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

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COASTAL AND MARINE INVESTIGATIONS AND EXPERIMENTS.

FISHES AND FISHERIES OF HAWAIIAN ISLANDS.

Reference was made in the report for the fiscal year ending June 30, 1901, to the party sent by the Commission to the Hawaiian Islands to make the investigation of the fisheries of those islands called for by the act of Congress of April 30, 1900. The investigations were carried on during the summer of 1901 and completed as far as the circumstances permitted. Most of the islands were visited; the fishery methods, appliances, laws, and customs were studied; a thorough statistical canvass of the commercial fisheries was made, and a very large and valuable collection of fishes was obtained. A preliminary report on the investigations submitted to the President in January, 1902, and by him transmitted to Congress, was printed as a special document (H. R. Doc. No. 249, Fifty-seventh Congress, first session).

It having been determined to continue the investigation of the aquatic resources of the Territory, more especially those in the deeper water, the steamer *Albatross* was detailed for the work, and Dr. D. S. Jordan, of Stanford University, was given general charge. The *Albatross* was fitted out in San Francisco, and sailed for Hawaii on March 11 with a party of naturalists, mostly from Stanford University. The vessel was engaged in this service at the close of the fiscal year.

DESTRUCTIVENESS OF SEA LIONS.

For a number of years the damage supposed to be done to fish and fishing gear by sea lions has been receiving much attention from the fishery interests of the west coast, and the systematic killing of the sea lions has been undertaken in some localities and planned in others, under either State or private auspices.[a]

The following article, from the San Francisco *Bulletin*, is a fairly conservative statement of the fishermen's views:

Fishermen of the North Pacific coast are undertaking a movement for the destruction of the sea lions, the inveterate enemies of salmon and other food-fishes, and which annually make incalculable ravages in the schools of chinooks, steelheads,

[a] According to an official communication, dated January 29, 1903, received through the Department of State from Mr. Victor E. Nelson, United States consul at Bergen, Norway, similar charges are made against the Greenland seal (*Phoca grœnlandica*). It is stated that "the cod have been driven entirely away from those parts of the coast (of Norway) where the seals appear in great masses," and the Government has included in the budget the sums of 4,000 kroner ($1,072) for killing the seals and 15,000 kroner ($4,020) for other repressive measures.

and other varieties of salmon that hover off the Washington and Oregon coast. The last Oregon legislature passed a bill offering a bounty of $2.50 for each sea lion killed in the waters of the State or within one marine league of the Oregon shore. Faulty wording of the bill renders the money set aside for the purpose unavailable, and the Fishermen's Protective Union has raised a fund by private subscription to hire men to shoot the lions at their breeding-grounds.

How many salmon each of these monsters kills each day is purely a matter of conjecture, but instances are known where a single sea lion has killed and eaten 18 salmon within a very few minutes, and it is certain that many hundreds of thousands of royal chinook salmon are killed every year by these pests. When fishing, the lions usually travel in groups of from six to eight, and they will follow a school of fish for days. They feast on the fish until they become quite dainty, and will take but one bite from the choicest part of the salmon, leaving the remainder of the fish to float ashore or to be devoured by the scavengers of the seas. The lions vary in size, but when fully grown average about 8 or 10 feet in length, although specimens have been seen fully 18 feet long and which would weigh 4,000 pounds.

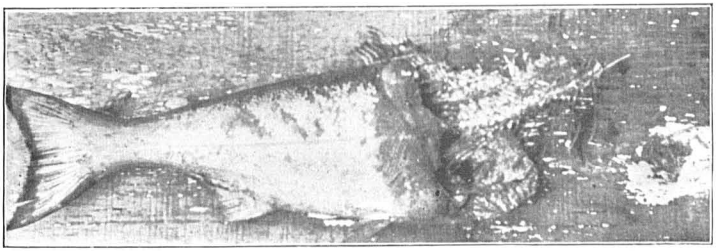
It is during the summer months that the lions do the greatest amount of damage. They are numerous at many places along the Pacific coast, but their favorite rendezvous appears to be in the neighborhood of the mouth of the Columbia River. Thousands of them congregate at Seal Rock light-house during the breeding season. These rocks are situated well out from the beach and can be reached only during the extreme low tides of the summer months, thus rendering the retreat of the lions comparatively safe from attack except during isolated periods. After leaving the rocks at the close of the breeding season the lions are even more voracious than usual, and the schools of fish in that region of the ocean have short shrift. Numbers of the lions gather off the mouth of the Columbia River, and the sands of the jetty are black with them during the warm hours of the day. The huge mammals appear to be warned by instinct of the approach of a school of salmon, which is always the signal for a hurried putting to sea, and before the return thousands of the choicest fish in the world have been devoured or so badly mutilated that they will die.

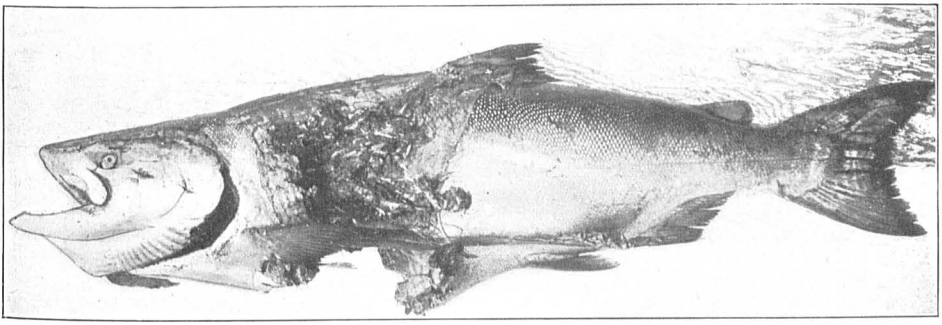
Commercially the sea lions are of little value, and not enough can be realized from their sale to make the killing of them profitable. This, coupled with the extreme difficulty of securing the carcasses of the animals, as the lions take to the water as soon as they are shot, makes the hunting of them a precarious means of livelihood and renders it absolutely necessary that a bounty be paid if the lions are to be exterminated. The hides, which weigh when green about 70 pounds, sell for half a cent a pound. The whiskers of the male sell for from 10 cents to 13 cents for the largest, which are from 10 to 12 inches in length. Those of the female are fewer in number and less valuable, but longer, some reaching 18 inches in length.

A vast amount of valuable fishing gear is destroyed each year by the lions. A big male lion, while in pursuit of a salmon, will become entangled in a gill net or trap, and before it can possibly be released will, by its desperate lashings and biting, tear the web into shreds. The amount of damage done each season would be difficult to estimate, but it is certainly enormous, and their extermination at the least would be of untold benefit to the fishing industry of the coast.

In California the State board of fish commissioners espoused the cause of the fishermen and strongly advocated a reduction of the size of the sea-lion herds on the California coast. As the sea lions can be killed most expeditiously when resorting to rookeries for breeding purposes, and as the rookeries are mostly on islands which are Government reservations under control of the Light-House Board, the California commissioners sought permission for their agents to visit these rookeries and thin out the herds. The granting of this request was opposed

STONES FOUND IN THE STOMACH OF A SEA LION, POINT ARENA, CALIFORNIA.





SPECIMENS OF SALMON FROM GILL NETS, ASTORIA, OREG., SUPPOSED TO HAVE BEEN MUTILATED BY SEA LIONS.

by representatives of the Fish Commission, the Department of Agriculture, and other branches of the Government, on account of lack of evidence showing the destructive habits of the sea lions; and the desired permission was withheld by the Secretary of the Treasury.

Dr. C. Hart Merriam, of the Department of Agriculture, contributed the following article to Science for May 17, 1901, based on the action of the California authorities:

FOOD OF SEA LIONS.

The California State board of fish commissioners during the past two years has taken steps to kill off a very large number of sea lions on the California coast, on the ground that these animals are highly destructive to the salmon fishery. The president of the board, Mr. Alexander T. Vogelsang, claims that it is not the intention of the board to exterminate the sea lions, but merely to kill "10,000 of the 30,000 that now infest our harbor entrance and contiguous territory."* The opinion of observers familiar with the sea-lion rookeries is that the number of animals has been greatly exaggerated, and that long before Mr. Vogelsang has killed the contemplated 10,000 there will not be a living sea lion left on the whole coast. Already many have been killed, and, unless public sentiment is aroused to check the movement, some of the most interesting rookeries of the State are in danger of depletion. The fish commissioners have employed men to shoot the sea lions, and are loud in their lamentations because the Government light-house reservations have not been thrown open to the slaughter.

The local fisherman, the State fish commission, and others assert without qualification that the sea lions feed extensively on salmon, and the inference from their statements is that the animals subsist chiefly, if not entirely, on fish. A few years ago, when similar complaints were made against the fur seals, I took the trouble to examine the stomach contents of a large number of these animals, and found to my surprise that the great bulk of their food consisted of squids, hundreds of whose beaks and pens were found in the stomachs, while in only a few instances were any traces of fish discovered.

In 1899 a well-known naturalist, Prof. L. L. Dyche, of the University of Kansas, spent the months of June, July, August, and September on the California coast, at a time when the sea lions were being slaughtered in the alleged interests of the fishermen. Professor Dyche became interested in the question of their food, and took the trouble to examine the stomachs of twenty-five sea lions, not one of which contained so much as a trace of fish. The region visited extends from Monterey Bay southward along the coast for about 25 miles.

Between June 25 and July 16 there were washed ashore within 3 miles of Point Pinos, at the mouth of Monterey Bay, eight sea lions which had been shot, the fishermen said, because they were feeding on salmon. Professor Dyche examined the stomachs of all of these and has given me a detailed record of the contents of each. It would take too much space to print this in full. Suffice it to state that the remains of squids and cuttlefish (*Octopus*) were found in all, and that several were filled with large pieces of giant squid. Notwithstanding the fact that at the same time and place salmon were being caught by fishermen, not a fish scale or bone was detected in any of the stomachs. Whenever possible Professor Dyche opened the stomachs in the presence of the fishermen, who invariably expressed the greatest surprise at the result.

On July 20 Professor Dyche moved his headquarters southward and established a camp about 12 miles below Monterey Bay, between Point Carmel and the light-house, near which is an extensive rookery of sea lions. Between July 20 and August 16 the stomachs of seventeen additional sea lions were examined. Eight out of the

*In a letter to Hon. Lyman J. Gage, Secretary of the Treasury, dated San Francisco, June 3, 1899.

seventeen were well filled with the flesh of the giant squid; two were gorged with large octopus, while the remaining seven contained pens and beaks of squids, the quantity varying from half a pint to about a quart.

Professor Dyche was told that there were no fish within 2 or 3 miles of the sea-lion rookeries near his camp, as the sea lions had caught or driven them away. In the face of this statement, he himself caught a dozen rock-cod one morning between shore and the seal rocks, and his boatman, George Carr, an old salmon fisherman, caught plenty of rock-cod weighing from 1 to 8 pounds each within 60 feet of the flat rock where from 1 to 300 sea lions landed each day. The water close to these rocks, where sea lions had lived for ages, proved to be the best fishing-ground in the locality. Professor Dyche states further that he landed a number of times on the rocky islands where in places the excrement from the sea lions formed a layer a foot thick. He hunted through this for fish bones and scales, without being able to discover a single one. On the other hand, the tough pens from the backs of the squids were abundant.

Professor Dyche found the fishermen loud in their denunciation of the sea lions on account of their alleged destruction of salmon, but, although he was on the fishing-grounds continuously for more than three months, the fishermen were unable to show him a single instance in which a sea lion had killed a salmon. He adds: "You can hardly imagine the surprised look on these fishermen's faces when they saw the great masses of squid meat roll out of the sea lions' stomachs when cut open."

The fact that sea lions in captivity will eat fish rather than starve has little bearing on the question, and the additional fact that salmon in nets are sometimes found bitten off or eaten is by itself no evidence at all, particularly in places where either sharks or otters occur. It is not claimed that sea lions in their native element never eat fish; at the same time the only actual evidence we have on the subject fails utterly to substantiate the allegations of the fishermen. On the contrary, all of the twenty-five stomachs of sea lions examined by Professor Dyche contained remains of squids or cuttle-fishes, and not one contained so much as the scale or bone of a fish. And is it not significant that in former years, when sea lions were much more plentiful than now, salmon also were vastly more abundant? If the fishermen will look into their own habits and customs during the past twenty-five years, it is believed that the cause of decrease of the salmon will not be difficult to find, and this without charging the decrease to the inoffensive sea lions, whose rookeries constitute one of the greatest attractions to the visitor on the California coast.

In 1901 the California board of fish commissioners again brought up the subject and asked that the United States Fish Commission investigate it. The Commissioner accordingly addressed the following letter to the chairman of the Light-House Board, under date of June 6, 1901:

Respectfully adverting to correspondence between the Light-House Board and this Commission regarding the killing of sea lions on Government reservations on the west coast under supervision of the Light-House Board, I have to advise you that this Commission has been asked by the board of fish commissioners of the State of California to make an investigation of the food and feeding habits of the sea lions on the Californian coast, and that the Commission is disposed to accede to the request of the State authorities, in order that the question at issue may be definitely settled by competent official authority.

I have therefore to request that you will cause to be issued the necessary orders to the keepers of light-house reservations, permitting a duly selected scientific assistant of this Commission, with such associates or aids as he may require, to visit the reservations and make the desired investigations, including the killing of a limited number of animals.

I need hardly assure your board that under the desired permission only the minimum number of sea lions required for the settlement of the question will be killed by the Commission's agent.

The Treasury Department made a favorable response to this request, and steps were taken to begin the inquiry at once. Mr. Cloudsley Rutter, scientific assistant of the Commission, was placed in charge of the investigation; and the California board of fish commissioners and the California Academy of Sciences were asked to nominate representatives to cooperate with Mr. Rutter. In accordance with this invitation, Mr. Robert E. Snodgrass was named by the California Fish Commission and Mr. Edwin C. Starks by the California Academy of Sciences. The instructions issued for the conduct of the investigation called for a consideration of the following subjects: The species of sea lions on the California coast, their characteristics, size, distribution, and general habits; the number and location of the rookeries, and the number of sea lions resorting to each rookery; the food and feeding habits of sea lions, in salt and fresh water, at all seasons; the times and places of the appearance of sea lions in fresh water; the damage to fishing apparatus occasioned by sea lions.

The inquiries were begun July 10 in Half-moon Bay, San Mateo County, about 18 miles south of the Golden Gate. Here Pillar Point and vicinity and the Purissima rookery were visited. This is the only rookery where accurate count of the sea lions can be made, and it was kept under observation throughout the year, semimonthly records being made. From the 13th to the 16th of July the rookery at Ano Nuevo (about midway from Half-moon Bay to Monterey Bay) was under observation, and a number of sea lions were here killed. This is the only rookery which can be visited except during the most favorable weather, and is well suited for the study of feeding and breeding habits.

After leaving Ano Nuevo the party divided, Mr. Rutter going north and Messrs. Snodgrass and Starks south. The latter visited Santa Cruz Island, where a number of specimens were obtained, and also other islands of the vicinity, all the rookeries being located with the aid of seal hunters, although most of the rookeries were deserted at that time. Early in August the rookeries near San Pedro were inspected, and later the fishing stations farther south were visited and the fishermen and seal hunters were interviewed. The inquiries were brought to a close by second visits to the Purissima and Ano Nuevo rookeries, August 26 to September 1.

Mr. Rutter spent a week at the Farallone Islands, but was unable to reach the rookeries owing to rough weather, and a later attempt was also unsuccessful. At Point Arena four sea lions were killed and examined. Some time was then spent at the mouth of the Columbia River, where sea lions were under observation from fishing scows and the jetty, and many persons interested in the fishing industry were interviewed. Rough water prevented a visit to the Tillamook rookery. After visiting various points on Puget Sound and Straits of Fuca, Mr. Rutter joined the other members of the party at San Francisco.

Following is the substance of the report submitted by Messrs. Rutter, Snodgrass, and Starks, the description of rookery sites and data on the general habits of the sea lions being omitted. It will be seen that while much has been established regarding the question at issue, further inquiries should be addressed to some aspects of the subject.

REPORT ON THE SEA LION INVESTIGATION, 1901.

The Steller sea lion (*Eumetopias stelleri*) was found at Ano Nuevo Island and northward, and the California sea lion (*Zalophus californianus*) in the Santa Barbara Channel and southward. The Steller sea lion is reported to breed on San Miguel and Santa Rosa islands, but this could not be verified, owing to the rookeries being deserted at the time of visit.

Following is a tabulated statement of the stomach contents of 42 sea lions, 18 of the species *Eumetopias stelleri* and 24 of the species *Zalophus californianus*. An examination of this table shows, among other things, the following points:

1. Of the 26 sea lions whose stomachs contained food, fish remains were found in 18 and squid or octopus in 15.

2. All of the 13 Steller sea lions whose stomachs contained food had eaten fish and 5 had eaten squid or octopus. The number of squid eaten was small, 6 being the maximum number in 1 sea lion, while the quantity of fish was large, at least 35 pounds being taken from 1 stomach.

3. Of 13 California sea lions whose stomachs contained food 5 had eaten fish and 11 had eaten squid. The quantity of fish was inconsiderable, 17 small fishes being the maximum, while the remains of 100 to 300 squid were found in each of 5 stomachs.

This study, as far as it goes, indicates that the Steller sea lion is largely a fish consumer and the California sea lion is chiefly a squid eater. It seems apparent, however, that either species feeds on whatever is most convenient.

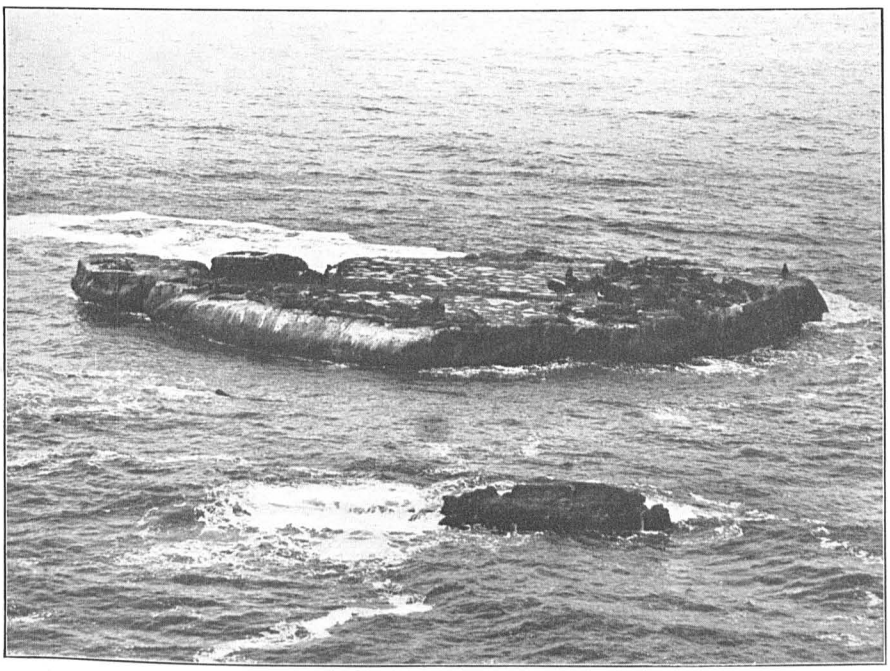
Very little positive information was obtained regarding the damage done to the fishing industry at southern points. On one trip made with the fishermen a net was found torn in one place, but there was no proof that the injury was done by sea lions. The testimony of the fishermen was so contradictory that it is of no value. One fisherman claims that in securing $3 worth of fish his net was damaged $75, while another claims that there is very little damage done by sea lions. One man holds that the sea lions are becoming more numerous and destructive every year, while another claims that they are rapidly becoming exterminated.

In former years the fishermen in the vicinity of San Francisco complained a great deal about the sea lions, but there was practically no complaint at the time of the investigation. Sea lions were scarcely ever seen in the vicinity of the salmon nets during the year 1901.

At the mouth of the Columbia River, as elsewhere, the direct evidence obtained on this point is meager. Sea lions were seen fishing in considerable numbers about the shoals near the jetty at the mouth of the river, but none was seen to catch a fish of any kind. Gulls were frequently observed hovering about a group of sea lions and acting as if picking up food. One such flock of gulls was seen coming gradually nearer the jetty from a group of sea lions about a mile away; after a time, it was shown that they were following a large piece of salmon flesh which the tide brought within 20 feet of the observer. Salmon were seen and photographed that had been mutilated (presumably by sea lions and seals) after being caught in gill nets. Such mutilated specimens were common. The fishermen stated that the seals simply pull off the gills, but the sea lions always take a bite out of the belly of the netted salmon.

A number of pound nets were visited, but no sea lions were seen in them.

A PART OF THE AÑO NUEVO ROOKERY.



PURISSIMA ROOKERY.

The following is a statement of the number of times sea lions entered various pound nets set in the mouth of the Columbia River, as reported by the owners:

Owner.	No. of traps.	No. of times entered.	Owner.	No. of traps.	No. of times entered.
C. Oleson	6	4	G. Johansen	2	1
B. Hawkins	9	3	B. Sutherland	2	6
C. Davidson	1	1	W. B. Donaldson	2	3
C. Johnson	2	4	Sam Oleson	2	3
N. Fodrop	2	2			
F. Gardner	2	4	Total	30	33

The fishermen were unanimous in their denunciation of the sea lions. A fishing company at Chinook, Wash., states that it was damaged $1,500 in 1901 by sea lions letting fish out of the nets, the damage to the nets not being included. The sea lions enter the traps in the same way that fishes do, and, after eating what they wish, break their way out through the side.

Sea lions were not found in Puget Sound in 1901, and no complaint whatever was made concerning them.

It appears from the above that the sea lions are doing very little damage anywhere, excepting at the mouth of the Columbia River. The shallow water and the large number of salmon make that point a favorite feeding ground, and there is no doubt that the sea lions are doing much damage there.

Table of stomach contents of sea lions.

Specimen No.	Rookery.	Sex.	Age.	Date.	Hour.	Food present.
	Eumetopias stelleri.					
1	Point Arena	Male	Bachelor	July 31	Noon	Yes.
2	.....do	Male	.....do	.....do	2 p. m.	Do.
3	.....do	Male	.....do	Aug. 1	10 a. m.	Do.
4	.....do	Male	.....do	.....do	.....do	Do.
5	Ano Nuevo	Male	.....do	July 15	7 a. m.	Do.
6	.....do	Male	Adult	July 14	5 a. m.	No.
7	.....do	Fem	.....do	.....do	.....do	Yes.
8	.....do	Fem	.....do	.....do	.....do	Do.
9	.....do	Fem	.....do	.....do	.....do	No.
10	.....do	Fem	.....do	July 15	7 a. m.	Yes.
11	.....do	Fem	.....do	.....do	.....do	Do.
12	.....do	Fem	.....do	Aug. 29	9 a. m.	Do.
13	.....do	Fem	.....do	.....do	3 p. m.	No.
14	.....do	Fem	.....do	Aug. 30	8 a. m.	Yes.
15	.....do	Fem	.....do	.....do	.....	Do.
16	.....do	Fem	.....do	.....do	3 p. m.	Do.
17	.....do	Fem	.....do	.....do	.....do	No.
18	.....do	Fem	.....do	.....do	6 p. m.	Do.
	Zalophus californianus.					
19	China Harbor, Santa Cruz Island	Male	Bachelor	July 23	7 a. m.	Yes.
20	.....do	Male	.....do	July 24	8 a. m.	Do.
21	.....do	Male	.....do	.....do	.....do	Do.
22	.....do	Male	.....do	.....do	9 a. m.	Do.
23	.....do	Male	.....do	July 31	8 a. m.	No.
24	.....do	Male	1 year	Aug. 1	5 a. m.	Yes.
25	.....do	Male	Adult	July 23	8 a. m.	No.
26	.....do	Male	.....do	July 29	10 a. m.	Do.
27	.....do	Male	.....do	.....do	.....do	Do.
28	Gull Island	Fem	1 year	July 28	6 a. m.	Yes.
29	East End Cove, Santa Cruz Island	Fem	Young	Aug. 1	4 a. m.	Do.
30	China Harbor	Fem	Adult	July 23	8 a. m.	No.
31	.....do	Fem	.....do	.....do	.....do	Yes.
32	.....do	Fem	.....do	July 29	10 a. m.	Do.
33	.....do	Fem	.....do	.....do	.....do	No.
34	.....do	Fem	.....do	July 31	7 a. m.	Yes.
35	.....do	Fem	.....do	.....do	.....do	No.
36	.....do	Fem	.....do	.....do	10 a. m.	Do.
37	.....do	Fem	.....do	.....do	11 a. m.	Do.
38	East End Cove, Santa Cruz Island	Fem	.....do	Aug. 1	5 a. m.	Yes.
39	.....do	Fem	.....do	.....do	.....do	Do.
40	China Harbor	Fem	.....do	.....do	.....do	No.
41	San Clements Island	Fem	.....do	Aug. 6	9 a. m.	Yes.
42	.....do	Fem	.....do	.....do	1 p. m.	No.

Table of stomach contents of sea lions—Continued.

Specimen No.	Kind and quantity of food.																					
	Rock-fish.	Perch.	Clupeoid fish.	Carangoid fish.	Hake.	Large fish, 12 to 18 inches long.	Small fish.	Skate.	Shark.	Hog-fish.	Chimera.	Fish bones. Number of quarts.	Fish bones. Representing at least — fishes.	Small squid.	Giant squid.	Octopus.	Shrimp.	Crab.	Gasteropod shell.	Milk.	Stones ¼ to 1 inch in diameter.	Stones 1 to 3 inches in diameter.
1	....	....	....	....	....	....	....	2	....	....	....	4	52	1	1	....	....	1	....	....	....	....
2	....	....	....	....	....	....	....	....	....	....	....	2	25	....	....	....	....	....	....	....	....	....
a3	....	....	....	....	....	16	1	....	6	....	....	....	23	....	....	....	....	....	....	....	....	8
4	....	....	....	....	....	....	....	....	....	....	....	3	40	1	....	....	....	....	....	....	....	4
5	....	....	....	....	....	1	....	....	....	....	....	¼	7	2	....	....	....	....	....	....	....	....
6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
7	....	2	....	....	....	....	....	4	....	1	....	....	7	....	....	....	(b)	....	....	....	....	....
8	14	....	....	....	....	....	....	....	2	....	....	....	16	....	....	....	....	....	....	....	....	....
9	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
10	....	....	....	....	....	....	....	....	....	....	....	2	15	....	....	....	....	....	....	....	....	....
11	×	....	....	....	....	....	....	....	....	....	....	1	6	....	....	....	....	....	....	....	....	....
12	....	....	30	1	....	....	....	....	....	....	....	....	31	6	....	....	....	....	....	....	....	1
13	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
14	....	....	....	....	....	....	....	....	....	....	....	¼	5	....	....	1	....	....	....	....	....	....
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21	....	....	....	....	....	....	....	....	....	....	....	....	....	200	....	....	....	....	....	....	....	....
22	3	....	....	....	....	....	....	....	....	....	1	....	3	....	....	....	....	....	....	....	....	....
23	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
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25	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
26	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
27	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
d28	....	....	....	....	....	....	7	....	....	....	....	....	7	8	....	....	....	....	1	....	15	....
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42	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	17	2	30	1	2	17	25	6	8	1	1	18	286	1,122	1	1	(b)	1	1	...	50	34

× Indicates that the forms mentioned were present, but their number could not be determined.

a Several "sea pens."
b Few.
c Unrecognizable material.
d Shell apparently empty when swallowed.
e Filled with clear liquid, in which floated a light, yellow, flaky substance.

The following additional information regarding the number of sea lions on the California coast has been submitted by Mr. Rutter:

In 1902 the Ano Nuevo rookery contained 150 pups, which would indicate as many adult females. As there are more males born than females, there is no apparent reason why there should not have been as many adult males, so that the adults of the herd certainly numbered 300, not including the 1 and 2 year old individuals. The number of pups could not be determined at any of the other rookeries, and there is, therefore, no basis of estimating the number of adults at any point except at Purissima, where the adults themselves could be counted. But as Purissima was not a regular breeding rookery in 1901 and 1902, and as it is probable that many of the Ano Nuevo sea lions spent part of the year there, the Purissima counts can not be relied upon for statistical estimates. The most that can be said is that there were more sea lions at Point Arena than at Ano Nuevo Island, and that there were several

times as many at the various Farallon rookeries. Probably half the sea lions of California are found at the Farallon Islands, and it seems doubtful whether the total number on the coast amounts to 5,000.

During the breeding season of 1901 there were about 400 adults at Ano Nuevo rookery. The larger males began leaving in July, and were followed by the younger males, and these by the cows and pups. The rookery was entirely deserted by the first of September, and remained so till the middle of the following May, the beginning of the next breeding season. Such was not the case with the Purissima rookery, however. This was not an important breeding place, though a few sea-lion pups were found there in 1901 and also in 1902.

The Purissima rookery is located on a single flat-topped rock lying close to a high bluff, affording an excellent opportunity for observation. Mr. James Mosconi, an employee of the Light-House Service, was engaged to make a count of the sea lions on this rookery at regular intervals, and his figures are as follows:

Date.	No.	Date.	No.	Date.	No.	Date.	No.
1901.		1901.		1902.		1902.	
July 15	225	October 15	417	January 15	16	April 15	66
July 31	312	October 31	313	January 31	42	April 30	36
August 15	578	November 15	311	February 15	0	May 15	122
August 31	558	November 30	59	February 28	68	May 31	64
September 15	302	December 15	48	March 15	7	June 15	78
September 30	370	December 31	90	March 31	29	June 30	143

THE REARING OF LOBSTERS.

Profiting by the experience gained from the previous season's observations and experiments in rearing lobsters, the Commission, during the spring and summer of 1901, made substantial progress in this important work. It having been shown that the station at Wickford, R. I., on Narragansett Bay, afforded better facilities and conditions for lobster rearing than did any of the other stations occupied in 1900, the experiments of 1901 were chiefly conducted at that place, where, as heretofore, the Commission cooperated with the Rhode Island Fish Commission, represented by Dr. A. D. Mead.

The essential factors in lobster rearing are (1) to keep the larval lobsters in motion so they will not settle to the bottom of the retaining vessel and there suffocate or devour each other, and (2) to provide them with suitable food so they will grow and molt quickly and take on the habits of the adults. The vessel in which young lobsters may be best held was devised only after much study and experimentation.

The following report of Dr. H. C. Bumpus, who directed this work, may be advantageously quoted as to methods and results:

Large salt-water ponds, small pools, artificial pools made by the building of dikes, inclosures made of wire screen and floated, and of wire screen and submerged, huge canvas boxes and cars, cars of scrim floated and anchored at the bottom, glass jars of various sizes, running water in vessels of wood, glass, porcelain, and stone, and various rotary devices, all proved efficient agents for the killing rather than for the rearing of lobster fry. After many experiments a relatively simple and inexpensive device was adopted. Several bags of scrim about 3 feet in diameter and 4 feet in

depth were so suspended in the pool of the floating laboratory that the current could not change their general shape or cause them to collapse. In each bag was placed a dasher, the blades of which in rotation would constantly lift the water through the mesh at the bottom of the bag and urge it with obviously less velocity through the pores of the vertical walls. The dashers were kept in motion by means of a small gasoline engine. We found that when the mechanism was in actual operation, the current, in rising through the bottom of the bag, brought with it large numbers of pelagic animals, while the reduced current of the water passing through the greater expanse of the vertical walls was not sufficient to carry this living material out of the bags; thus the apparatus sufficed not only for keeping the fry and artificial food from the bottom, but also provided the fry with living natural food. To Mr. G. H. Sherwood is due the credit of devising and installing this aerating and feed apparatus.

In practice it was found that the eggs stripped from the abdomen of the female would hatch in these scrim inclosures under much more favorable conditions than in the McDonald jars. Indeed, I am inclined to believe that a far higher percentage of eggs would hatch in these bags than in the McDonald jars, and I am sure that the young are in a much more healthy condition than when hatched by the older method. Even a superficial examination of the young that have spent some hours in the trituration of the McDonald jars will show that a large proportion of them have the appendages broken, bent, or indented.

The number of fry that were available for the purpose of experimentation during the first season was considerably less than in 1900, and the period of experimental work was also materially reduced. Nevertheless, Dr. Mead, who had the work immediately in charge, reports that by actual count in no case was the number of lobsters that reached the fourth stage less than 16 per cent of the number of fry originally placed in the inclosure. In a few cases it was above 40 per cent, and in at least one case it was as high as 54 per cent. In previous years no experiments had yielded more than a fraction of 1 per cent. The total number of lobsters raised to the fourth stage during the season of 1901 (in the 12 cylinders) was a little more than 9,000.[a]

OYSTER-FATTENING EXPERIMENTS AT LYNNHAVEN.

For several years past the Commission has been conducting experiments in Lynnhaven, Va., under the direction of Messrs. H. F. Moore and W. W. Blackford, for the purpose of developing a method by which oysters may be fattened artificially with the same degree of certainty attained by stock-raisers in fattening cattle.

The practice of allowing oysters to fatten on the beds where they are grown is haphazard in its methods and uncertain in its results, and coves and other places where the natural food supply is sufficiently great at all times and under all conditions are too rare to be available to most oyster-growers. Ordinarily there is no difficulty in raising oysters to a marketable size within a reasonable time, but there is often considerable difficulty in producing them in a marketable condition. Frequently a grower will be unable to ship during a large part of the most profitable season because for some reason, which he can not control, the oysters will not get fat. This difficulty often happens unexpectedly, even within the most favorable localities, and causes the grower to hesitate to enter into contracts which he could profitably

[a] The results attending the experiments in lobster culture made by the U. S. Commission of Fish and Fisheries, Science, December 27, 1901.

make had he available some method of fattening his oysters as they were needed. To overcome this difficulty in a measure, it has been customary in some places to resort to "floating" or "drinking," which consists essentially of transferring the oysters to fresh or brackish water. That practice, while giving them an illusive plumpness, injures them in both flavor and nutritive value.

The experiments which have been carried on by this Commission have nothing in common with this method, but are designed actually to fatten and improve the oyster in weight, flavor, and food value. The progress of the work has been briefly noticed from time to time in the annual reports of this Commission. Each year the results have approached more nearly the desired end, and during the season 1901–2 the work has been attended with such success that it is considered desirable to give a more extended account of the plant and its operations than has been before attempted. The work, however, is still in an experimental stage, and the financial results have not yet demonstrated the practicability of the method. During the coming season it is believed that the operations can be so simplified and cheapened and the output so increased as to show pecuniary advantages.

The plant at present consists of a 2-acre pond having an average depth of 2½ feet. Originally it was a cove with a narrow mouth, giving tidal communication with the main body of Lynnhaven Bay. Across the mouth a substantial dam has been constructed of such height as to exclude all save exceptionally high tides. There is some drainage into the pond from the surrounding land, so that after it was dammed it became practically a claire according to the French method.

During the first season of its operation oysters were spread on the bottom of the pond in limited numbers, but there was practically no improvement in their condition during the season, and it was evident that the diatoms, which constitute the principal food of the oyster, would not multiply to a measurable extent under these conditions. In the meantime laboratory experiments carried on in Washington had demonstrated that the growth and multiplication of these microscopic plants, like that of other vegetable organisms, could be stimulated and increased by using certain salts in solution; in other words, by the application of fertilizers to the water in which they were growing. During the following year ordinary commercial fertilizers, such as are commonly used for potatoes and similar crops, were placed in the pond and the number of diatoms increased very considerably, and during that season about 50 or 60 per cent of the oysters in the pond became reasonably fat, some of them excessively so, but the others remained poor and lean. It was evident, as a result of the season's work, that the food supply was ample, but that for some reason it was not equally accessible to all of the oysters, and a comparison of the conditions in the pond with the open waters of the bay indicated that the cause probably lay in the absence of the currents necessary to

transport the diatoms within reach of the sedentary oysters. In the open waters these currents were furnished by the tides, but in the pond there were only feeble currents produced by the winds and local differences in the temperature of the water.

To supply the necessary currents a canal faced with sheet piling was constructed along one side of the pond and communicating with it at both ends. This canal is about 150 feet long and 9 feet wide, and is provided with 16 wooden floats or trays 8 feet 8 inches square and 4 inches deep inside. Each float is capable of holding about three barrels of oysters in a single layer packed nib up, and is hung by ropes attached to small roller windlasses about 6 inches above the bottom. A current through the canal is produced by a propeller at the inlet driven by a gasoline engine connected by rubber belting. During the first year power was supplied by a windmill, but it was found that much power was lost, owing to the frequency of calms and winds too light to carry the load, and the more reliable motor was substituted.

The method of operating the claire is briefly as follows: Before the opening of the oyster season a supply of commercial fertilizer is applied in the shallow water around the edges of the pond, whence it gradually reaches the surrounding water, stimulating a vigorous growth of oyster food. Poor, unsalable oysters are then placed on the floats in the canal and, the propeller being set in motion, a current of about 1 mile per hour is maintained, carrying over the oysters a constant supply of diatoms from the rich store contained in the pond at large. It was found that by this means the oysters in the canal fattened quickly and uniformly, an extremely low proportion of blanks or watery oysters being found.

Owing to the exigencies of experimental work, the utmost capacity of the claire in fattening oysters has not yet been determined, but the fact that one lot was raised from a very poor to first-class condition in eight days indicates that it will be considerable when the proper arrangement is discovered. With the present canal capacity, which could probably be considerably increased to advantage, a maintenance of this rate would give a capacity of about 175 barrels per month, or 1,400 barrels during the season of eight months, from a 2-acre farm. During the past season two difficulties which militated against a true test of the capacities of the ponds were encountered: Occasionally a very slight marshy taste would be noticeable in the oysters, and at such times no shipments were made, for fear of injuring the demand. It has been learned that this can be overcome by the application of lime to the water at the end of the canal. The other difficulty is that in wet seasons with few high tides the water in the pond becomes too fresh and the oysters rather too insipid to bring the highest price in the market. A plan is now under consideration and will be put into operation during the ensuing season which it is thought will obviate this. Under the best conditions, oysters placed in the pond in an

unmerchantable condition sold after fattening for $6 per barrel in Philadelphia. It is believed that at the close of the next oyster season definite plans of a plant and a method of operating it can be placed before the oyster-planters of the country. At present the Commission does not feel prepared definitely to recommend the method.

INQUIRY REGARDING DESTRUCTION OF OYSTERS BY DRUM-FISH.

In the latter part of June, 1902, the attention of the Commission was called to the destruction wrought by the drum-fish (*Pogonias cromis*) in the vicinity of Tuckerton, New Jersey, and Dr. H. F. Moore was at once sent to that place to make an investigation and if possible determine what measures should be taken to mitigate the losses. Oyster-growing is the main industry of Tuckerton, and most of the available oyster bottoms of Little Egg Harbor and Great Bay are taken up by persons living in that town and its vicinity. Although there is some good spawning-ground in these waters, the industry is mainly dependent on seed brought from other localities. Until within a few years, most of it was brought from Chesapeake Bay and other parts of Virginia, but recently it was discovered that seed from Long Island and Connecticut grew with remarkable rapidity when laid down in that vicinity, and it has since been heavily purchased, almost to the exclusion of other seed. It is stated that in some instances seed oysters from Great South Bay, Long Island, have increased 400 per cent in bulk within a period of six months, and to a somewhat greater extent in value.

For several years past the oystermen have sustained losses for which they could account only by attributing them to theft, but in the spring of 1901 it was discovered that the drum-fish was eating the young oysters in considerable quantities, and during the spring of 1902 the destruction became so great as to demand concerted action upon the part of the oystermen. A meeting was held at Tuckerton, at which most of the principal planters were present, and a fund was created to defray the expenses of fighting the common enemy. Special permission having been obtained from the State authorities, an attempt was made to kill the fish and drive them away by dynamite and nets. The nets used were some that had been discarded by sturgeon fishermen, and had a mesh of about 14 inches extension measure, rather too large for the drum-fish. They were set at random over the oyster beds and at first made fair catches, but their efficiency gradually decreased, owing, the oystermen supposed, to the fish being frightened away, though it seems very probable that the fish deserted the beds owing to their practical depletion and to their consequent loss of attraction to the fish which came upon them in search of food.

At the time of the visit of Dr. Moore about 100 pounds of dynamite had been exploded during four days' work, and about 1,000 fish of large size had been killed. The dynamite is not used on the oyster

beds for fear of killing the oysters as well as the fish, but near the inlet, where the fish school at ebb tide. Two charges of 3 pounds each are attached, 50 feet apart, to a conductor, towed over the schools of fish, and exploded about 4 feet below the surface. On several occasions from 100 to 200 fish have been destroyed at a single explosion, and the survivors within a considerable radius of the disturbance are apparently badly frightened. As the dynamiting takes place at a considerable distance from the oyster beds and in the daytime, however, while the fish appear to feed on the beds principally at night, it is by no means certain that the effects will be very manifest in preventing the destructive inroads. The most efficient way of protecting the beds would, of course, be to inclose them completely with nets or stockades, but, owing to the large extent of the beds, to the navigable character of the water, and to the amount of material which drifts with the tide, this plan is not feasible at Tuckerton.

Some very extensive beds examined by Dr. Moore were found to be practically depleted of oysters. In one case where 15,000 or 20,000 bushels had been planted, and the owner estimated the loss at 50 per cent, an examination of areas selected at random indicated that upwards of 80 per cent of oysters had been eaten by the drum-fish, and nothing remained of them but a few ground-up fragments of shells. On these same beds native seed, owing, doubtless, to its much heavier shell, had not been destroyed. Should the present efforts of the oystermen to protect their beds prove unavailing, it seems probable that the only recourse is to abandon the use of the thin-shelled eastern seed and restrict planting to heavy-shelled varieties. If the beds can be efficiently protected each year for a period of two or three months after they are planted, it is probable that no further trouble will occur, as by that time the seed oysters will be large enough to resist the attacks of drum-fish.

TRIP TO THE TILE-FISH GROUNDS.

On July 28 the schooner *Grampus*, with a small party from the Woods Hole Station, made a short trip to the tile-fish grounds lying off No Man's Land. The grounds were reached during the night of July 28–29, and on the morning of the 29th four tubs of trawls, baited with squid, were set in water 65 to 70 fathoms deep, in latitude 40° 6′ north, longitude 70° 24′ west, 70½ miles south and one-half mile east from No Man's Land. One part of the trawl, owing to fouling, caught no fish; the other, after being on the bottom for about two hours, was hauled and found to have 62 fine fish, with an aggregate weight of about 700 pounds. The *Grampus* returned to Woods Hole on July 30, and the fish were shipped to dealers in New York, Boston, and Gloucester, who had expressed a willingness to handle them and endeavor to create a demand which would lead to the establishment of a regular fishery.

The reports as to the food value of these fish coincide with those

received in previous years in being unqualifiedly favorable. The following, from Mr. William H. Jordan, collector of customs at Gloucester and one of the leading vessel-owners and fish-dealers, shows the way in which the tile-fish is regarded in the leading fishing port of the country:

> The tile-fish arrived in the best of order, having been very carefully prepared, and I distributed them among fourteen of my acquaintances. I have heard from nearly all of them, and they have expressed themselves as highly pleased with the quality of the fish, considering them delicate and of high flavor. I, myself, found the fish exceptionally good, and enjoyed my dinner from it. Certainly it would seem to me that if the people could become familiar with the tile-fish in some such manner of distribution as you have made through me, it would open up a demand for a large quantity of the fish, should they be caught.

The prospects for the inauguration of a special tile-fish fishery from Gloucester, Boston, New York, and several other ports now seems much more promising than at any previous time. The investigations of the Commission have shown a great abundance of tile-fish over a wide area adjacent to our shores and clearly indicate that a profitable industry may be developed.

THE GROWING OF SPONGES FROM CUTTINGS.

The experiments in sponge-culture begun in Florida under the direction of Dr. H. F. Moore during the preceding fiscal year have been continued during the present year, and it is believed that considerable progress has been made toward the development of a practical commercial system of sponge-culture. The constant aim has been to reduce as far as possible the niceties of experimental work to a basis adapted to the requirements of the practical sponger.

As stated in a previous report, several thousand sponges were planted in January and February, 1901, and at the end of six weeks these were found to be growing well. Examination in November, 1901, however, showed that most of the cuttings had died and that some of them had been stolen for the value of the wire to which they were attached. Most of these plants were made upon copper wire, which, while it has the power of resisting to some extent the action of salt water, is in some localities more or less subject to corrosion, and the salts produced are inimical to the sponge, causing it to die near the point of attachment and fall from its support. During the present year it has been sought to overcome this difficulty by using insulated copper wires, so that the cuttings would not be brought into contact with the bare metal. Further improvement was made in slitting the sponge cuttings and placing them astride the wire or other support to which they were attached, and then binding the surfaces of the flap in close apposition by means of a wire. In the course of a few days the two flaps grew together and the cutting became permanently attached, independently of any artificial binding. Temporary tie wires of aluminum wire were

used, which, while slowly acted upon by salt water, lasted a sufficient length of time to permit the sponge to permanently heal.

During the winter months the growth of the cuttings was rather slow, so far as increase in bulk was concerned, although eyes, or oscula, were promptly put out and the circulatory system quickly reorganized and completed. During the spring when the water, especially in the more southern part of the State, was becoming warmer, there were indications of more rapid growth. About six thousand cuttings were planted in Biscayne Bay, Sugar Loaf Key, and in the vicinity of Anclote Keys, and in the latter part of April, after they had been planted for periods varying from two to five months, most of them were growing and in an apparently healthy condition.

Between the lower end of Biscayne Bay and Matecumbe Key there is a long stretch of water where sponges do not grow naturally. An investigation of this region was made to determine the reason for their absence, and an experimental plant of about a thousand cuttings was made in a small sound back of Key Largo, with a view to determining whether they could be artificially introduced there. At the end of six weeks practically all of these cuttings were dead, although others planted at about the same time in more favorable localities were alive and growing. A series of observations developed the fact that the water in this region is of a much lower salinity than in places where the sponge grows naturally, and it is probable that this is the cause of their absence naturally and of the mortality of the cuttings.

Practically nothing is known of the rate of growth of sponges under natural conditions, or of the rapidity with which they will develop from fragments and cuttings, and it will probably require several years' investigation to determine these points and to develop, if it can be developed, a system of sponge-culture which will be of value to the State of Florida. At the present time the production of sponges in this State, which is the only one in the country producing them, is about $500,000 per annum. An equal or perhaps greater value of sponges is imported from abroad, and it is hoped eventually to supply this excess of demand over production by sponges raised artificially. Many of the sponge-dealers are showing considerable interest in the experiments, and it is believed that they will promptly undertake sponge-culture if a reasonably practical method can be developed.

SURVEY OF THE FLORIDA SPONGE-GROUNDS.

The steamer *Fish Hawk*, working under the direction of this division, in October, 1901, resumed the survey of the sponge-grounds of the western coast of Florida, and in March, 1902, completed the examination of the waters lying north of Tampa Bay, comprising all those grounds designated under the names "Gulf," "Bay," "Rock Island," and "Anclote." The location of the sponge-grounds has been plotted

on charts, and, for the first time, the extent, position, and relations of the grounds have been determined.

The sponge-bearing bottom stretches in a continuous but irregular band or zone, 5 to 35 miles wide, from Apalachee Bay nearly to Tampa Bay, the length, following the curvature of the coast, being about 175 miles. The grounds are widest off Withlacoochee Bay, Deadmans Bay, and Rock Island, and narrowest off Cedar Keys. Three large disconnected areas, between the shore and the sheepswool grounds, on which grass sponges grow rankly to the exclusion of most other kinds, are in or near St. Martins Bay, Deadmans Bay, and Apalachee Bay.

It is intended to continue this work by detailing the *Fish Hawk* to survey and plot the remaining sponge-grounds, of which those about the Florida keys are the most important.

RIVER AND LAKE INVESTIGATIONS.

GREAT LAKES BIOLOGICAL SURVEY.

Prof. H. S. Jennings, of the University of Michigan, directed inquiries addressed to various subjects connected with the animal and plant life of the Great Lakes, in continuation of the work begun a number of years ago. As in previous seasons, Lake Erie was the field of investigation, and the Fish Commission station at Put-in Bay was the headquarters of a party of specialists employed throughout the summer.

Among the fishes specially considered were the white-fish and wall-eyed pike, by Dr. Raymond Pearl, of the University of Michigan, the carp, by Mr. Leon J. Cole, of the same institution; and the sturgeon, by Prof. S. O. Mast, of Hope College. Mr. Pearl's inquiries had for their object (1) the determination by detailed statistical methods of the existence or nonexistence of different races of white-fish (*Coregonus clupeiformis*) in the different lakes, and (2) the demonstration by the same methods of the relation of the blue pike to the yellow pike (*Stizostedion vitreum*) of the Great Lakes. The study of the variations of the white-fish will not be completed for several seasons, owing to the wide field to be covered and the extensive series of measurements of individual specimens necessary for the purpose in view. The work on *Stizostedion* need not be resumed, as enough has been learned to show that the wall-eyed pike is a species of remarkably low variability and that there are no structural differences between the blue and the yellow varieties, this being in accord with other observations. The continuation of Mr. Mast's examination of the lake sturgeon at the spawning season resulted in the collection of additional information as to the past and present abundance of the fish in the rivers of Michigan, and furnished data of importance in the event of the Commission taking up the artificial propagation of this species in the Great Lakes.

Prof. H. B. Ward, of the University of Nebraska, was in charge of the plankton work. He completed the field tests of the efficiency of the large plankton nets. Further work with these nets should be specially directed to the comparative abundance and food relations of plankton organisms. The small minnows which abound in the plankton region and form a link between the plankton and some of the larger fishes should receive attention at the same time. Prof. Ward also continued his study of the vermine parasites of fishes, assisted by Mr. H. W. Graybill.

Dr. Charles Fordyce, of Nebraska Wesleyan University, was engaged in a study of the small crustaceans of the order Cladocera, which are an important element of the fish food of the lakes.

Prof. F. C. Newcombe, of the University of Michigan, was in general charge of the investigations of aquatic flora. Dr. Julia W. Snow, of Rockford College, continued her work on algae. Prof. R. H. Pond, of the Maryland Agricultural College, completed during the fiscal year his study of the nutrition of the larger aquatic plants. During the summer he assisted Prof. Newcombe in his study of the distribution of water plants in relation to soils in Lake Erie.

For several weeks in April and May Prof. Jacob Reighard, of the University of Michigan, was engaged in studying the breeding habits of fresh-water fishes. The forms chiefly studied were the black bass, the brook lamprey, the stone roller, and the horn dace.

During the year Prof. Reighard and Prof. Ward were engaged in discussing and preparing for publication the results of their work in determining the efficiency of plankton nets. At the same time Professor Jennings studied one of the families of rotifers (the *Rattulidæ*), and prepared a monograph of the family.

A bill "to authorize the establishment of a biological station on the Great Lakes under the control of the United States Commission of Fish and Fisheries" was introduced in the Senate on December 17, 1901, and favorably reported back by the committee on fisheries on April 1, 1902. The report of the committee embodied a communication from the Commissioner advocating the passage of the bill. The bill passed the Senate on May 16, but was not acted on by the House.

THE STATUS OF THE CARP IN THE GREAT LAKES.

With the probable exception of the Illinois River, no body of water in the United States appears to be so well-stocked with carp as Lake Erie. There is also an abundance of carp in Lake Huron, Lake St. Clair, and other Great Lakes. In view of the continued disfavor with which this fish is regarded in some quarters on account of its supposed objectionable qualities, the Commission decided to institute a systematic investigation of the species in the Great Lakes, and assigned to the work Mr. Leon J. Cole, of the University of Michigan, who began his inquiries in the latter part of June, 1901, and continued until the last of November. The points to which special attention was

given were the food and feeding of the carp, the relation of the carp to other fishes, the relation of the carp to wild fowl, and the food and market value of the carp. Much information of interest and importance was obtained, but it will require another full season's inquiries in order to render the investigation approximately complete.

The carp investigation was begun in Lake St. Clair, where Mr. Cole went to investigate some statements of a fisherman which were published in the Port Huron (Mich.) *Times* of April 16, 1901. These assertions were to the effect that "the carp eats the spawn and destroys the perch, bass, and other good fish of these waters"; that "the supply (of these fish) is already much reduced," and that "in three years more there will be no fish except carp left in the lake." At New Baltimore and other places on the lake Mr. Cole found the same sentiments prevailing in regard to the carp as those expressed in the newspaper article referred to. Inquiry among the fishermen, mostly city sportsmen, showed that certain stock charges were made against the carp, and it was not usually claimed that these charges were based on direct knowledge or observation.

The sentiment against this fish in this region was due largely to a belief (1) that the carp thrashes about and stirs up the mud, so that the breeding-grounds of other fish are spoiled; (2) that the carp roots up the vegetation, destroying the wild rice, etc., and thus ruining good duck-shooting grounds; (3) that the carp eats the spawn of other fish; (4) that the carp eats the young of other fish; (5) that the carp is of no value as a food-fish; (6) that the carp is of no value as a game fish.

The fact that black bass and other fish were nesting at this time afforded opportunity to make observations on several of these points. In a small bay where carp were commonly found in the shallow water among the weeds and grasses, there were a number of bass nests. At no time was a carp seen among the bass nests, which were some distance apart and hence covered a considerable area. A fyke net was set with a view to intercept any carp that might cross the tract covered by the bass nests, but with negative results. On several nests young bass were later noticed, and Mr. Cole thinks it probable that more would have hatched if the parent fish had not been speared (in violation of law) or caught with hook and line (in conformity with law), thus leaving the eggs exposed to any fish that might come along. Nests of some of the sun-fishes were found close inshore where carp were common, and these nests contained eggs; when the parent fish were frightened way, it was noticed that swarms of minnows, which seemed to be waiting this opportunity, rushed in and began to devour the eggs.

The observations showed that the carp makes the water very roily where it splashes about and evidently tears up more or less vegetation, but there was no evidence that the flags often found floating were not torn loose by muskrats or other animals.

Considerable time was spent at Port Clinton, Ohio, as this is the principal market for carp on the lakes. The wholesale dealers here rendered every possible assistance to Mr. Cole, including all the carp needed for examination and a room in which to work. Many carp were here examined with reference to their food, and the study of various related subjects was made possible by the abundance of material. During the course of the season all important points between Buffalo and Detroit were visited, and the fishermen and dealers in each place were interviewed. Among the data thus obtained was a statement from each wholesale dealer of the quantity of carp received from Lake Erie fishermen in 1900, this representing the approximate catch of carp in the lake. The figures as tabulated give 4,595,000 pounds as the carp product in 1900, an increase of 964,000 pounds over the previous year; of this quantity about 4,069,000 pounds were landed at Monroe, Toledo, Port Clinton, and Sandusky.

Carp ponds at Monroe, near Sandusky, at Port Clinton, and on Catawba Island were visited and information regarding the feeding, etc., of carp was obtained.

In the fall of 1901 the inquiries were addressed particularly to the relation of the carp to the white-fish during the spawning season of the latter, and were conducted at the Bass Islands and Port Clinton. As a basis for the investigation, the following assertions of the fishermen of North Bass Island were taken: Carp are abundant about the Bass Islands when the white-fish are spawning; carp eat the spawn of other fish, especially white-fish; white-fish spawn has been taken from a carp's stomach; when carp are numerous on a reef, the white-fish are not there, being driven away by the carp.

At Port Clinton Mr. Cole made trips to the fishing-grounds with the fishermen and also examined the carp landed by the fishermen; and at North Bass Island examined carp brought in by fishermen using white-fish gill nets on the reefs. He reports that very few carp were caught on the white-fish grounds, and that the result of their examination was entirely negative as to any damage done by carp to white-fish. The evidence indicates that the number of carp on the white-fish spawning-grounds in fall is very small, and the carp which are there have not been found to contain white-fish spawn. The eggs of the white-fish, not being adhesive to any great degree, probably become widely scattered over the rocky reefs; and unless the carp were present in large numbers, the relative number of eggs destroyed would be small. There is no direct evidence as to the destruction of white-fish fry by carp, except that during the entire course of this investigation no young white-fish or any other kind of fish were found in carps' stomachs. Considering the shape of the carp's mouth, the lack of teeth, and other anatomical peculiarities, it seems very doubtful that the fish-eating charge against the carp could be very serious.

FISHES OF CHAUTAUQUA LAKE, NEW YORK.

In September, 1901, this lake was visited by Prof. B. W. Evermann for the purpose of determining its general biological features and the variety and abundance of its fish fauna. A report[a] on this inquiry gives an annotated list of 31 species of fishes known from the lake. Although this lake is only 8 miles from Lake Erie, it is in the Ohio River drainage basin, and its fish life partakes of the character of the latter. Among the important species are bullhead (*Ameiurus nebulosus*), rock bass, blue sun-fish, large and small mouthed black bass, and muskallunge. The last named is the leading fish, from the standpoint of both angler and commercial fishermen. Although extensively caught, its abundance appears to be maintained from year to year as a result of limited protection and artificial propagation by the State authorities. It appears from this investigation that the Chautauqua Lake muskallunge is not identical with the muskallunge of the Great Lakes (*Esox nobilior*), as has generally been held, but is a distinct species (*Esox ohiensis*) peculiar to the Ohio basin. The two gars or bill-fish (*Lepisosteus osseus* and *L. platostomus*), worthless as food and very destructive to other fish, were systematically destroyed by the State Fish Commission for several years and their numbers much reduced.

FRESH-WATER FISHES OF LONG ISLAND, NEW YORK.

During September and October, 1901, Dr. Tarleton H. Bean collected and studied the fishes of Long Island, New York, in the interests of the Commission, with headquarters on Great South Bay. Particular attention was given to the fresh-water species, which, while few in number, are of considerable interest.

The peculiar topographical features of Long Island are responsible for the scarcity of fresh-water fishes. The total number of such fishes known to occur in the streams and lakes is 27. One of these—a hybrid trout—has been artificially produced; another, the black-nosed dace, is of doubtful occurrence, and 13 others have recently been introduced. The permanent residents in fresh water, as determined by Dr. Bean, are horned pout, chub sucker, chain pickerel, killifish, pirate perch, silverside, sun-fish, yellow perch, and darter, all of which could easily have been introduced by man within the last century or two.

Mitchill, in his Report on the Fishes of New York (1814), mentions only the yellow perch, brook trout, and pickerel as occurring on Long Island. Mitchill, in 1790, transplanted yellow perch from Ronkonkoma Pond to Success Pond, Queens County, a distance of 40 miles.

FISHES OF LAKE MASHIPACONG, NEW JERSEY.

Lake Mashipacong lies in the New Jersey mountains about 10 miles south of Port Jervis, N. Y., and covers approximately 100 acres. In

[a] Notes on the Fishes and Mollusks of Lake Chautauqua, New York. Report U. S. Fish Commission for 1901.

October, 1901, Prof. B. W. Evermann made an examination of the lake with reference to its fish fauna. The maximum depth, as determined by numerous soundings, was 14.5 feet. Although fish food is abundant, the larger fishes are limited in both species and individuals.

The following fishes were found to inhabit the lake: Common bullhead (*Ameiurus nebulosus*), white sucker (*Catostomus commersonii*), chub sucker (*Erimyzon sucetta*), roach (*Abramis crysoleucas*), eel (*Anguilla chrysypa*), banded pickerel (*Esox americanus*), common eastern pickerel (*Esox reticulatus*), and blue-gill sun-fish (*Lepomis pallidus*). A few large-mouthed black bass were recently planted in the lake, and the conditions seem favorable for their rapid increase.

FRESH-WATER FISHES OF MAINE.

In accordance with a request from the Debsconeag Fish and Game Club that the waters composing the fishing privilege of the club be examined to ascertain why trout attain only a small size and if the lakes were suitable for the introduction of trout and landlocked salmon, Dr. W. C. Kendall devoted the month of August to the study of these waters.

Debsconeag lakes are a chain of five or six small lakes, which from the westward debouch into the West Branch of the Penobscot not far from Debsconeag Falls and about 20 miles from Norcross. Other waters not connected with this chain of lakes, but comprised within the Debsconeag privilege, are Hurd Pond and tributaries and Rainbow Lake, besides a number of smaller ponds and streams. These waters are not exclusively controlled by the club, being public waters, but the club has camp privileges on all of them within certain townships. The water area was found to be so extensive that only superficial examination of all of them could be made, so most of the time was devoted to First Debsconeag Lake and Hurd Pond.

Brook trout are apparently uncommon in Debsconeag lakes and Hurd Pond, but very abundant, though of small size, in Rainbow Lake; in some of the small ponds they occur in fair numbers. Togue (*Cristivomer namaycush*) are doubtless common; some of large size have been caught, but only small ones of 2 or 3 pounds were obtained during the month of August, and these only in Hurd Pond. There seems to be a scarcity of species of the minnow tribe in some of these lakes, and the fish faunas of the several bodies of water seem to differ somewhat in character; for instance, the chub (*Semotilus corporalis*), common in the Debsconeag lakes, was not found in Hurd Pond, but there its place is taken by the brook chub (*Semotilus atromaculatus*), which, so far as ascertained, did not occur in the Debsconeag waters. If the conditions prevailing in August obtain throughout the year, the scarcity and smallness of trout is probably due to paucity of food.

In order to obtain important information regarding small salmon occurring in the East Branch of the Penobscot, mention of which was

made in last year's report, Dr. Kendall visited Matagamon Lake, and the East Branch was examined from the dam at the foot of the lake to Stair Falls. The small salmon were found common in the pool below the dam and at Stair Falls. Specimens were obtained by fishing with very small artificial flies, but none over 9 inches long was found. All but one of these fish were males in well-advanced breeding condition, the exception being a female with distinct eggs, but which would not have matured before another fall.

From here opportunity was taken to visit more northern Maine waters to obtain much-needed information regarding the character and distribution of the fish life of this region. Accordingly, a canoe voyage was made from Matagamon via Matagamonsis, Webster, Telos, and Chamberlain lakes to the Allagash River, thence down the stream through numerous lakes to the St. John, and from the St. John a trip was made up the St. Francis to a few miles above Beau Lake and return, thence down the St. John to Fort Kent. It was the intention to haul from here to Cross Lake, thence proceed by canoe down the Eagle lakes or east branch waters of Fish River, up Fish River to Portage Lake, and thence haul to Ashland; but owing to the uncertainty of getting through the proposed route on time, it was decided to bring the explorations to a close after making some collections in Cross Lake. Very interesting collections were made in all the lakes en route, as well as in some tributary waters, and much valuable knowledge was gained.

Some interesting facts regarding the geographical distribution of the Maine fishes were developed. The recorded range of some species was extended into the State, and others already recorded from Maine waters were found in new localities.

At least four species of fishes apparently new to science were obtained, the most interesting and important being a white-fish (*Coregonus*). Two species of white-fish were already known to occur in the State, the round white-fish (*Coregonus quadrilateralis*) and the "attahawmeg" (*C. labradoricus*). The latter is the best known and reaches the largest size. The only locality in Maine from which the round white-fish has hitherto been recorded is Clearwater Pond, at Industry. It was ascertained to be very common in northern Maine.

The little stickleback (*Gasterosteus atkinsii*), for many years known only from a few specimens from Grand Lake Stream, was found to be widely distributed over northern Maine and is not so insignificant as from its size it at first might appear. In the fall it was found to constitute the principal food of the lake trout, or "togue," sometimes to the exclusion of everything else. Many togue were caught gorged with these little fish. *Couesius plumbeus*, until recently not known from Maine waters, was found to be one of the commonest minnows. In the lakes it seems to be a deep-water form, seldom approaching the shore except at night and in breeding season, when it enters streams

and shallow water to spawn. This habit and the abundance of the fish would indicate that it must be an important food for larger fishes.

Coherent reports and descriptions of a red forked-tailed trout in some of the waters of St. Francis River suggests the possibility of another char occurring in these waters.

BIOLOGY OF THE SACRAMENTO SALMON.

On the conclusion of the sea-lion investigation elsewhere alluded to, Mr. Cloudsley Rutter resumed the study of the quinnat salmon in the Sacramento basin, on which he had been engaged for a number of years.

The work began September 1 at Black Diamond, California, where by weighing and measuring many specimens of salmon recently from the sea a standard weight was established for fishes at the mouth of the river. Then 150 specimens were weighed, branded with serial numbers, and released, in the expectation that some of them would be taken again at the hatcheries and light thus be thrown on their rate of travel upstream and their loss of weight during migration. Three of the marked fish were subsequently recaptured.

During October two trips were made down the Sacramento River in a skiff for the purpose of charting the spawning-beds and noting the dates at which the beds were successively occupied. November was spent at the Mill Creek hatchery near Tehama, the principal work being the weighing and measuring of salmon in various conditions for comparison with those examined at the mouth of the river.

The run of quinnat salmon in Papermill Creek, Marin County, was investigated, as the species had never been known in that stream prior to the planting of fry there in 1897 and 1898.

The preparation of a general report on the salmon investigations and the study of material with a view to a report on the embryology of the quinnat occupied Mr. Rutter's time during the remainder of the year.

The habits of the Pacific salmons are vitally different from those of the Atlantic species, and as these have an important relation to natural reproduction, artificial propagation, and commercial fishing, the Commission deemed it desirable that the species be subjected to a careful physiological investigation. While the Atlantic salmon, *Salmo salar*, has been studied from the standpoint of physiology,* the Pacific salmons have up to this time been neglected in this respect. The Commission therefore engaged the services of Prof. Charles W. Greene, of the University of Missouri, who has devoted much attention to comparative physiology. Professor Greene began his field work early in July and continued until September, examining the salmon before they entered the rivers and after they reached their spawning-grounds,

*See Investigations on the Life History of the Salmon in Fresh Water, by D. Noel Paton, M. D. Special Report of 1898, Fishery Board for Scotland.

and at intermediate points in the Sacramento basin. Most of the time was spent at Baird hatchery, where there was an abundance of material and where the superintendent, Mr. Lambson, and the foreman, Mr. Wallich, rendered valuable assistance.

INTRODUCED FISHES IN UTAH AND IDAHO LAKES.

Continued public interest in the planting of the Great Lakes white-fish (*Coregonus clupeiformis*) in Bear Lake (Idaho and Utah), Coeur d'Alene Lake (Idaho), and Pend d'Oreille Lake (Idaho), induced the Commission to make another effort to determine the results of the plants of fry in these waters a number of years ago. Accordingly, in July, 1901, a party, consisting of Mr. S. P. Wires, superintendent of the Duluth (Minnesota) hatchery; Mr. S. L. Pritchard, of the Washington office, and Mr. Dwight E. Miller, was dispatched to these lakes with an equipment of gill nets of various sizes, seines, and other appliances. Fishing was carried on in Bear Lake (and Mud Lake connected therewith) at ten different points and during six days; in Lake Coeur d'Alene at thirteen different points and during eight days; in Pend d'Oreille Lake at nine different localities and during six days. No introduced white-fish were discovered, and no evidence of the existence of this species in any of the lakes was obtained, although three other species of introduced fishes were found.

The water of Bear Lake is reported to be very hard, unfit for domestic use, and possibly unsuited to the white-fish of the Great Lakes, although Williamson's white-fish (*Coregonus williamsoni*) is found in it. During the first week in August the surface temperature of the water in the vicinity of Fish Haven was found to be from 69° to 71°. The minimum bottom temperature determined was 50°, at a depth of 105 feet; fishing, however, was carried on in water 175 feet deep, but no temperature data were obtained therefor. Suckers (*Catostomus macrocheilus*) and chubs (*Leuciscus lineatus*) abound and are the characteristic fishes of the lake; black-spotted trout (*Salmo clarkii*) also occur. Mud Lake is reported to be little more than a marsh during July and August, although it contains some black bass, carp, and a few black-spotted trout.

The water of lakes Coeur d'Alene and Pend d'Oreille is deep and cold, resembling in every respect that of the Great Lakes; and it would seem that the white-fish whose introduction has been attempted should do well in both of them. Besides Williamson's white-fish, many fine specimens of bull trout (*Salvelinus parkei*) 11 to 12 inches long and of the black-spotted trout were found in both these lakes, and suckers (*Catostomus macrocheilus* and *C. catostomus*) are abundant. The introduced species, large-mouth black bass and yellow perch, seem to have become well established in Lake Coeur d'Alene; examples of the latter 10½ inches long were obtained.

MARINE BIOLOGICAL LABORATORIES.

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

During the season of 1901–2 the work at the Woods Hole laboratory was under the direction of Dr. Hugh M. Smith, assistant in charge of division. Dr. H. C. Bumpus, who had been in charge of the laboratory for a number of years, was unable to continue his relations with the Commission owing to other duties.

The usual facilities for research and collecting existed, and the rare opportunity for marine biological work here afforded was appreciated by the representatives of many institutions of learning. Two large fish-traps operated for the laboratory in Vineyard Sound and Buzzards Bay furnished much useful material. The steamer *Fish Hawk* and the schooner *Grampus* were temporarily attached to the station during the entire summer, and the steam yacht *Phalarope* and the steam launches *Blue Wing*, *Cygnet*, and *Merganser* were in constant service. The director had the efficient assistance of Prof. R. W. Tower, Mr. George H. Sherwood, and Mr. Vinal N. Edwards.

Among the biologists who occupied tables, the following carried on special investigations in behalf of the Commission:

Dr. Gary N. Calkins, of Columbia University, studied the marine protozoa found in the vicinity of the station. This group of animals has been neglected by systematists in the United States. The protozoa are numerous, and are important as being the ultimate animals on which the higher animals are dependent for food. Dr. Calkins found the water in the immediate vicinity of the station to contain many species and individuals, including a number of species not previously described. His report, published in the Fish Commission Bulletin for 1901, is an important contribution from one who is a leading authority on the subject.

Dr. George H. Parker, of Harvard University, studied and reported on the effects of light, temperature, gravity, currents, and other natural agencies on the movements of copepods. These minute crustaceans are found throughout the year in varying abundance, and constitute one of the most important foods of young and small fishes, young lobsters, and other animals. Dr. Parker's observations and experiments were directed to the determination of the physical factors controlling the appearance and disappearance of copepods in a given region at different times, and his conclusions bear on the movements and abundance of the food-fishes whose immediate or ultimate pabulum the copepods are. His paper is published in the Fish Commission Bulletin for 1901.

Prof R. W. Tower, of Brown University, conducted a number of chemical and physiological investigations addressed to the food-fishes of the region. An inquiry regarding the organic constituents of the scales of fish and their use in the manufacture of gelatin was conducted

jointly by Professor Tower and Mr. E. H. Green, and a special report thereon was published in the 1901 Bulletin. Numerous gallstones were found in several of the squeteague caught in the pound nets, and the determination of the chemical constituents of the calculi formed the subject of a paper by Professor Tower and Mr. A. K. Krause, forming a part of the 1901 Bulletin, which is an important contribution to the diseases of wild fishes. A related subject which received attention was the bile pigments and bile acids of squeteague, blue-fish, and bonito.

In the course of a general study of noises produced by fishes, some important physiological observations were made on the "drumming" of the squeteague. The drumming of the drum-fishes (*Sciænidæ*), of which the squeteague is the most prominent representative at Woods Hole, has been variously explained by different writers; and in the case of the squeteague, at least, it would appear that no accurate account of the factors producing the characteristic sound has heretofore been given.

Professor Tower's observations and experiments have developed the following facts:

1. There is in the squeteague a special drumming muscle, lying between the abdominal muscles and the peritoneum, and extending the entire length of the abdomen on either side of the median line.

2. The muscle fibers are very short, and run at right angles to the long axis of the muscle.

3. The muscle is in close relation with the large swim-bladder, and by its rapid contractions produces a drumming sound, with the aid of the tense bladder which acts as a sounding-board.

4. This muscle exists only in the males, and only the males are able to drum.

In continuation of the plan of issuing from time to time systematic reports on the various groups of water animals in the Woods Hole region, studies of the following groups were carried on during the year: The crabs, by Dr. Robert P. Bigelow, of the Massachusetts Institute of Technology; the jelly-fishes and sea-anemones, by Prof. Charles W. Hargitt, of Syracuse University; the parasitic copepods of fishes, by Mr. M. T. Thompson, of Brown University, and Mr. C. B. Wilson, of the Westfield (Massachusetts) State Normal School; the isopods, by Miss Harriet Richardson, of Columbian University (Washington, D. C.); the amphipods, by Prof. S. J. Holmes, of the University of Michigan

Following is a list of those in attendance at the laboratory, arranged under the institutions with which they were connected:

U. S. Department of Agriculture: W. T. Swingle, Ph D.; Dr. Geo. T. Moore; Karl Kellerman, B. S.

Brown University. R. W. Tower, A. M.; L. W. Williams, Ph. D.; George H. Sherwood, A. M.; M. T. Thompson, A M.; A. K Krause, A. B.

Bryn Mawr College: T H. Morgan, Ph. D.

Columbia University Gary N. Calkins, Ph D.

Harvard University: George S. Amsden, A. B.; Henry B. Bigelow, A. B.; J. H. Converse; Julius M. Johnson, A. B.; Clarence H. Lander, B. S.; F. T. Lewis, M. D.; James H. McMurray; Thomas Ordway, A. B.; George H. Parker; H. W. Rand, Ph. D.; M. E. Stickney, A. M.; R. M. Strong. Ph. D.; William A. Willard, A. M.; Robert M. Yerkes, A. M.

Indiana University: W. J. Moenkhaus, Ph. D.

Johns Hopkins University: Caswell Grave, Ph. D.; Henry F. Perkins, A. B.

Massachusetts Institute of Technology: Robert P. Bigelow, Ph. D.; Erik H. Green, A. M.

College of City of New York: Francis B. Sumner, Ph. D.

Princeton University: Ulric Dahlgren, Ph. D.; C. F. Silvester.

Syracuse University: Charles W. Hargitt, Ph. D.

Yale University: W. G. Van Name, Ph. D.

Miscellaneous: John Barlow, A. M., Fairmont College, Wichita, Kans.; E. W. Barnes, Tabor College, Iowa; W. B. Bell, University of Iowa; W. A. Denny, A. M., Anderson (Ind.) High School; Otto Folin, Ph. D., McLean Hospital, Waverly, Mass.; Henry R. Linville, Ph. D., De Witt Clinton High School, New York City; Porter E. Sargent, A. M., Browne & Nichols School, Cambridge, Mass.

BEAUFORT, NORTH CAROLINA (H. V. WILSON, DIRECTOR).

The Fish Commission laboratory at this place was in operation at the beginning of the fiscal year and remained open until September 25, the same temporary quarters being occupied as in previous years. Prof. H. V. Wilson, of the University of North Carolina, continued in charge. A dwelling-house near the laboratory was rented for a dormitory and mess-house. The launch *Petrel* was attached to the station during the season and was in constant use. About 20 persons availed themselves of the privilege of working at the laboratory; these, with the institutions with which they were connected, were as follows:

Johns Hopkins University: Prof. W. K. Brooks, Dr. Caswell Grave, Messrs. R. P. Cowles, D. H. Tennent, O. C. Glaser, R. E. Coker, and J. A. E. Eyster.

Columbia University: Prof. E. B. Wilson, Messrs. H. B. and J. C. Torrey.

University of North Carolina: Prof. H. V. Wilson and Mr. C. A. Shore.

University of Missouri: Prof. George Lefevre and Dr. W. C. Curtis.

Washington and Jefferson College: Prof. Edwin Linton and Mr. C. W. Stone.

University of Alabama: Dr. J. Y. Graham.

Bryn Mawr College: Prof. T. H. Morgan.

Dartmouth College: Dr. J. H. Gerould.

Professor Brooks studied the eggs of the oyster and preserved material for further work on the same. Prof. E. B. Wilson was engaged in experimental studies of the living eggs of the sea-urchin, *Toxopneustes*, and Professor Morgan worked on the eggs and larvæ of the same species in connection with his researches on regeneration. Professor Linton began a systematic examination of the food-fishes of the Beaufort region with reference to their parasites. Professor Graham studied a trematode worm which is parasitic in the oyster.

Dr. Grave, assisted by Mr. Glaser, continued the work on the biology of the North Carolina oyster and conducted experiments with a view to develop a method by which oyster-farming may be successfully carried on in the North Carolina sounds, where, on account of the peculiarity of the bottom in many places, the ordinary methods of planting are inapplicable.

Mr. Coker investigated a barnacle (*Dichelaspis*) parasitic on the gills of the common edible crab. From a report submitted by Mr. Coker it appears that this parasite affects over 50 per cent of the male crabs and about 90 per cent of the females; that it is not found in young crabs, being thrown off by the frequent molting; that crabs whose gills are heavily burdened with the parasite have less vitality, are sluggish in their movements, and are the first to die in captivity. While the usual number of barnacles found in one crab is from 2 or 3 to 8 or 10, in some the gills are filled to overflowing and may contain 500 to 1,000 of the parasites.

The new laboratory buildings on Pivers Island were nearly completed by the end of the year, and on May 26 it was practicable to throw the laboratory proper open to investigators. Prof. H. V. Wilson, the director, having gone abroad, Dr. Caswell Grave, of Johns Hopkins University, was appointed to the position. The operations of the laboratory during the last few weeks of the fiscal year 1902 will be referred to in the report for the next year.

WORK IN FISH PATHOLOGY.

The occurrence of serious disease among fishes at the hatcheries of the Commission and elsewhere has required the almost constant attention of Mr. M. C. Marsh, the assistant assigned to this subject, and has shown the wisdom of making special provision for the study of this increasingly important branch.

A part of the summer and fall was spent by Mr. Marsh at the Northville (Michigan) station of the Commission in considering the disease affecting the brook trout. A bacterial organism was isolated from the dying fish and the disease was reproduced in healthy trout by inoculation. On the recommendation of this division, two ponds were constructed entirely of concrete and cement for the purpose of excluding disease-producing bacteria, and the ponds were stocked with healthy trout from the Au Sable River and from a private trout farm at Osceola, Wis. Mr. Marsh visited this farm to inspect the fry and yearling fish prior to securing a supply for Northville. The large spring pond constituting the main water supply was drawn down, cleaned, and thoroughly disinfected with chlorinated lime. Pathological material and cultures were brought to the Washington laboratory, and a study of the the offending organism was taken up. This germ can not be identified with any hitherto-known species, and a full description of its form and behavior is substantially completed.

At the meeting of the American Fisheries Society, held at Milwaukee, Wis., in July, Mr. Marsh brought the brook-trout disease to the attention of the assembled fish-culturists.

An investigation of the mortality among brook trout at the Paris station of the Michigan Fish Commission disclosed the same disease as at Northville, but in a milder form. Mr. Marsh visited by request

the hatchery of the Pere Marquette Club at Wingleton, Mich., where brook trout were found to be slowly dying of the Northville disease, and some suggestions for the amelioration of the conditions were made.

The existence of fungous disease among fishes in the Government aquaria at the Pan-American Exposition, as noted in the report for last year, continued during the summer and required attention. Experiments with potassium permanganate and formalin confirmed the previously expressed opinion that they had no advantages over common salt as a remedy for this troublesome disease.

In March a visit of about one week was made to the Charleston Exposition to look into some cases of mortality among aquarium fishes. No serious losses were occurring, and some previous trouble was probably due to polluted water from the lagoon from which the water supply was drawn. The brook trout were slowly dying and these were infected with the Northville organism, which makes an interesting addition to the recorded distribution of this species. Local fishes taken for the exposition were not in the best condition and this accounts partly for the aquarium losses. Both salt and fresh water supplies were rather peculiar and not of the best for aquarium purposes, the river water being subject to contamination from phosphate works and the fresh artesian water containing considerable soda, like all of the artesian water of the region.

MISCELLANEOUS LABORATORY WORK, REPORTS, ETC.

FISHES FROM THE PHILIPPINE ISLANDS.

The Commission received through the Surgeon-General of the Army specimens of fishes and fish cakes from medical officers in the Philippine Islands. The fish were from Lake Buhi, in southern Luzon, and represented five or six species, several of which were previously unknown. The most interesting and important of these was an exceedingly diminutive form, caught in large numbers by the natives and used for food. In forwarding specimens of these fish, Dr. George A. Zeller wrote as follows from the military hospital at Buhi:

I inclose herewith samples of a strange article of diet greatly relished by the Bicols, among whom I have been stationed for the past eighteen months. Rice and fish are the staple articles of diet for most Filipinos and in the provinces of the Camarines there is little variation from these two. Fishes of every size and many varieties are prepared in every conceivable form, but the samples inclosed are unique in that they are found here and nowhere else. * * * Many varieties of fish abound in the lake, but by far the most numerous are these minute specimens. They are called in the native Bicol tongue *sinarapan*, and when dried in the sun on a leaf are called *badi*. They are caught by a large sheet of close web, which is dipped under wherever a school congregates. They are put into tightly woven baskets from which the water soon drains, leaving a compact mass of fish. They are not minnows or immature fish. The natives buy them eagerly; and when the little fleet of fishermen return from their morning's quest and place their baskets upon the ground on the market place, they are instantly surrounded by a crowd of waiting children, who, armed with every sort of dish, are anxious to take home the family

meal. They bring three or four potatoes, tubers, a handful or two of rice, or a few copper pennies, and in exchange receive about a pint of fish. In the kitchen the fish are made up with peppers or other spiced herbs, and they do not taste bad. The soldiers have become quite fond of this food, and liberally patronize the little native restaurants where it is served.

This fish proved to be of an undescribed genus and species, and its diagnostic features were given in an article in Science (January 3, 1902), where the name *Mistichthys luzonensis* was applied to it. The maximum length of the species is only 0.6 inch and the average slightly over 0.5 inch. It is the smallest known fish and probably the smallest known vertebrate.

Through the courtesy of the Surgeon-General of the Army, the Commission was enabled to place three collecting outfits in the hands of medical officers located in various parts of the archipelago, and it is expected that additional specimens of interest will thus be obtained.

SHAD OF THE OHIO RIVER.

Prof. B. W. Evermann concluded his study of the shad of the Ohio River, referred to in the annual report for 1898, and submitted a paper thereon which was published in May, 1902. Publication of this article was delayed in the hope that opportunity might be afforded for obtaining further information on this fish, especially its migration from the Gulf of Mexico up the Mississippi and its tributaries.

This shad proves to be an indigenous species, and is not, as some have supposed, the transplanted shad from the Atlantic coast. It has appropriately been named *Alosa ohiensis*. It is an excellent food-fish, probably not inferior to the common shad, but is not highly regarded by the people of the Mississippi basin, the price received by fishermen being only 2 cents a pound. Its abundance and distribution are not yet known, and the annual catch is quite small and localized.

FISHERIES OF THE GREAT LAKES, ST. LAWRENCE RIVER, AND LAKE CHAMPLAIN.

The extensive collections of fishes from these waters obtained by the Commission during a series of years have been reported on by Prof. Barton W. Evermann and Dr. W. C. Kendall, in four annotated lists published in March and April, 1902. The number of species and subspecies known from the Great Lakes and their tributary waters is 152, of which 27 are peculiar to Great Lakes basin. From Lake Ontario 73 species are recorded, and from the St. Lawrence River 71. The fish fauna of Lake Champlain includes 54 species.

SILVERSIDES OF THE EAST COAST.

The silversides are among the most abundant of the small fishes inhabiting the salt, brackish, and fresh waters of the Eastern and Southern States. Their maximum length is but little over 6 inches, and most of them are hardly half so large; they are, therefore, only sparingly eaten by man, but they constitute one of the most important

foods for many of the best food-fishes of the coast. Extensive collections of the Fish Commission, supplemented by material in the National Museum, were studied by Dr. W. C. Kendall, and a report[a] thereon was issued in April, 1902. In this paper the abundance, uses, habits, food, etc., of the silversides are considered, and a detailed description, with figure, of each species is given.

FISHES OF MEXICO.

Recent collections of fishes from various parts of Mexico, obtained by the Division of Biological Survey of the U. S. Department of Agriculture, have been referred to this Commission for identification, and have been reported on by Messrs. B. W. Evermann and E. L. Goldsborough in a paper issued May 3, 1902. These collections, supplemented by several smaller ones from various sources, comprised 56 species, of which 5 were previously undescribed.

FISHES OF LABRADOR.

At the request of Prof. Leslie A. Lee, of Bowdoin College, Maine, Dr. W. C. Kendall identified and reported on a small collection of fishes obtained on the Labrador expedition of that college in 1901. The report will form one of a series of articles on the natural history collections of that expedition. Professor Lee donated to the Commission specimens of all the desirable duplicates.

[a] Notes on the Silversides of the genus Menidia of the East Coast of the United States, with descriptions of two new subspecies.