteriori* by the comparative consideration and comparison of all the earlier above-mentioned observations. These can not be regarded as refuted by the opposing view of Hensen; for the empirical basis of the latter is, in regard to its time and place, *much too scanty and incomplete.*

One might perhaps object that the *technical methods* of plankton capture which Hensen employed gave more complete results than the methods hitherto used; but this is not the case. The recent description which Hensen gives of his technical methods for obtaining plankton (or pelagic fishery) is very praiseworthy (9, pp. 3 to 14). The construction of the net (material, structure of the net, size of filtration), the management of the catch and of the craft, are there carefully described. The advance of the new technique there realized may indeed serve to carry on the pelagic fishery or plankton capture more productively and more completely than was possible with the previous simpler technical apparatus of planktology; but I can not find that one of the proposed improvements of this pelagic technique shows a great advance in principle and is at all comparable to the great advance which Palumbo and Chierchia made in 1884 by the invention of the closible net. Besides, I can not understand how the new "plankton net" constructed by Hensen could give more accurate results than the simple "Müller net" hitherto employed, and the "tow-net" used by the *Challenger.* Such a vertical net will always bring up only a part of the plankton contained in the volume of water going through it, and by no means, as Hensen and Brandt believe, is a column of water whose height and base area can be measured with sufficient accuracy *perfectly* filtered. In this supposition the incalculable disturbances by conditions of currents, especially of concealed deep streams, are left out of account, as already mentioned. Besides, Chierchia has lately shown how unreliable and little productive is the fishery with the vertical net on account of the considerable horizontal swimming movements of the pelagic animals (8, p. 79). At any rate, the improvements Hensen has introduced into the technical methods of plankton capture are not so important that the remarkable difference between his and the earlier results can thereby be explained.

OCEANIC POPULATION—STATISTICS.

Statistics in general is known to be a very dangerous science, because it is commonly employed to find from a number of incomplete observations the approximate average of a great many. Since the results are given in numbers, they arouse the deceptive appearance of mathematical accuracy. This is especially true of the complicated biological and sociological conditions, whose total phenomenon is conditioned by the coöperation of numerous different factors, and is, therefore, very variable according to time and place. Such a highly complicated condition, as I believe I have shown, is the composition of the plankton. If, as Hensen actually wishes, this were to be sufficiently analyzed by counting the individuals, and oceanic population statistics were thereby to be made, then this would only be possible by the formation of numerous statistical tables, which should give results in figures of the plankton fishery quantitatively in at least a hundred different parts of the ocean, and in each of these at least during ten different periods of the year.

A single "reconnoitering voyage" on the ocean, a single "trial trip," limited in time and place, like the three-months Atlantic voyage of the *National* expedition, can furnish only a single contribution to this subject. But it can in no way, as Brandt thinks, offer "firm foundations" for the solution of this and that "thorough analysis" (23, p. 525). If, also, after six years the 120 catches should actually be counted through (after a labor of more than 17,000 hours), if by statistical arrangement of this numerical protocol, by rational reckoning of their results, a serviceable conception of the quantity of individuals of the oceanic region investigated should be obtained, then at best this one computation would give us an *approximate* conception of the conditions of population of a *very small part* of the ocean; but from it by no means can we, as the investigator of Kiel wishes, arrive at conclusions bearing upon the whole ocean; for that purpose hundreds of similar computations must be made, including the most diverse regions and based upon continuous series of observations during whole years. The zoölogical stations would be the best observatories to carry out *complete series of observations* of this character, not such trial trips as the three-months voyage of the *National*.*

*In my opinion the results of the *National* expedition of Kiel would have been quite different if it had been carried out in the three months from January to March, instead of from July to October. On the whole, the volume of planktonic catch, at least in the North Atlantic Ocean, would have more than doubled; in some places it would have been increased many fold. Its constitution would have been entirely different. If the expedition had by accident fallen in with a zoöcurrent, and its voyage had continued in it for a few miles, the contents of the nets would have certainly been a hundredfold, possibly a thousandfold, greater.

COUNTING OF INDIVIDUALS.

Since the new method of oceanic population statistics introduced by Hensen seeks its peculiar basis in the counting of the individuals which compose the plankton, and since it finds in this "counting the only basis upon which a judgment can rest" (9, p. 26), then we must examine more critically this cardinal point of his method, upon which he lays the greatest stress. The counting of the single organic individuals, which compose the mass of the plankton, is in itself, quite apart from its eventual value, an extremely difficult and doubtful task. Hensen himself has not concealed a part of this great difficulty, and attempts to partly allay the doubts which arise against his whole method.* But in fact these are much greater and more dangerous than he is inclined to admit.

WHAT IS AN ORGANIC INDIVIDUAL?

This simple question, as is known, is extremely difficult to answer. If one does not accept all the grades of physiological and morphological individuality, which I have distinguished in the third book of my "*Generelle Morphologie*," 1866, there are at least three distinct chief grades to be kept apart: (1) The cell (or plastid); (2) the person (or bud); (3) the cormus (or colony).† Only among the *Protista* (*Protophyta* and *Protozoa*) is the actual individual represented by a single cell; on the other hand, among the *Histona* (*Metaphyta* and *Metazoa*), by

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* The fourth part of the "Methodik" in the plankton volume of Hensen, which treats of "the work on land," (*a*) Determination of the volume, (*b*) the counting (9, pp. 15-30), is especially worthy of reading, not only because it gives the deepest insight into the error of his method, but also into his very peculiar conception of a general biological problem.

†The swimming animals and plants which compose the plankton should in this respect be arranged under the following heads: (*a*) *Protophyta*—among the *Chromaceæ, Calcocyteæ, Murracyteæ, Xanthelleæ, Dictyochæ,* and *Peridineæ,* all single cells are to be counted; among the diatoms partly the latter, partly the cenobia or cell aggregates. (*b*) *Metaphyta*—among the *Halosphæra* are to be counted the spherical *Thalli;* among the *Oscillatoriæ* the single, thread-like *Thalli;* among the *Sargassa* the cormus as well as its buds; but the cells which constitute each thallus and bud are also peculiar. (*c*) *Protozoa*—the *Infusoria* (*Noctiluca* and *Tintinna*) as well as the rhizopods (*Thalamophora* and *Radiolaria*), are all to be counted as unicellular individuals, but among the *Polycyttariæ,* besides the *Cœnobia* (colonies of *Collozoidæ, Sphærozoidæ,* and *Collosphæridæ*). (*d*) *Cœlenterata*—among the *Medusæ* and *Ctenophores,* as also among the pelagic *Anthozoa* and *Turbellaria* the single persons are to be counted; among the *Siphonophores* these as well as the single colonies; for each person (or each medusom) of a cormus is here equivalent to a medusa. (*e*) *Tunicata*—among the *Copelata, Doliolum,* and the generations of solitary *Salpas,* the single persons are to be counted; on the other hand, among the *Pyrosoma* and the *Salpa* chains, the single cormi as well as the persons which compose them. (*f–k*) In all the remaining groups of planktonic animals, in the case of sagitta, mollusks, echinoderm larvæ, articulates, and fishes, not merely the persons are to be counted, but also the cells which make up each of these metazoa.

the higher unit of the person or of the colony, which is composed of many cells. If we actually wish to carry out exactly the method, held by Hensen as indispensable, of counting the individuals, and wish to obtain useful results for his statistical work, then nothing remains except a counting of all single cells which live in the sea. For only the single cells, as the "organic elementary individual," can form the natural arithmetical unit of such statistical calculations and the computations based thereon. If Hensen in his long "numerical protocols and comparisons of captures" (9, pp. XI–XXXIII) places close to one another as counted individuals—as coördinated categories—the unicellular radiolaria, the *cormi* of siphonophores and tunicates, the persons of medusæ, ctenophores, echinoderms, and crustacea, the eggs and persons of fishes, then he places together vastly incommensurable bulks of quite different individual value. These can only be comparable for his purpose if all single cells are counted. But since each fish and each whale in the ocean daily destroys milliards of these planktonic organisms, so, in order to gain an "exact" insight into the "cycle of matter in the sea," the cell milliards which compose the bodies of these gigantic animals must be counted and placed in the reckoning.

ECONOMIC YIELD OF THE OCEAN.

Hensen holds the quantitative determinations of the plankton not only as of the highest importance in theoretical interest to science, but also in practical interest to national economy. He thinks "that we will be able to invent correct modes of action in the interest of the fisheries,* only if we are in position to form a judgment upon the productive possibilities of the sea" (9, p. 2). Accordingly he regards it as the most pressing problem to determine the economic yield of the ocean in the same way as the farmer determines the useful yield of his fields and meadows, the yearly production of grass and grain. By the counting of the planktonic individuals which Hensen has carried on for a long time for a small part of the Baltic Sea, he thinks he has become convinced that the "entire production of the Baltic in organic substance is only a little inferior to the yield of grass upon an equally large area of meadow land."

The farmer determines the yield of his meadows, garden, and field by quantity and weight, not by counting the individuals. If instead of this he wished to introduce Hensen's new exact method of deter-

*How the practical interests of the fisheries can be advanced by quantitative plankton analysis I am not able to understand. The most important modes of action which we can employ for the increase of the fish production of the ocean—artificial propagation, increase and protection of the fry, increase of their food supply, destruction of the predaceous fishes, etc.—are entirely independent of the numerical tables which Hensen's enumeration of individuals gives. That the number of swimming fish eggs furnishes no safe conclusion upon the number of mature fish has been pointed out above.

mination, he must count all the potatoes, kernels of grain, grapes, cherries, etc., and not only that, he must also count the blades of grass of his meadow, even every individual weed which grows among the grain of his field and the useful plants of his garden; for these also, regarded from the physiological point of view, belong to the "total production" of the ground. And what would be gained by all these immense countings? Just as little as with the "desolate figures" in Hensen's long numerical protocols.*

VOLUME AND WEIGHT OF THE PLANKTON.

If one actually regards the determination of the planktonic yield as a highly important subject, and believes that this can be solved by a certain number of quantitative plankton analyses, then this goal can be reached in the simplest way by determination of the volume and weight of each planktonic catch. Hensen himself naturally first trod this nearest way; but he thinks that it is not accurate enough and encounters difficulties (9, p. 15). In his opinion, "an accurate analysis of the plankton, on account of the great variety of its parts, can only be obtained by counting; he quite forgets that such a counting of individuals also possesses only an approximate and relative value, not a complete and absolute one; farther, that from the counting of the different individuals no more certain measure for the economic value of the whole diversely constituted planktonic catch is furnished; finally that the counting of one catch is of highest value as a single factor of a great computation, which is made from thousands of different factors.

The only thorough method of determining the yield, in planktology as in economy, is the determination of the useful substance according to mass and weight and subsequent chemical analysis. In fact, the determination of the planktonic volume, as of the weight, just as the qualitative and quantitative chemical analysis of the plankton, is possible up to a certain degree. The difficulties are less than Hensen believes. It seems odd that the latter has not mentioned these two simplest methods in a single place in his comprehensive volume (9, p. 15), but hastily casts them aside and replaces them with the quite useless "counting of individuals," a Danaidæ task of many years.

*While Hensen is going over the counting of the single constituent parts of the plankton, he calls special attention to the fact "that in spite of the apparently" desolate figures, in almost every single case certain results of general interest have come out, though the opportunity is not offered to show them in a comparison.

CYCLE OF MATTER IN THE OCEAN (*Stoffwechsel des Meeres.*)

The many and great questions which the mighty cycle of matter in the ocean furnishes to biology, the questions of the source of the fundamental food supply, of the reciprocal trophic relations of the marine flora and fauna, of the conditions of support of the benthonic and planktonic organisms, etc., have, within the last twenty years, since the beginning of the epoch-making deep-sea investigation (13), been much discussed and have received very different answers (11). Hensen has also devoted considerable attention to this, and particularly emphasizes the physiological importance of the fundamental food supply (*Urnahrung*). He believes this complicated question can be solved especially by *quantitative determination of the fundamental food supply.*

I have already shown why this method of quantitative plankton analysis must be regarded as useless. Even assuming that it were possible and practicable, I can not understand how it could lead to a definite solution of this question. On the other hand, I might here point to one side of the oceanic cycle of matter whose further pursuit seems very profitable. The two chief sources of the "oceanic fundamental food supply" have already been correctly recognized by Möbius (11), Wyville Thompson (13, 14), Murray (6), and others: First, the vast terrigenous masses of organic and particularly vegetable substances, which are daily brought by the rivers to the sea; secondly, the immense quantities of plant food which the marine flora itself furnishes. Of the latter we previously had in mind chiefly the benthonic littoral flora, the mighty forests of algæ, meadows of *Zostera*, etc., which grow in the coast waters. Only in recent times have we learned to value the astonishing quantity of vegetable food which the planktonic flora produces, the *Fucoids* of the Sargasso Sea on the one side, the *Oscillatoriæ* and the microscopic *Diatoms* and *Peridineæ* on the other. But the smaller groups of pelagic *Protophytes*, which I have mentioned above, the *Chromaceæ*, *Murracyteæ*, *Xanthelleæ*, *Dictyocheæ*, etc., also play an important rôle. The great importance which devolves upon the small symbiotic *Xanthelleæ*, has been especially emphasized by Brandt (24), Moseley (7), and Geddes. Evidently their multiplication is extremely rapid, and if each second milliard of such *Protophytes* were eaten by small animals, new milliards would take their places. Whether or not the number of these milliards is shown to us by the quantitative planktonic analysis seems to me wholly indifferent. More important for the understanding of their physiological importance would be the ascertainment of the rapidity of the increase.

The importance of these *Protophytes* and of the *Protozoa* living upon them has lately been particularly described by Chun (28, pp. 10, 13). He has also rightly emphasized the extraordinary importance which the *vertical migration* of the bathypelagic animals has for the support of the deep-sea animals. They are to a great extent the under workmen, who constantly bring the provision transports into the deep sea (15, pp. 49, 57). Thither, in addition, come the immense quantities of marine plant and animal corpses, which daily sink into the depths and are borne away by currents. Thither comes the constant "rain" of the corpses of zonary *Protozoa* (especially *Globigerina* and *Radiolaria*), which uninterruptedly pour down through all the zones of depth into the deepest abysses, and whose shells form the most abundant sediment of the deep sea, the calcareous *Globigerina* ooze and the siliceous *Radiolaria* ooze. In general, it seems to me that the daily supply of food materials which the decaying corpses of numberless marine organisms furnish to the others, is much more important than is commonly supposed.* How much food would a single dead whale alone furnish?

But especially important and not sufficiently valued in this regard, it seems to me, is the trophic importance of the benthos for the plankton. Immense quantities of littoral benthos are daily carried out into the ocean by the currents. Here they soon disappear, since they serve as food for the organisms of the plankton. If one weighs all these complicated reciprocal relations, he obtains without counting a sufficient general conception of the "cycle of the organic material in the marine world."

COMPARATIVE AND EXACT METHODS.

The farther the two great branches of biology, namely, morphology and physiology, have developed into higher planes during the last decade, so much farther have the methods of investigation in both sciences diverged from one another. In morphology the high worth of comparative or declarant methods has always been justly more recognized, since the general phenomena of structure (*e. g.*, in ontogeny and systemization) have been in great part removed from exact investigation, and comprise historical problems, the solution of which we can strive for only indirectly (by way of comparative anatomy and phylogenetic speculation). In physiology, on the other hand, we constantly strive to employ the exact or mathematical methods, which have the advantage of relative accuracy and which enable us to trace back the general phenomena of vital activity directly to physical (particularly to chemical) processes. Plainly it must be the endeavor of all sciences (of morphology also) to find and retain as much as possible this exact mode of investigation. But it is to be regretted that among most branches of science (and particularly the biological ones) this is not possible, because the empirical foundations are much too incomplete and

* Hensen values this source of food very slightly, because "only a very few animals live upon dead matter," and explains it in this way, "that material in a state of foul putrefaction requires a stronger digestive power than the organization of the lower animals can produce" (9, p. 2). I must contradict both ideas. The sponges live chiefly upon decaying organisms, as do also many *Protozoa, Helminths, Crustacea,* etc.

the problems in hand much too complicated. Mathematical treatment of these does more harm than good, because it gives a deceptive semblance of accuracy, which in fact is not attainable.* A part of physiology also embraces such subjects as are with difficulty, or even not at all, accessible to exact definition, and to these also belong the chorology and œcology of the plankton.

The fundamental fault of Hensen's plankton theory in my opinion lies in the fact that he regards a highly complicated problem of biology as a relatively simple one, that he regards its many oscillating parts as proportionally constant bulks, and that he believes that a knowledge of these can be reached by the exact method of mathematical counting and computation. This error is partly excusable from the circumstance that the physiology of to-day, in its one-sided pursuit of exact research, has lost sight of many general problems which are not suited for exact special investigation. This is shown especially in the case of the most important question of our present theory of development, the species problem. The discussions which Hensen gives upon the nature of the species, upon systemization, Darwinism, and the descent theory, in many places in his plankton volume (pp. 19, 41, 73, etc.) are among the most peculiar which the volume contains. They deserve the special attention of the systematist. The "actual species" is for him a physiological conception, while, as is known, all distinction of species has hitherto been reached by morphological means.†

In my Report on the *Radiolaria* of H. M. S. *Challenger* I have attempted to point out how the extremely manifold forms of this most numerous class (739 genera and 4,318 species) are on the one hand distinguished as species by morphological characters, and yet on the other hand may be regarded as modifications of 85 family types, or as descendants of 20 ancestral orders, and these again as derived from one common simple ancestral form (*Actissa*, 4, § 158). Hensen on the other hand is of the opinion that therein is to be found "a strong opposing proof against the independence of the species" (9, p. 100). He hopes "to lighten the systematic difficulties by the help of computation" (p. 75). Through his systematic plankton investigations he has reached

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* A familiar and very instructive example of this perverted employment of exact methods in morphology is furnished by the familiar "Mechanical theory of development" of His, which I have examined in my anthropogeny (3d edition, p. 53, 655) as well as in my paper upon *Ziele and Wege der Entwickelungsgeschichte* (Jena, 1875).

† Since of late the physiological importance of the "species" conception has often been emphasized and the "system of the future" by the way of "comparative physiology" has been pointed out, it must here be considered that up to this time not one of these systematic physiologists has given even a hint how this new system of description of species can be practically carried out. What Hensen has said about it (9, pp. 41, 73, 100) is just as worthless as the earlier discussions by Poléjáeff, which have been critically considered in my Report on the Deep-Sea Keratosa (*Challenger*, Zoölogy, vol. XXXII, part 82, pp. 82–85.)

the conviction that "the more accurately the investigation has been made, so much the more plain becomes the distinction of species" (9, p. 100). On the other side I, like Charles Darwin, through many years of comparative and systematic work, have arrived at the opposite conclusion: "*The more accurately the systematic investigations are made, the greater the number of individuals of a species compared, the intenser the study of individual variation, by so much more impossible becomes the distinction of actual species, so much more arbitrary the subjective limits of their extent, so much stronger the conviction of the truth of the Theory of Descent.*"*

PLANKTOLOGICAL PROBLEMS.

The wonderful world of organic life, which fills the vast oceans, offers a fund of very interesting subjects. Without question, it is one of the most attractive and profitable fields of biology. If we consider that the greater part of this field has been open to us scarcely fifty years, and if we wonder at the new discoveries which the *Challenger* expedition alone has brought to light, then we ought to count upon a brilliant future for planktology.

Above all we ought to cherish the hope that our German *National* expedition, the first great German undertaking in the field, may promote many planktonic problems, and that the six naturalists who, under such favorable conditions and with such important instruments, studied the oceanic plankton for ninety-three days and in 400 hauls of the net were able to obtain a rich collection of pelagic organisms, will by their careful working up of these enrich our knowledge many fold. However, the preliminary contributions of Hensen (22) and Brandt (23) give us no means of passing judgment upon the matter now. Among the results which the former has briefly given to the Berlin Academy few require consideration; but for this the difference of our general point of view is to blame. Thus, for example, I have attempted to explain the remarkable "similarity to water of the pelagic fauna," the transparency of the colorless glassy animals, in 1866, in my General Morphology (II, p. 242), according to Darwin's Theory of Selection, by natural selection of like colors (30, p. 248). Hensen, on the other hand,

* F. Heincke has briefly, in his careful "Investigations upon the Stickleback," given expression to the same conviction in the following words: "All the conclusions here deduced by me are simply and solely founded upon the comparison of very many individuals of living species, or, in other words, upon the study of *individual variation.* I am convinced that in essentials the study of embryology will confirm my theory. It will be a proof of this, that he who wishes accurately to describe related species, and races of a species, and to study their genealogical relation to one another, must begin by *comparing a very great number of individuals from different localities* accurately and methodically. He will then soon see *that proofs of the theory of descent by this means are found in great numbers at all times,* if only one does not spare the pains to trace them out." (Ofversigt af K. V. Akad. Forh. Stockholm, 1889, No. 6, p. 410.) This view of Heincke is shared by every experienced and unbiased systematist.

regards hunger as the cause of this, and the "tendency to explore a relatively great bulk of water." In general, according to his view, "many larger pelagic animals bear the outspoken character of unfavorable conditions of life, of a life of hunger."

Regarding the *appearance* of many pelagic animals *in swarms*, Hensen explains "that the young do not float, but swim freely. In consequence of this, the mother animals drive them away, and if the larvæ finally rise to the surface the former can not enter into competition with them" (22, p. 252). The accumulation of numbers of *Physalia* in great swarms stands, according to his view, in correlation with the mode of movement. The animals which are capable of no independent movement of progression must remain rather closely crowded together, in order to be able to reproduce *bisexually;* those carried too far away must perish." On the other hand it is to be noted that the *Physalia* is not, as Hensen assumes, *gonochoristic*, but always *hermaphroditic*.*

The above-mentioned phenomena, the similarity to water of the pelagic fauna, the periodic appearance of many pelagic organisms in swarms, their abundant accumulation in the zoöcurrents (p. 85), particularly their relation to the currents, are only a few of the greater problems which planktology furnishes for human investigative energy. For these, as for so many other fields of biology, Charles Darwin, by the establishment of the descent theory, has opened to us the way to a knowledge of causes. We must study the complicated reciprocal relations of the organisms crowded together in the struggle for existence, the interaction of heredity and variation, in order to learn to understand the life of the plankton. But in these plankton studies, as well in physiological as in morphological questions, we must use that method which Johannes Müller, the discoverer of this field, always employed in a manner worthy of imitation: simultaneous "observation and reflection."

* The cormi of all *Physalidæ* are monœcious, their cormidia monoclinic. Each single branch of the racemose gonodendron is monostylic, and bears one female and several male medusoids. The facts were brought out thirty-five years ago by Huxley. (Compare my Report on the Siphonophoræ: Zoölogy of the *Challenger*, vol. XXVIII, pp. 347, 356.)

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