REPORT ON INQUIRY RESPECTING FOOD FISHES AND THE FISHING GROUNDS.

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INVESTIGATIONS AND EXPERIMENTS REGARDING SPECIAL ECONOMIC ANIMALS.

OYSTERS.

Experiments at Lynnhaven, Va.—The Commission has continued, under the direction of Dr. H. F. Moore, the oyster experiments at Lynnhaven, Va., the progress of which has been recorded in previous reports. During the preceding years trouble had been encountered in maintaining the salinity of the claire in seasons of great rainfall, and in the autumn of 1902 an appliance was installed for the purpose of obviating the difficulty. It consists of a 14-inch propeller revolving on a vertical shaft in a well connected with the outer waters by a short canal. With the tide at a height of 10 inches above mean level, it is possible to raise the height of the claire one-half inch per hour, and the water lost by evaporation and seepage can be replaced by bay water of maximum salinity. With the water in the claire always maintained at the highest level, rainwater falling on the pond tends largely to keep on the surface and spills over the crest of the dam without considerably lowering the density of the claire. This is an important improvement, as a low salinity makes fattened oysters too fresh, injures their flavor, and lessens their value in the markets.

The difficulty heretofore experienced with an occasional "marshiness" in the flavor of the oysters has been overcome by the use of a lime solution in small quantities and the occasional removal of accumulations of filamentous algæ, which, stimulated by the same artificial conditions which favor the growth of oyster food, tend, under ordinary circumstances, to grow luxuriantly.

Owing to delays in the construction of the propeller pump and to difficulties encountered in its adjustment to the conditions, the claire was not filled with oysters until late in the season. The product was therefore smaller than hoped for and the price realized per barrel was less than would have been the case otherwise. From February 28 to

May 5, 166 barrels were shipped. During April, the only month when the claire was operated at any approximation to its full capacity, 93 barrels were fattened and the average price realized was $4 per barrel.

In order that the system may be commercially applicable a higher price must be received, and to accomplish this it is necessary to be assured of a constant supply of oysters early in the season, when the most advantageous shipping arrangements can be entered into. It is believed that these conditions can be attained during the next fiscal year.

Oysters in Sheepscot River, Maine.—During the summer of 1902 the attention of the Commission was called to the recent volunteer growth of oysters in Sheepscot River, and Dr. W. C. Kendall, who was conducting other inquiries in the vicinity, was directed to make an investigation of the facts. It was found that in general the oysters extend from near the dam at Sheepscot village to about 2 miles above that place wherever they have found proper bottom. It is probable that the area of the beds could be considerably increased by the distribution of suitable cultch. At the time of the settlement of the country productive beds existed in this river, but about 1860 they ceased to exist, although occasional large oysters have been taken from time to time since then. No young oysters were noticed until about 1898, but since then there has been a set of spat each year. Just what change of condition has brought this about is not known, and further inquiry into the matter is contemplated by the Commission.

Oyster planting in North Carolina.—In collaboration with the geological and natural history survey of North Carolina, the Commission has conducted, through the Beaufort laboratory, experiments in oyster culture in Pamlico Sound and Newport and North rivers. The maintenance of experimental beds has been continued with a view to determining the factors, favorable and unfavorable, which confront the commercial oyster planter in North Carolina, and to devise the best means of overcoming the untoward conditions. A subject of some interest, which was under consideration by Mr. O. C. Glaser, was the production of normally shaped oysters from reef oysters and the artificial production of reef oysters from well-shaped ones.

Oyster culture in Japan.—Taking advantage of a visit to Japan by Dr. Bashford Dean, of Columbia University, New York, the Commission arranged to have this well-known biologist investigate and report on the methods of oyster cultivation there pursued. Doctor Dean's report,[a] issued in February, 1903, is the first publication in the English language dealing in detail with the Japanese oysters and their cultivation, and is an important and timely contribution, especially in view of the proposed acclimatization and cultivation of Japanese oysters on the Pacific coast of the United

[a] Japanese Oyster Culture. Bulletin U. S. Fish Commission, 1902.

States. It is reported that during the past winter a considerable consignment of oysters from Japan was planted in Washington waters.

LOBSTER.

Lobster rearing.—Experiments in the hatching and rearing of lobsters were continued at Woods Hole during the summer of 1902, in charge of Mr. George H. Sherwood. A special floating nursery was constructed and moored at the head of Great Harbor. Eggs and newly-hatched larvæ were supplied from the Woods Hole hatchery as required, and other facilities of the station were freely used. Considerable progress was made beyond the previous year's work, and it is believed that the methods which have now been developed are practicable for operations on a large scale. One of the chief drawbacks this season was the extraordinary abundance of minute diatoms which thickly covered eggs and larvæ, and seriously interferred with hatching and growth. A final and complete report on the lobster-rearing experiments will soon be made by the special commission having this matter in charge.

Handbook of the lobster.—Interest in the lobster continues unabated among fishermen, legislators, state fishery authorities, and biologists, and there is a very active demand for printed information in regard to the habits, growth, spawning, development, etc., of the lobster, as well as the methods and extent of the lobster fisheries. The monographic work on the American lobster by Prof. F. H. Herrick, published by the Commission about seven years ago, is now out of print and no other report on the general subject is available for distribution. With a view to supplying the demand, the Commission has decided to issue a handbook on the lobster and its fisheries, and to this end has engaged Professor Herrick to condense and bring up to date his work referred to. During the summer of 1902 Professor Herrick visited the important lobster fishing communities on the coast and collected much new material on the natural history of the lobster. The lobster fisheries, lobster legislation, lobster rearing, and other matters connected with the economic aspects of the subject will be discussed by Dr. H. M. Smith.

BLUE CRAB.

The recent increase in the catch of blue or edible crabs in Chesapeake Bay, where the fishery was already of great extent, and the appearance in the eastern markets of large quantities of soft-shell crabs of very small size, has led to the belief that the supply of crabs may be declining. The Commission therefore decided to begin an inquiry into the habits, breeding, abundance, etc., of the crab in Chesapeake Bay, and assigned Prof. W. P. Hay to the work, in conjunction with his study of the diamond-back terrapin in the same waters.

Many points were visited and observations made in all parts of the bay, and considerable new light was thrown on the habits of this crab. The information thus collected will be of value should it become necessary to enact measures for protecting the species. Among the interesting facts apparently established are: (1) that in Chesapeake Bay the blue crab seldom or never produces eggs at any great distance from the ocean, and therefore that the myriads of adult crabs found in the upper waters of the bay represent young crabs which have migrated thither from the denser waters near the Virginia capes; (2) that the crab produces eggs only once, and dies shortly after spawning; and (3) that the males undoubtedly live longer than the females, great numbers of large adults surviving the winter by burying themselves in the mud in the deeper channels.

DIAMOND-BACK TERRAPIN.

The growing scarcity of the diamond-back terrapin in Chesapeake Bay, which has for years been the most productive region, has led to the belief that the species may eventually become almost exterminated if the present methods of the industry continue, or if no steps are taken to arrest the decline by cultivation. The reported catch of terrapins in Maryland in 1901 was only one-sixtieth of the quantity and one-twentieth of the value of that in 1891; and in Virginia the output in 1901 was one-tenth the quantity and one-thirteenth the value of that for 1891. The decrease in the local output has in part been made good by the importation by the dealers of terrapins from the South Atlantic and Gulf States—these southern terrapins being kept for a while in pounds and then shipped to market. There have been many requests for data regarding the growth, food, breeding, etc., of the terrapin, but the only report on the subject, published many years ago, is out of print and much of the information therein contained is obsolete and incomplete.

During the summer of 1902 a complete study of the diamond-back terrapin of the Chesapeake Bay region was undertaken by the division, Prof. W. P. Hay being placed in charge. In addition to the natural history of the species, there were considered the extent and causes of the decrease, the laws regulating the terrapin fishery, terrapin pounds and their management, the trade, markets, prices, etc. Special atten-was given those points in the natural history of the species which bear on the question of artificial rearing, and a series of experiments was inaugurated addressed to this phase of the subject. Supplemental to this inquiry, an experimental pound was established at a favorable locality on the Choptank River, Maryland, and another at the laboratory at Beaufort, N. C., for the purpose of keeping terrapin under observation and noting their growth, breeding habits, etc.

There was also taken up a study of the diamond-back terrapin from the standpoint of systematic zoology, and specimens were collected and brought together in Washington from Delaware, Maryland, Virginia, North Carolina, Florida, Mississippi, Louisiana, and Texas in order to determine the specific or varietal differences.

The inquiries and experiments will be conducted during another season, after which it is hoped that a final report on the biology of the diamond-back terrapin may be made and that a practicable method of cultivation may have been developed.

PACIFIC SALMONS.

Salmon fisheries of Alaska.—The unusual activity displayed in the Alaska salmon fisheries during the last few years, the remarkable extension of the fisheries, the great increase in the amount of gear used and in the number of canneries operated, together with the very close competition among the different companies, each striving to secure as large a pack as possible, made it evident that the demand upon the salmon supply was greater than could be met by natural reproduction. Fearing a serious depletion of the fisheries, the President, under date of November 8, 1902, requested the Commissioner of Fish and Fisheries to appoint a special commission to make a study of the condition of the salmon fisheries of Alaska, the efficiency of the existing regulations under which they are carried on, and the necessity for artificial propagation, and to submit a report embodying such recommendations as might be thought needful for the proper regulation and preservation of those important fisheries. The special Alaska salmon commission consisted of Dr. David S. Jordan, president of Stanford University; Dr. Barton W. Evermann, assistant in charge of the division of statistics and methods of the fisheries; Lieut. Franklin Swift, U. S. Navy, commanding the *Albatross;* Mr. A. B. Alexander, fishery expert on the *Albatross;* Mr. Cloudsley Rutter, naturalist on the *Albatross;* and Mr. J. Nelson Wisner, field superintendent of fish-cultural stations. In addition to the regular members, the following assistants to the commission were appointed: Mr. F. M. Chamberlain, Mr. E. L. Goldsborough, and Mr. H. C. Fassett, of the Fish Commission; Dr. Harold Heath, Dr. C. H. Gilbert, Mr. M. H. Spaulding, and Mr. Harold Jordan, of Stanford University, and Mr. A. H. Baldwin, of Washington, as artist.

The steamer *Albatross* was detailed for use during the investigations, but before the ship went north shore parties for the study of certain phases of the salmon fisheries were established as follows: Early in March Mr. Chamberlain went to Loring, Revillagigedo Island, in southeast Alaska, where he entered upon a study of the habits of the salmon, which it is expected will be carried on continuously for at least one calendar year. One of the largest salmon canneries of Alaska and the largest and best equipped salmon hatchery in the world are located here, and the place affords exceptional opportunities for a study of four of the five species of Alaska salmon. In May Mr. Rutter and Mr. Spaulding established a similar station at Karluk on Kadiak Island. The facilities for a study of the salmon are unsurpassed at Karluk. Karluk River is one of the best salmon streams in Alaska; there are two well equipped canneries at its mouth, and the Alaska Packers' Association operates an extensive salmon hatchery at the head of the lagoon. Early in June Doctor Gilbert was sent to Bristol Bay, Bering Sea, where he entered upon similar studies of the salmon and salmon fisheries of that region. At the end of June all these investigations were in progress and were carried over into the next fiscal year. The *Albatross*, with the other members of the commission and their assistants on board, sailed from Seattle for Alaska, June 18, and the investigations were in progress at the close of the fiscal year.

Blueback salmon in Baker Lake.—In conjunction with the operations of the hatchery for blueback salmon on Baker Lake, at the head of Skagit River, Washington, the superintendent desired to have certain biological investigations undertaken, and Mr. Cloudsley Rutter was assigned to the inquiry. One of the questions raised by the superintendent was whether there was sufficient natural food in the lake and its tributaries to support the young salmon liberated by the hatchery. When the lake was visited in November young salmon were found to be abundant, but no more so than other salmonoids usually are in suitable waters. It seems to be established that many of the bluebacks go downstream at an early age, and there is food enough in the lake for all that remain. Young silverside salmon were more abundant than bluebacks, although bluebacks are much more extensively propagated than the others. In view of the importance of the Baker Lake station, as the only known place in the Puget Sound region where the valuable blueback salmon can be artificially propagated on a large scale, it seems desirable that there should be a thorough study of the entire Skagit basin with reference to the movements, spawning, etc., of the salmon. From the information already at hand it seems probable that there are other sites suitable for hatcheries on the Skagit or its tributaries.

Natural history of the quinnat salmon.—The investigations of the quinnat salmon in the Sacramento basin, which had been in progress for a number of years under the charge of Mr. Cloudsley Rutter, assistant of the Commission, were incorporated in a report[a], issued in March, 1903, which is an important contribution to the knowledge of this valuable fish. Supplementary inquiries addressed to special points in the life of the quinnat salmon of the Sacramento were carried on during September, October, and November, 1902, by Mr. Rutter and

[a] Natural History of the Quinnat Salmon. A report on investigations in the Sacramento River, 1896-1901. Bulletin U. S. Fish Commission, 1902.

Mr. F. M. Chamberlain. One of the topics considered was the movements of spent salmon, more especially the tendency of spent fish to move downstream. The season was unfavorable for observations in Battle Creek, the point selected for this purpose, and the data obtained were meager; a few spent fish were caught and tagged, and some of these were subsequently taken in a trap above the place of release, but none was caught below. A site suitable for a branch hatchery for the summer run of salmon was found on Battle Creek, opposite the mouth of Baldwin Creek; the advantages of the place are a gravity supply of water, facilities for placing a rack, seining grounds, and spawning beds.

The effects of light on developing salmon eggs were determined by experimental tests at Battle Creek hatchery in November. These proved that eggs are injured by sunlight and light on a cloudy day up to the age of 3 weeks; before the age of 2 weeks the eggs thus exposed will die in twenty-four hours; after that age there is greater resistance but still considerable loss. When a basket of young salmon eggs is placed in the light, the eggs in the top layer will die, while the deeper eggs are uninjured; and if one end of a basket is sheltered the line of demarcation is sharply defined by the number of dead eggs on the two sides. Inside the hatchery, eggs in an open basket, in a basket covered with the ordinary trough screen, and in a basket inclosed in a light-proof box opened only by candlelight exhibited no appreciable differences in percentage hatched or in health of fry. Prof. C. W. Greene continued his studies of the physiology of the Sacramento quinnat salmon, making observations and experiments on salmon at sea, in the lower course of the river, and at the spawning grounds in the headwaters at Monterey, Black Diamond, and Baird, respectively. Mr. Rutter assisted in this work.

ATLANTIC SALMON.

Salmon of Penobscot Basin.—The investigation of the inland waters of Maine, on which Dr. W. C. Kendall has been engaged for several seasons, was continued during the first four months of the fiscal year, most attention being devoted to the salmon of Penobscot River, especially the young salmon of the East Branch. The basin of this stream was thoroughly explored, including its two principal tributaries, Wissataquoik River and Sebois Stream, together with numerous brooks and lakes. It is alleged that owing to artificial obstructions but few salmon are able to ascend the East Branch, and only a few adult fish were observed above Grindstone, at the mouth of Wissataquoik River; it is possible, however, that there were other fish lying concealed in the deep pools. Although salmon are said to have been very scarce for the past few years on their spawning beds, young salmon evidently of this year's hatching were fairly numerous in all suitable places in the main stream from the Wissataquoik to Grand Pitch, and were common in Wissataquoik and Sebois rivers and in nearly every spring brook. While these young salmon had attained a length of only 5 to 6 inches, those found between Grand Pitch and the dam at the foot of Matagamon Lake were from 6 to 10 inches long. These larger fish have been mentioned in previous reports as peculiar in that the males were sexually mature; but it was found that even smaller fish from farther downstream showed the same condition and apparently when only a few months old. A number of young salmon were marked by attaching small copper tags to their dorsal fin, for the purpose of determining their movements and rate of growth.

Landlocked salmon in Massachusetts.—Some attempts have been made to stock with landlocked salmon certain Massachusetts ponds, and further requests for fish for stocking purposes having been received, it was deemed advisable to determine whether the ponds are adapted for salmon and to ascertain the results of the plants already made. In November, 1902, Mr. Vinal N. Edwards, of the Woods Hole station, was detailed to visit the ponds in question, which are near Osterville, in Barnstable County, and to make observations on their size, depth, temperature, character of bottom, vegetation, and animal life. A dredge and a seine were used in collecting specimens of fish, etc., and fishing trials were made with hook and line. Following are the results of the examination of these ponds as reported by Mr. Edwards:

Neck Pond.—Area, 50 acres; depth, 35 feet; 100 feet from shore there is a depth of 25 feet all around the pond; temperature November 10, 1902, 46° F. at surface, 44° at bottom; no outlet; water can not be drawn off. Pond surrounded by trees and by a white sandy beach 10 to 20 feet wide; bottom gravelly to depth of 25 feet, then sandy, with grass (which is very thick in some places).

Dredged all over pond, but found very little animal life in the grass. Water so deep that seining was impossible except close to shore; there caught yellow perch and minnows. Other fish found in the deeper parts of the pond are brook trout, black bass, several kinds of small fish, and landlocked salmon. In October, 1900, 1,000 young landlocked salmon were planted here. When fishing for a few minutes in the middle of the pond with saltwater shrimp, two salmon were caught and two others were brought to the surface; then, the shrimp being expended and minnows being used, only large yellow perch were caught. It is reported that everyone who has fished for perch with shrimp-bait has taken some salmon.

Michaels Pond.—Area, 25 acres; depth, 30 feet; temperature November 11, 53° F. at surface and bottom; shores gravelly; bottom hard, covered with grass; no shade; water not so clear as in other ponds; no outlets or inlets; water can not be drawn off.

Pond contains an abundance of yellow perch, horned pouts, and minnows. Seven years ago 5,000 rainbow trout were planted, but none has since been seen.

Grigsons Pond.—Length, 1¼ miles; width, three-fourths to 1 mile; half the pond is 80 feet deep, the deep water close to shore; temperature November 10, 54° F. at surface, 52° at bottom, summer temperature said to reach 70°; little shade; very clear; sides gravelly to depth of 30 feet, beyond that mostly hard bottom covered with grass; no outlets or inlets; water can not be drawn off.

Black bass, pickerel, and yellow perch abundant; a few brook trout said to occur; no salmon ever planted here.

It therefore appears that Neck Pond has been rather well stocked with landlocked salmon and that at least one of the other ponds is adapted to it, although it may be questioned whether these waters will permanently support a good supply of salmon in view of the abundance of the predaceous fishes therein.

It may be mentioned, as bearing further on the suitability of Massachusetts waters for this species, that a pond in East Falmouth, near Woods Hole, is plentifully stocked with the fish, many being taken by anglers in the summer of 1902, some of which weighed 4 pounds; and that Long Pond in Falmouth has also been successfully stocked.

CARP.

The study of the carp in Lake Erie was continued by Mr. L. J. Cole during June, 1903, and a full report on this subject will shortly be completed. Making his headquarters in the region of Sandusky, Mr. Cole gathered further information on the breeding habits of the carp, the relations of the carp to aquatic vegetation, the introduction and increase of carp fisheries, and effects on the movements of the carp of the changes in the water level so prevalent in the region.

CAT-FISHES.

Both commercial fishermen and anglers throughout the country are showing an increasing interest in the various species of cat-fishes, and the requests for cat-fish for stocking public and private waters have been numerous. It is possible that it will soon become necessary for the Government to undertake extensive fish-cultural measures addressed to certain species in order to meet the growing demand. The establishment of a special cat-fish breeding station in the South has also been suggested. There has been but little information published in regard to the spawning habits of the cat-fishes, and practically nothing is known of the breeding and other habits of some of the most important species. Some specimens of the common bullhead or yellow cat-fish (*Ameiurus nebulosus*) which spawned at central station, Washington, D. C., in July, 1902, were kept under close observation and served as the basis for a paper[a] in which the nest making, spawning habits, eggs, incubation, care of eggs and young, and growth of young were described. In another paper[b] there were brought together many notes, mostly extracted from published records, on the food value, food and feeding habits, acclimatization, etc., of some of the best-known species.

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[a] Breeding Habits of the Yellow Cat-fish. By Hugh M. Smith and L. G. Harron. Bulletin U. S. Fish Commission, 1902.

[b] Habits of Some of the Commercial Cat-fishes. By W. C. Kendall. Bulletin U. S. Fish Commission, 1902.

TILE-FISH.

The recent reports of the Fish Commission have had references to the abundance of tile-fish (*Lopholatilus chamæleonticeps*) off the southern New England and Middle Atlantic coast, and to the efforts of this bureau to create a demand for the fish that would lead to the establishment of a fishery. The numerous requests for the fish from wholesale and retail fresh-fish dealers and from curers, who were desirous of making known to the public the edible qualities of this fish, induced the Commission to undertake to obtain another supply for gratuitous distribution. Accordingly, the schooner *Grampus*, sailing from Woods Hole on July 30, 1902, made a short trip to the most easily reached grounds. On July 31, 76 miles SE. by S. of No Mans Land, in latitude 40° 10′ 45″ W. and longitude 70° 20′ 30″ N., the fishing trials were made, five lots of trawls being set about the vessel, in water 65 fathoms deep. Fresh menhaden and frozen squid were used for bait, the former appearing to be the better. The results of the fishing were as follows, the trawls being left down two hours:

Set No.	Tubs of trawls.	Hooks.	Fish caught.
1	3	1,050	102
2	3	1,050	78
3	4	1,400	128
4	3	1,050	99
5	2	700	67

The number of fish caught was 474, ranging in weight from 3 to 40 pounds, and the aggregate weight was estimated to be between 7,000 and 8,000 pounds. This was the largest catch of tile-fish ever made, and, considering the very short time the trawls were left down, the trials confirm the previous indications of the remarkable abundance of this species. A vessel equipped with the fishing gear of the Boston and Gloucester fresh-fish fleet should be able to take 50,000 pounds in a day's fishing.

The fish were landed at Woods Hole and shipped in ice in small lots to many well-known firms in Gloucester, Boston, New York, and elsewhere, by which they were distributed to hotels, clubs, and private customers. Enough has probably been published to show the general sentiment as to the edible qualities of the tile-fish, but the following information and special opinions in regard to the market value of this year's catch may not be without practical interest:

Thirty fish were sent to the members of the Boston Fish Bureau. The secretary reported that the fish were held to be good and that the members believed there was a satisfactory market for them. One member thought the fish tasted like the red snapper and another said it greatly resembled the striped bass in flavor.

Mr. A. F. Rich, wholesale fish dealer and commission merchant, of Boston, received 126 pounds of fish and "disposed of them among several fish markets, charging them 5 cents a pound, and they sold all of them at a profit and have been asking for more."

Messrs. John Pew & Son, owners of fishing vessels, curers, and wholesale dealers, Gloucester, Mass., wrote: "We had heard considerable about these fish, but had never had the opportunity of examining them or eating them. It seems to us that they would be quite an addition to the food supply of the country if the quantity easily taken could be assured. We tried them under various forms, and they are certainly palatable, and would find a ready market, we think. We would prefer the cod and haddock, however, to the tile-fish."

The J. Maddock Company, wholesale fresh-fish dealers, Boston, wrote: "We are of the opinion that a ready market can be found for this fish at a fairly good price, say, about 5 to 10 cents per pound. We trust that you may be successful in arousing interest among the fishermen in the catching of this fish."

Mr. W. H. Prior, wholesale fresh-fish dealer, Boston, reported that he sold the barrel of tile-fish sent him for 12 to 15 cents a pound, and that they gave perfect satisfaction.

In order that the value of the tile-fish in the dry-salted and boneless states might be determined, about 1,000 pounds of fresh fish were sent to a curer in Gloucester. When split and dry-salted, like cod, and also when prepared like boneless cod, it was found that the tile-fish is a very satisfactory food, the muscles being thick, flaky, and well-flavored. The objections to the tile-fish when cured are purely æsthetic, the flesh being of a somewhat darker color than that of cod and being slightly discolored by fat, which is more plentiful than in the cod. When slack-salted and smoked, the tile-fish is reported to be excellent.

It is interesting to be able to announce the first deliberate attempt to catch tile-fish on the part of a regular fisherman. The information is communicated by Mr. William H. Jordan, of Gloucester, who writes as follows, under date of October 4, 1902:

Captain Langworthy, of Noank, Conn., is superintending the building at Essex of a vessel he will command in the fishing business, and is here at intervals. He became interested in the information about the tile-fish which I furnished him as originating with you. He saw those we have cured on the wharf, and, without announcing his intention, went to Stonington, where there is a fishing yacht named the *Gazelle*, owned by Captain Atwood, who keeps her for pleasure, but is an old fisherman. They made a trip, south by east from Block Island, until they struck 56 fathoms of water, and they found the fish in abundance. As fast as a hand line would reach the bottom it secured a fish. They had a short piece of secondhand haddock trawl, which they set and obtained quite a quantity of fish. These fish they did not attempt to market, but gave away, as they simply went to verify the information that Captain Langworthy had received. I think he will try this fishing next winter, when his new vessel is ready.

The capture of a tile-fish on Quero Bank by a cod-fishing vessel greatly extends the previously known range of the species. It appears that about December 15, 1902, the schooner *Monitor*, of Gloucester, caught a small tile-fish on the eastern edge of Quero, in latitude 44° 26′ N. and longitude 57° 13′ W., in 170 fathoms of water. The specimen was seen and identified by Capt. S. J. Martin, agent of the Fish Commission at Gloucester, and by various other persons who are familiar with the species.

COMMERCIAL SPONGES OF FLORIDA.

Survey of the sponge grounds.—The steamer *Fish Hawk* continued the survey of the sponge grounds off the Florida coast, beginning work at Cape Sable on December 17, and concluding in the vicinity of Cape Florida about the end of February. During this period all the sponge grounds of the east coast were examined and plotted, thus concluding the survey of the sponge-bearing bottoms of the state begun several years ago. Complete collections of sponges were made, and much information was acquired in regard to the productivity of the sponge grounds, the comparative abundance of the different kinds of sponges on the various grounds, etc. Experiments were undertaken to test the feasibility of transporting sponges alive in aquaria on the ship, but without marked success. During the course of the survey lines of dredgings and soundings were run at right angles to the coast, in order to determine the general character of the bottom fauna on the inner edge of the Gulf Stream, and considerable collections of valuable material were made.

Sponge culture.—During the year the experiments in sponge culture have been continued under the direction of Dr. H. F. Moore, at three different points on the coast of Florida. Practically the same methods have been followed as during the preceding year, but additional materials for attachment have been tried in order to determine the cheapest and most durable. As stated in previous reports, the method which appears to give the best results, having due regard for the requirements of a commercially profitable industry, is the attachment of the cuttings to wires fastened to stakes driven into the bottom about 50 feet apart, in such manner that they are suspended free of the bottom. It has been determined that the cuttings not only grow more rapidly and of more regular shape when suspended freely in the water, but that a larger proportion survive. Numerous parallel experiments, where the free suspension of the cuttings in one case was the only difference in the conditions, show indubitably the advantage of raising the wires above the bottom. When the cuttings are not suspended, wave movements produce attrition upon the bottom and subsequent abrasion of the surface of the sponge, and the mortality rate is high, especially during the early stages of growth.

The deposit of silt and the overgrowth of vegetable matter in portions of the sponge also restrict the growth, causing not only a reduction in weight, but an irregularity of form which reduces the market value. When the cuttings are suspended the ultimate shape, whatever be the original shape of the cutting, is invariably regularly spherical or ellipsoidal. From a commercial standpoint the method is manifestly an improvement upon nature's, for the suspended sponge is more advantageously situated as regards water currents and food supply; it grows more rapidly than when at the bottom; it is more regular, and there is no "root," the portion of the sponge which in service proves itself least durable.

As stated in the report for the preceding fiscal year, the cuttings are in general subcubical in shape and about 2 cubic inches in volume. They are cut from the live sponges with a sharp knife, and each has at least one face covered by the original skin. A slit about 1 inch in depth is made parallel to the longest axis and placed astride the suspension wire. A piece of aluminum wire about 4 inches in length is thrust through the two flaps and the ends twisted around the suspension wire in such manner as to close the slit. Within a week the opposed faces of the slit unite and the cutting heals around the suspension wire.

The general system already evolved is believed to be that which will ultimately obtain in practice, but the ideal material for the suspension lines has not yet been found. Copper wires with okonite and underwriter's insulations, asbestos cord, thin manila and cotton rope, and stranded galvanized iron wire were the materials first employed. The ropes quickly rot, and within a year the okonite insulation softens and breaks from the wire, so that the exposed copper is acted upon by the sea water and weakens to the breaking point. Underwriter's wire, a much cheaper insulation and inferior for electrical purposes, lasts much longer, but at the end of the fiscal year lines which had been in use eighteen months were beginning to lose their insulation in places. A heavier wire and thicker covering than that already employed would doubtless be more durable. Asbestos cord, which is about twice as costly as the underwriter's wire, is slightly, if at all, acted upon chemically by the sea water, but when wet the fibers become slippery and the tensile strength of the cord is much reduced. When the sponges are large the strain on the line becomes considerable, especially during storms, and it is doubtful whether plain asbestos cord will prove sufficiently strong. Experiments now under way indicate, however, that by suitable treatment the strength of the wet cord may be more than doubled without materially increasing the cost.

The organic attachment of the cuttings to the suspension wire is advantageous, but not essential. The condition has been attained with none of the materials above enumerated, and during the present year experiments have been conducted with the accomplishment of this end in view. Lead has proved to be the most satisfactory material, as it is but little affected by sea salts and the cuttings soon become fixed. Lead wire is useless on account of its lack of tensile strength. Lead-covered insulated copper wire is too heavy, or, if made sufficiently light, the lead casing is so thin that it breaks, cuts the insulation, and, coming into contact with the copper, establishes a destructive electrolytic action. To overcome these several difficulties, ordinary marlin with a lead covering one thirty-second of an inch thick was employed, with results that were satisfactory at the end of a trial of eight months. It is possible that marlin may rot in a period of time shorter than that required for the maturing of the sponges, in which event the material will have to be abandoned.

On the whole, the progress of the work has been encouraging. Cuttings which originally measured 1 by 1 by 2 inches have in eighteen months grown into spheroids in some cases 4 inches in diameter, or twenty-five times the original weight. These sponges are larger and heavier than the minimum size marketed from the natural beds. The proportion of survivals after sixteen to eighteen months varies with the condition of the experiment between 45 and 95 per cent. Though the experiments have not reached a conclusive stage, the results so far attained are such that a firm engaged in the sponge business has begun operations on a commercial scale, the results of which will be available for the information of the Commission.

AQUATIC RESOURCES OF HAWAII AND SAMOA.

At the close of the fiscal year 1902 the steamer *Albatross* was engaged in an investigation of the fishes and other aquatic resources of the Hawaiian Islands. These investigations were under the general direction of Dr. David S. Jordan, president of Stanford University, and Dr. Barton W. Evermann, of the Fish Commission. The investigators on board the *Albatross* were Dr. Charles H. Gilbert, Prof. John O. Snyder, and Mr. Walter K. Fisher, of Stanford University; Dr. Charles C. Nutting, of the University of Iowa, and Mr. A. B. Alexander and Mr. Fred M. Chamberlain, of the permanent staff of the *Albatross*. The work continued until August 30, when the ship returned to San Francisco.

During the conduct of this survey most of the islands of the Hawaiian group were visited. Dredging was carried on in the channels and on the banks among the islands, shore collecting was done whenever practicable, and the abundance and values of the different commercial fishes as seen in the markets at Honolulu and elsewhere received attention. Knowledge of the shore fishes was greatly increased, many species not previously known having been found. Deep-water dredging about the islands proved exceedingly difficult, owing to the roughness of the lava and coral bottom; the trawls were frequently torn and sometimes entirely carried away. Nevertheless, large and valuable collections were obtained, including many species of fishes, mollusks, crustaceans, and other invertebrates, either previously unknown or very rare.

A visit was also made by the *Albatross* to the Leeward Islands, some 800 miles northwest of Honolulu, giving an opportunity to determine the extension of the Hawaiian shallow-water fauna in that direction and to land on Laysan Island, which is of very great interest on account of immense numbers of birds that have their breeding grounds there. The amount of sea food which this vast multitude of birds takes from the ocean probably exceeds a thousand tons daily. As this food doubtless consists wholly of either fish or food of fish, the importance of aquatic birds in their relation to the fisheries becomes at once apparent.

The large collections made during the Hawaiian investigations of 1901 and 1902 have been assigned to specialists in the various groups, and the reports are now in course of preparation. It is expected that the report by Doctor Gilbert on the deep-water fishes of the Hawaiian Islands will soon be ready for publication, and that the final report by Doctor Jordan and Doctor Evermann, containing descriptions and illustrations of all the species of fishes known from those islands, will soon follow.

The investigations by the Commission of the fishes and other aquatic life of the Hawaiian Islands naturally led to a consideration of the origin of the Hawaiian aquatic fauna and its relation to that of the islands to the southward. It was therefore arranged that Doctor Jordan should spend the summer of 1902 at the Samoan Islands making collections of the fishes of that group. Doctor Jordan sailed for Apia in May, 1902, accompanied by Prof. Vernon L. Kellogg and Mr. Michitaro Sindo, and returned in August following, bringing with him a very large collection, embracing about 600 species of fishes, many of which are new to science. This collection is now being studied by Doctor Jordan, and the report will be published by the Commission.

SPECIAL INQUIRIES IN JAPAN.

The Commission having decided to make a study of certain biological and other phases of the fisheries of Japan in the interest of the fishing industry of the United States, Dr. H. M. Smith was detailed to this duty in the latter part of the fiscal year. Besides making a general survey of the Japanese fisheries, which are among the most extensive and interesting in the world, attention was directed to certain special branches in which the Japanese have attained prominence and which are of practical importance to the United States, among them being the cultivation and utilization of marine algæ, the production of pearls in mollusks by artificial means, and the culture of terrapin. Another subject of special study was the dwarf salmon—its habits, growth, distribution, food value, cultivation, etc.—with a view to determining the feasibility of its acclimatization in the United States. The advisability of introducing some of the Japanese fishing and curing methods into the United States, and the opportunities for promoting the fishery trade of the two countries, were also considered.

The Japanese minister to the United States very courteously acquainted his Government in advance with the purposes of the investigation, and the Japanese Government, through its department of commerce and agriculture, extended every facility and made most ample provision for the prosecution of the inquiries, detailing different members of the imperial fisheries bureau to accompany the Commission's representative on his travels to the fishing districts. The thanks of the Commission are due especially to Hon. N. Maki, director of the imperial fisheries bureau, and to his efficient assistants, Doctors Kishinouye, Oku, Kitahara, Nishikawa, and Nishimura. Many courtesies were also extended by officials of various local governments, as well as by private citizens in all places visited.

At the request of the Imperial Fishery Institute in Tokyo, Doctor Smith delivered an illustrated lecture on the organization and work of the United States Fish Commission, and, at the solicitation of the Imperial Fisheries Society, he gave an illustrated lecture in Osaka on the fishery industries of the United States.

DISEASES AND PARASITES OF FISHES.

GENERAL STUDY OF FISH DISEASES.

Routine consideration of the diseases affecting domesticated and wild fishes has been given by Mr. M. C. Marsh, the assistant assigned to the subject of fish pathology; and numerous investigations have been made in the interests of the Commission, various States, and private owners of fish ponds or fish-cultural establishments.

The cause of the destructive epidemics among artificially reared brook trout, referred to in previous reports, has been definitely traced to a germ, of which a full account has been published.[a] This organism was obtained from the blood of diseased brook trout and stands in specific causal relation to the disease. It is a pleomorphic form, which appears in the blood and local lesions of its host as longer or shorter rods with occasional spherical forms. It is pathogenic particularly to the brook trout (*Salvelinus fontinalis*), but has been isolated from Loch Leven trout (*Salmo trutta levenensis*) in epidemic, and in a few cases from the lake trout (*Cristivomer namaycush*). It has been found only in domesticated or aquarium fish and never in wild trout from natural waters. Healthy brook trout succumb to the disease in a few days by direct inoculation beneath the skin into the peritoneal cavity or into the orbital cavity, and after a longer time by mixing cultures with their food; the organism recoverable in all cases from the heart blood. Inoculation into the dorsal lymph sac of a frog of 1 per cent of its

[a] Bacterium Truttæ, a new Species of Bacterium Pathogenic to Trout: Science, xvi, 706-707, October 31, 1902. A More Complete Account of Bacterium Truttæ: U. S. Fish Commission Bulletin, 1902, pp. 411-415, 2 pl.

body weight of a bouillon culture was negative, the frog showing no effects. Trout dead of the disease may be eaten, after ordinary cooking, without ill effects. A cat has habitually eaten and thrived upon the fresh, uncooked bodies of the dead trout, and the organism is probably not pathogenic to any warm-blooded animals. Attempts to stain flagella have had negative results, and the species is placed in *Bacterium* and named *truttæ* for the group of fishes that apparently contains its chief hosts.

In February, 1903, in response to a request of the Surgeon-General of the Public Health and Marine Hospital Service, the Commission detailed Mr. F. M. Chamberlain, assistant on the steamer *Albatross*, then at San Francisco, to cooperate with the representative of the Service and of the health department of San Francisco in a special inquiry growing out of the efforts to eradicate the plague from the Chinese quarter of San Francisco. It being proposed to bring about a wholesale destruction of rats in the sewers by means of poisons (such as arsenic and phosphorus), the authorities desired to have an assistant of the Commission keep watch at the outlets of the sewers to note the effects of such poisons on the fish life of San Francisco Bay, and if it appeared that injury was resulting, to suggest modification in the methods of procedure.

EFFECTS OF POLLUTED POTOMAC WATER ON FISHES.

In the case of the United States against a local company, charged with violating section 901 of the code of the District of Columbia, this Commission became interested because of the alleged contamination of the Potomac River by refuse from gas works and the effects thereof on fish life. In November, 1902, the police authorities submitted to the Commission a sample of over 20 gallons of water from the Eastern Branch of the Potomac, with the request that it be examined with reference to its effect on fishes, the water having been taken from a point near the place where refuse products from gas manufacture were said to be entering the river. The water was of a very dark color, almost black, and full of sediment, a considerable quantity of black tarry mud having been introduced; an iridescent scum was present, and the odor of coal tar was very marked.

About 6 gallons of this water immediately poured into a glass aquarium jar, artificial aeration was begun, and three large-mouth black bass about 6 inches in length were introduced; these were dead at the end of forty minutes. A control experiment of three bass of the same size in Potomac service water, with aeration, was carried on at the same time; the control bass did not suffer. In each experiment described a corresponding control continued throughout the experiment, unless otherwise indicated.

A considerable sediment was kept in circulation by the aerating current, and as this sediment deposited in the gills to a slight extent and might be held to injure mechanically, the agitation due to the air was excluded by repeating the trial with two black bass, without aeration, using a new sample of the polluted water. These bass died in one hour, the unaerated controls being unaffected. The agitation caused by the struggles of the fish, however, kept the sediment distributed about as much as the air current had previously done.

After the remainder of the sample had stood over one night and it had cleared considerably by sedimentation, about 5 gallons were siphoned from the middle of the can, so that all the sediment and the surface scum were excluded. Into this water were introduced three carp between 5 and 6 inches in length, four sun-fish of about 4 inches, four calico bass of 3 inches, and two rock bass of 1½ inches. All died within two hours, the gills free and unclogged, the controls being unaffected.

The next day, using the same sample of water, into which the air current had been running all night, two very small cat-fish and one of about 7 inches were introduced. The two small ones died in twenty and forty-eight hours, respectively, while the larger one was still alive at the end of two days, but in distress. The water was then replaced by a fresh sample of the polluted water from the fish can, and the large cat-fish succumbed in three hours. The aeration seemed to purify the polluted sample, evidenced by the reduction in the strength of the odor and by the fact that the cat-fish survived in it much longer than in a fresh sample from the can.

After the remainder of the sample had stood seven days in the can it became comparatively clear. A portion of the clear water was poured off without excluding a small amount of scum and the iridescent film on the surface, and in it were placed one small calico bass and one small rock bass. The former died in one and one-half hours, the latter in one hour, the controls living and normal.

The water after settling for seven days was neutral in reaction to litmus, and it had a less marked odor than the black unsedimented water, but the characteristic tarry odor was still unmistakable. The conclusion is that the sample of water in question is readily fatal to ordinary fishes and fatal also, but somewhat less quickly, to hardy forms such as the cat-fish.

A representative of the Commission testified to the foregoing facts in court on summons issued by the government. The defendant was found guilty and sentenced—an appeal being taken.

DESTRUCTION OF YOUNG TROUT BY HYDRA.

At the Leadville, Colo., station of the Commission in the summer of 1902, many newly-hatched black-spotted trout were destroyed by an agent not previously met with, and the existence of which was not suspected until a special examination of the water supply disclosed great numbers of a minute animal in the hatching troughs. Mr. A. E. Beardsley, professor of biology in the State Normal School at Greeley, Colo., was asked to visit the hatchery and look into the mortality among the fish; and his report[a] shows conclusively that the trouble was due to a species of hydra, which gained access to the hatchery from a shallow lake which is one of the sources of water supply. A careful investigation having failed to disclose any other cause for the death of trout, and the hydras being known to be armed with dart cells, which secrete a fluid by which small crustaceans and other animals are quickly paralyzed, the responsibility of the hydras was demonstrated by experimental tests. Newly-hatched fry were placed in beakers filled with water from the supply pipes with a little sediment from the hatching trough in which the hydras were found. In less than thirty minutes 25 per cent of the fry were dead, and in seventy-five minutes all were dead, while in a beaker filled with water containing no hydras all the fry were alive the next day. With the aid of a lens the hydras could be seen with their mouths closely applied to the surface of the fry, particularly on the yolk sac—a dozen hydras sometimes attaching themselves to a single fish. When first attacked the fish struggled violently, but the movements gradually diminished in frequency and intensity until death supervened.

This hatchery pest is to be overcome by excluding water from the lake containing hydra, and by scrubbing the troughs with a stiff brush and then quickly flushing them so as to wash out the hydras before they can become attached.

This particular hydra appears to represent an undescribed form, characterized by its large size and absence of color, and has been named *Hydra pallida* by Mr. Beardsley.

GAS DISEASE IN AQUARIUM FISH.

For a number of years the aquarium at the Woods Hole station has with great difficulty been kept stocked with fish and other animals, owing to their rapid death from what has come to be known as the gas or bubble disease. The condition of affairs having become more aggravated, it was necessary, in the interest of the fish-cultural work, as well as of the biological laboratory, to give the matter special attention. In the Bulletin for 1899 Prof. F. P. Gorham published a paper[b] which explained some of the phenomena, but was not applicable to all the manifestations of this affection; and it was therefore decided to reopen this subject, which, while not as yet of great practical importance, may at any time have a bearing on fish-cultural work and aquarium management. The following data on the symptoms and cause of the disease are embodied in a report submitted by Mr. M. C. Marsh,

[a] Destruction of Trout Fry by Hydra. Bulletin U. S. Fish Commission 1902, pp. 157-160.
[b] The Gas-bubble Disease of Fish and its Cause.

who visited the station in December and made a thorough examination of the water supply, pipes, pumps, tanks, aquarium, and fishes.

Under date of December 1, the superintendent had reported that fish could not be kept alive in the aquaria more than forty-eight hours, notwithstanding every possible attention and care. This accorded with the experience during the previous summer when, on account of the workers in the laboratory and the large numbers of visitors at the station, an effort was made to keep the aquaria well stocked. These aquaria are supplied with sea water from the same tanks that feed the hatchery, the tanks being kept full by two steam pumps which carry the water from the basin or pool in front of the hatchery.

Specimens of the common winter fishes available for the aquaria (white perch, tautog, tomcod, sculpins, and flat-fish), caught in a fyke net in the harbor and immediately transferred to the aquaria, in about three minutes became covered with minute bubbles of gas. These bubbles increased in number and, after ten minutes, thickly covered the fish, giving to dark species like the tomcod a silvery appearance. When a fish was removed from the water a moment the bubbles immediately dissipated, but were renewed, as before, when it was returned to the water. They constantly escaped in small numbers from the body and rose to the surface of the water, while a sudden movement on the part of the fish released a cloud of thousands of bubbles. After a short time, however, it was again covered with them, so that it was seldom without more or less of these gas bubbles clinging to any or all parts of the body and fins. After a period varying from three hours to several days, the fish died, usually with spasmodic convulsions. Of a lot of about 100 specimens, 70 per cent were dead after forty-eight hours, though a few flat-fish survived four days.

Dissection of the bodies showed a remarkable condition. The blood vascular system contained notable quantities of gas. In the mildest degree this appeared as large bubbles here and there in the larger vessels, which still contained blood. In the extreme cases the heart itself contained gas to the exclusion of the blood. The bulbus of the heart was often greatly distended—even to several times its normal bulk—its walls stretched to an attenuated thinness, tense and firm with the pressure of the contained gas to the entire exclusion of the blood, the whole resembling the air bladder of a small fish. The auricle sometimes continued beating, but without propelling any blood. Often the thick wall of the ventricle was emphysematous. The vessel from the heart to the gills was empty of blood, and in the gills was found perhaps the most constant and significant lesion. The main vessel of the gill filament was filled with gas, which was often seen just entering the capillaries that branch from this vessel. It seldom filled these capillaries, however. These gas plugs of the gill filaments were usually present, even when the evidences of gas within the body were not very marked. When nearly all the filaments were well filled with gas the condition modified somewhat the microscopic appearance of the gill, and the individual emboli were seen on a careful inspection by the naked eye. Gas emboli were the usual immediate cause of death by asphyxiation.

On the exterior of the fish, besides the minute bubbles that appear almost immediately after immersion in the water, blebs appear after some lapse of time which are made by an accumulation of gas beneath the membranous portions of the epithelium. They may hold several centimeters of gas, and occur chiefly in the fins in nearly all species, also on the belly of the small sculpin, and rarely on the cornea. "Pop-eye" was not observed at this time.

The agent that produces this fatal evolution of gas is evidently present in the water and is introduced into it somewhere between the suction intake and the taps that deliver the water at the points where it is used—in aquaria and hatchery; for neither in the fyke net, 8 feet beneath the surface of the water in the harbor, nor in live boxes at the surface of the basin in close proximity to the intake, do fish die or exhibit any of the symptoms described. After this water has passed from the basin through the system of pipes, including the steam pump and the supply tanks, it possesses the power to produce such symptoms, ending invariably in the death of the fish. This pathologic agent is volatile, for if one of the large stationary aquaria be filled and allowed to stand for seven days with the flow cut off, the water has lost markedly its lethal power; it will produce external bubbles on fishes, but will not kill. About 2½ gallons of the freshly drawn water held in the cylindrical glass hatchery jars cease entirely to produce the external bubbles after standing from two to three days. In proportion as the water is exposed to the air it loses this quality, and an aeration apparatus which divides the water into fine streams immediately dissipates this power to such an extent that the fish do not die in it. Thus an aquarium that received several capillary jets spurting into it from a distance of several feet held its fish successfully, while the fish in a control aquarium which received the same amount of capillary flow, and which differed only in the fact that the capillary jets were submerged within the aquarium, died after one day. The agent evidently passes off into the air.

In the course of some aquarium experiments, using water directly from the pump, it became evident that the water passing through the pump constantly contained a considerable quantity of air in small bubbles. This air must have entered the suction area, and a wooden supply pipe between basin and pump, several feet beneath the ground, was subsequently found to leak in a number of places. The pressure of this air in the water suggests immediately an explanation which is in accord with all the facts observed. Water absorbs air in proportion to the pressure, and cold water takes up more than warm water. The station water in winter approaches 0° C. The supply tanks are some 18 feet above the ground, and the water in the system of pipes leading from them is under corresponding pressure. Accordingly, any air accompanying the water in these pipes must constantly tend to pass into solution, and as the water when taken up from the basin is approximately saturated for atmospheric pressure the water in the pipes must tend to saturate with air for the increased pressure it sustains, or to supersaturate for atmospheric pressure.

In the hatchery and the aquaria the water emerges from the pipes into ordinary atmospheric pressure, containing in solution more air than it can hold at that pressure. The excess of air instantly begins to pass off, or evaporate, the rapidity of the process depending on a favorable exposure of the water to the air, and therefore on the conformation of the containing vessel, a very shallow open vessel facilitating the escape of air. The aquaria are not particularly adapted to this release, and the constant inflow from the pipes maintains the supersaturation of the volume of water in the aquarium to very nearly that of the water in the pipes.

The gill apparatus of fishes, for the osmotic interchange of gases which keeps the blood purified, is adjusted to water in which the gases are dissolved at atmospheric pressure. In this supersaturated aquarium water an extraordinarily high osmotic pressure exists at the gill membrane. On the inside of this membrane the blood stream tends toward a supersaturation equal to that of the water on the outside. Two chief factors are then conceived to operate to separate the air from solution, one being the temperature of the systemic blood, the other the mechanical effect of the surface of the vessels and of the corpuscles.

The oxidation which is constantly taking place within the blood must determine a higher temperature in the blood than in the water surrounding the fish. This has been shown by observation to be the fact for certain marine fishes, the difference in some cases amounting to several degrees. The blood must be cooled as it passes through the gills and receives its supply of air, and the subsequent elevation of temperature must cause some of the air to come out of solution and appear in the blood stream as free bubbles. In a liquid supersaturated with gas, contact with a solid surface causes some of the gas to deposit in bubbles on this surface. The vascular and corpuscular surfaces therefore probably add to the tendency of the gas to come out of solution. The process continues until the inevitable mechanical stoppage of the circulation occurs.

With the advent of the flat-fish season nearly ripe fish began to arrive at the station, to be held in wooden tanks until spawning occurred. The first lot of these fish, a small number, being in the station water, were killed by it like the aquarium fish, as was expected, and before they had cast their spawn. Thus it appeared impossible to carry on the flat-fish work in this water. In order to hold these fish until the radical remedy of repairing the intake pipes could be applied, a simple apparatus was suggested for the speedy dissipation of the excess of dissolved air. The superintendent suspended high above the upper tank of each series of three a dish pan with the bottom perforated with many small holes. The water was piped up from the taps to these pans, entering them in several jets from a metal delivery head, the jets impinging against the side of the pan, to flow down through the perforations and drop several feet in a shower of separate streams to the surface of the water in the flat-fish tanks. This device, which could aerate water at all deficient in dissolved air, accomplishes a de-aeration for supersaturated water. The de-aerating process removed sufficient of the excess of air to hold the flat fish without loss, and flat-fish operations were carried on in this way during the season.

Plates made from the blood of the dead and dying fish indicate the absence of bacteria from the blood, and indeed the explanation given above, ascribing the mortality to purely physical causes, excludes bacteria from any part in it. Moreover, the immediate appearance of gas renders it practically impossible that it should be the product of a gas-producing organism, for the reaction occurs too quickly. It is evident that this particular epidemic or mortality is not an infection, and that contamination of the water is not related in any way to this disease of fishes.

The immunity of the cod fry and eggs from the gas disease is to be commented upon. These are incubated and hatched in the same station water that is fatal to adults of all species experimented with, including the adult cod. In no case have they been seen to exhibit the gaseous symptoms, and hatching operations have gone on as usual. The egg and the fry are of course very differently organized from the adult, their tissues are not yet so differentiated and specialized, and the gaseous interchange not to be compared, in degree at least, with that of the adult. Were the fry to be held for a time, it is to be expected that they would fall victims to the disease, but they are planted almost as soon as hatched.

Of any factors that readily occur to mind as playing a part in the immunity, that of temperature is probably the most important. The fry can scarcely be conceived to maintain a temperature appreciably above that of the surrounding water. There must be some combustion taking place, nevertheless, and theoretically there should be a difference in temperature. It is to be remembered, however, that it is not the difference in temperature between blood and water, but between the systemic blood and the gill blood that throws the gas from solution. The gill blood is cooled by its intimate contact with the water, and the air is absorbed at this cooler temperature. In the fry the general and this special circulation may well be of the same temperature.

While it is possible to temporize with the present leaky pipes and obviate or greatly reduce the extent of the disease by providing for the de-aeration of the water, as before indicated, the only satisfactory way to overcome the difficulty is to replace the present old and evidently worn-out pipes by new ones which will permit the maintenance of an air-tight suction apparatus.

MARINE BIOLOGICAL LABORATORIES.

WOODS HOLE, MASSACHUSETTS (DR. HUGH M. SMITH, DIRECTOR).

This laboratory was operated under the same general arrangements that prevailed in the previous year, with the usual facilities for collecting biological material and for supplying the needs of those occupying tables. The following persons, numbering forty-seven and representing twenty-four institutions, were in attendance; of these, seventeen were engaged in special investigations in the interests of the Fish Commission:

Adelbert College, Cleveland, Ohio: Prof. F. H. Herrick.

American Museum of Natural History, New York: Mr. Frank M. Chapman; Mr. J. D. Figgins; Mr. George H. Sherwood.

Brooklyn High School, Brooklyn, N. Y.: Mr. Fred Z. Lewis.

Brown University, Providence, R. I.: Prof. F. P. Gorham; Prof. R. W. Tower; Dr. Millett T. Thompson.

College of the City of New York: Mr. Frederick K. Morris; Mr. George G. Scott; Dr. Francis B. Sumner.

Clark University, Worcester, Mass.: Mr. Ernest S. Jones.

Columbia University, New York: Mr. Naohidé Yatsu.

Columbian University, Washington, D. C.: Miss Harriet Richardson.

Denison University, Granville, Ohio: Mr. I. A. Field; Prof. C. Judson Herrick.

Harvard University, Cambridge, Mass.: Mr. Robert S. Breed; Mr. Frederick W. Carpenter; Dr. W. E. Castle; Mr. Clarence W. Hahn; Dr. E. L. Mark; Dr. George H. Parker; Mr. A. W. Peters; Dr. Herbert W. Rand; Mr. Grant Smith; Mr. Frank E. Watson.

Johns Hopkins University, Baltimore, Md.: Mr. H. F. Perkins.

Massachusetts Institute of Technology, Boston, Mass.: Dr. Robert P. Bigelow.

McLean Hospital for the Insane, Waverly, Mass.: Dr. Otto Folin.

Northwestern University, Chicago, Ill.: Mr. Arthur D. Howard.

Olivet College, Olivet, Mich.: Prof. Hubert Lyman Clark; Mr. W. L. Sperry.

Princeton University, Princeton, N. J.: Mr. Joseph Caspar; Prof. Ulric Dahlgren; Mr. W. Phillips.

Rhode Island College, Kingston, R. I.: Mr. John Barlow.

State Normal School, Westfield, Mass.: Prof. Charles B. Wilson.

Syracuse University, Syracuse, N. Y.: Prof. Charles W. Hargitt; Mr. W. Martin Smallwood.

University of Texas, Austin, Tex.: Mr. Charles T. Brues.

United States Department of Agriculture, Washington, D. C.: Dr. Joseph S. Chamberlain; Mr. Karl F. Kellerman; Dr. George T. Moore; Dr. Rodney H. True.

Williams College, Williamstown, Mass.: Prof. James L. Kellogg.

Worcester High School, Worcester, Mass.: Mr. Myron W. Stickney.

Yale University, New Haven, Conn.: Dr. Wesley R. Coe.

Professor Tower, besides assisting in the administration of the laboratory affairs, continued his studies of the functions of the swim bladder in fishes. Professor Parker conducted a series of interesting and ingenious experiments as to the sense of hearing in fishes—a subject which has been much discussed and is not without its practical bearing on the fisheries. His report has been published in the Bulletin for 1902. Professor Herrick experimented on the sense of taste as developed in fishes, and submitted a very interesting report thereon, which was published as a part of the Bulletin for 1902. Doctor Sumner made some experimental studies of fish development, and also considered variation and eliminative selection in the killifish, *Fundulus majalis*. Mr. Field took up the question of the destructive powers of fishes having little or no food value.

The following were engaged in a systematic study of the groups indicated, having in view the preparation of special reports thereon pertaining to the Woods Hole region: Dr. Robert P. Bigelow, the crabs; Prof. Charles W. Hargitt, the medusæ; Miss Harriet Richardson, the isopods; Prof. H. L. Clark, the echinoderms; Prof. C. B. Wilson and Dr. M. T. Thompson, the copepods parasitic on fishes. The work of Professors Hargitt and Wilson was completed and their reports submitted; and Prof. S. J. Holmes, who had been engaged for several years in a study of the amphipods of the region, also completed his report.

Beaufort, North Carolina (Dr. Caswell Grave, Director).

The new laboratory buildings, which had been thrown open on May 26, 1902, were occupied until September 30. The laboratory proved to be admirably adapted in every way to the climate and to the special work intended to be carried on, and called forth unstinted praise from all who had an opportunity to occupy or visit the station. As in previous seasons, the launch *Petrel* was employed in making collections for the laboratory and in determining the aquatic resources of the sounds, the harbor, and the ocean in the vicinity of the entrance; it was not considered safe, however, to send the launch more than 5 miles from the mouth of the harbor. The *Fish Hawk* was attached to the laboratory during July, August, and September, and was employed in exploring the ocean floor as far as the Gulf Stream. The dredgings of the vessel showed a barren condition of most of the bottom, owing probably to the shifting character of the sand of which it is mainly composed. A conspicuous exception, however, was a bank or reef called locally "the fishing ground." It lies 20½ miles ssw. ¼ w. from the outer buoy on Beaufort bar, covered by 13½ fathoms of water, and has been known to the fishermen for some time, although their ideas of its size, location, and character are very indefinite. The exploration, measuring, and charting of this ground was the most important work done by the *Fish Hawk*, for this reasonably accessible locality will doubtless provide much material for biological investigation and may also eventually support an important commercial fishery.

The ground is of a rough coralline nature, and contains a great abundance and variety of animal life. A 7-foot beam trawl and an oyster drédge brought up many specimens of fishes, crustaceans, mollusks, starfishes, immense holothurians, sea-fans, corals, and other animals characteristic of tropical coral reefs. The abundance of fish was surprising. While the vessel was drifting twice across the ground 15 hand lines were used, and 10 bushel basketfuls of fish, representing about 700 specimens, were caught. The time occupied in fishing was two hours. Most of the fish were sea bass, but a few red snappers, large red-mouthed grunts, and other species were taken. So long as the vessel was over the ground the fishes were caught as fast as the lines could be hauled in, rebated, and cast, but the moment the vessel drifted over the edge of the reef no more fish were caught.

Those who availed themselves of the privileges of the laboratory numbered seventeen, and were as follows, arranged under the institutions with which they were connected:

Johns Hopkins University: Prof. W. K. Brooks, Dr. Caswell Grave, Mr. R. E. Coker, Mr. R. P. Cowles, Mr. O. C. Glaser, Mr. E. W. Gudger, Mr. C. W. Stone, Mr. D. H. Tennant.

University of North Carolina: Mr. C. A. Shore, Mr. I. F. Lewis, Mr. F. M. Hanes.

Columbia University: Prof. E. B. Wilson, Mr. W. S. Sutton.

Washington and Jefferson College: Prof. Edwin Linton.

Trinity College, North Carolina: Prof. J. I. Hamaker.

Western Reserve University: Dr. F. C. Waite.

University of Pennsylvania: Prof. E. G. Conklin.

Professor Brooks was engaged in a study of the early stages of the development of the oyster egg and in rearing oyster larvæ up to the point where they become fixed. Mr. Glaser continued the experimental oyster planting in Newport and North rivers. Mr. Tennant resumed his work on the life history of the oyster parasite, *Bucephalus*. Professor Linton had under consideration the parasites of the fishes of the Beaufort region. Mr. Coker made observations on the diamond-back terrapin, and studied the development of the ship-worm. The habits, structure, and development of the stone crab were studied by Mr. Shore. This is one of the best of the crabs for food, but in the Beaufort region it is not sufficiently abundant to be of importance commercially. Professor Conklin and Professor Wilson carried on experimental studies of the eggs of various invertebrates. Mr. Gudger gave attention to the development of the pipe-fish. Doctor Hamaker continued his work on the actinians of the Beaufort region, having in view a complete account of the biology of each species.