TRANSACTIONS

of the

American Fisheries Society

"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

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CONTENTS

NOTES ON THE NEW KANSAS FISH HATCHERY AND THE FIRST YEAR'S OUTPUT

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Since submitting our last report to this society, the contracts for the building of the new Kansas Fish Hatchery have been completed, and much other work has been done to complete details of many parts of the work not included in the contracts. Everything promised by the plans and specifications seems to have been developed and worked out in a satisfactory manner. The new Fish Hatchery is now in working order. The first crop of fish raised in 1913 has been distributed and the second crop raised in 1914 is ready for distribution and is being distributed.

THE EMBANKMENTS SODDED.

All the embankments near the waterline of the ponds are now covered with swamp grass sod. The grass from these sods made a good growth during the spring and summer of 1913. The growth this summer (1914) has been most phenomenal. At the present time the banks near the waterline are densely covered with grass that has made a growth of from three to six feet in height this season. This heavy growth of grass mixed with some semi-aquatic plants completely protects the banks against the action of wind and waves. It also protects the shallow water near the shores where the old fish spawn and the young fish feed. We have never seen a better protection, natural or artificial, for earth embankments of fish ponds.

WATER IN THE NEW PONDS.

All the 99 ponds are full of water and the supply has been good all this year. A few of the ponds in the east part of the hatchery suffered some for water during July and August in 1913. However, last year, (1913) was an unusually dry season and the ponds were all new and did not hold water as well as they do this year. It takes some time for artificially scooped out ponds to seal their own bottoms so that they will hold water in good shape. This is especially true of such ponds as those constructed for the State Hatchery where the soil in many places was sandy and the ponds were not puddled.

No fish were lost at the hatchery during the summer and fall of 1913 on account of dry weather and low water. The fish were removed from a few ponds and sorted and placed in other ponds where there was plenty of water. What really bothered the Department was the fact that the water in many of the good streams of the State was so low that we did not think it advisable to place fish in them, and many of the ponds for which fish had been ordered were either dry or the water conditions so bad that we did not think it wise to stock them. This made it necessary to hold fish in the hatchery ponds that would otherwise have been distributed. However, when the water did come in the late fall and spring, the hatchery had the fish to restock the waters of Kansas and, as said in another place, distributed fish in the ponds and streams of 102 of the 105 counties of the State.

PLANT AND ANIMAL LIFE IN THE PONDS.

We have stated before that the new ponds have been stocked with good varieties of water plants. These plants got fairly well started in some ponds last year. This year they have done better and most of the ponds have more or less water plants growing in them. By another year we have reason to believe that all the ponds will have a fairly good supply of suitable water plants.

Fish were placed in the ponds in the spring of 1913. The ponds were new and there was no more food in them than could be found in newly dug cellars, except what was brought in the water through the 21-inch pipe that supplies the hatchery from the Ninnescah River. However, a considerable amount of food was brought in from this source. The water from the river carried various forms of plant and animal life, and this life, in addition to what was placed in the ponds by artificial processes, soon established itself and furnished more or less food for the newly hatched schools of young fish. We noticed that various forms of insects and their larvae and many forms of small worms, mollusks and crustaceans soon appeared in the waters of the new ponds.

FISH IN THE PONDS.

The ponds were lightly stocked in the spring of 1913 with the common varieties of fish such as bass, crappie, bluegill sunfish, bullhead catfish and goldfish, the latter being put in as a food fish for other fish. These fish, their relation to each other and the manner of stocking the ponds are described in the Bulletins issued by the Department. Owing to the fact that the ponds were new and the supply of food scant, not more than from 1/4 to 1/6 as many brood stock fish were placed in them as were placed in the older ponds where the food supply was established and the spawning grounds well known.

THE OUTPUT OF THE NEW PONDS.

The output of the new ponds was good, all things considered. During the fall of 1913 and the spring of 1914, twenty-nine carloads of fish were distributed. Twenty-five of the twenty-nine carloads of fish, about 300,000, were taken from the new hatchery ponds. These twenty-nine carloads of fish, together with about twenty thousand large tadpoles — the kind that develop into large edible bullfrogs—were distributed in 102 of the 105 counties of the State of Kansas. A carload of fish such as we handle usually ranges from 500 to 14,000, depending upon size, age and weather conditions. We distributed many fish that might be called large for distribution. They would range from six to eighteen inches in length and would weigh from three ounces to three pounds each. We believe in the distribution of good sized fish,—for reasons see Bulletins published by the Department.

GENERAL OBSERVATIONS.

It was very noticeable that the ponds that had the best supply of vegetable matter were the ones that produced the most and best fish. Ponds that had but little vegetation, and consequently but little food, furnished but few fish. The fish taken from such ponds, if there were many in them, were small, thin and poor. This was especially true of the crappie. The bass taken from such ponds were sometimes unusually large, but as a rule there were not many of them and dissection showed that they were cannibals or were feeding extensively upon other kinds of fish that might be in the ponds. In fact the young black bass in all these ponds were large for their age. Many of them ranged from five to ten inches in length in October, November and December. One bunch measured and weighed November 2, 1913, averaged in length 7½ inches and in weight 6½ ounces. Most of these young bass were taken from ponds that had been stocked with bluegill sunfish and goldfish as food fishes for the bass. The lengths of some of these young bass, in inches, taken just as they came ran thus: 7.6, 7.7, 8.3, 7.8, 7.2, 7.4, 8, 7.3, 7.8, 6.9, 6.8, 7,6 and the corresponding weights were, in ounces: 6.5, 7, 7, 8, 8, 5.5, 6.5, 8.5, 5, 4.5, 4.5, 6.5.

It was very apparent that the ponds that had unfixed and unsettled banks and whose shores were being cut by the waves, produced but few fish. We are more convinced than ever that it is necessary for ponds to have suitable spawning grounds or they will not yield a good supply of fish. What we call suitable spawning grounds for the common kinds of fish such as we raise are described in our Bulletins on fish culture. An unsuitable spawning ground for the large mouthed black bass, for instance, can be found in a pond where the waves cut the banks and where there is little or no vegetation.

Even if fish are hatched under such conditions they seem to disappear soon. To produce such a fish as the large mouthed black bass, it is necessary to have not only the proper spawning grounds but conditions that produce the proper food for both old and young fish. The young fish when first hatched must have certain forms of animal life, and as they grow, other forms must in turn supply the young fish with food; and the time soon comes when the young fish will devour each other, unless young fish of other varieties can be had to fill their ever hungry and expanding stomachs. From young bass less than one and a half inches long we have taken young crappy, young bluegills, young goldfish and young bass. (A preserved specimen of a bass one inch in length that was caught June 2, 1914, while in the act of swallowing a young goldfish 5/8 of an inch in length, was exhibited.)

REMARKS.

Fish culturists are continually receiving letters from people who want to know how to raise fish. Without assuming to give advice to any one, we would like to drop a long distance hint to such people. First we would refer them to bulletins and other literature published by fish culturists; and, second, we would say, that in our judgment, if one desires to know how to raise fish and become a fish culturist, it is almost necessary to make an all day and all night—in fact, an all year and an all life time study of the subject, and especially of the spawning and food habits of the kind or kinds of fish that one desires to produce.

DISCUSSION.

Mr. Lydell, of Michigan: I desire to ask Professor Dyche if the fish introduced into the pond with the bass were blue-gills and sunfish and whether he keeps any small-mouth bass?

Professor Dyche spoke of fish eating one another. We have found that if our old bass are well fed all the time they do not bother the young bass to any great extent. We endeavor to feed our bass in all the ponds once a day and give them all they will eat, and we raise a great many more fingerling bass in the pond with the old bass than we would in a pond from which the old bass were excluded.

Prof. Dyche: I do not like to put blue-gills in with the bass when spawning. I put in goldfish, hickory shad, or any sucker-mouthed minnow; but I prefer to spawn blue-gills in an adjoining pond and have a screen between that will allow the young bass to go in where the blue-gills are, or the blue-gills where the bass are. The blue-gills are very bad about eating up the young bass, which are the most foolish of fish when they are little and do not know how to take care of themselves at all. After they have attained some size the tables are turned.

We have no small-mouth bass at all.

As to feeding bass, I plan to raise all I want without feeding them artificially at all. I furnish them with abundant food, just the same, by planning ahead and having certain things grow in the ponds for them to feed on.

Mr. Woods, of Missouri: We do not feed our large bass, but rely on other fish and crayfish. We separate our breeders from the young bass as soon as the latter are able to take care of themselves. Our superintendent, Mr. Cochran, who has had thirty-two years' experience, claims to have the most success by that method.

Mr. Fearing, of Rhode Island: For twenty-eight years we have followed the custom of placing the fry in ponds and feeding them. When they are not provided with sufficient food they turn cannibals and the larger ones eat up the smaller. The smaller ones may even attempt to eat the larger. But if they have all the food they want, you can have both large and small trout in the same place and they will leave each other alone.

Professor Dyche: The problem of feeding depends on conditions. I have ponds where hornwort, milfoil and other fine-leaved plants, commonly called "moss," grow to such an extent that they form a solid mass. On these plants are found large numbers of molluscs, crustaceans, insects and larvæ, that furnish food for all kinds of fish to start with, and some of those fish make food for the larger fish. I could not seine one of those ponds to get the large fish without destroying all the plants. So they all live there together, and in October or November I can get, when they do well, from 20,000 to 30,000 bass, from four to six inches long, out of an acre pond, and in addition the old fish are still there and in good condition.

Besides, those young fish must feed out of the way of the older ones and fight for existence. Not only that, but they swim all around the pond and learn to know food when they see it; they know the different kinds of insects, the little goldfish, hickory shad and suckers, and learn to feed on them. When you place such fish in a stream they know how to find food. There are many things to be considered in this business of raising fish to stock ponds and streams, and much that we have learned this year may not be of much use next year because the conditions have changed and each pond or stream will have its own peculiarities.

Mr. Graham, of Massachusetts: You spoke of losing fish in the tanks by the larger ones devouring the smaller ones. Is that because of underfeeding?

Professor Dyche: Yes; I have had a four-pound bass swallow a two-pound bass in a tank while the fish were being moved. I presume it was because they were hungry. Young fish sometimes swallow each other when held in small ponds or tanks a few days before they are shipped.

Mr. Speaks, of Ohio: In some of our ponds which can be seined readily the young fish are taken as soon as they come from the beds and placed in brooding places. In other cases where seining is difficult, we placed a series of wire fences, to enable the young fish to escape from the old ones. The young fish appear to know instinctively that it is necessary for them to keep entirely away from the old ones. Also by feeding the old ones well their appetites are reduced. We use a great deal of prepared food—meal and meat scraps ground together with some preservative which keeps it indefinitely. By these two methods we have for two years succeeded in raising a very satisfactory number of fish.

In our state fishing has become apparently the prevailing pastime. We estimate that we have now in Ohio nearly a million people who are interested in hook and line fishing. We have succeeded in organizing such persons into clubs for the protection of fish in the streams, until now these clubs are common over the state. But we are put to our wits' ends to supply the demands. Last spring I got eighteen carloads from the marsh districts of Lake Erie. We put out a number of carloads of bass weighing from two to four pounds. We got them very early, so we had the benefit of the spawn in the spring. I have found this so successful that in the future I expect to devote a good deal of effort to restocking by this method. We are fortunate in being able to get from the marsh district an almost unlimited number of small-mouth bass, rock bass and blue-gills. We put out eight carloads of blue-gills in March when the streams would receive the benefit of all the spawn. We are making provisions for enlarging our reservoirs and contemplate adding a number of small systems in various parts of the state. It may be better to follow Professor Dyche's plan of concentrating all effort at one point, but from experience in the past three years with little wild ponds I am convinced that under ordinary conditions such numbers of fry can be raised that it seems unnecessary to go into a big scheme of pond propagation.

In one little pond, with an area of less than half an acre, we put last fall, thirty pairs of breeders. I have seen it several times and looked it over recently. We are just beginning to take out the young and it looks as if there were from 50,000 to 100,000 of them. They have had no careful attention of any kind.

We find, as Professor Dyche does, that the young are cannibals from infancy, but it has been our experience, after five years close observation, that when we feed properly this is greatly reduced.

In Lake Erie waters it is interesting to note the difference in habitat of the two species of bass. In Sandusky Bay one can get a carload of small-mouth bass at one haul of the seine. As soon as the water turns cold they all make for the deepest waters. I have been over the bay during the winter season and have seen tons and tons of pickerel and perch caught through the ice, but never a small-mouth bass, where three months later they could be found at every point. In the marsh district we take carload after carload of large-mouth and never see a small-mouth bass. They do not frequent the same waters, yet we are putting them into every stream in the state. It was a common notion a few years ago that small-mouth bass would not live in our ordinary Ohio streams, but we have disproved this by using them to stock the streams, and this year our fishermen had remarkable success with them.

Mr. Titcomb, of Vermont: I wish to ask Mr. Speaks what he uses for food and where he gets it, and to ask also for Mr. Lydell's experience with prepared foods.

Mr. Speaks: It is meat ground with meal and some sort of preservative added so that it will keep. It may be had from any of the Chicago packing houses under the name of "prepared fish food." Our fish appear to relish this food and do well with it.

Mr. Lydell, of Michigan: We use beef liver, beef milt and beef scrap. Last year I fed a lot of young perch on this diet and they were four or five inches long by the latter part of August. They were in a cemented pool and there was nothing else there for them to eat. I tried the same food on bass, but they did not grow satisfactorily on this food exclusively. In the larger ponds where they got a lot of natural food in addition to this, they did very well.

MR. SPEAKS: I wish to inquire as to the experience of the members in placing some carp in bass ponds for food. Last year one of our superintendents stripped two female carp, and in eight days had 400,000 young carp. If food that will suit the bass can be produced in that way it would be a simple matter.

MR. GRAHAM, of Massachusetts: When you once put carp into a pond it is impossible ever to get them out again. If you wish to bring upon your head the condemnation of every fisherman, put the carp in.

MR. SPEAKS: I know from one or two experiences that if bass are introduced into water completely stocked with carp, it will be only a matter of time until the carp disappear. They eat up all the young carp.

PROFESSOR DYCHE: I do not favor carp. They eat up much of the food that the little bass should have and they grow too fast. In the same period a bass will grow to weigh a pound and a carp three pounds. I prefer goldfish for food for bass. Young and small goldfish make excellent food for young bass and larger goldfish are good for the larger bass.

But I do not want you to be misled by what I have said about feeding. I have started out to found a hatchery where I will not have to feed the fish and am working out every idea to make the ponds self-sustaining. I have a great deal of vegetation in the ponds and fish that will consume such matter and convert it into food for other fish. I do not attempt to sort or remove small fish. Twenty thousand of the larger fish eat up eighty thousand smaller ones, and that is all right, as I get rid of the weaker bass that do not grow at a proper rate. I have only 600 bass that I am feeding for a new stock of spawners.

A MEMBER: What is the preservative used in the fish food?

MR. SPEAKS: I do not know. It cannot be injurious because the fish eat it every day and relish it. It is something to prevent the food from becoming rancid.

PRESIDENT WARD: How do they compare in growth with fish fed on other foods?

MR. SPEAKS: We used only this food in one pond last year, and after the pond was frozen over we put lines in and took out bass eight inches long, which is a rather remarkable growth in one season.

THE FEEDING OF TROUT IN RELATION TO THYROID TUMOR

By M. C. MARSH, *State Institute for the Siudy of Malignant Disease, Buffalo, N. Y.*

The enlargement of the thyroid gland in various members of the salmon family is familiar to most of you either from the fish itself or various publications. This enlargement is of the most various degree and produces often a distinct, palpable swelling, or thyroid tumor. It is a disease process whose various stages have been held to include goiter and cancer, though we now consider the whole process as really one disease. A more detailed account is unnecessary here, extended reports having already been made. Some recent observations make it desirable to offer to this society some brief remarks on the relation of food to this growth.

The tumor occurs in both wild and domesticated trout, but is everywhere rare in the former and very common among the latter in this country. It has been supposed that the raw meat foods so largely fed in American hatcheries were an important factor in causing the tumor growth. These foods, consisting of liver, heart, lungs and other organs of various domestic animals, often mixed with mush made from flour, make a diet to which trout are quite unaccustomed in the wild state but upon which domesticated trout have lived for many generations. However unnatural such foods, trout are able to grow, fatten and reproduce by their use. This feeding of mammalian flesh, however it may predispose to and accentuate the disease in hatcheries, is not necessary to the growth of thyroid tumors. This was inferred from their occasional occurrence in wild fish, especially in a whitefish, which is a species whose natural food is plankton. Now there is important additional proof of this. In the aquarium at Naples, Italy, five among a few hundred sea bass dying in the tanks have developed thyroid tumors. They were fed only upon fresh sea fish, mostly herring, and were, of course, themselves held in sea water. These tumors were found by Dr. Paul Vonwiller, a Swiss student, working in Naples. Since hitherto no marine fish in sea water has been known to show a thyroid tumor, and since iodine has a marked remedial influence on such growth in fresh water, this find at Naples is of unusual interest. The sea water contains appreciable iodine, in amounts much greater than those effective in fresh water. Yet the tumors originated and progressed in the presence of this iodine content.

In Germany, trout culture is widely and extensively practiced, but there the thyroid tumor is practically unknown. Fish so affected are perhaps as often found in the natural streams as in trout hatcheries. The Germans have, with respect to feeding, a régime quite different from that which obtains here. In the first place sea fish as a food for trout is largely used. Second grade codfish is cheap, and with other members of the cod family has become almost a staple food among the hatcheries. A small quantity of shrimp is added to the fish by some breeders. In the second place it is almost or quite a universal practice to cook the food that is fed to trout, whether it consists itself of fish, or the organs and offal of animals. Sea fish, no doubt fresh water fish also, used as a food, and the cooking of meat used as food, are both practices having at least a tendency to prevent thyroid disease. When both are combined the rarity of thyroid tumor in German hatcheries ceases to cause surprise. There are very few, if any, hatcheries in Germany where artificial propagation of trout is based on raw meat food. One may plausibly infer that these two practices are wholly or chiefly the cause for the freedom of Germany from thyroid tumor, and we may suppose that raw meat-fed fish would there acquire the tumors as they do here and in other countries, although this is not necessarily true. I have recently heard that feeding tests which should determine this question have been begun during the past summer in Germany near Munich.

Through control of the feeding of trout it is likely that practically all of the enlargement of the thyroid gland which is entitled to be considered a disease can be prevented. It is a matter of a properly balanced ration, and exactly what is effective and at the same time cheap enough and procurable in quantity sufficient to meet fish cultural requirements I think no one is yet in a position to say. It is probable that such a food might contain a considerable proportion of meat (liver, heart or lungs, etc.), but that to this should be added a vegetable food (flour), and a smaller portion of fish. With little doubt such a mixture would then be greatly improved by a necessarily small addition of either shrimp, mussels, maggots or insects, or similar animals. In Germany, for instance, one hatchery uses a food consisting of about one-third shrimp and two-thirds fish. Since the fish cost less than a cent and a half per pound and the shrimp about four cents, this is understandable. But in this country shrimp are regarded as a luxury and not usually as an available fish food. However, you will recall that in a paper before the Fourth International Fishery Congress convened in this city in 1908, Mr. Worth set forth the abundance and availability of the fresh water shrimp (*Palaemonetes*) as a fish food and even proposed its culture for this purpose. I imagine that when this resource is properly exploited it will be found that it can be harvested, or cultivated, or both, in quantities adequate for practical use.

Having thus a rather complex mixture of foodstuffs the whole mess should be cooked or at least heated through to the boiling point. I think the basis or starting point of cooking food for trout in Germany was to kill the parasites so largely harbored by the fishes which constitute the food, and which thus add to the danger of the live trout becoming infested. The German Fisheries Research Station constantly advises the hatcheries to cook the food as a general precaution against fish parasites, since the trout have difficulty enough getting away from the direct attacks of parasites without swallowing them bodily and alive in food. Whether this cooking of the food is further a physiological advantage perhaps does not yet appear.

Now, it has been said that cooking, and the use of fish as food for trout are each to an extent preventives of thyroid tumor. But some recent observations make it seem certain that neither alone is sufficient for this end. One is the occurrence already mentioned, of such tumors, in a small percentage, in the sea bass of the Naples aquarium on a raw fish diet. The other is a practice at a commercial trout farm in Pennsylvania which constitutes a departure in brook trout feeding which should be of much interest to this society aside from any bearing it may have on the present subject. At this hatchery the fry are fed for about two months on beef liver in the usual way. Then a wheat flour mush is added in small and very gradually increasing quantity until by the end of the next four months all the liver is eliminated. After this nothing but cooked flour mush is fed and the trout are so reared to adults. The trout keep in fine condition, resemble wild fish in color and activity and make a surpassing table trout, but they do not grow rapidly. The object of the feeding is to produce a fish resembling the wild trout in edible qualities and without the flavor of liver fed fish. In this success has been achieved and the adults reach a high-priced market. Trout so fed are used as breeders and yield a good quality of eggs which hatch out with excellent results, but it is not claimed that this flour feeding has any advantages from the breeding standpoint. It has been adopted solely to obtain a superior table trout, and this result is achieved at considerable sacrifice of the rate of growth. By universal experience it appears to be demonstrated that rapid growth requires meat or fish feeding.

From other sources, where trials have been made with a purely vegetable food, opinion is for the most part against the practice. Here it is necessary to direct attention to the fact, often demonstrated in fish culture, that the same methods do not work out alike in all hatcheries. Feeding which produces certain results under the conditions at one place will produce quite other results at some other place, where the water supply and other component conditions are different. It may also be said, that in introducing or experimenting with vegetable feeding, to break off abruptly the meat feeding of adult trout is to invite failure. It seems necessary to begin with fry and to make the transition very gradual. Whether fry could be made to thrive upon flour alone from the very beginning of feeding has perhaps not been put to the test and the chances seem against it, but surely some one ought to try it.

However well the feeding of flour serves the purpose for which it was undertaken, neither the nature of this food nor its cooking suffice to prevent the development of thyroid tumors. The yearlings and the two and three year olds exhibited growths typical of the disease both to the naked eye and the microscope. The tumors, however, were very small and the percentage of fish affected low, the progress of the disease being much restricted in comparison with liver or other animal tissue feeding. Since the tumors are so closely associated with liver feeding, one might infer that possibly their origin in flour fed fish is to be referred to those first few months of free life, when they received the usual diet of beef liver paste. But the tumor growth is progressive under the flour feeding, and changes of diet which affect the thyroid do so rather quickly. The adult fish with tumors had been without liver or meat food since their first half year of life. Such an inference is opposed to the results of feeding experiments, and can not plausibly be made.

It remains therefore to be proved just what are the constituents of a balanced ration which will be efficient to entirely prevent that relatively immense overgrowth of the thyroid gland which shows as visible tumors, if indeed there be any such combination of foods. Although thus far among the salmonoids, marine fish as a food has not produced any tumors, it has not been so largely fed as other foods, and since sea bass in captivity under such feeding have developed such tumors, one must be conservative in assuming that fish as food will absolutely protect the trouts. This matter of the balanced ration for trout in fish culture is fundamentally important and rather difficult, as it is in human and animal feeding. It is not more demanded as a preventive of thyroid disease than against fish disease in general, for when the diet is as exactly adapted as possible to the needs of fish, the latter have a better defense against all their diseases and parasites.

Thyroid tumor disease does not impress most trout culturists as a very serious enemy to their operations, and in this they have much justification, for even enormous relative enlargements of the thyroid are yet so small as not to force themselves on the attention. The very large tumors are not common, and it is exceptional when the mortality is high at any stage. The fish culturist does not and need not give himself any particular worry over thyroid disease, though we may assume he would rather not have any of it in his ponds. That a gland should become enlarged to hundreds, perhaps thousands of times its normal size, is, of course, not desirable and indicates something is wrong. One can say in general that the situation can at least be greatly improved by diluting the liver and other mammalian food materials used, with flour and especially with fish, shrimp or any natural food available.

Since a thyroid tumor in a trout is a form of fish cancer, and there has always been some talk of the contagiousness of cancer, it may be well here to insist on making some common sense distinctions. Infectious diseases are those caused by microbes, that is, microorganisms or minute parasites, and most of them may be easily "caught" or passed from person to person. But some of them do not transfer readily from person to person, that is, they are not readily contagious. One can scarcely "catch" them. Now cancer has not even been shown to be an infectious, that is, a parasitic disease. It can only be transferred from one subject to another, and this with some difficulty, by transplanting a piece of the actual cancer, as illustrated in the lower animals; and it has to be into an animal of the same species. While there is the widest difference of opinion concerning the cause or causes of cancer, nobody at all—not even those who think it caused by a parasite—thinks it is contagious, or "catching," after the fashion of our known infectious diseases. It is proper to say that fish cancer is not contagious. Careful experiments show that they do not catch it from each other even by the closest association. Of course, no one need hesitate to catch, handle, buy, sell or eat fish of any kind on account of cancer. Fish are always eaten cooked. I have eaten trout with thyroid tumors, and the results were exactly like those from eating trout without thyroid tumors. They even taste exactly the same. I would eat the tumors themselves and not without hope of finding a new delicacy, were it not that they are too valuable for other purposes.

DISCUSSION.

Mr. Titcomb, of Vermont: Mr. Marsh has covered the subject so fully that there is not much opportunity for discussion, but I wish to ask one or two questions. Is the food the cause of these tumors, or is it in any way related? In what conditions as to other food, space and water were these fish kept that were fed on flour? Could they get any animal life out of the water?

Mr. Marsh: I would not say that the food is the cause of the tumor, it is only the predisposing factor. It enables the real active agent to act more readily and on more fish. The fish were kept in ponds larger than the ordinary ponds used at hatcheries—perhaps half an acre in extent. They were fed no insects, nothing but flour of a low grade, not quite white. It is not whole wheat ground up, but it has a small amount of the hull of the grain.

Mr. Titcomb: Was the flour cooked, and do you think it would be advisable to mix raw flour with liver?

Mr. Marsh: The flour is cooked. I asked the fish culturist about mixing the food, but he thought there would be a mechanical difficulty in giving the mixture the proper consistence to feed the fish.

President Ward: It is probable that the raw flour would be absolutely indigestible.

Mr. Hayford, of New Jersey: The newspapers have given so much publicity to certain scientific articles that our correspondence files show that there has been considerable alarm over the possibility that fish might be cause of human cancer. Consequently it is pleasing to be reassured that there is strong improbability that cancer of human beings can be derived from hatchery-bred trout.

THE USE OF COPPER SULPHATE FOR THE DESTRUCTION OF OBNOXIOUS FISHES IN PONDS AND LAKES

By John W. Titcomb,
State Fish and Game Commissioner for Vermont.

In the early days of the State Fish Commission it was found that black bass multiplied rapidly when introduced into new waters and as a result the Fish Commissioners in the various New England states, and particularly in Vermont, proceeded to introduce black bass in trout ponds and lakes where the trout fishing had become poor. The bass thrived until the trout were all devoured, and then, for lack of sufficient food and range, they were forced to live on each other and in some instances, due to environment, became a stunted race. Perch, pickerel, bullheads and other coarse fishes were introduced either by the Commissioners or by individuals. As a result many cold water ponds and lakes have been ruined for trout and furnish rather poor returns to the angler in the warm water fishes which succeed them.

To illustrate conditions, attention has recently been called to the fact that in one town there are fourteen trout ponds ranging in area from ten to thirty acres, all of which contain perch. The presence of this species renders the waters almost uninhabitable for the trout family, none of which is armed to compete with its spiny rayed enemy.

Fortunately a remedy for these conditions has been discovered which, at comparatively small expense, makes it possible to restore some of the smaller lakes and ponds to their original condition as trout waters.

*The use of copper sulphate for the destruction of algæ in municipal water supplies first led to experiments to ascertain how strong a solution can be used without

*Kellerman, Bul. 76, and Bul. 100, part VII, U. S. Dept. of Agriculture.

destroying fish. Advantage is now being taken of the knowledge thus obtained to see how little copper sulphate can be used to exterminate fish.

The first attempt in Vermont to exterminate the introduced species by the use of copper sulphate was made at Silver Lake in the town of Barnard in October 1913. So far as the writer knows it is the first attempt of its kind anywhere. It would have been more satisfactory to begin with a body of water of less area and shallower, but it happened that the lake was drawn down to an unusually low level this summer, thus reducing its area from about one hundred to sixty-five acres or less and its depth some six or eight feet. At low water level the maximum depth was twenty-five feet. It contained pike, pickerel (*Esox lucius*), pike-perch, yellow perch and horned pouts, all in limited numbers, and afforded rather indifferent fishing.

The copper sulphate was administered by dragging it over the surface in gunny sacks. Two launches and a number of row boats were employed for the purpose. At the first attempt, 2700 pounds of copper sulphate were administered, but this was not sufficient to kill all the fish and at a second attempt 3600 pounds were administered. The copper sulphate precipitates quickly. On each occasion it took about six hours to administer the poison. Dead fish began to rise the evening of the same day. More rose the second day and some on the third day.

It was hoped that all the fish in the pond had been killed, but recent reports indicate that a few pike survived.

This is the beginning of a movement to restore some of the trout waters to their primeval conditions.

With the changes rapidly taking place in the natural conditions of our forest and streams, the trout streams will naturally grow less in number. The ponds and lakes will, if properly conserved, continue to afford recreation and food supply long after many of the streams are dry or are too polluted to permit of fish life. Upon these natural ponds and lakes, then, and upon artificial ponds and lakes must we look more and more for our supply of native food and game fishes.

The copper sulphate precipitates so rapidly that there is little danger of contaminating streams flowing out of lakes while the poison is being administered.

As a result of the experiment at Silver Lake, the Lake Tarleton Club in New Hampshire has undertaken the extermination of pickerel in a forty acre trout pond with a view of restoring it to its primeval conditions.

Laboratory tests indicate that twelve pounds of copper sulphate evenly distributed to one million gallons of water will cause the death of such common fishes as pike-perch, yellow perch, and pickerel (*Esox reticulatus*). These are the species most commonly found in the trout ponds of New England, but many such waters are ruined for trout by the presence of black bass.

If the water contains an abnormal amount of lime a larger proportion of copper sulphate must be used. As it is impossible to know all of the subaqueous conditions, variations of depth, spring holes in the bottom of the ponds, etc., twenty to thirty pounds of copper sulphate per million gallons is a safer solution to use, as the success of the work depends upon the extermination of every pair of fish of the species it is desired to kill. With present knowledge it is impossible to tell what solution is necessary to exterminate black bass, but it must be much stronger than the one above referred to. No laboratory tests have been made with the pike, pickerel (*Esox lucius*), but from the results at Silver Lake where thirty pounds of copper sulphate were used to 100 million gallons, it is evident that this species is in the class with the black bass. There is no definite information as to the resistant qualities of the rock bass which also infests many waters in the northern states which were once trout waters and which, but for the presence of some of these fishes, would still be trout waters.

To persons undertaking to destroy fish in a pond or lake the following suggestions are offered:

First ascertain the volume of water. This, of course, necessitates ascertaining the area and average depth. In sounding for depth it would be well to mark with buoys the deepest places. Note, if possible, any spring holes under the surface of the lake and mark them. Note all possible sources of water supply—even the smallest rivulets.

Copper sulphate wholesales at around 5½ cents per pound and comes in barrels. It should be transferred to bran-sacks or some form of bag of loosely woven material. For rowboats, fifty pounds to a sack is sufficient. For power boats, one hundred pounds is a convenient amount to handle.

By the use of a 12-foot joist or bar equally strong fastened crosswise of the stern of the boat, a sack may be fastened at each end so that two bags may be drawn through the water by each boat. The sack should be suspended at the surface of the water with no more of it under water than is necessary to dissolve the contents.

The copper sulphate should be thus distributed along the entire surface of the lake at intervals not exceeding twelve feet apart and the more quickly it is done the better. In other words, the more boats that can be mustered into the service the better, with a view to a general, simultaneous distribution. Each boat should move at about the same pace as that of a fisherman when trolling.

The deeper portions and the spring holes should be covered more thoroughly than the shallower portions. If a definite boiling spring is found in the lake put a small sack of the material over it so that the water will percolate through it.

After the surface of the lake has been covered as thoroughly as possible and as near to the shore as boats can take it, have men on foot drag sacks around the edge of the shore line. Every stream or rivulet must be covered with the material as far up as objectionable fish are known to go. A strong solution of the mixture may be poured into the small streams at intervals with good effect. However, the dissolved copper sulphate precipitates so quickly that there may be conditions in tributary streams where the introduction of lime would be more far-reaching in its effect than copper sulphate.

To avoid the necessity of having each boatman return to the source of supply one boat should be detailed to carry a supply of sacks filled and ready to replace the empty ones at any place on the lake where needed. This is important.

Some of the copper sulphate will not dissolve readily and the supply boat will find a few pounds remaining in each sack when he makes the exchange. This can be gathered from the various nearly empty sacks into one and this may be dragged over the surface until dissolved. To deposit a bag of the material at any one place will have very little effect. It must be dissolved at the surface of the water in ponds of ordinary depths. There is too little knowledge of the subject to attempt to advise how to exterminate fish in very deep lakes.

DISCUSSION.

Prof. Dyche, of Kansas: There are unquestionably tremendous opportunities for improving the productiveness of waters by getting rid of surplus fishes and introducing finer species. However, you cannot attempt to destroy a species of fish in a pond for the introduction of others unless you destroy all of them. If more than a single individual of the former species is left it will be only a question of time till conditions are back where they were before. Unless the destruction is complete the introduction of finer species must fail.

Mr. Graham, of Massachusetts: In New England and New York there are numerous ponds that formerly contained trout and salmon, which today contain only bass, perch, pickerel and such species. There is a great demand for the planting of trout and salmon in these ponds, but is almost impossible to establish them in the presence of the other fish. This work of Mr. Titcomb's is very important in showing how we may be rid of the pernicious fishes. At the suggestion of Mr. Titcomb I tried out this method on a pond belonging to a friend. The pond was full of pickerel. We first drained it down till there was only the stream running through, and then put in the copper sulphate at the spring which feeds the pond. We kept this up for a week, and at the end of that time it was impossible to find any living thing in that stream except the bullheads—they seemed to thrive on it.

In a little pond in my back yard, about 12 by 30 by 2½ feet deep, in which I have a number of kinds of fish, I desired to get rid of the algæ. I used about a half pound of copper sulphate in a sprinkling can of water and distributed it about over the surface. It was very effective on the algæ, which died and sank to the bottom, but there was a secondary effect produced by the decomposition of the algæ in which there was a large amount of carbon dioxide liberated. The immediate effect of this was that the fishes came to the surface gasping for air. The suckers came first, then the black bass, and later both died. The perch and sunfish withstood it perfectly, but a number of minnows were lost. The bullheads all came to the surface, but none of them died.

Mr. Titcomb: We must learn in all cases what proportions to use. In one town we have ten trout ponds which, I believe, could be rid of the yellow perch and pike-perch successfully, at a cost of perhaps $400 to $500, and so restore them as trout ponds, together with the streams tributary to them.

Mr. Bower, of Michigan: We have in Michigan thousands of lakes containing undesirable fishes and we would be very glad to find some method of destroying all the desirable as well as the undesirable fishes in order to start in with a clean sweep, using only the best and most desirable species. I wish to inquire whether there is any method of reaching fishes in deep lakes, say down to 100 feet? Also I wish to inquire whether it is feasible to destroy the carp, which bury themselves in the mud? Perhaps the bullheads escape by burying themselves in the mud, and so escape the toxic effects of the copper sulphate.

Mr. Titcomb: In Dr. Kalbfuss's experiments he found that the carp was one of the first to succumb. I think it is even more sensitive than the trout and one can get rid of the trout without destroying the other fishes by making the solution only one part in six millions. That is getting it down to very small proportions and it is not easy to figure the cubic contents of a lake. As to deeper waters, I think it is possible in any depth of water; but I have not tried it at a depth greater than 25 feet.

A Member: How does this affect the fish? If they are stunned or killed outright are they rendered unfit for food?

Mr. Titcomb: They die slowly and come to the surface. They do not keep well after they are killed by this method, and I do not think any one would care to eat them.

Mr. Marsh, of New York: I believe Mr. Bower could use copper sulphate in lakes of any depth. It is merely necessary to sink the bag to the depth you wish to reach and let the crystals dissolve there where they will come into contact with the fishes you wish to kill.

Mr. Cobb, of Minnesota: We had an experience with copper sulphate, but it is not as valuable as it might be, for we do not know just what took place. In a small lake used for bathing purposes all the fish were reported dying. I went out to it and found that all the animal and vegetable life of the pond was dead or dying and discovered a substance on the shore that proved to be copper sulphate. The work was evidently done in the evening by persons having access to boats. One thing which interested me was that horses were drinking from the lake the next morning and campers were getting their drinking water there, and it had apparently no effect on any of them.

Mr. Titcomb: That brings out very clearly the fact that the copper sulphate precipitates very rapidly. You can poison a lake very effectively and feel perfectly sure that you have not destroyed the fishes in a stream below.

A Member: How soon afterwards can a lake be restocked? If it can be done soon it would be possible to clean out some of the desirable fish and hold them for restocking the pond after the others have been exterminated.

Mr. Titcomb: That is quite feasible. After three or four days the fish could be put back safely.

A Member: If the fish were good to eat after being killed in this way it might be a very dangerous thing in the hands of certain people who make a practice of getting fish in any way they can. If they were to use this method our lakes would soon be depleted of all the fish.

Mr. Titcomb: They could kill the fish readily enough, but I think they would not care to try it, since they would not want to eat fish poisoned in this manner.

SUGGESTIONS AS TO INDICES OF THE SUITABILITY OF BODIES OF WATER FOR FISHES

By Dr. V. E. Shelford,

University of Illinois, Urbana, Ill.

The relations of fishes to environment are very complex due to the great complexity of the environment itself. This complexity seems to grow greater as our knowledge of it is increased and our perspective widened. The decomposition of organic matter in water under the action of bacteria yields many substances, even under primeval conditions, the physiological effects of which have been too little studied to make a statement of their importance practicable at the present time. When we look to the field of contamination and the products which it yields the complexity is increased many fold. Still, in spite of this, we believe that it is practicable to use the presence of certain conditions as indices of the suitability of an entire great complex for food fishes.

In such a discussion we must keep in mind the fact that in fresh water the majority of food fishes deposit their eggs on the bottom. The eggs of many marine fishes rest on the bottom, but a considerable per cent. have pelagic eggs. It is to the bottom that the dead bodies of organisms sink and decompose and, accordingly, at or near the bottom the poisonous products of decomposition occur in greatest quantity. Decomposition of the bodies of plants and animals results finally in gases such as ammonia, carbon dioxide, hydrogen sulfide, methane, etc., which diffuse rather slowly to the surface and into the atmosphere. Thus the extent to which they occur is dependent upon the amount of decomposition and the circulation of the water. It must further be borne in mind that the same processes of decomposition which result in these gases consume oxygen and as a rule there is insufficient oxygen for eggs and young fishes and in many cases for adult fishes where these decomposition products are present.

Turning to the fishes themselves we note that their presence or absence is controlled by (a), their ability to recognize the presence of strange or deleterious substances and to turn back when they are encountered, and (b), by their survival or death in situations where they cannot escape the deleterious conditions. Their ability to recognize strange or deleterious substances has been shown (Shelford and Allee '11; Shelford and Powers '14; Wells, unpublished) to be very elaborate and effective. Fishes recognize exceedingly minute quantities of numerous substances and not only turn back upon encountering them, but are able to recognize and orient their bodies with reference to increases and decreases of such substances often present in water. Various workers have shown that the products of decomposition are in the main very poisonous to fishes, especially to eggs and young fry (Wells '13 and citations). It must further be noted that all fishes young and adult require oxygen and eggs require a large quantity of it for development. Aside from the ill effects of the decomposition products themselves, there is usually little oxygen in their presence, especially in fresh water. From these considerations it is readily seen that it is useless to expect the presence of food fishes where the bottom of the waters generally contain any quantity of decomposition products. Thus in seeking indices of the suitability of bodies of water for fishes we are concerned primarily with decomposition products. The peculiar physiological constitution of the fishes in question is, of course, a matter for consideration, for the character of different species differs in this respect. However, the difference between different species is one of degree and special habits. The effects of the various decomposition products are the same in a wide range of species with only slight differences in degree. Furthermore when we consider the best food fishes (we believe both fresh water and marine fishes though our experience with the latter has been limited), we find that, considering their behavior they are very sensitive to decomposition products and their life and death resistance to them is low. The less sensitive fishes are usually of less food value. Food fishes usually live associated with organisms which, like themselves, are very sensitive to decomposition substances, and these organisms are usually absent when the fishes are.

Indices are then of three types (1), results of the inspection of bottom, (2), results of chemical tests of the water for decomposition products, and (3), the presence or absence of index organisms of a semi-stationary character, such as snails, etc. Here we will concern ourselves with the first two types only. The third is doubtless the basis of common though restricted practice in judging the suitability of waters for fishes, being the result of experience of individual naturalists, but is not as yet organized for general purposes. This is to be taken up experimentally by the writer in connection with the work of the Illinois State Laboratory of Natural History to be reported on later.

Considering the first two we must comment separately upon fresh and salt water. If a body of fresh water is to support the most desirable fishes it should have an area of clean sand, gravel or other terrigenous bottom covered by from six inches to two feet of water and an area of emerging and submerged vegetation to supply food. It is probable that for the best results these three areas should be about equal. The terrigenous bottom should usually be free from blackened debris for this usually accompanies decomposition. It should be borne in mind, however, that there is nothing deleterious about humus provided the material in it has passed the early decomposition stages. Thus darkened bottom usually, though not always, indicates decomposition and bad conditions. For many fishes an area of water more than four feet deep is relatively unimportant. This much of the inspection can readily be completed by a cursory mapping of the different areas in the body of water. Since most bodies of water contain sufficient vegetation to supply insects and other food for more fishes than can exist there, *the amount of terrigenous bottom up to one-third of that occupied by vegetation may be regarded as an index of the suitability of the body of water for food fishes.*

The second index is essential but must accord with the first. The chemical character of the water must be such that the fishes will not suffer from it or leave on account of it. Carbon dioxide results from the decomposition of organic matter. In the process oxygen is consumed so that the presence of any quantity of carbon dioxide nearly always indicates lack of oxygen. Fishes are very sensitive to carbon dioxide, turning back from increase of one or two cubic centimeters per liter of the gas in solution. Their reactions are especially striking when carbon dioxide is accompanied by lack of oxygen (Shelford and Allee '12). Likewise low oxygen and high carbon dioxide in combination are more rapidly fatal than any other combination of these two factors (Wells '13). While exact figures cannot be given it is probable that the carbon dioxide content of water over breeding grounds (terrigenous bottom) should not average more than one cubic centimeter per liter, nor exceed 5 cubic centimeters during the summer months. Such amounts are not usually accompanied by lack of oxygen. *Thus the amount of carbon dioxide may be taken as an index* of the suitability of the water.

In salt water the more complex conditions make additional indices necessary. As in fresh water, bottom conditions are important to fishes which use them for breeding. Clean rock, sand, or gravel bottom in one to six feet of water (at low tide) and free from darkened decomposing matter and foul odor is probably essential to the eggs of many salt water species because of the poisonous character of decomposition products. Thus in general the relative absence of decomposition products from the shallow water of any bay or enclosure may be regarded as favorable to demersal fishes like the herring.

In the sea where such vast areas are connected the behavior of fishes plays a most important role (Shelford and Powers '14) as is shown by the well known erratic and commercially important migrations of the herring. These fishes recognize slight deviations from neutrality with a precision not excelled by litmus paper, and turn back very constantly from acidity such as is given in 1 cubic centimeter of carbon dioxide per liter. Essential neutrality is usually selected by herring. Twenty cubic centimeters of carbon dioxide per liter in the presence of oxygen to saturation is more quickly fatal to herring than is the same amount to any number of fresh water species.

Decomposition in the sea nearly always takes place in the presence of certain bacteria which yield quantities of hydrogen sulfide. This is often accompanied by carbon dioxide and lack of oxygen. In shallow shore waters it may exist in the presence of abundant oxygen and essential neutrality because of the use of the carbon dioxide by the plants and their production of oxygen in the process of photosynthesis. Fishes not only turn back on encountering hydrogen sulfide but it is more quickly fatal to them than any other gas of common occurrence. *Thus we must add the amount of hydrogen sulfide as an index of the suitability of sea water.* A good sea water should not contain more than a trace of this gas.

To summarize, we note that *the amount of terrigenous bottom and of free carbon dioxide serve as indices for bodies of fresh water while the amount of clean bottom, carbon dioxide and hydrogen sulfide serve in bays and enclosures of the sea.* The determination of these gases is not difficult provided one has a chemist make the required solutions. Contaminations such as sewage, organic wastes from slaughter houses, etc., influence the water much as does an increase in the natural organic matter and the indices apply where the commonest forms of contamination occur. The writer is familiar with cases in which these requirements have apparently been met and still the body of water proved unsatisfactory for the production of fishes, but in spite of these exceptions he regards these indices a suitable working basis, in no way preventing the proper investigation of such exceptions as exist.

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PROGRESS IN THE PROPAGATION OF THE DIAMOND-BACK TERRAPIN

By Lewis Radcliffe,

U. S. Bureau of Fisheries, Washington, D. C.

In 1904, Dr. K. Mitsukuri[1] made the following statement:

"The place occupied among gastronomical delicacies by the diamond-back terrapin in America and by the green turtle in England is taken by the 'Suppon,' or the snapping turtle, in Japan. The three are equally esteemed and equally high priced, but the Japanese epicure has this advantage over his brothers of other lands—he has no longer any fear of having the supply of the luscious reptile exhausted. This desirable condition is owing to the successful efforts of a Mr. Hattori, who has spared no pains to bring his turtle farms to a high pitch of perfection and is able to turn out tens of thousands of these reptiles every year."

During the ten years that have elapsed since that statement was made, the Bureau of Fisheries has perfected its experiments on the cultivation of the diamond-back terrapin conducted at Beaufort, N. C., to a point where American culturists may now expect to duplicate the work of Mr. Hattori, and supply the market with thousands of terrapin each year.

Previous attempts of buyers and others unfamiliar with the requirements of terrapin culture, to propagate terrapin have met with little success beyond the hatching of the eggs in beds provided for the purpose. Last year a company was formed at Beaufort, N. C., and plans following closely the methods perfected by the Bureau of Fisheries were adopted for growing terrapin for market on a large scale. This company has built an excellent plant covering several acres and stocked it with about

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[1]In Bulletin of the U. S. Bureau of Fisheries for 1904, vol. xxiv, p. 260.

4500 terrapin, of which 1800 are adult breeding females. The adaptability of terrapin to artificial conditions was well illustrated in this case in that breeders purchased by the company during the laying season of 1913, continued their activities in captivity and from the eggs thus laid over 700 young terrapin were added to the company's stock. This year's brood numbers over 3500 and would have been considerably greater save for some mistakes in the management of the laying beds. The annual brood at the Beaufort Laboratory has shown a marked growth in numbers, beginning with 12 in 1909, there were 460 in 1911 and over 1500 in 1913.

One of the factors that has seemed especially unfavorable to terrapin culture as a commercial proposition has been the long period that it was expected would be required for the terrapin to reach a marketable size. While the experimental results at Beaufort are still incomplete, it now appears that this period may be considerably shortened by improving on nature's methods. You are aware that during the winter months the terrapin hibernate. It is believed that the young terrapin, as a rule, remain in the nest during the first winter and do not begin feeding until the following spring, having increased very little if any in size during this period. At Beaufort the young are not allowed to remain in the nest but are dug out shortly after hatching, placed in wooden tanks, and soon begin to eat. At the approach of cold weather part of them are placed in hibernating boxes and the rest are transferred to the terrapin house, which is modeled after the order of a greenhouse and is heated, the temperature not being allowed to fall below about 75° F. The warmth in this building is sufficient to keep the terrapin active and feeding. The start which they thus acquire enables them to grow more rapidly during the following summer, increasing the lead they had in the spring over stock which was allowed to hibernate.

New-born terrapin average slightly more than one inch in length. This is the length of the flat plastron (bottom shell) measured along the median line and, expressed in inches, is the standard of length used. The rate of increase in length for terrapin allowed to hibernate each year is about one inch, the growth of the males being slower after the second year. A year-old terrapin of average size that has hibernated the first winter should measure a little over two inches. Of the remaining 500 young terrapin of the brood of 1913 belonging to the Beaufort terrapin company and fed last winter, the largest one now measures four inches, or nearly twice the size of the average terrapin not fed during the first winter, and 200 of this lot will measure three inches and over. The rate of growth of terrapin is exceedingly variable and the experiments with winter feeding are still too incomplete to enable us to determine the time required for the majority of the stock to reach a marketable size, but results of the character mentioned indicate that winter feeding may do much to hasten their growth.

After the first year of confinement, the loss of adults is negligible. As an instance of this, of over 3000 terrapin purchased by the Beaufort company in 1913, only two have died during the active season this year. The loss after hatching, of young terrapin from adult stock held in confinement for several years, is also very small, being about 5% at the Beaufort Laboratory. Aside from the initial cost of pounds and breeders, in places where fresh fish may be purchased cheaply, the running expenses of a terrapin farm should be light. These factors, added to the adaptability of this form to artificial conditions, should make the subject of terrapin culture an interesting undertaking to those of you who are fish culturists and whose sphere of action lies within the natural range of the species. Before undertaking to stock depleted waters, proper laws governing the taking of terrapin should be required and a public sentiment that will insist on their enforcement aroused. Stock grown for distribution should be fed the first winter and planted late in the following summer.

Doubtless many questions relating to the construction of breeding pens, selection of breeding stock, care of adults, eggs and young, will arise in the minds of those of you who are interested in this subject. These subjects are discussed in Economic Circular No. 5 of the Bureau of Fisheries, issued June 24, 1913. This paper is entitled "Artificial Propagation of the Diamond-Back Terrapin" and was written by W. P. Hay and H. D. Aller, who have been most closely associated with the progress of the experiments at Beaufort.

NOTES ON SOME NORTH CAROLINA SHARKS AND RAYS

By Lewis Radcliffe,

U. S. Bureau of Fisheries, Washington, D. C.

During the course of preparation of a report on the sharks and rays found in the vicinity of Beaufort, N. C., the difficulties of the field man who secures one of these monsters of the sea to determine its identity, have frequently been felt. One cannot carry a 12 to 40-foot shark with ease to his library or workshop, nor does he, as a rule, have his library with him. In the majority of cases I have found that if the jaws and a portion of the skin from below the dorsal fin are saved, these will afford sufficient material for determining the identity of the species. I hope the specimens which will be shown you, and a few notes regarding them, may prove of interest.

As you are aware, the teeth aid the mouth in seizing, holding, cutting or crushing the various kinds of food material. The diversity in form and arrangement of these organs, developed according to the needs of the particular species, is surprising. In the sand shark (*Carcharias taurus*), the teeth are long and subulate, well fitted for seizing and tearing to pieces smaller fishes. It is said that the species is very voracious, that they work together in schools and surround and attack schools of other fish, even those imprisoned in the nets of the fishermen. The teeth of the thresher shark (*Vulpecula marina*) are similar in form. This species is also reported to be very destructive to fish life, using its tail, which is about as long as the rest of the body, to strike and stun, or kill, the unfortunate members of the school of fish who fail to get out of its reach.

In many species of sharks, some or all of the teeth are triangular, with or without serrate cutting edges. This is true for the man-eater (*Carcharodon carcharias*), the blue shark (*Galeus glaucus*), most of the species of the genus *Carcharhinus* and others. In the hammer head

(*Cestracion zygaena*) a transition to the paved type of teeth may be noted. The teeth of the two dogfishes common to our coast are very unlike. In the spiny dogfish (*Squalus acanthias*), they are compressed, with a distinct cutting edge; in the smooth dogfish (*Galeorhinus lævis*), they are blunt, in pavement.

Certain of the rays have powerful crushing jaws which are capable of breaking the thick shells of clams and other mollusks upon which they feed. The paved teeth of the cow-nosed ray (*Rhinoptera quadriloba*) and the spotted sting-ray (*Aetobatus narinari*) are well fitted for this purpose, and the functioning teeth of these are usually very much pitted and worn by such use. The spotted sting-ray, which reaches a length of 12 feet or more, feeds almost entirely on clams, which it digs from the natural beds. The specimen from which the jaws, which I will show you, were taken was 9 feet, 6½ inches long. The stomach of this specimen contained a considerable quantity of the meats of clams without any pieces of the shells. As much as a gallon of clams is stated to have been taken from the stomach of a single individual and no pieces of shell were found. A surprising degree of specialization is revealed to us, as shown by the ability of this species to dig the clams, to crush or open the shells and separate the meat from the shells.

In some of the rays the teeth differ according to sex, those of the female being blunt, while those of the male are sharp pointed, in some cases almost needle-like. We find such differences in the barn-door or smooth skate (*Raja stabuliforis*), in some of the sting-rays, of which *Dasybatus hastatus* is an example, and in the small devil-fish (*Mobula hypostoma*).

A microscopic examination of the armature of the skin of different species of sharks and some of the rays, will disclose as great variation in the form of these defenses as have been found in the teeth. When these calcified papillæ are small and close set, they are referred to as dermal denticles, and the skin is called "shagreen." In some cases they are larger, taking the form of tubercles, bucklers or spines. As a rule, in the sharks the denticles from a particular body region are very uniform in shape. In many species this form appears to remain constant through life, in others there is some modification with age. Once we have learned the form and the variation, if any, for a given species, these have an important classificatory value.

One of the questions frequently asked regarding the sharks is that of whether they will attack a human being. On this subject we have very little positive information.

As an illustration of their ferocity I wish to relate an incident that happened at Beaufort this summer. On August 8, a small school of large tiger sharks (*Galeocerdo arcticus*) appeared in the Fort Macon channel near the Fisheries Laboratory, swimming around the Fisheries Steamer "Fish Hawk."

A baited shark hook thrown over the side was seized by the largest of the school. The line offered little resistance to this big fellow and he disappeared, taking bait and hook with him. During the time that was required to secure and bait another hook, the rest of the school came up under the stern of the ship, showing no fear for the men a few feet above them. Apparently they were very hungry and prepared to grasp anything in the nature of food that might fall to them. When the second hook was thrown over it was seized by one of these. This shark, which was 8 ⅔ feet in length was killed and brought on deck. For the second time the hook was thrown overboard and soon another specimen, slightly over 10 feet in length, was hanging from the boom with its head out of the water. On the third cast another, 9 feet 2 inches in length, was hooked. At this time a shark, larger than any of those taken, swam up to the one hanging from the boom and, raising his head partially out of the water, seized the dead shark by the throat. As he did so, Captain O'Brien began shooting at him with a 32-caliber revolver, shooting as rapidly as he could take aim. The shots seemed only to infuriate the shark, and he shook the dead one so viciously as to make it doubtful whether the boom would withstand his onslaught. Finally he tore a very large section out of the unfortunate one's belly, tearing out and devouring the entire liver and leaving a gaping hole across the entire width of the body, large enough to permit a child to crawl into the body cavity. At this instant one of the Captain's bullets hit a vital spot and, after a lively struggle on the part of a launch's crew, a rope was secured around the shark's tail and the four were brought to the laboratory for examination. The last shark was 12 feet in length, and the liver of the smaller one was still in its stomach,—the estimated weight of this was 40 pounds.

DISCUSSION.

MR. FEARING, of Rhode Island: Some years ago when I was going around the world I was requested by Mr. Agassiz to make notes of any absolutely authentic cases of sharks attacking human beings. He believed that there is no shark known at the present time that will attack a living man and there is no shark known whose jaws are capable of biting a man's leg off.

I inquired wherever I went. In Singapore, where the sharks are thicker than in any other place I remember, except in Java in the very warm waters under the equator, I approached the English captain of the water police who had been there for over twenty years. He told me that while he had seen thousands of dead bodies that had been mauled and torn by sharks, he had never known, in all his experience, of a case where a shark had attacked a living person. In Aden I saw a boy, who, it was said, had had his leg bitten off by a shark. On careful inquiry, however, it developed that he was drunk and was run over by an ox cart and injured so that his leg had to be amputated. That was the nearest to any actual case that I was able to discover in a trip around the world! However, Dr. Chas. H. Townsend has told me that he has absolute personal proof and that he has himself seen natives in the tropics grabbed by sharks and eaten.

SOME CASES OF NARROWLY RESTRICTED PARASITISM AMONG COMMERCIAL SPECIES OF FRESH WATER MUSSELS

By Dr. A. D. Howard,

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The U. S. Bureau of Fisheries has now carried on for some six years an investigation of methods of propagating fresh-water mussels.

The work has gone on beyond the experimental stage and operations have been conducted upon a scale that it is hoped will appreciably increase the supply for commercial purposes.

While certain species of mussels have been successfully dealt with by the methods first adopted, difficulties have been experienced with other species. In a paper read before the American Fisheries Society in 1912 I showed that I had been able to propagate the Warty-back Mussel on the catfish and that apparently they could not be reared on other species. From my studies of natural infection it looked to me at that time as if other cases of restricted parasitism would be found. The subject of natural infection has been made the object of special study at the Fairport Station and some considerable data published showing the species of fish on which the various mussels have been found. The data thus obtained have in some cases pointed conclusively to definite results while in others the interpretation was less obvious.

The identification of the larvæ (*glochidia*) when imbedded in the tissues of the host is uncertain in some forms, and accidental infections of a temporary nature undoubtedly occur. This makes necessary some method of proving out. In practice I have taken the indications obtained from observation of natural infections as a guide and made a test of the suspected species, comparing other species as a control. As the object of the investigation is to find a method of propagation, such a test meets the ultimate requirements.

The results obtained from these artificial infections are frequently very definite, giving conclusive support to the indications obtained from natural infections.

The following cases are concrete illustrations of this: Last May I undertook a series of experiments to determine to what extent the common fishes could be used in artificial propagation of certain mussels of the family Lampsilinae (Ortmann). The species were the Mucket, *Lampsilis ligamentina* Lam.; the Fat or Lake Mucket, *Lampsilis luteola* Lam., and the Yellow Sand Shell, *Lampsilis anodontoides* Lea.

The glochidia of these species were brought in contact with some sixty fish of 12 different species in each experiment. The infections with each species of mussel were kept separate so that I had three separate experiments. These I carried on under as nearly identical conditions as possible, so that they were practically parallel. The results summarized show what usually occurs in such an experiment. The glochidia took hold more or less on every fish, dropping off of some species in from 1 to 4 days without development, in other remaining on to the full period, which was three weeks in each of these cases. The muckets and fat muckets remained the full period on the basses (*Centrarchidæ*); sea basses (*Serranidæ*), and perches (*Percidæ*). They dropped off of the catfishes (*Siluridæ*), the sheepshead (*Aplodinotus grunniens* Raf.) and the gar (*Lepisosteus platostomus* Raf). The yellow sand shells remained on the gars, and dropped off of all the other species. We have here rather striking results. Chances of error were largely eliminated, from the fact that the experiments were carried parallel. As a further check I have repeated tests where there seemed to be any possibility of doubt.

The mucket and lake mucket are indicated as mussels having an extensive range of parasitism on several genera of fishes, while the yellow sand shell, a closely related species, is parasitic upon a single genera of fishes far removed genetically from the hosts of the others.

My experiment will illustrate how a study of natural infections was of assistance. The gar would not have been included in this test ordinarily, as it is commonly thrown away as a nuisance. I had found it infected with glochidia which I identified with some uncertainty as *L. anodontoides*. On this account when the opportunity came to infect with the yellow sand shell I made a special effort to bring in the gars with the other fishes.

The natural infections which I collected first on July 17, 1912, were upon the long-nosed gar (*Lepisosteus osseus* Linn.).

The following year infected gills of the alligator gar, (*L. tristoechus* Bl. and Schn.), were sent to the laboratory from Indiana by Mr. Ernest Danglade. These were identified as the glochidia of the yellow sand shell. As I used the short-nosed gar (*L. platostomus*) in my experiments, we have a pretty clear indication that any of the three species of gar is a suitable carrier for this mussel.

Definite results in a similar manner were obtained with the Missouri niggerhead (*Obovaria ellipsis* Lea). Natural infections of doubtful identification had been found on the sturgeon (*Scaphirhynchus platorhynchus* Raf.). This was an especially difficult case because the infections in question were of an appearance and dimensions corresponding to those of a group of glochidia which are much alike, viz.: *Lampsillis ventricosa* Bar., *L. fallaciosa* Simp., *L. higginsii* Lea., *Obovaria ellipsis* Lea., and *Quadrula pustula* Lea. In the experiments the glochidia of *O. ellipsis* remained and passed through the parasitic stage on the sturgeon while they were promptly shed by the black bass, sunfish (*Lepomis pallidus*), sheepshead (*A. grunniens*), white crappie, black crappie, and channel catfish. It will be noted that the sturgeon did not retain glochidia in the other experiments.

The butterfly shell (*Plagiola securis* Lea.) I have found in several instances of natural infection on the sheepshead (*A. grunniens*). In artificial infections I obtained development upon the sheepshead as expected and immediate shedding by the black bass, the black crappie, and the bluegill sunfish. Mr. Surber (1913)* reported the host as unknown. Two other species of *Plagiola* have been reported on this fish and one of them, *P. donaciformis,* seems to be very common here at Fairport on the sheepshead, so that we apparently have three species of one genus confined chiefly to one host, together with other species of paper shell mussels which are at present considered of little value.

The three fish, the gar, the shovel-nosed sturgeon, and the sheepshead or grunter, which we find to be the carriers of these mussels have held economically quite different positions. The sheepshead and shovel-nose are now esteemed food fishes, although it is not many years ago that the latter was considered worthless. The gar at present is well known, and as I intimated above is considered a nuisance and, worse than that, a positive menace to the welfare of other fishes. The discovery then that it is practically the sole host for one of the most desired of shells is perhaps not agreeable. As a rule, however, we have to take nature as we find her, and for those who expect always to find a *raison d'etre* for each creature, this nursing of the yellow sand shell by the voracious gar will satisfy the belief that things are as they should be.

These results open up interesting problems as to details in the ecological relations of the associated species and the nature of the specific reactions which control them. These are applicable to all cases of specific parasitism and have been solved for some. It is of practical importance to those interested in mussel propagation that at least an answer be found for some of the questions of this nature raised here.

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*Surbur, T., 1913: Notes on the Hosts of Fresh Water Mussels. Bul. Bureau of Fisheries.

A NEW RECORD IN REARING FRESH-WATER PEARL MUSSELS

By Dr. A. D. Howard,

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Last May, Mr. A. F. Shira, of the U. S. Bureau of Fisheries at Lake Peppin, Minnesota, shipped to the Biological Laboratory at Fairport, Iowa, a number of gravid mussels of the species called "fat mucket" *Lampsilis luteola*, Say. This mussel has a reputation for bearing pearls and is of economic importance for its mother-of-pearl used in the manufacture of buttons, etc.

At the time, I was engaged in a series of experiments to determine to what extent the common fishes could be used in artificial propagation of certain members, including this species, of the family Lampsilinæ (Ortmann). On May 21, 1914, I took the glochidia from these mussels and infected a dozen different species of fish; of these, six species proved susceptible and carried the young mussels through their metamorphosis. As the young mussels began to be shed by the fish, I placed a number of infected black bass (*Micropterous salmoides* Lac.) in a floating crate made for the purpose of catching the young mussels as they fell off. The crate I devised to meet a number of difficulties that had been experienced in attempts to raise mussels under observation. In aquaria, either balanced or with running water direct from the usual habitat of the mussels, they do not thrive. The majority are apparently eaten by predacious worms, or those which do not fall prey to their enemies, stop growing, apparently owing to some lack of nutrition.

Among European investigators who have attempted to grow young mussels are M. Brown, W. Harms and Karl Herber.* The latter this year reports having carried the

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*Brown, M.: 1889, Die postembryonale Entwicklung der Najaden.

Harms W.: 1909, Postembryonale entwicklungsgeschichte der Unioniden.

Herber, Karl: 1913, Entwicklungsgeschichte von *Anodonta cellensis*, Schröt. Zeitschrift Wiss. Zool., Bd. 108.

juveniles to a size of 3 mm., the largest which has been recorded so far as I know.

Having had about the same indifferent results as other investigators in such attempts, it seemed to me that a promising line of attack for a solution of the problem would be to find some way which would depart from the natural habitat only so far as the necessity of mechanical control demanded. In our situation, where we take the mussels from the Mississippi, the most practicable solution that offered itself to me was a floating crate containing baskets of sufficient size to hold the fish and made of small enough mesh to retain the microscopic mussels.

A crate thus held at the surface accommodates itself to the frequent rise and fall of the river, is convenient of access and removes the young mussel from many of its enemies at the bottom. Another advantage of a surface location is that the precipitation of silt is at a minimum. The crate was constructed from a floating fish car to which were added barrels to give greater buoyancy. Four baskets of rectangular shape were made to fit inside. These consisted of a frame work of galvanized iron attached to a galvanized iron bottom tray. On the frame was stretched copper cloth of one hundred mesh to the inch.

Two or three weeks after obtaining the plant of young mussels from the bass, I found evidence that they were thriving in the crate. A small sample of sediment from the bottom revealed some half dozen or more, and at various intervals during the summer, I readily obtained specimens, making observation on rate of growth and preparing material for anatomical studies. At the last observation in September, the young mussels were about an inch in length (twenty-five millimeters). This compares very favorably with the length of 3 mm. secured by Karl Herber.

For comparison, I put some of the rapidly growing mussels from the crate in an aquarium of running water and compared their growth for a period of three weeks with those growing at the same time in the crate. I found the rate in the aquarium one-third as fast as in the crate. The rate in the crate was a constantly increasing one, and in the aquarium apparently decreasing. The growth of one inch gives us an actual observation on the growth for one season and removes some uncertainties as to what young mussels may do the first summer.

At this writing, without a study of the records, I am unable to give the percentage of survivals from the original plant, but an estimate of the number gave two hundred living and rapidly growing mussels. All examined had byssi of about six inches length attached to some base in the basket. Each juvenile had the anterior end buried as commonly seen in adult mussels and none were suspended in the current as some have supposed the condition to be with byssiferous forms.

In this experiment we have succeeded in carrying mussels under cultivation, we may say, through what are apparently the most critical periods in the life history, namely, the parasitic and early juvenile stages. Just what bearing these results will have in practical artificial breeding of mussels, is still a question, but the information gained is of obvious value. Early in the investigation of the subject Lefevre and Curtis suggested the feasibility of raising mussels to this more hardy stage and then distributing them. A point in favor of such a method would be that results could be quite definitely measured. By the method of infecting fish and letting them go at large, results are not as readily ascertainable. The planting of mussels according to a definite plan, in favorable locations, might have a distinct advantage over the natural distribution by fish. The assumption of an advantage in the more artificial method would be based upon results with the analagous rearing of fish, young lobsters, oysters, etc. This phase of the subject requires investigation. The raising of young mussels in a floating crate can doubtless be perfected and adapted to many species. I fully realize that the result obtained is only a beginning, but it is at any rate a start.

ON THE SEASONAL DISTRIBUTION OF FISH PARASITES

By Prof. Edwin Linton,

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This paper is in response to an inquiry addressed to the writer a short time ago. In substance it was desired to know at what particular season one should expect to find worms in the flesh and other parts of various named marine species of food fish.

While satisfied at the outset that there is practically no seasonal periodicity in the occurrence of cases of parasitism among marine fishes, it seems to be worth while to examine some typical cases, of which data are available, in order to set the matter in as clear a light as possible. My own period of investigation on the subject of parasitism has been confined almost exclusively to the months of July and August and parts of the months of June and September. If my data, therefore, were limited to what I have collected myself I would be in a poor position to shed any light on the inquiry. Fortunately I succeeded some years ago in interesting that veteran and intelligent collector, Vinal N. Edwards, of Woods Hole, Mass., in this matter, and, as a result, I have found each season since then a large collection of material waiting for me upon my arrival at Woods Hole for the summer's work. These collections of parasites, mainly from fishes and fish-eating birds, usually requiring from 300 to 400 bottles and vials to accommodate them, have been collected in the months from September to June. As a result of the preliminary study of these collections, I have notes on parasites of many of our common fishes that have been collected throughout the year. In this paper I propose to summarize some of the results obtained from an examination of the collections made by Mr. Edwards and those made by myself in the Woods Hole region from fishes which are taken there throughout the year or at least during a considerable part of the year.

NEMATODA.

The parasitic helminths that are most commonly encountered belong to the order Nematoda, commonly called round, or thread worms. It may be added that the members of this order come the nearest to the popular conception of the word "worm." In this paper I shall consider only those Nematodes that belong to the family Ascaridæ, which includes the most commonly occurring round worms of fishes. Those who have had much to do with the preparation of fish for the market and have been at all observant can scarcely have escaped noting the not unusual presence of worms of this order enclosed in membranous coverings and distributed on the viscera, sometimes, as is often the case in the whiting, for example, forming a tangled mass on the viscera generally, or, attached to the mesentery. In the butterfish they sometimes occur in considerable numbers on the pyloric cæca. Careful search will reveal the fact that scattering specimens may be found in the mesentery or on the viscera of a large proportion of the food fishes. In most cases they will be found to be coiled in a flat spiral. They are quiescent, although when liberated from the cyst which the tissues of their host have built around them, may become somewhat active. They will measure, as a rule, from 10 to 20 millimeters in length. Whatever the preceding life-history of these worms may have been their situation represents now, as a rule, the final stage of activity in the particular fish in which they are encysted. They are invariably immature and must await the, to them, happy fate of being eaten by a suitable host before they can become sexually mature. This final reproductive stage must be looked for therefore in the alimentary canals of fishes, or of fish-eating animals. Many fishes such as the cod, haddock, pollock, sword-fish, etc., harbor, at the same time, adult nematodes in the alimentary canal and immature, encysted forms in the body cavity. Occasionally these worms will be found coiled up in the peritoneal lining of the body cavity, and less often they succeed in penetrating the flesh of their host. For example, in a lot of codfish examined by Mr. Edwards in December, 1908, it was found that in about 2% of them a few of these parasites had penetrated the flesh in the vicinity of the back-bone. A few cases have been brought to my attention where these parasites have been noticed in salt codfish. For example, Dr. C. B. Wilson recently sent me a piece of salt codfish with the request that an examination be made of it. I found in it three immature ascarids, two of which had become lodged in the intermuscular tissue while the third had burrowed into the muscle tissue. Again, this past summer, a fish dealer brought to my laboratory at Woods Hole some ascarids which an agitated customer had returned to him from some salt codfish which had been purchased from him. A more disturbing case is furnished by a correspondent who made the following inquiry:

"Incidentally may I also ask what the worm is which is so commonly met with in the muscles of the cod? In those specimens which are caught in Mahone Bay (on the south shore of Nova Scotia) proper, the worm is almost invariably found, while in the deep water cod, which is gotten some miles outside, it is quite exceptional to meet with the parasite."

In discussing such cases I always attempted to show, what I shall here also attempt to make clear, that the occasional presence of such parasites should not be permitted to arouse alarm. Of course when seen in the process of preparing food for the table it would be no sign of excessive fastidiousness to remove them, any more than it is to reject the occasional caterpillar that the cook may find in the lettuce that has come from the market. Danger or damage to health or digestion is no more to be apprehended in one case than in the other. In short, when it is remembered that such forms will be killed in the cooking, and will then be simply so much cured meat in the salt cod, it may be easily understood that there can be no such thing as infection following their accidental introduction into the human stomach along with the food. If there should chance to be one who prefers his fresh-fish rare or underdone, I feel reasonably secure, in the absence of experimental proof, that his digestive juices will furnish unkindly cultures for such forms as *Ascaris clavata,* adult in the alimentary canal of the cod, and immature and encysted in the body cavity of a large number of fish.

Upon looking over my records I note immature and encysted nematodes in small numbers in the large sculpin (*Acanthocottus octodecimspinosus*) in all the months in which examinations were made, viz., January, February, March, April, May, July, October, November and December. So far as my records go, therefore, there does not seem to be any seasonal control over the source of infection in this case.

My records for the cod (*Gadus callarius*) are made up, almost entirely from collections made by Mr. Vinal Edwards. They show that examinations were made in January, May, August, October, November and December. Again the record shows adult and young ascarids appearing in each of these months, indicating that there is no particular season when these worms are acquired. When it is recalled that the adult ascarid in the intestine of the cod was an encysted ascarid in the body cavity of another host that was eaten by the cod, where it had lain for months or even years, since one often finds them surrounded by considerable accumulations of degenerate tissue, it can easily be seen that the seasons can have nc effect on the occurrence of such parasites so long as the final and secondary host are associated throughout the year. In cases of migrations, which do not accompany migrations of food, conditions might arise which would occasion a periodicity in the occurrence of parasites.

Whiting (*Merluccius bilinearis*) were examined in the months of March, June, July, August, September, October and November. Immature nematodes were found in the body cavity of this species in each of these months.

Tomcod (*Microgadus tomcod*) were examined in every month of the year. Adult ascarids were found in each month except July and August, and immature ascarids in each month except June and September. It should be stated that very few tomcod were examined in the months of June, July and September.

Pollock (*Pollachius virens*) were examined in the months of April, May, June, July, September, October and November. Both young and adult ascarids were found in each of these months.

The Hakes (*Phycis tenuis* and *Urophycis chuss*) were examined in the months of May, June, August, September, October and November, and immature ascarids found in each species in each of the months.

Goose-fish (*Lophius piscatorius*) examined in the months of April, May, June, July, August, September, October, November and December yielded immature ascarids in each of these months and adults in all except the months of April and June.

Toad-fish (*Opsanus tau*) examined in May, August, September, October and November yielded both adult and immature ascarids in each month.

ACANTHOCEPHALA.

Similar distribution throughout the year for the Acanthocephala seems to be shown as for the Nematoda. For example, the species *Echinorhynchus acus* was found in the Winter Flounder (*Pseudopleuronectes americanus*) in every month in which examinations were made, viz., January, February, April, May, July, August, September, October, November and December.

TREMATODA.

My record of Trematodes is not so full as that of the other orders of helminths. So far as it reveals anything, however, it gives no indication of seasonal variation. A distome, recorded under the name *Distomum simplex,* has been found in the tomcod in every month of the year. Another small trematode, *Gasterostomum increscens,* is recorded from the Barracuda (*Sphyræna borealis*) in the months of April, September, October and November.

CESTODA.

A tetrarhynch, *Rhynchobothrium imparispine,* has been found adult in the spiral valve of the winter skate (*Raja ocellata*) in the months of April, May, June, August, September, October and November. The larval stage of this cestode has a wide distribution among the fishes of the Woods Hole region, where it is found encysted, usually on the viscera, and not confined to any season of the year. Another cestode recorded under the name *Dibothrium rugosum,* is of frequent occurrence in the cod, where it is usually found with the heads impacted in the pyloric cæca. It has been collected in the months of January, February, May, August, October, November and December.

I have called attention in previous papers to the exceptional case of flesh parasites afforded by the Butterfish (*Poronotus triacanthus*). For many years, during the months of July and August, I have been examining a greater or lesser number of butterfish for flesh parasites. The parasite is a cestode, *Otobothrium crenacolle,* whose adult stage has been found most frequently in the spiral valve of the Hammerhead Shark, and less frequently in the Dusky and the Sharp-nosed Shark. In addition to the July and August records I have a few also for the months of June and September. On account of the large number of butterfish that have been examined it is worth while to scrutinize the statistics carefully in order to see if there is any indication of an increase in the number of parasitized fish as the season advances. As a matter of simple observation it was obvious in the earlier years in which this flesh parasite was studied that the proportion of parasitized fish was greater towards the end of the season than it was at the beginning. In some of the succeeding years this difference was not so obvious. Now with data covering additional years available, it will be interesting to see if the conclusion from the observations of former years still holds.

A calculation of the percentage of fish in which no flesh parasites were found, based on examinations made on a considerable number of fish in the months of July and August in the seven years from 1909 to 1914, inclusive, shows a lesser percentage of nonparasitized fish for August than for July, thus indicating a greater degree of parasitism for the month of August in five out of the seven years. This is shown in the following table:

Year	Number of fish examined		Number of fish having no cysts in flesh		Percentage of non-parasitized fish	
	July	August	July	August	July	August
1909	149	49	14	6	0.094	0.122
1910	262	50	72	12	0.274	0.240
1911	58	342	23	63	0.396	0.184
1912	576	171	212	84	0.368	0.491
1913	354	660	163	166	0.460	0.291
1914	235	395	116	184	0.493	0.465
	2134	2565	600	515	0.281	0.200

The result of this calculation, which is based on a sufficiently large number of fish presumably to overcome the effect of the very considerable fluctuation in the degree of parasitism indicated from year to year, seems to be in accord with conclusions reached from observations on each year's record. Furthermore something in the nature of seasonal variation appears to be indicated.

The results of examinations of butterfish for flesh parasites by Mr. Vinal N. Edwards are of interest and are here recorded:

1907 June 7	6	No record of cysts in the flesh.
Sept. 24	6	"Worms in flesh of each."
1908 June 30	1	No record of cysts in flesh.
Oct. 10	15	"Flesh full of parasites."
1909 Nov. 13	6	"Many cysts in flesh."
1910 May 31	12	"Cysts in flesh of 9."
1911 May 22	12	"No worms."
June 17	8	"No worms."
Sept. 29	100	"Cysts in flesh of all."
Oct. 3	100	"All contained cysts in flesh."

So far as this record of Mr. Edwards's goes, it shows a decided increase in the proportion of parasitized fish in the latter part of the year. It must be remarked, however, that conclusions should not be drawn from occasional examinations, even if considerable numbers of fish are examined. This may be illustrated by a single case compared with others of its class. It was noted in the earlier years of observation of the flesh parasites of the butterfish that the smaller fish, 100 millimeters or less in length, seldom had parasites in the flesh. This continues to be the rule. Thus, in 1912 out of 220 fish, measuring less than 100 millimeters in length, that were examined for flesh parasites, only 3 were found with cysts in the flesh, and but few in either case. In 1914, out of 76 small fish examined but one was found with cysts in the flesh, and in that case very few. In September, 1911, however, I examined 270 small butterfish, under 100 millimeters in length, 12 on the 9th, 36 on the 11th, and 223 on the 15th, with the following wholly unexpected and exceptional result: Cysts were found in each of the 270, distributed as follows: 23 with very few cysts, 36 with few, 78 with many, 66 with numerous, and 67 with very numerous cysts in the flesh. In this case it is evident that a school of small fish had been exposed to a common source of infection at the same time. I think that there can be no doubt that, as a rule, the butterfish that are taken in the autumn, or late summer, in the waters of the Woods Hole region show a larger percentage that have cysts in the flesh than is the case earlier in the season. I have interpreted this as indicative of a general northward movement of the butterfish from the warmer waters of the coast farther south. At Beaufort, N. C., I found this species of cestode which is represented by the flesh parasite of the butterfish, the encysted stage, very abundant in the submucosa of many species of fish, and the adult in two species of shark other than the hammerhead, which has thus far proved to be its most usual final host. There is much reason for thinking, therefore, that the chances of infection are many times greater in the latitude of Beaufort than they are off the New England coast. The method of infection, especially where many cysts occur in the flesh, may be easily inferred, when it is remembered that the ripe, egg-containing joints of the adult worm, living in the intestine of a shark, continue active for a long time in sea water, and when discharged in the water along with the fæces of their host, would be greedily eaten by small fish. A single ripe joint may contain many hundreds or even thousands of eggs. Each of these eggs, when once it is swallowed by a fish, may ultimately become an encysted larva. Thus in the extreme case of parasitism of the small fish examined in September, 1911, noted above, it is probable that the school to which they belonged, happened to be in the near vicinity of a shark, most likely a hammerhead, at the time when a considerable number of ripe joints were discharged into the water. The frequent possibility of such happenings will be understood when it is recalled that the chyle in the spiral valve of sharks is often literally swarming with the free joints of these small tapeworms, each of them being the bearer of a large number of eggs.

CONCLUSION.

There does not appear to be evidence of any marked periodicity in the occurrence of helminth parasites of marine fishes, either adult in the alimentary canal, or immature encysted in the tissues of their hosts, beyond what may be expected where fishes are exposed to varying sources of infection in the course of their migrations.

FISH MEAL AS A FOOD FOR TROUT

By Prof. G. C. Embody,

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The College of Agriculture of Cornell University, for the past three years, has offered a Course in Aquiculture. A part of the work of those students electing this course consisted in hatching a certain number of trout eggs, rearing the resulting fry to fingerlings and planting the same in local waters.

Among the many problems which arose was the one concerning fish food. It very early became evident that the classic food, ground liver, could not be used satisfactorily. First, no refrigeration facilities were available, making it necessary to buy only a small amount daily and at a very high price. Second, the daily preparation of this food consumed more of the student's time than was deemed expedient.

A food was desired which might be prepared beforehand in large quantities and which might be kept for a month or so. To this end, a few carp were cleaned and passed through a meat grinder. The resulting hash was boiled tender, passed through a fine sieve, some table salt added and finally one percent boric acid was incorporated in the mixture to insure preservation. The whole was sealed in small wide-mouthed bottles under sterile conditions. It was found that this food would keep for about three weeks. Young rainbow trout were very fond of it and grew satisfactorily. It was not long, however, before the task of preparing the food and removing daily the unconsumed waste from each trough, became so great that a substitute was sought.

In the Transactions of this Society for 1911 (p. 183), Mr. J. J. Stranahan gave an account of his success in feeding bluegill sunfish upon a "Prepared Fish Food," supposed by him to have been made from fresh meat scraps. Upon reading this article, the use of some such dried and concentrated food for salmonoids was suggested to the writer. Accordingly, samples of dried blood, fish meal and various grades of meat scraps were obtained. Up to the present time only the first two have been tried. All attempts to feed young rainbow trout with the blood failed, so this was abandoned after a trial of two weeks. On the other hand, the use of fish meal was so successful that it has been continued for the last two years.

Fish meal, as nearly as can be learned, is that residue obtained after the extraction of oil from fish carcasses. It varies considerably in texture and purity apparently depending upon the place of manufacture. That which was used by the writer was clean, dry, buff in color and consisted of a mixture of fine meal and coarser material, a few particles of which were as large as small peas. By sifting through a screen thirty meshes to the inch, a fine meal was obtained suitable for advanced fry. Passing the residue through a screen with larger meshes, a coarser material fit for fingerlings was obtained; while the last residue was of good size for yearlings.

All sizes of this food have been used successfully both in a dry condition and softened in water. For advanced fry and small fingerlings the writer has merely sprinkled the dry meal over the water surface. The young trout rise and clean it up in a surprisingly short time. A very small portion of the food will sink, but this is immediately seized by the less ambitious feeders. For larger trout the food is first softened by placing for a period of ten or fifteen minutes in sufficient water to cover it. The water is completely absorbed, thereby preventing the extraction of nutritive materials. It is then only necessary to cast a handful at a time over the pond.

Rainbow and brown trout of all sizes will take the food greedily. No trial has been made with brook trout or other salmonoids. All minnows worked with, including the horned dace and various shiners, immediately seized the food without any coaxing. Success was attained also in feeding yellow perch and common sunfish, although it was found necessary first to introduce live minnows to assist in teaching the former to take the food.

In order to obtain some definite idea of the effect of this meal upon growth, one hundred rainbow trout just beginning to feed were isolated May 26, 1914, in a hatching trough eight feet long by fourteen inches wide. They were fed four times per day for the first two weeks, twice daily for the next four weeks, and from then until September 26, once a day. The mean daily temperature of the water during this period of four months varied from 53° to 61° F.

Total weight of 100=283 gms., or 9½ oz.		
Weight of average individual		=2.83 gms.
Length of	largest fish	=3 inches
"	smallest fish	=1⅝ "
"	average fish	=2.4 "

CONCLUSION.

Fish meal is a highly concentrated food containing about 65% protein as compared to the 40 or 60% present in the better grades of meat scrap. It consists not only of the flesh but of the bones and scales of fishes, and, therefore, possesses much of the mineral matter needed by the living fish. It lacks the oil which has very little value in the nutrition of fishes.

It is a dry food and, therefore, must be fed in smaller portions than is the case with liver. Because of this dry condition and high protein content, one pound of the meal is equivalent to at least two pounds of liver in nutritive value. And yet the cost is only about three and one-half cents per pound in hundred-pound sacks.

Taking into consideration all of these facts, together with the keeping qualities and the ease of preparation and feeding, it seems to the writer that by its use a great saving in the expense and labor of operating any trout hatchery is possible. Some disadvantages may arise by continued use, but such are not apparent to the writer at the present time. It is his belief that the product is worthy of a fair trial by every fish culturist.

Author's Note, Dec. 5, 1914: It has been recently ascertained that the "fish meal" referred to above was made from lean beef and not from fish flesh. This error is regretted very much, and in justice to himself the writer desires to say that the food was labelled "fish meal" by the company selling same and was sent to him in answer to a specific request for a product made from fish flesh.

The general results given above are not affected by this mistake. But the portion of the paper referring to the manufacture and composition of the food applies to a meal made from fish flesh. The methods of manufacture and analyses of several brands of true fish meal may be learned from the following publication, namely, "The fish-scrap fertilizer industry of the Atlantc Coast," by J. W. Turrentine, Bulletin No. 2, Bureau of Soils, United States Department of Agriculture.

A meal made from the flesh of salt water fishes may be obtained from The Flavell Company, Asbury Park, N. J.—G. C. Embody.

DISCUSSION.

Mr. Lydell, of Michigan: I wish to ask where this food may be obtained and what is the name of it?

Prof. Embody: It has been used by poultry men for a good many years. I procured the best meal from Darling & Co., Union Stock Yards, Chicago. It is known by two names, "fish meal" and "fish food."

Mr. Titcomb: I had some of this stuff several years ago. It contained about a pound of sand to five pounds of the so-called meal. This looked to me more like ground meat scraps than fish. We used it successfully with young perch, but with other fish it was a failure.

Prof. Embody: The Darlington Co. claims that this is ground fish, and it is very clean. It is probably made from salt water fish, as most of our fish scrap and fertilizer material comes from the Atlantic coast.

THE FISHERIES OF THE PACIFIC COAST

By John N. Cobb,

Editor of the Pacific Fisherman, Seattle, Wash.

But few persons except those intimately associated with the fisheries of the Pacific coast appreciate their magnitude. While the products prepared in other parts of the country circulate widely in their own region, occasionally having a country-wide distribution (as in the case of sardines), certain products of the Pacific coast have a much wider distribution. Canned salmon, almost all of which is packed on this coast, is one of the world's great staples, and the same may be said of salted salmon, while the mild-cured and frozen salmon of the Pacific can be found in all parts of the world except the more remote portions where cold storage is not available. Of the enormous quantity of fresh and frozen halibut consumed in this country, more than nine-tenths come from the Pacific banks, and this product is rapidly making for itself a market in European countries. The most extensive cod banks in the world are to be found off our Alaskan coast, and some day they will support even greater fleets than do the Atlantic banks. At present our Pacific cod find not only a general market in the country west of the Mississippi river, but large quantities are shipped to New England and other points in the East, to the West Indies, Australia, Hawaii, and various Asiatic ports.

Herring are to be found on this coast in immense numbers, while countless other species, some of which are well known to the country at large, as smelt, sea basses, albicore, flounders, sole, tomcod, whitefish, shad and striped bass (both introduced from the Atlantic), are to be found here in large numbers, while others which are peculiar to this coast, as eulachon, black cod, Atka mackerel, etc., are to be found here in great abundance.

Shrimp, crabs, clams, mussels, and scallops are abundant, while both the eastern and the native oyster thrive well and with more modern methods of cultivation will ultimately prove a very profitable industry. Heretofore it has been a rare occurrence for the transplanted eastern oyster to breed on this coast, but in August last Prof. Trevor Kincaid, of the University of Washington, who has been engaged in making an investigation of the oyster fisheries of the state of Washington for the U. S. Bureau of Fisheries, discovered in Willapa Harbor four generations which have grown and thrived from the spat of the eastern oyster. The importance of this discovery will be patent when I state that heretofore our growers have had to import eastern oysters in the seed and depend upon their growth alone for their profit. A plant for the canning of mussel's was established on the northern California coast last spring, and is one of the first in the country to be put to this use.

An idea of the vastness of the Pacific fishing industry may be gained when I state that the census report of 1908 (the last government report containing full data of the fisheries of the United States) places the Pacific coast division, exclusive of Alaska, second only to the Atlantic coast division in almost every particular so far as persons employed and the various items of investment are concerned, while in the matter of quantity of products prepared the Pacific coast division leads all the others, although second to the Atlantic coast division in the total value of products as they leave the hands of the fishermen. Had the fisheries of Alaska been included in the investigation the Pacific coast fisheries would have led all sections in everything except, possibly, in value of products prepared.

The little table below shows the value of the principal fishery products prepared on this cost, exclusive of Canada, during the calendar year 1913. With the exception of halibut, products sold fresh or in the shell are not included, and the best estimate I have been enabled to obtain of these indicates a value of about $2,500,000, making the gross value of all the fishery products prepared on this coast in 1913, over $41,000,000. During

1913 the lower grades of canned salmon sold at figures but slightly above the cost of packing same. This year (1914), however, all grades have been advanced in price from 10 to 40 per cent., and this increase, provided approximately the same pack is made as in 1913, will mean an increased return to the packers of about $7,500,000.

VALUE OF PRINCIPAL PREPARED FISHERY PRODUCTS OF THE PACIFIC COAST IN 1913.

Salmon, canned, salted, mild-cured and frozen,	$33,296,787
Halibut, frozen, fletched and fresh	2,750,000
Fertilizer and Oil from Whales	700,000
Fertilizer and Oil from Fish	250,000
Tuna, canned (77,500 full 48-lb. cases)	500,000
Cod, dry-salted, pickled, etc	375,000
Sardines, canned (73,686 cases 1-lb. ovals)	350,000
Herring, pickled, dry-salted, frozen, etc	200,000
Clams, canned (69,040 full cases)	200,000
Various canned (Trout, 820 cases; shad and shad roe, 5,852 cases, etc.)	125,000
Total	$38,746,787

Since 1908 there has been a great expansion of the industry on this coast, and as but a tithe of our vast production is consumed locally, it has been necessary for our producers to expand their markets throughout the world sufficiently to take care of this production at a remunerative price.

Most of my readers have doubtless during the past year frequently had their attention called to the energetic campaign which is being waged to induce our people to eat more fish. This campaign had its origin in the Northwestern section of this country, and is being systematically pursued not only through the Pacific Fisherman, the only journal representing the fisheries of this coast, but in many other ways. One of the most effective agents was Economic Circular No. 11, issued by the U. S. Bureau of Fisheries, through the broad-mindedness of Commissioner Smith, and entitled "Canned Salmon: Cheaper than Meats, and Why. Including Fifty Tested Recipes." This little pamphlet has been circulated throughout the world by the Government and is now being translated into various languages by steamship and trading companies which operate to and in foreign countries, and it has proved the greatest "boost" ever given to a food product by this or any other government. Dr. M. E. Pennington, chief Food Research Laboratory, Bureau of Chemistry, Department of Agriculture, has also materially aided the good work by preparing a bulletin entitled "Supplementing Our Meat Supply with Fish," which was published in the 1913 Year Book of the Department.

The fixing of an annual Salmon Day (occurring this year on March 13), on which date all are asked to eat salmon, has also aided in focusing the minds of our people upon the wholesomeness and cheapness of this excellent Pacific product. The Salmon Canners Associations of this coast have also issued a number of booklets, leaflets, etc., telling of the nutritious qualities, food value, etc., of canned salmon, while the tuna, sardine and clam packers have also done a great deal of work along these lines.

This systematic work has been found to yield valuable results to the producers of this coast, and I believe other sections would achieve like results if they were to take up the good work so far as their own special products are concerned. The increasing scarcity of meat, with the consequent high cost of same, is making our work easier each day.

THE PACIFIC FISHERIES SOCIETY

By John N. Cobb, *Secretary, Seattle, Wash.*

The members of this Society will doubtless be interested in learning the details of the formation of a sister society with a much more restricted sphere, viz., The Pacific Fisheries Society.

On March 11, 1914, a meeting of those interested in the upbuilding and perpetuating of the great fisheries of the Pacific slope was held in Seattle, Wash., and it was decided to form a temporary organization and to hold a meeting later in the year for the purpose of making the organization a permanent one. The constitution of this Society, with the exception of a few slight changes necessitated by the present smallness of the membership, was adopted.

The following officers were elected to serve temporarily: President, Carl Westerfeld, California Fish and Game Commission, San Francisco, Cal.; Vice-President, Henry O'Malley, Pacific Coast Superintendent of Hatcheries for U. S. Bureau of Fisheries, Seattle, Wash.; Vice-President, Prof. Trevor Kincaid, Head of the Department of Zoology, University of Washington, Seattle, Wash.; Secretary, John N. Cobb, Editor of the Pacific Fisherman, Seattle, Wash., and Treasurer, Russell Palmer, Seattle, Wash.

The first annual meeting was held at the University of Washington, in Seattle, on June 10-12, 1914, and was attended by over 50 of the 126 members on the rolls of the Society on June 10. A number of interesting and instructive papers were read by the members, not the least important of which was one by Dr. H. M. Smith, U. S. Commissioner of Fisheries, who came to the coast especially to attend this meeting, and who was unanimously elected an honorary member.

The Society voted to retain for another year the officers elected at the March meeting, and in addition the following, to serve as an executive committee: Dr. Barton W. Evermann, Director of the Museum of the California Academy of Sciences, San Francisco, Cal.; C.

McLean Fraser, Director of the Biological Laboratory, Nanaimo, British Columbia; Dr. Charles F. Holder, Pasadena, California; Leslie H. Darwin, Washington Fish and Game Commissioner, Seattle, Wash.; M. J. Kinney, Oregon Fish and Game Commission, Portland, Oregon; Ward T. Bower, Pacific Coast Agent U. S. Bureau of Fisheries, Seattle, Wash., and M. D. Baldwin, Montana Fish and Game Commission, Kalispell, Montana.

It was also decided to hold the next annual meeting in San Francisco in 1915, the date to be fixed later.

The geographical boundaries of the Society are restricted to the states of Washington, Oregon, California, Arizona, Nevada, Idaho and Montana, and the territories of Alaska and Hawaii, in the United States, and the Province of British Columbia in Canada.

CATCH BASIN PONDS

By W. O. Buck,

U. S. Bureau of Fisheries, Neosho, Mo.

The Neosho, Mo., station of the Bureau of Fisheries was planned to provide a water surface of about five acres supplied from a spring yielding about 350 gallons per minute and with a temperature of 57° F. at all seasons. The water was brought to a distributing tank on the highest part of the station grounds and thence to the hatchery and in four other directions to supply several series of ponds and pools and with provision for overflow of surplus to another series of ponds. As this surplus, though varying in amount, is likely to be small, it is supplemented by overflow from four small pools supplied direct from the tank. Overflow from the hatchery furnishes the supply for still another series of ponds and four of these series finally empty into a large pond at the lowest point of the original grounds. All the ponds and pools are arranged so that the overflow is of surface water, the result being that in summer the temperature rises from pond to pond while in winter the reverse is true. Ice seldom forms in the upper ponds and is not often more than three inches thick in the lowest and only for a short time, while in summer an extreme water temperature of 92 has been noted.

Omitting now the questions of evaporation and seepage, although both are important factors of the problem here, it remains to consider the results of the arrangement and to determine the proper use to be made of the different ponds. The sorts of fish to be handled number a dozen or more, the principal ones being rainbow trout, large-mouth and small-mouth black bass, rock bass, crappie and bream.

Rainbow trout spawn here from the latter part of November to early April, bass mostly in May and rock bass and sunfish from April till September, so that the work naturally divides itself into two periods, in winter with trout and in summer with bass. Trout are handled by the usual method being allowed as much room as practicable in summer and confined in winter where they can be conveniently handled for egg-taking. It will be recognized that in summer they must be held in ponds or pools near the supply tank and that a good flow must be provided to keep the temperature down. This can be accomplished by giving the trout the smaller upper ponds and, by selecting those from which part or all of the overflow can be diverted from the bass ponds below, it is practicable to avoid sending too much water into the latter. Before the station was built the spring had its outlet by a small stream running diagonally across the present grounds and deep enough so that all the ponds may be drained into it and most of them cannot be entirely emptied except into this stream. While this outlet must be used for part or all of the overflow from the trout ponds, with the other sorts it is necessary to keep it tightly closed while the fish are small enough to pass the screens or they will do so and be lost to the station. It may be thought that the overflow from the trout ponds can hardly be too great for the supply of the bass ponds, but it is to be considered that for bass the supply of cold water may easily be too great, not only because they require a rather high temperature but because the small life, on which they feed, is also greatly stimulated by warmth. But besides this it has been found that the young fish are much more easily held in the ponds when the overflow is shut off or nearly so. It is well known that the young fish move about the pond when so small as to be able to pass through almost any screen that can be maintained and that at this stage their tendency is to go down stream. When they are larger and seek the intake, a larger flow may be furnished as the weather is then warmer and there is less likelihood of the water being made too cool.

It is evident, therefore, that some provision must be made to turn part at least of the overflow from the trout ponds away from the lower ponds of their series and fortunately this can be done by locating the trout in ponds having a drainage outlet other than to the ponds below. The arrangement is such, however, that it is necessary to supply part of the trout ponds through the hatchery or through other trout ponds or pools. No harm appears to result from this except the risk of communicating disease, but this risk is now an important matter and an effort is being made to effect such a rearrangement that each trout pond shall have its own supply, or better still that each shall have two independent supplies. This latter is now possible since the flow of another and larger spring has been brought to the station.

It is worth considering whether repeated use of water has any causal relation to the appearance of the disease, which has for years been on the increase in hatcheries and the control of which is now a problem of prime importance. But, however this may prove, it is reasonable to avoid risk of infection so far as practicable and for this reason the series or catch-basin plan seems undesirable for trout ponds.

It is also objectionable because aeration is less in the lower ponds unless there is sufficient difference of level to admit of a drop through the air from pond to pond, which is not the case here in most of the series. The other sorts of fish do not appear liable to infection nor to miss the fresh aeration and, the disadvantages not applying, it remains to consider what advantages the catch-basin system offers in their case. Two have been referred to above: (1) economy of water and (2) raising of temperature, the latter being an advantage not only directly to the fish but indirectly by promoting the increase of the minute life necessary for their food. The catch-basin system offers the means of saving and disseminating this. Not that the diffusion from pond to pond is likely to be great at most times, but because it is practicable, when the ponds are drawn, to float it down in great quantity to the pond below. This requires beginning with the lowest pond and working up the series.

Although the pond fish are more adaptable than trout, it is still worth while to give each sort its proper location. Thus it appears that small-mouth bass do better in rather cool water and crappie are supposed to prefer theirs roily, while sunfish thrive in the warmest locations, and the catch-basin plan affords opportunity to humor these preferences.

It is probably quite impracticable to prevent occasional overflow in some direction in case of heavy rain and on such occasions small fish are likely to pass the screens to the pond below or even through the entire series and into the stream. The chance of this last may be lessened by holding the large lower pond at such a level that it will not easily overflow and the size of the pond makes it unlikely that small fish will promptly find their way around it and out. It is, therefore, to be expected that this pond will collect some fish, which escape from the ponds above and it seems worth while to stock it with a sort as little voracious as available. With this in mind crappie have been bred there for the last few years and have yielded a crop of young although black bass and sunfish have drifted in. It may be of interest to mention that under the plan described above trout are constantly fed and that aquatic plants appear dangerous rather than useful in the trout ponds while the other sorts are never fed and thrive about in proportion as vegetation is made to thrive.

By way of summary attention is invited to four results of the catch-basin arrangement.

1. Economy of water.
2. Control of temperature.
3. Collection of stray fish.
4. Conservation of minute life.

AN EXPERIMENT IN FEEDING YOUNG LARGE MOUTH BASS

By E. N. Carter,

U. S. Bureau of Fisheries, Bullochville, Ga.

The result of an experiment in providing natural food for young large-mouth black bass at the Cold Spring, Ga., station of the U. S. Bureau of Fisheries, may be of interest to the members of this society.

Dr. Hugh M. Smith, in his very interesting book on goldfish culture as practiced in Japan, tells of the methods carried on there of manuring ponds for the purpose of providing the minute life upon which daphnia, etc., thrive. "The essential point," says Dr. Smith, "is the fertilization of the pond, so that the growth of the minute animals and plants that serve as the immediate and ultimate food of the crustaceans may be greatly stimulated."

One of the methods, and the only feasible one at this station, is the spreading of fresh horse manure over the bottom of the rearing pond at the rate of about 100 bushels to the acre. This is left exposed to the sun for about a week before the filling of the pond with water. Dr. Smith writes: "In a few days the color of the water becomes decidedly green from the presence of unicellular algae in great abundance, and in 2 to 4 weeks the water fleas exist in such numbers that they will support many thousand young goldfish with constantly increasing appetites."

Having decided to give this plan a trial with young bass, commencing May 19th, the writer had fresh horse manure spread over the bottom of one of the rearing ponds, Pond D, 32/100 of an acre in area. The manure was spread near the outlet and in the deepest portion of the pond. Each day thereafter, for four days, all manure available at the station stable was spread in the same manner over the balance of the pond. On the seventh day after the first lot was spread the water in the pond was raised sufficiently to cover this lot and on each succeeding day it was raised until the pond was full and the last lot of manure covered.

By June 10th, 3,000 young bass from an inch to an inch and a quarter long, which had been collected from other rearing ponds, were placed in this pond. From it, up to August 31st, 2,800 fingerlings from 2 to 2½ inches long had been secured for distribution and during September about 100 more 3 inches in length were collected. All of these fish made excellent growth and were in fine condition when shipped. They were given no other food.

This experiment is considered eminently satisfactory and will be repeated next year.

In pond G, 45/100 of an acre in area, and which is supplied largely from small, bottom springs, 7,000 bass from an inch and a quarter to an inch and a half in length were placed, within a day or two of the introduction of fish into Pond D. Pond G had not been previously manured but the natural food it contained was supplemented to some extent by occasional feedings of a ground animal food purchased in Chicago and which is used at this station for feeding young and old fish. From this pond only 750 fingerlings were secured but they were from 3 to 4 inches in length and, of course, fat and in excellent condition. They had attained this condition by feeding on the other 6,250.

Mention of the Chicago food has been made. Repeated experiments at this station have proved that this is not a satisfactory food for bass under 2½ to 3 inches in length, although they take it fairly well after that size has been reached. Even at this 3-inch size, however, they much prefer finely chopped mullet.

THE PADDLE-FISH

(*Polyodon spathula*).

(COMMONLY CALLED "SPOONBILL CAT.")

BY M. L. ALEXANDER,

Pres. State Conservation Commission, New Orleans, La.

This is one of the most singular and interesting fish occurring in American waters. Its range is said to be along the Mississippi Valley from Texas and Louisiana on the south to Minnesota and Wisconsin on the north. It is not uncommon in the Ohio and its larger tributaries, and in the Missouri basin it is found as far west at least as western South Dakota. Its home is mostly in the bayous and lowland streams.

In Louisiana these fish have been rather plentiful in the past, but in recent years, through lack of protective measures, are fast disappearing. They are found in the fresh water lakes of the State and on its rivers and bayous. They sometimes reach an immense size. One of these fishes, a female, was recently taken from a small lake near Angola, Louisiana, which weighed, when dressed, 102 pounds, and contained 10 pounds of eggs. These eggs were sold at $2.00 per pound for manufacturing into caviar, bringing a total of $20. The flesh was disposed of at 10 cents a pound, or for $10.20, bringing, therefore, to the fisherman a gross amount of $30.20.

Another fish of this species was taken from Lake Larto in the northern part of the State, weighing approximately 140 pounds and bringing something over $40.

The spoonbill roe is converted into caviar by the same methods used with sturgeon eggs; that is the fish is opened, the eggs taken out and rubbed through wire screens having a mesh slightly over an eighth of an inch, thereby separating the eggs and removing them from the egg sacs and other foreign substances. Sufficient salt is then added and mixed thoroughly through the eggs, after which they are placed on fine screens to drain. Then they are packed into cans with a capacity of 50 to 75 pounds and shipped to the markets of the north, principally to New York.

Fishing for this species is carried on in widely different sections of Louisiana, but our principal investigations have been made in White Lake, a body of water 22 miles long and 18 miles across, situated in the southwestern part of the State. The spoonbill cat fisheries of White Lake are probably at present the most important in the State, if not in the south. At one time during December and January, 1913-14, there were ten large outfits operating in this body of water for taking this species exclusively. I am told that four of these outfits netted their owner each over $4000 during the season of three to four months. Practically all of this money was paid them for eggs from which to make caviar. It is said that all but three of the ten companies operating in White Lake averaged a net income of from $2000 to $4000 each; also that the other three made a comfortable living for their owner.

Each outfit consists of two good gasoline boats of not less than fifteen to twenty horse power each, and one good, well-equipped seine of 600 feet in length. The crew of each outfit generally consists of from four to six men.

The method of operating seines in those waters has only been in vogue about a year and is very unique. Its efficiency was discovered quite by accident by some fishermen who were towing a seine across a small lake connected with White Lake and, upon drawing it up, found that a number of the spoonbill had become entangled in its meshes.

Once on the fishing grounds each end of the seine is fastened to a gasoline boat and is then dragged up and down the lake by them all day without being hauled out. About every half hour a fisherman in a row boat starts at one end of the seine and pulls his boat along by the twine which he raises sufficiently to remove each fish as he comes to it, being able to detect the fish by its mild struggles to release itself. As a fish feels the touch of the seine being dragged along, he shoots up toward the top of the waters so close to the twine that its bill is pushed through one of the meshes where it remains practically motionless until hauled up by the fisherman. We know of the existence of no other species of fish which are sufficiently docile to submit to this mode of capture. To be sure, the paddle or bill conspires to make its capture in this manner easy, but if they possessed one-half the activity of almost any other species of fish they could not be taken in this manner, since their bill is so smooth that it does not become entangled in the coarse twine of which the seines are made. In spite of being so very inactive, these fish cling tenaciously to life, and live a long time out of water, probably fully as long as a catfish under similar conditions. It is hardly necessary to say that the seines, fished in this manner, rarely ever capture any other species of fish, although catfish and the various species of game fish are fairly numerous in White Lake and are readily taken in seines when hauled out upon the surrounding shores or up under a "round-up."

The spoonbill cat taken from White Lake average much smaller than those taken from other bodies of water in that vicinity. The fish taken from this lake are also more uniform in size and much lighter in color than those taken from other waters of the State, even than those taken from smaller lakes connected with White Lake.

We estimate the average weight of the fish taken from White Lake to be from eight to ten pounds each, and each female having eggs suitable for caviar will produce from one to one and a half pounds of roe,—it being only on rare occasions that one is caught which contains over two pounds.

In the investigation by our Fisheries Department in the study of spoonbill cat conditions in White Lake, about the middle of February of this year, it was found that very few females had already deposited their eggs. However, no fully matured milt was found in any of the males captured. The roe from the fish found in this lake is only suitable for caviar from about November 15th or

December 1st until about March 15th or 30th, according to climatic conditions.

In spite of the short season, it is admitted by fishermen who are familiar with the present spoonbill cat conditions in White Lake, as compared with a few years ago, that they are fast disappearing from this lake and other waters of the State. The situation appeared so grave that our Commission had introduced in the State Legislature a bill, which was passed, making a close season on these fish from January 1st to July 15th of each year. Not that it is likely that spawning spoonbill cat will be found in any Louisiana waters as late as July 15th, but this is necessary to prevent the capture and sale of both catfish and spoonbill cat during the close season on catfish.

In spawning season the spoonbill are seen in schools on the borders of the lake close to the hard sandy bottoms. But little is known of the food of this fish; they are bottom feeders and their chief food is probably minute vegetable and animal organisms, found by stirring the mud and vegetation with their spatulate snout.

Previous to last year large quantities of both species were caught, dressed and sold as spoonbill during the catfish close season, the flesh and appearance of both being very similar when dressed and the heads removed.

It is more apparent that such valuable fish as the spoonbill or the sturgeon should never be caught solely for the purpose of selling their flesh at from four to ten cents a pound and that these fish should be protected for the great value of the eggs which they produce.

The fishermen in Louisiana are now being paid from $1.50 to $2.00 per pound for the spoonbill cat roe. We estimate that the value of this industry to the fishermen of the State at the present time, would aggregate approximately $200,000 per annum.

We believe that every effort should be put forth, both by state and federal governments, to propagate these fish and to build up this industry which promises to be one of unlimited magnitude. The State of Louisiana is now, and will continue, giving it its closest attention.

DISCUSSION.

Mr. Titcomb, of Vermont: May I inquire if you have been successful in propagating the spoonbill?

Mr. Alexander: We have not made any attempt at propagating this fish so far.

Prof. Dyche, of Kansas: I should like to know if you have succeeded in obtaining the eggs of the spoonbill? If you have, you have found something entirely new to science.

Mr. Alexander: I am inclined to think you can locate the eggs of the spoonbill in the waters to which I have called attention. We have frequent reports of the small fish, measuring an inch or two up. In the shallow waters of the lakes, and in the spawning season, these fishes are seen in large schools around the borders of the lakes, which would indicate that they are there for the purpose of depositing their eggs.

President Ward: There is only one case recorded in the literature of anyone having had what is known to be a ripe female of this species. Are you sure that these females are really ripe and ready to discharge the eggs?

Mr. Alexander: There is no question about that in the latter part of February. Mr. E. A. Tulian, the head of our Fisheries Department, told me that they had stripped a number of them. I do not know to what extent scientific men have carried on their search for these eggs, but I am inclined to think they have been making their investigations in the wrong territory. I know of none made in our waters. We will be glad to place every means within our power at their disposal if they will come to us.*

The eggs of the spoonbill are manufactured into caviar, probably sold as Russian caviar. We buy our own eggs back again in this form.

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* On account of the importance of this discovery the Editor took occasion to write to Mr. Alexander after the presentation of his paper, for further data in regard to the eggs of this fish. Mr. Alexander writes in part, "It is possible that only a limited number of eggs could be secured and fertilized, owing to the apparent scarcity of ripe males during the spawning season at White Lake. Our investigations there covered only a few days during the latter part of February, the last few of March and the first few of April, 1914. The operations conducted by us at this point show that a very small portion of the total number of females caught during February contained ripe eggs. Most of these taken during the latter part of March and the first few days of April had either partly or entirely deposited their eggs. However, two or three females contained eggs which were not fully matured. Only two or three nearly ripe males and no spent ones were taken during our February operations, while we found only spent males the last of March. Up to the present time, so far as we know, no ripe eggs of the paddlefish have been found in any of the fish taken from the rivers of our State to which they are indigenous, although the young, not over five or six inches in length, are often seen in the Little, Tensas, Ouachita and Black Rivers early in the spring, so we are told. It is probable that these are hatched in Catahoula Lake. Our experiments with this species were conducted by the head of our Fisheries Department, Mr. E. A. Tulian.

In view of these and other facts I feel confident that I have made no claims that we cannot substantiate."

Zoologists will await further information on this matter with interest.

Editor.

We are laying down our opportunities and rights by neglecting to take advantage of our resources and making something out of these fish. I went before the legislature and had them pass a closed season of over six months against the protest of the fishermen, recognizing that it was necessary because these fish are disappearing from the waters of our State.

PROF. DYCHE: If the fishermen get such a high price for the eggs it will be but a short time until you will have no fish. The lake sturgeon were caught for their eggs and in a short time they were exterminated. You will have to have some restrictions regarding the management of that business.

MR. ALEXANDER: We protect them six months out of the year, and permit no fish to be taken under twelve inches in length.

PROF. DYCHE: That is taking a long chance on saving them. You might protect them nine or ten months, but if you allow them to be caught at the spawning time the same result will follow.

PRESIDENT WARD: Professor Dyche is quite right in emphasizing the danger in collecting fish for caviar. They must be taken at the time when the eggs are nearly if not fully ripe and the consequent destruction is, of course, enormous. This might be met by providing protective measures through hatching, or otherwise, but it certainly is dangerous ground that the fishermen are treading on when they capture ripe fish for the eggs exclusively, and it is a fact that sturgeon have been exterminated in certain regions of the earth by reason of their pursuit for the eggs.

THE PROPERTIES AND UTILIZATION OF SOME MARINE ANIMAL OILS[1, 2]

BY DR. GEORGE F. WHITE, *Clark College, Worcester, Mass.*

(From the Laboratories of the U. S. Bureau of Fisheries, Woods Hole, Mass., and Clark University Worcester, Mass.)

The term "fat" may be considered, for technical purposes, to include all those substances which are glycerides of fatty acids, exclusive of the lipoids, which may be nitrogenous and phosphorized glycerides such as lecithin. Fats are divided for convenience into solid and liquid fats, the latter being classified ordinarily as oils. It should be noted, however, that oils may become solid fats by lowering the temperature and solidifying the contained glycerides, so that the distinction is purely arbitrary. Oils, in turn, are either vegetable or animal, and to this class belong the marine animal oils.

Fish, liver and blubber oils constitute the class of marine animal oils and show fairly distinct differences in composition and behavior. Sperm oil is not included in these as it contains a large amount of spermaceti, which is a wax and not a fat, waxes being esters of other alcohols than glycerol. Some important and characteristic differences between a vegetable oil (linseed) and marine animal oils of various kinds, and of sperm oil and spermaceti, may be best shown by the following table, compiled from the results of experiments at Woods Hole.

It is not in the scope of this paper to discuss methods of preparing oils. The methods of obtaining menhaden oil are simple in principle, involving a digesting process, pressing by one means or another, steaming out the oil

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[1]Published by permission of Dr. Hugh M. Smith, U. S. Commissioner of Fisheries, Washington, D. C.

[2]For a fuller account of the industrial side of this topic, see "Aquatic Products in Arts and Industries," C. H. Stevenson, Part XXVIII, Report of the Commissioner, U. S. Commission of Fish and Fisheries, p. 177, 1902.

TABLE I.

CHARACTERISTIC PHYSICAL AND CHEMICAL CONSTANTS OF SOME VEGETABLE AND MARINE ANIMAL OILS.

Kind of Oil	Specific gravity at 30°c.	Viscosity at 50°c.	Iodine number	Saponification number	Acid number
Linseed	0.9251	0.1751	152.4	194.7	4.00
Menhaden	0.9230	0.1727	143.3	191.1	0.88
Dogfish (*Mustelus canis*)	0.9185	0.2135	135.9	193.0	0.94
Squeteague	0.9177	0.2402	103.9	196.5	7.40
Scup	0.9168	0.2141	117.3	188.9	16.73
Butterfish	0.9090	0.2092	91.1	191.4	62.07
Eel	0.9135	0.2026	117.4	191.1	1.02
Dogfish liver (*Mustelus canis*)	0.9164	0.1977	124.8	189.9	1.60
Dogfish liver (*Squalus acanthias*)	0.9187	0.2049	142.7	171.4	4.84
Dusky Shark liver	0.9127	0.2386	118.2	185.2	0.81
Sand Shark liver	0.9262	0.1943	....	182.7	1.52
Hammer-head Shark liver	0.9245	0.2682	155.5	174.1	3.32
Torpedo liver	0.9044	0.2133	111.0	164.0	0.92
Cod liver	0.9277	0.2001	142.6	185.8	1.82
Barn-door Skate liver	0.9253	0.1970	155.8	184.9	0.38
Sea-elephant	0.9135	0.2452	127.8	197.8	1.66
Sea-leopard	0.9153	0.1858	121.6	197.5	0.00
Whale	0.9192	0.1822	156.6	192.8	6.70
Blackfish head	0.9135	0.1132	33.90	277.8	0.81
Porpoise body	0.9221	0.1208	30.26	....	1.53
Porpoise jaw	0.9176	0.1084	30.68	286.0	0.89
Sperm		0.1720	85.5	167.0	0.33
Spermaceti	0.8627	0.1040	65.75	137.7	0.26

from the filtrate, and reclaiming some oil of inferior grade by filter-pressing the gurry. Liver oils of good quality are obtained by steaming fresh livers for a short time and allowing the oil to rise. Extraction with solvents may be resorted to where difficulties are encountered, as in reclaiming oil from digested dogfish, the mushy character of which causes a poor separation in the modern screw-presses. I have obtained good fish and liver oils by steaming at brief intervals of time in an autoclave at 5 to 10 pounds pressure. This process suggests possibilities for the reclaiming of oil from dogfish.

Crude marine animal oils all have a fishy taste and odor. They turn dark on long standing, and may deposit a solid fat, which fat is composed of glycerides mainly of palmitic, together with some stearic and oleic acids. This deposition of fat (roughly called "stearine" in the trade, and used for soap-making) is of course markedly hastened by cooling. It has been noted by the writer that the liver oil of the smooth dogfish deposits much larger amounts of "stearine" than does that of the spiny dogfish. Torpedo liver oil gave none even after one hour's standing over ice.

The specific gravities of the various marine animal oils and of linseed oil are very similar, averaging about 0.92 at 30° C.

The viscosity, which is of great importance in considering the value of oils for paints and lubricants, varies around the value 0.2 at 50° C. Viscosity values are expressed in C. G. S. units. I have studied this phase of the subject to a considerable extent and have devised a viscometer requiring only five minutes for a determination and but five cubic centimeters for a sample of oil. The accuracy of the instrument, method of manipulation, and results are discussed in the original papers.[1] It was found that the viscosity of the oils is very characteristic and constant even if the different samples of oils were obtained under diverse conditions. Mixtures of oils were studied, and it was observed that the *fluidities* (fluidity being the reciprocal of viscosity) of the mixtures are strictly additive; that is, from the fluidity the percentage composition of the mixture can be calculated. It was stated that such a test of the character of an oil is not of great value if taken by itself, but is well worth consideration along with other physical and chemical tests. The fluidities of fish and vegetable oil mixtures were also shown to be additive.

Some marine animal oils have the property of drying to a considerable degree, and this is a good reason for the assumption that such oils contain large amounts of unsaturated fatty acid esters. The nature of these is not well understood as it is extremely difficult to isolate such

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[1]Journal of Industrial and Engineering Chemistry, vol. 4, pp. 106 and 267 (1912).

unstable compounds without breaking them up. Ordinary distillation decomposes the oils, changes their composition, and the almost hopeless mixture of glycerides presents a very complex problem to the analytical chemist. The drying power of the oils is shown by the iodine numbers. The iodine number is the percentage of iodine absorbed by an oil, and is probably the constant which tells more of the value of the oil than any other. While many of the fish oils have iodine numbers nearly as great as that of linseed oil, they do not necessarily dry in exactly the same manner, a sticky gum being sometimes obtained instead of a hard, dry film.

Many attempts have been made to refine fish oils and rid them of their fishy odor, taste and color. Very few of these attempts have met with any degree of success. Physical methods may include washing with water and drying either by allowing to settle, or drying with calcium chloride, cooling to separate "stearine," allowing to stand over or filtering through fullers' earth, infusorial earth, or animal charcoal, and steaming under ordinary, reduced, or increased pressure. As far as my observations go, the use of such agents as charcoal do not change the character of the oils to any appreciable extent, especially if they are of fairly good quality to start. The results of steaming oils will be considered later.

Chemical methods of purification may be used, although very few of these attempts have met with any degree of success. The oil may be treated with a small amount of concentrated sulphuric acid and the slightly charred product allowed to settle, the albuminous impurities thus being dragged down. I have found this process practically worthless for marine animal oils. Treatment with ozonized air, and chlorine generated in various ways, have been tried, as well as very many other processes. That process which seems at present to promise ultimate success is the so-called hardening of the oils by hydrogen.

"The treatment of unsaturated oily bodies with hydrogen to obtain saturated derivatives is of great scientific and technical interest. In the fat industry a most fascinating problem has been that of the conversion of oleic acid or olein into stearic acid or the corresponding glyceride."[1] Since fish oils contain large amounts of glycerides of unsaturated acids, under proper conditions they should add hydrogen directly, just as they take up bromine and iodine. Hydrogen is very active in the presence of finely divided nickel heated to a suitable temperature, and such carefully prepared nickel will hasten the reduction of any reducible substance.

Catalyzers are those substances which change the rate of a chemical reaction without being noticeably affected at the end of the reaction. "With a powerful catalyzer the hydrogenation of oils becomes a rapid, simple procedure; almost, as it sometimes seems, independent of the hydrogenating apparatus."

"Catalyzers recognized as useful for the purpose are nickel and palladium, although platinum, copper, iron and other metals have been used to a great extent. . . . As nickel is probably the most important of these catalyzers, in view of its efficiency and relatively low cost, it will be first considered. The preparation of an effective nickel catalyzer requires considerable care. The oxide or hydrate of nickel is first obtained by reduction of nickel nitrate, or precipitation of nickel hydrate from, say, a nickel sulphate solution by the addition of an alkali. Obtained in this or any other suitable manner, the next step is the reduction to metallic nickel. For this purpose the nickel is placed in a receptacle which may be heated controllably, and hydrogen gas is passed over the mass at a temperature ranging from 250° to 500° C. or so, until water is no longer evolved." Such a catalyzer is very sensitive to outside influences, and is poisoned by certain gases, loses its activity if exposed to the air, etc. "Catalyzer made from the oxide without supporting material, weight for weight, is hardly as efficient as when the active surface is increased by the use of a carrier. Hence we find many proposals for the production of cata-

[1]The quotations referring to the hydrogenation of oils are taken from the article of C. Ellis, Journal of Industrial and Engineering Chemistry, Vol. 5, p. 95 (1913).

lyzers with a great diversity of carriers, ranging from pumice stone and kieselguhr to charcoal and sawdust."

"By hydrogenation, oils which formerly made soaps only of soft consistency, now yield the more valuable hard soaps. This has led to a very rapid development of the art with respect to the production of soap-making fats. In particular, fish and whale oils have been made use of because these oils may be completely deodorized by the addition of hydrogen. . . . When hydrogenated down to an iodine number of about 50, fish oil has the consistency of hard tallow and the odor of fish oil is wholly absent. Even the fishy taste is scarcely in evidence. For soap-making, this product is satisfactory as it complies with the test for a deodorized fish oil suitable for soap-making in that the odor of the original oil is not apparent when ironing laundered goods on which such soaps are used."

In the consideration of the edibility of hydrogenated oils, the presence of the catalyzer in the finished product must be considered. "Whale oil, containing 0.6 per cent. fatty acid, yielded 0.006 per cent. ash and 0.0045 per cent. nickel oxide. Such an amount of nickel presumably would not be tolerated in a product intended for edible purposes."

MENHADEN OIL.

In the United States, menhaden oil obtained in the south Atlantic waters is called "Southern" oil and is distinguished from "Northern" oil by its lighter color, and by the fact that it contains more glycerides of higher fatty acids, therefore depositing a greater quantity of stearine when cooled. The oil is sold under several trade names—"Prime Crude," "Brown Strained," "Light Strained," "White Bleached" and "Yellow Bleached," depending on the degree of refinement. Sometimes the grades are called "A," "B," "C," and "D," the distinction being based on the color, "A" grade being a very light yellow, while "D" grade is the very dark brown oil.

The condition of the market in December, 1913, may be best shown by the following quotation:[1] "Authorities estimate this season's yield of oil will come fully 40 per cent. short of last year's output. Crude Southern oil was offered at 33 cents per gallon, f. o. b. Baltimore, but there were no buyers at this price. Northern oil was nominal at 36 to 37 cents per gallon, most sellers asking the outside figure. The pressed grades were steady in the face of a quiet demand. There was a moderate inquiry for the light pressed. Prices closed unchanged as follows: light and brown strained, 40 to 42 cents; yellow bleached, 42 to 44 cents; white bleached, 44 to 45 cents per gallon."

Menhaden oil is used in the leather industry for currying, in soap-making, and in the paint and varnish industry as a substitute for linseed oil. Its use for rubber substitutes, etc., is kept a trade secret.

"The oil that gives the best and most lasting results for paint purposes is menhaden oil, and the winter bleached variety is the one that should be recommended.[2] This is an oil fairly pale in color, with an iodine number of 150 or over, and with little or no fishy odor. . . . The results I have obtained from the proper grades of fish oil . . . warrant me in saying that fish oil in the hands of an intelligent manufacturer, and used up to 75 per cent., produces excellent results for exterior purposes. For interior purposes fish oil does not seem to be desirable, for it gives off noxious gases for a long time."

"Menhaden oil should, of course, be used with a drier, and for that purpose the best results are obtained by means of a Tungate drier. Tungate drier is one in which tung oil or China wood oil is boiled with a lead and manganese dioxide, and when the solution is complete, this is then mixed with a properly made resinate of lead and manganese. Such a drier becomes soluble in the oil at temperatures over 100° C., and hardens the resulting

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[1]Oil, Paint and Drug Reporter, Vol. 84, p. 35, Dec. 15, 1913.

[2]Toch. "Fish Oil as a Paint Vehicle." Journal of Industrial and Engineering Chemistry. Vol. 3. p. 627. (1911).

paint very thoroughly. For fabrics, however, fish oil must be heated to a temperature of over 200° C., and if air is injected at such a temperature the glycerides are expelled and thick oil is producd which, in conjunction with the drier just named, is equally good for printing inks. It is advisable, however, to add at least 25 per cent. of either a heavy bodied linseed oil or a raw linseed oil which does not break before the manipulation just referred to has begun."

"Since last year some of the enamel leather and printing ink manufacturers have adopted the use of fish oil as a medium to replace linseed oil, with excellent results, and the enamel leather which is produced, while not so high in gloss as that made entirely of linseed oil, is much more flexible and possesses an unctuousness which prevents it from cracking. But fish oil for leather purposes shows a peculiar defect, and a campaign of education will be necessary if ever this material is to be used for the manufacture of shoes or auto tops, for fish oil, particularly when it originally has a high acid number, seems to effloresce and gives an undesirable bloom to enamel leather, which, however, can be removed from the surface by the ordinary application of benzine or a mixture of benzine and turpentine."

"We are all aware that paint made from fish oil can be applied to hot surfaces and will not blister or peel as readily as that made from linseed oil, and for this purpose—as a smoke-stack paint—it is very desirable."

"There is great demand for baking japans which shall be flexible and at the same time so thoroughly baked that they adhere to the surface most tenaciously and form an excellent enamel, and for this purpose we know that the reasonable use of fish oil improves baking japans very much indeed. We are also aware that along the seacoast, where paint disintegrates very rapidly on account of the sea air, a fairly liberal use of properly treated fish oil serves a useful purpose."

"When red lead is mixed 33 pounds to a gallon of linseed oil it thickens up after a short time and becomes unfit for use. A properly neutralized fish oil prevents the hardening or setting of the red lead in the package, and a paste of this material can be transported a great distance and will last many months in a fresh and soft condition."

COD LIVER OIL.

The production of a medicinal cod liver oil of good quality requires considerable care. Such oil is now made from selected fresh livers, those livers being discarded which are at all discolored. The livers are subjected to the action of steam at a fairly low temperature, (the best oil is obtained when the temperature is not allowed to exceed 70° C.) and the oil rising to the top is skimmed off. This oil is of the first grade, and after filtering from liver tissue, may be bleached by treatment with fullers' earth or by exposure to the sun. Longer heating affords a darker oil, and a brown oil may be finally obtained by pressing the residues.

Good medicinal oil should be of very light color, slight fishy odor and taste. It should have a small amount of free fatty acids, of volatile acids, and its iodine absorption value should be high. Its medicinal value is very probably not due to the amount of free acids, to the small amount of iodine contained in all cod liver oil, nor to the presence of any bases from the decomposed protein matter of the liver. Lewkowitsch[1] thinks that "the medicinal effect of cod liver oil . . . must be looked for in the facility with which it is hydrolyzed or digested, and it cannot be doubted that this property is caused by the peculiar constitution of its unsaturated fatty acids. From the medicinal point of view, that cod liver oil is the best which has been prepared from fresh livers and kept protected from the action of light and air."

There is on the market an oil called "cod oil" which is nothing but a crude cod liver oil. It is prepared in

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[1]"Chemical Technology and analysis of Oil, Fats and Waxes." Vol. II, p. 361.

this country on the Eastern and Western coasts. Livers of other fish than the cod help to increase the supply of this oil. Cod oil, on cooling, deposits "stearine" which may be used for soap-making, while the expressed oil is employed in the leather industry. In December, 1913, domestic cod oil was selling for 37 cents a gallon.

TORPEDO LIVER OIL.

The liver of the torpedo yields a large amount of oil; one liver weighing 15 pounds gave one gallon of oil. The unrefined oil obtained by steaming the livers is a very light yellow oil, of slight fishy taste and odor, and deposits no stearine when cooled. Treatment of the oil with bleaching powder seemed to improve the quality only slightly, the physical and chemical properties remaining practically unchanged. An exceedingly clear, light colored and odorless product was obtained when the crude oil was subjected to the action of steam. The oil was heated by steam, a current of steam was passed through, and drawn out under reduced pressure. Thus all volatile aldehydes (the odor of acrolein was decidedly noticeable in preparing the crude oil from the livers), free fatty acids of low boiling point, and all those products causing the fishy odor, were removed.

The oil was hydrogenated at a temperature of 200° C. in the presence of reduced nickel. Hydrogen was simply bubbled through the oil which was placed in a vessel

TABLE II.

PROPERTIES OF CRUDE AND REFINED TORPEDO LIVER OIL.

	Acid number	Saponification number	Iodine number	Viscosity at 50°c.	Density at 30°c.
Crude oil	0.70	165.4	110.2	0.2097	0.9013
Oil treated with bleaching powder	0.73	....	104.0	0.2156	.....
Oil treated with steam	...	....	104.6	0.2142	0.9049
Oil treated with hydrogen	0.91	....	97.2	0.2629	0.9066

heated by an oil bath. The nickel was deposited on asbestos fibre. An oil of pleasant nutty odor was prepared by hydrogenating for a few hours. It is hoped that this problem may be studied to a greater extent.

While torpedo liver oil has been used to a small extent by some fishermen for rheumatism, it has otherwise been unutilized. It was applied to the bearings on lathes, to the valve-stem of the steam engine, and elsewhere in the machine shop at Woods Hole. The results were very promising. It of course saponified readily on the steam engine, and was found an excellent lubricant as it did not gum, although the bearings on the lathe heated up somewhat. It is too light an oil for such purposes, as the viscosity is low, but it should serve well as a spindle oil. The refined oil should be an excellent lubricant for light machinery.

SPINY DOGFISH LIVER OIL.

Spiny dogfish livers yield 45 to 55 per cent. oil of good quality if rendered properly. Prepared in the best manner, the oil is light yellow in color, clear, and of slight odor. Bleaching powder does not improve the oil to any extent, nor treatment with charcoal or diatomacious earth. By the steam treatment as with the torpedo liver oil, a product of excellent character was obtained. The following table presents the results of analyses:

TABLE III.

PROPERTIES OF CRUDE AND REFINED SPINY DOGFISH LIVER OIL.

	Acid number	Saponification number	Iodine number	Viscosity at 50°c.	Density at 20°c.
Crude oil	0.59	172.0	116.1	0.2171	0.9066
Oil treated with bleaching powder	0.62	171.4	....	0.2186	.....
Oil treated with steam	0.59	172.6	112.7	0.2183	0.9083

While the character of the oil of the torpedo liver varies but little, as evidenced by the two sets of constants given in Tables I and II, that of the spiny dogfish shows considerable variation, especially in the iodine number. Thus Thomson and Dunlop[1] obtained an iodine value of 126.4, and 8.4 per cent. unsaponifiable matter. I found the iodine value to be 116.1 in one case and 142.7 in another, and 2.65 per cent. unsaponifiable matter. The oil should be studied further to characterize it fully, particularly with regard to the volatile and soluble acids.

Lewkowitsch[2] states that the dogfish "is caught on the coast of Oregon, Washington and British Columbia in large quantities. One hundred livers are stated to yield 6 to 8 gallons of oil. The oil is not generally kept separate from cod liver oil, and is sold in admixture with the latter for currying purposes." Dogfish liver oil carefully prepared may well be used for other than the above purpose.

SPINY DOGFISH BODY OIL.

The oil in the body of the dogfish is retained exceedingly tenaciously, and steaming under pressure does not seem to be wholly satisfactory. Pressing in the continuous screw presses yields a soft mushy product from which it is difficult to obtain a good yield of oil. Extraction by solvents is being tried at some plants now in operation for the manufacture of fertilizer and oil.

By extraction of the dry flesh with ether I obtained a brown oil with the following constants:—iodine number, 128.3; saponification number, 182.4; acid number, 1.66; density at 30° C., 0.9176; viscosity at 50° C., 0.1766. The oil is of lower quality than the liver oil, although its drying power is fully as great as indicated by the iodine absorption value.

SPINY DOGFISH EGG OIL.

The utilization of dogfish eggs for the tanning of leather is dependent on the quality of the contained oil.

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[1]Chemical Technology of Oils, etc. Vol. II, p. 370.
[2]Ibid. p. 368.

I found that in one sample of eggs there was 44.79 per cent. water, and 22.37 per cent. oil as obtained by extraction with carbon tetrachloride. This makes 49.96 per cent. oil in the dry yolk.

By extracting the dry yolks with ether, a rather viscous, light brown oil was obtained, of slightly fishy odor. This oil contained a solid fat which possibly consisted largely of "stearine," but probably was also composed of "lecithin," a nitrogenous and phosphorized glyceride which is found in egg yolk to a considerable extent. A more intensive study of this oil will be made.

The constants of the oil are as follows:—iodine number, 124.1; saponification number, 176.0, acid number, 8.1; density at 30°, 0.9268; viscosity at 50°, 0.3610.

* * *

The other shark oils are of not enough commercial importance on account of the supply, and the qualities of the blubber oils mentioned in Table I are too well known, to be considered here. From the interest in the skate on account of its value for fertilizer and glue, the exceptionally high iodine value of the liver oil should be noted (this value is exceeded sometimes) and its possible use as a drying oil should be considered.

94

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CONTENTS

TAXONOMIC AND FISH-CULTURAL NOTES ON THE CHARS OR TROUTS OF NEW ENGLAND

By William Converse Kendall,
Assistant, Bureau of Fisheries.

I have no formal paper to present, but should like to call your attention to a few matters pertaining to the chars or "trouts" of New England, which include the "brook trout" as their best known representative.

Authorities differ regarding their geographical distribution, and whether or not the different forms should be regarded as distinct species. They are mainly boreal and of wide distribution in the northern hemisphere, as a group extending entirely around the globe and northward to even beyond the limits of open water. There are southward extensions and more or less isolated occurrences as far as southern Europe and in the United States to New England and northern California. The brook trout, however, is found in the mountain sources of some rivers as far south as Georgia and Alabama.

The typical char of Europe is *Salvelinus alpinus,* which is nominally represented in Greenland by *Salvelinus stagnalis* and in the north Pacific by *Salvelinus malma.* There are intermediate nominal species, however, which are apparently so closely related that from descriptions and scanty material it is difficult to decide where one species leaves off and another begins. Some authorities regard all or most of them as constituting one species composed of various forms, each possessing characteristics of merely local significance.

The first two pictures shown you (demonstration) are of the common lake trout from a small lake in western Maine. In Maine, it is known as "togue" and in New Hampshire and Vermont as "lunge" or "longe," and farther west as "lake trout," "Mackinaw trout," etc.

The lake trout has been regarded as a distinct genus from the rest of the chars and for a long time bore the generic name of *Cristivomer*. This genus was apparently based upon the form of the vomer alone, but it has recently been shown that this ground is untenable. Therefore, according to the rules of taxonomy, this genus *Cristivomer* has to be abandoned and the fish again falls into the generic group designated as *Salvelinus*. However, while this character alone does not serve to generically distinguish it, there are indications that there may be found some other quite tangible characters, or even more than tangible—something that we can get hold of and grasp—that will separate it as a distinct genus, regardless of the character of the vomer. As a rule, we cannot find one character alone that can be regarded as of generic value. There must be a combination of characteristics and each of these may alone be of little significance or value but in combination wholly sufficient. In regard to the lake trout, one apparently minor characteristic is a permanently strongly forked tail, and another is its general deep water habitat. Other chars have forked tails in their younger stages and in some instances the character is retained in later life, but this is irregular and inconstant in those fishes while it is constant in the lake trout. The forked tail alone, however, will not avail, so it must be associated with other characters which investigation may quite probably reveal, for the fact that the younger stages of other *Salvelini* have forked tails and the lake trout a permanent one suggests that the lake trout originated earlier in the line of ascent or evolution than did the other chars from some common fork-tailed ancestry. If this is true the lake trout must naturally and necessarily be a distinct genus. However, the combination of distinctive characters must be demonstrated before the fish can be entitled to resume the title of *Cristivomer*.

In this connection, I beg to refer to another matter which bears upon this question but not directly upon the New England chars. Mr. C. Tate Regan, of the British Museum, has decided that the generic name *Oncorhynchus* which has been adopted for the Pacific salmon is no longer tenable because he found an individual of a Japanese species, which was supposed to be of the group formerly called *Oncorhynchus,* having as few anal rays as the genus *Salmo.* One of the distinguishing marks of the genus had been held to be the more numerous rays in the anal fin than in that of the genus *Salmo.* However, besides some minor associated or combined differential characters, the Pacific salmon have one prominent characteristic that sets them out as a sharply defined group of fishes, and which, taken in combination with predominant, if not defined, structural characters, I think should be regarded as sufficient to distinguish it as a genus. That characteristic is that the fishes composing this group invariably die soon after having reproduced once only in their life time.

Reverting to the New England trouts, the four pictures following the lake trout are of the blue-back trout (demonstration). For many years this fish was supposed to be peculiar to the Rangeley lake in western Maine, but was comparatively recently discovered in Rainbow lake, the headwaters of a tributary of the West Branch of the Penobscot river. The first published description of this species was by Girard in 1853, from which time no other species of the saibling group of chars was recognized in New England until about 1885, when the golden trout of Sunapee lake was discovered. A peculiarity of the blueback was that until comparatively recently they were small fish, never over 9 or 10 inches long and never varied from about one-fifth of a pound each. They were hardly ever taken on a hook but were netted by the inhabitants in large quantities as they ascended the affluents to spawn, appearing in those places about the tenth of October. Finally they began to decrease rapidly in number, so rapidly that the Maine Fish Commission considered it necessary to prohibit catching them by any means. The commissioners apparently ascribed the growing scarcity to excessive and untimely fishing. But such fishing had been carried on for fifty, seventy-five or a hundred years with no apparent reduction in the number of the fish. Finally, however, they became so scarce that when I was up there in 1901 we had a man on those brooks night and day and failed to secure a single fish and none was seen in any of their former spawing places. We did manage to secure one fish, in Kennebago stream, weighing about three-quarters of a pound, which was much larger than usual. I got several others in 1903 and 1904, all large fish. Subsequently they appear to have become extinct. The few that remained prior to their disappearance increased in size. The cause of the extinction, I believe, was the "successful" introduction of the land-locked salmon, which, with the common trout, subsisted to a great extent upon the little blue-backs. The blue-backs disappeared down the maws of the salmon as it were. It was not until 1891 that other food was afforded them by the introduction of the smelt, which was too late.

The later phenomenal increase in size of the blue-back was probably attributable to the smelt, in the young of which it found an increased and unaccustomed abundant food supply, as the young smelt apparently go into deep water while almost in a larval state.

The pictures following those of the blue-back are of the famous golden trout, or *Salvelinus aureolus* of Sunapee lake (demonstration). It was not described until 1887. It is closely related to the blue-back, and it is difficult to distinguish the preserved dead specimens of this fish from blue-backs of the same size under the same conditions. In fact, it was believed by many to have appeared in Sunapee lake as the result of the introduction of blue-backs. Some, however, maintained that it was the introduced Europen saibling. Those who advocated the blue-back theory would have been delighted had they foreseen the increase in size of that fish in Rangeley lake, as the principal argument of the opponents of the theory was that the Rangeley blue-back was always a much smaller fish. Regarding this fish, I have fears, which, however, are not shared in by many who are familiar with the conditions at Sunapee, that the beautiful golden trout, unless the object of the utmost conservative attention, is doomed to extinction in the same way and for a similar reason as the Rangeley blue-back.

After the pictures of the Sunapee trout you come to the "peculiar trout" of Monadnock lake or Dublin pond, New Hampshire, described and named by Mr. Samuel Garman, of the Museum of Comparative Zoology, Cambridge, in 1885. This fish (demonstration) was the subject of controversy for many years, to settle which specimens were sent, from time to time, to different authorities. It was sometime in the early sixties that Prof. Louis Agassiz, having received some specimens, considered them closely allied to a form found in Switzerland. Later, Prof. Baird pronounced it a variety of the common lake trout, after which, by others, it was denominated a color form of the common brook trout, and apparently, subsequently to his description of it as a new species, Garman regarded it as a color variety of the brook trout. To cut a long story short, I will simply state that the trout appears to be in its habits and general appearance more closely allied to the golden trout of Sunapee lake and the blue-back of Rangeley than to the common trout. All that it seems to have in common with the latter is the mottled dorsal and caudal fins.

The last picture (demonstration) is not a good representative of the brook trout as we know it, but in respect to its coloration there is an interesting fact. That fish was artificially raised in a little pond in Falmouth, Maine. You will notice that the colors of the ventral region are brilliant orange or yellow. The trout from which the eggs were obtained that produced the Falmouth fish were from a pond in Hollis, Maine. They were of an intense rose color, but in their progeny became the yellow trout of Falmouth, indicating that color of this kind alone can be of no specific value, at least so far as the brook trout are concerned.

There is another matter pertaining to these trout of more fish cultural importance than what I have previously said, which I wish to submit for your consideration. Some ninety years ago a distinguished anatomist and embryologist by the name of Rathke described the ovaries of various fishes and amongst these were the Salmonoid fishes, concerning which he mentions that while the Salmonoids have no oviduct and the ovaries are suspended free without any covering in the abdominal cavity, there extends back behind each ovary a narrow flat band which commonly arises at the upper and posterior end of the plate-like ovary, gradually diminishes in width backward, and finally becomes lost towards the end of the abdominal cavity. In the salmon proper, he states, it disappears upon the air bladder, opposite the commencement of the last fifth of the abdominal cavity, in the fresh water trout on the side of the intestine not far from the anus, and in the *Coregoni* on the intestine close to its end. In all these fishes, he says, the central abdominal cavity must take the place of an oviduct, as it receives the eggs when they are detached and allows them to make their exit by a single opening at its posterior extremity.

In the smelt, however, which is a salmonoid fish, he says that there passes from each ovary a band, one end of which is attached to the dorsal, the other to the abdominal wall, so that, in each lateral half of the abdominal cavity, there is a chamber which receives the eggs when they are detached from the ovary; that the two chambers ultimately unite above the anus; and in fact, close in front of the place where, in other fishes, the oviduct is situated.

In 1883, Huxley studied the smelt and reviewed Rathke's paper, confirming the statements Rathke made, but in the case of the smelt going a little farther. Huxley showed that in this fish there were oviducts formed in this way: Each ovary has the form of a half-oval plate, with the curved edge ventral and the straight edge dorsal. The latter is suspended by a narrow mesoarial fold of peritoneum from that part of the dorsal wall of the abdominal cavity corresponding with the ventral surface of the air bladder. The ovary was stated to be covered on its inner surface by the peritoneum and that the outer face gives rise to a great number of ovigerous lamellae which are disposed transversely to the length of the organ and perpendicularly to its body. Before going further into this subject, it may be well to state that the folds or projections of the peritoneum, the lining of the visceral cavity, support and more or less attach to each other the organs within the cavity. It may be likened to a membranous sack with no opening which, placed in the abdominal cavity, forms a lining of two coats and by projecting folds invests, or partly invests, or is attached to some of the organs, forming their support. The fold which proceeds from the dorsal area of the cavity and supports the ovary is known as mesoarium or mesovarium. In the Salmonoid fishes then, according to the authorities named, this mesoarial fold covers the inner surface and extends around the lower edge and for about one-quarter or one-third of the height of the outer surface of the ovary, thus leaving the laminae on this outer side free or exposed without covering. However, in the case of the smelt, it was shown that the inner mesoarial covering continued, not in the narrowing band mentioned by Rathke in the other salmonoids or as a dorso-ventral partition, but a short distance back of the posterior end of the ovary it folded over and became attached to the lateral abdominal wall, thus forming a funnel-shaped channel, the wide mouth of which was close behind the ovary and the small end joining with the corresponding one on the other side in a common outlet at the ovipore. The lower portion of this oviduct, therefore, accordding to this idea, was formed below by the extension of the peritoneal or mesoarial fold and above by the abdominal wall.

The idea that the eggs of these fish were deposited free in the abdominal cavity has been handed down from Rathke to the present day in all literature pertaining to salmonoid fishes. Do not understand that I am going to try to controvert the statements of Rathke, Huxley, or any of the great masters, for I am not. But, as Rathke did not go quite so far as did Huxley in the case of the smelt, I venture to suggest that Huxley and others did not go quite far enough in respect to the other salmonoid fishes—at least that their application of the principle laid down to all salmonoid fishes was too general, and there may be exceptions similar to those shown by Huxley in the case of the smelt.

Some years ago, for purposes of classification, I was examining some chars in the National Museum and wished to ascertain the sex of the fish. Upon opening a Sunapee trout (*Salvelinus aureolus*) I was surprised to find extending from each ovary what appeared to be a tube exending nearly to the ovipore where it joined its fellow of the opposite side, making a common outlet channel. These were what are termed spent fish. I do not know whether they had been stripped or not, but there were full-sized eggs in each of these tubes. Until I found the second tube I thought it was an intestine. I also found that the ovary appeared to be completely covered with a membrane. Another specimen showed the same apparent conditions. I have not those fish here, but they are in the National Museum collection and, I have no doubt, can be seen. However, I have a fish of another kind.

This fish is the common brook trout, but there does not seem to be any tube extending for the whole distance from the ovary to the ovipore. Yet, if you will examine it, you will observe that each ovary is completely invested by a membrane with an opening at a shoort distance behind the posterior end of the ovary. The fish, however, is not ripe, but one that would have required perhaps three months for it to reach that stage. Therefore, it cannot be positively stated whether or not the whole ovary is permanently completely covered. However, whether it is or not, or whether other kinds of salmonidae have their ovaries covered completely or not makes but little difference in regard to the points I wish to make, although it would support my views and emphasize those particular points if they were shown to be so.

In respect to the salmon and trout in fish culture, it has been, consciously or unconsciously, assumed that Rathke, Huxley and other anatomists following them were correct and that as the eggs were deposited free in the abdominal cavity all that was necessary to do was to get them out and use them and that no harm would be done to the fish. The abdominal cavity was regarded as a sort of bag filled with eggs and in order to get them all that was necessary was to use pressure and the eggs would run out.

In stripping trout (*Salvelini*) it is well known that it is necessary to press several times to get all of the eggs, and it is customary for the stripper to try the fish to ascertain if the eggs will flow. He presses along the ventral surface from forward toward the tail and if he gets no eggs the fish is returned to the car or pen for it to ripen. When eggs are obtained by a light preliminary pressure, he repeats the pressing or stripping movement, a little harder each time, until all that can be expressed are forced out and the process usually, I may say almost invariably, results in some blood, fæcal matter and mucous coming with the last eggs, indicating that considerable force is used. If the eggs were all ripe, it should not be necessary to exert much force. When naturally depositing her eggs, the fish does not lose any blood, and they are extruded, so far as we know, in an easy flow. All of the ripe eggs are emitted but it takes time for the process as the eggs do not all ripen at the same time.

The point that I want to make is this: That when such undue force is used in stripping the fish, this very delicate membrane may be ruptured or the ovary injured, especially if the membrane completely covers the ovary as has been suggested.

I ought to mention that at the thirteenth annual meeting of this society, Mr. Charles G. Atkins presented some notes on the landlocked salmon, regarding which, among other things, he said: "Among the migratory salmon of the Penobscot, ovarian disease is very rare; but with the land-locked salmon of the Schoodic lakes it is very common. In 1883, by careful observation, we learned that 18 per cent of the female fish were affected with some disease of the ovaries, resulting in defects of the eggs which were apparent to the eye, in some instancs involving the entire litter, but in general a very small number of eggs. The phenomenon was observed before artificial breeding began at Grand Lake stream, and does not appear to be influenced thereby."

We do not know how extensively that phenomenon had been observed prior to that fishery conference, because not a great deal of anatomical study or many observations had been made on the land-locked salmon, but this suggested to me that a rupture of the membrane or injury to the ovary had possibly caused the ovarian disease. I will mention further that I have seen a number of the golden trout of Sunapee lake with distorted and diseased ovaries, and hardened eggs in them. Taken together with what I saw in the National Museum fish, this fact and Mr. Atkin's statement gave me a suspicion that those abnormal ovaries after all were probably due to rough stripping. I have not had time for thoroughly investigating this subject, but hope that I or someone may soon settle the question.

Even the small amount of evidence already presented suggests that no harm and possibly much good can result from exercising more care in stripping the fish than has been employed in the number of instances that have come under my observation.

DISCUSSION

Mr. Titcomb, of Vermont: Dr. Kendall has very properly emphasized an important point for fish culturists, that we should use great caution in stripping to avoid injury to the membrane around the ovary. Another point to which I would call attention is, that if too much pressure is applied in expelling the eggs, the undeveloped eggs of the next season's series may be injured. One often hears the argument made that we should not catch trout before the breeding season, because to do so means the destruction of the eggs. But no matter when you catch trout, eggs will be taken because there is always a series developing. In May you will destroy just as many eggs as you will in September.

Mr. Neal, of Maine: The fish in my State are a conundrum. We have tried different methods and have made numerous mistakes. Perhaps if we had had more assistance from the scientists we should have had better success. It is still a question with us whether it is possible for us to stock our lakes permanently with land-locked salmon and trout. We have about 2,300 lakes and ponds in Maine, most of them adapted to these fishes, and they have been stocked. We have eleven hatcheries and hatch millions of trout and salmon, but in some localities we have been stocking lakes with salmon and trout for twenty years, and there has never been a trout caught there. George's lake, for example, has been stocked extensively for the past fifteen years, but there has never been a trout caught there, and only large salmon weighing over five pounds. As soon as the ice goes out there is good fishing, but only the salmon, and they run very large. At Swan lake, only fifteen miles from there, stocked in a similar manner, there is excellent fishing of both land-locked salmon and trout. Most of the salmon weigh from three to five pounds and very rarely as much as ten, while the trout weigh from a pound up and have been taken weighing eight pounds. We are trying in every way to solve these problems, which puzzle us, and will welcome any assistance the scientist can give us.

Mr. Graham: The question of introducing fishes into different waters is a very important one. As Dr. Kendall says, there is no doubt that the introduction of the land-locked salmon into the Rangely lakes caused the disappearance of the blue-backed trout. On the other hand the land-locked salmon were introduced into Sunapee lake, and while they thrived very well and were caught in large numbers as long as they kept planting them year after year, the deep-water trout also kept increasing, and I believe are increasing to-day. During the past four or five years the Sunapee trout have been caught by the thousands. But the smelts are very abundant in Sunapee lake, and apparently they have kept the salmon from destroying the trout. It seems to me, then, that any lake containing trout should be abundantly stocked with smelt before the salmon are introduced.

Along this line I wish to make a few remarks about the western salmon introduced from Oregon. These have been successfully established in Sunapee and New Found lakes in New Hampshire, by which I mean that they have been caught in large numbers, ranging in weight from a pound up to sixteen or seventeen pounds, but whether they will ever reproduce there we do not know. The Massachusetts Commission has had a little experience with these same salmon. Two years ago we planted in Lake Quinsigamond, in the city of Worcester, Mass., 10,000 young salmon from four to five inches in length, and last year 20,000 more. The lake had been carefully screened before stocking, and it is full of smelts. Here are some of the results: The fishermen caught this year in July, right in the city of Worcester, between 500 and 1,000 salmon, weighing from two and a half to five and a half pounds. Now, judging by these results, it seems to me good business to introduce these fish whether they will reproduce or not. This lake in Worcester abounds with pickerel, yellow and white perch, and other fish of that nature, yet we have introduced the western salmon, and in two years' time they have grown to as great a weight as five and three-quarter pounds.

Mr. Hayford, of New Jersey: Some of this discussion has had to do with the Rangely lakes. I had charge of the station at that place for five years and may be able to offer some suggestions concerning the disappearance of the blue-back trout from my own experience. There the brook trout spawn about the first of October and the blue-backs about the tenth of October. Then some ten days later, October 20, the land-locked salmon go up the same streams and use the same spawning grounds, and therefore destroy a great many of the trout eggs. On account of the low temperature the eggs do not hatch until April, and before that time the lumbermen come down these streams with their logs and dynamite. Both these conditions no doubt have something to do with the disappearance of the trout.

ONE YEAR OF PROTECTION AT THE SANTA CATALINA FISH RESERVE

By CHARLES F. HOLDER, L.L. D.,
Throop College of Technology, Pasadena, Calif.

It may be of interest to the American Fisheries Society to learn the attempts to protect the island of Santa Catalina, California, a recognized spawning ground, from the market fishermen. The writer has been in touch with the conditions at the islands off the coast of Southern California for about thirty years, and has had every opportunity to observe the effect of over-fishing as applied to the great marine fishes of the Southwest.

Twenty-five or thirty years ago, before the introduction of the gasoline launch, the waters about Santa Catalina abounded in a most remarkable variety of large game and food fishes, among which were the yellowtail, barracuda, albacore, white sea bass, black sea bass, two species of swordfish, the whitefish, many kinds of rock bass, and many more too numerous to mention. In 1885-6, when the writer first saw the island, nearly all these fishes could be caught in large numbers, the supply being apparently inexhaustible. So many were caught at this time by anglers that the writer organized a little society, raising a fund to send the fish to Los Angeles where they could be given to the poor and to various institutions. In fact, there were so many that people would not trouble themselves to carry them away, and on or about the year 1890, it was not an unusual sight to see literally tons of food fishes thrown into the bay to feed the sea lions and sharks. Such a supply of fine game fishes, as they ranged up to one hundred pounds in weight, soon attracted the attention of anglers from all over the world, and in the year 1898 the writer caught a large leaping tuna with a rod and reel. Soon after this the Tuna Club was organized by the writer to prevent the over-slaughter and over-catching of these fine game fishes, the work being accomplished by inducing the public to fish with a very fine line instead of the big hand-lines which they had formerly used, a procedure that made it impossible to land a fish of sixty pounds weight within half an hour; previous to this these large fishes having been hauled in with a hand-line in a very few minutes. In this way the Tuna Club produced a remarkable change. Distinguished anglers all over the country joined it and a great object lesson was given in fair play and conservation; as a result, the over-catching and waste was absolutely stopped.

Very soon another element, menacing to the fishes. came into the field. This was the introduction of the gasoline launch. This enabled hordes of alien fishermen —Greeks, Italians, Chinese and Japanese—to reach the island, across the Santa Catalina Channel, in an hour or two, haul their nets and return in a very short time. It did not take many years for the effect of this to be apparent, and conservationists in Los Angeles County, interested in sea fishing, took up the matter and began to interest themselves in methods to regulate the catch. Every attempt was made to induce the fishermen to observe some care during the spawning season of fishes, and a special attempt was made to protect the spawning sardines in Avalon bay.

It was soon found that it was like "talking up the wind," as these men were out for fish and they proposed to take all they could get on every trip, and if the market was so over-loaded that there was danger of the price being lowered, boatloads of the finest kinds of market fish were thrown into the ocean and fed to the sharks. Conservationists finding that they could not argue with these men, sought the aid of the state legislature and the county authorities, but here politics entered into the situation and it was evident that the market fishermen's vote was a decided factor in the situation. Various attempts were made to secure laws and legislation, but for one reason or another, they all failed until 1913. During all these years the Tuna Club had led in these fights for the conservation of the fishes and bore the brunt of the burden, which meant various attacks.

In 1913 the writer made a careful examination of the situation, summed up the information from eminent authorities, and decided that the fishes of Southern California had decreased, since 1886, 75% or 80%, and that it was emminently necessary that something should be done. The claim which I made, which was based upon my own observations and examination of the island by Dr. David Starr Jordan and many other experts, was that Santa Catalina and San Clemente islands were spawning grounds for the great sea fishes of Southern California; in other words, were sources of supply for market fishes of all the region about, and I beg herewith to include a letter received from Dr. David Starr Jordan bearing on this point:

December 5, 1912.

Dr. Charles F. Holder,
Throop College of Technology,
Pasadena, Cal.

Dear Sir: I trust that you may be successful in having Santa Catalina and San Clemente islands set aside as game preserves. These two islands and the smooth waters off their shores are the spawning grounds, above all others, of the greatest game fish in the country. The white sea bass, the great jewfish, the spearfish, swordfish, tuna, bonito, albacore, the Japanese tuna (yellow-fin tuna), all spawn on the rocky and other places about these islands, as well as a multitude of smaller fishes valuable to the angler or to the markets.

Many of these fish spawn in the kelp which surrounds these islands. The netting carried on inshore disturbs these fishes at spawning time, and it is said that there has been a very marked falling off of these species. As Avalon, on Santa Catalina, is the great center of big game fishing, the disappearance of any of these species makes a great loss to the people who have investments there as well as to the visitors who come there for fishing purposes.

It is desired to prohibit the use of seines and all nets for market purposes within three miles of the shores of either of these islands. This allows the professional fisherman the entire Santa Barbara channel, Santa Rosa, San Miguel, and the rest comprising the Santa Barbara group.

I trust that you and our friends will be successful in getting the statute passed which shall protect these islands and set them apart as spawning grounds for the great game fishes of southern California.

Very truly yours,
David Starr Jordan.

It was argued that the fish would spawn along the shores of these islands in the summer months and that the young would return to these regions the following year, and when large enough, would swim out into the channel and become the legitimate market fishes of the country. The peculiar methods of the market men of Southern California were absolutely fatal to the carrying out of a hypothesis of this kind, as they would follow up schools of fishes, surround them with great purse-nets, during the day time, taking from five to ten tons at a haul, of spawning sardines, or the larger fish; as this was carried on every day and every hour in the day, whenever the fish could be found, it was absolutely fatal to any method of protection. Not only this, every night the Japanese fishermen would come in flocks to the island and set their nets, generally in the form of gill-nets or seines, fastening them to the shore or kelp, and run them out from one hundred to a thousand feet into the ocean. A report made to the writer from San Clemente Island showed that there were fifty of these set-nets set in less than a mile and a half on the east shore of this island in one night. Besides this, there were other methods of taking the fish.

This was kept up day and night, in season and out, for about fifteen years, and the end soon came to some of the largest and most valuable of the fishes. Among these I would mention the leaping tuna. Fifteen years ago this fish was found in such vast numbers, within three miles of Santa Catalina Island, that it became a valuable and important source of income to hundreds of people and bid fair to become one of the great economic fishes of the State of California, and as valuable as the great tunny fisheries which have been carried on in the Mediterranean sea from the earliest historical times. The leaping tuna in California had a peculiar habit of coming inshore to feed at night or late in the afternoon, and I believe they spawned within the five-mile limit at Santa Catalina. In any event, these miles and miles of nets extending out into the ocean into their natural feeding ground where they pursued the flying fish, stopped them, just as innumerable hurdles would stop any animal, and had such an effect upon them that they were absolutely driven away and for the last ten years there were less tunas caught than in a single month ten or fifteen years ago. In fact, the leaping tuna industry, attracting thousands of dollars to the Pacific coast in the form of anglers from all over the world, was absolutely ruined, and during the present season of 1914, the first leaping tuna of over one hundred pounds has been seen in years and but one caught.

Such was the situation in 1913, when I determined to literally take the question to the country and if possible induce the legislators to do something. I made a report giving full particulars of the situation at Santa Catalina Island showing the deadly decrease of the fisheries and its relation to sport, the market man, and the State in general. This was read to a Fish Protective Association which had been formed as a sort of an organization through which to work on the legislature. Finally, with the assistance of many interested men, our bill was introduced, calling for the protection of the fisheries of Santa Catalina Island, on the grounds that it was, in the opinion of Dr. David Starr Jordan and many other experts, the spawning ground, and asking that region within three miles off shore should be called a spawning ground and that all net fishing should be prohibited within that region. It was specifically allowed in the bill, that any one could fish with a hand-line. This was done because at that time the Japanese were catching all their albacore, which are canned as tuna, in this way. There was, by any stretch of the imagination, no class legislation in this, as everybody was served exactly alike; even the men whose fishing depended on netting for bait were prohibited. In a word, all netting was stopped within three miles of the shore, yet all the market fishermen and all the anglers could fish within this region with either the hand-line or rod and reel. This bill, then, did not interfere with the men who caught albacore and canned them, now one of the most important industries on the coast, nor did it interfere with the angler, who was said to bring a million dollars to Southern California every year. The only persons it interfered with were those directly aimed at—the market fishermen of Los Angeles, who had hundreds of square miles of coast on which to haul their nets, but who insisted upon despoiling the shore line of this island which was known and demonstrated to be the source of supply of their own business. This bill was carried through both houses of the legislature despite the protests of 3,000 market fishermen and their friends of San Pedro, and other coast towns, and became a law in August, 1913, the result of twenty-five years of almost constant endeavor.

To those who had been working in this field of conservation, it was a moment of keen gratification, and did I have the time it would give me pleasure to mention the names of the scores of distinguished men in America who aided in this most important fight, among whom I may mention Dr. Henry van Dyke, Dr. David Starr Jordan, Mr. J. B. Burnham, president of the American Propagation Society, Col. Theodore Roosevelt, Dr. George F. Kunz, of Tiffany & Company, and many more throughout the East. This was in 1913. In the summer of 1914, for the first time in fifteen years, large numbers of tuna were seen, and even in the fall of 1913, only a few months after the passage of this law, more yellow-fin tunas were seen in close proximity to the island than had been seen within the past decade. I took the pains to interview twenty-five or thirty of the professional boatmen at Avalon, Santa Catalina Island, men who had constantly fished the island from ten to thirty years, and it was their unanimous opinion that so many large fishes had not been seen on the spawing beds of Santa Catalina Island since the old days of 1890. In fact, a seeming miracle had been performed even in one season, and at the end of the season of 1914, it is the belief of all those who are most familiar with the situation, that if this spawning ground could be relieved from the incessant netting of the past twenty-five years, for at least five years, it could be restored to its normal condition.

The average citizen might think that a measure of this kind, advocated by all the great experts of the country, would not be attacked. Again, it was so evidently a movement in the interests of the marketmen themselves, that it might be imagined that they would be sufficiently intelligent to appreciate it, but I was not one to indulge in such a Utopian dream. They acted immediately and began to devise means to render the law ineffective. I venture to say there has not been a week since the passage of the bill that efforts have not been made to break the law, and it has been necessary for the friends of conservation to have the men arrested and see that their nets were destroyed, all of which was very much against the desires of conservationists.

In the spring of 1914 a society was organized in San Francisco whose object was to enable the markets of San Francisco and California in general, to place game on sale. That this might be accomplished with dignity and without creating any suspicion, it was given the euphonious title of "The People's Fish and Game Protective Association of California." I am reminded in this connection, of the statement of an old friend and missionary in San Francisco many years ago, when we were discussing the "ways that are dark and tricks that are vain" of the heathen Chinese. He told me that to enable them to purchase slaves and bring Chinese women into the country and to sell them at high prices in San Francisco, and to protect their criminals caught in carrying out their nefarious projects, it was necessary for them to have various organizations through which to work, and here are some of the names which he gave me and which were named by the most notorious highbinders in the San Francisco region. Note, if you please, the high-sounding names under which these desperadoes carried on their affairs:

"The Chamber of Far-Reaching Virtue, or the Kwong Tack Tong"; another the "Ping King Tong, or the Hall of Maintained Justice"; still another conveying the idea of lofty sentiments, was the "Po Shin She, or the Guild for the Protection of Virtue," and what could be finer than the "Kai Shin She, or The Guild of Hereditary Virtue?"

What relation there could be between these high-sounding names and the People's Fish and Game Protective Association, will be apparent when I tell you that the founders of this society, claiming to be carried on in the interest of the conservation and the protection of the fishes of the State of California, were either marketmen, market-hunters, or commission-men engaged in the sale of wild game, or in some way identified with this business which means extermination to the wild life of the State of California. I am informed by President Newbert, of the California Fish and Game Commission, that it has been his painful duty to arrest some of them a number of times and that all are regarded with suspicion by those who are deeply interested in the non-sale of game.

This society proceeded at once to accumulate a large membership and to raise a large sum of money among those particularly interested in it in San Francisco—hotel men, restaurant keepers, etc. They became so brazen in view of their successes, that they decided to entirely rewrite the game laws of California and arrange them to suit themselves, notwithstanding the fact that everyone knew that their work meant the extermination of many of the wild animals of California. They invoked the referendum which had for its object the placing of wild ducks on sale in the markets, and to this they secured, it is said, 33,000 signers, an amazing body blow to the conceit of the conservationists of California, as it was not supposed that 33,000 persons so absolutely ignorant could be found in the state which prides itself upon its culture and higher education. Encouraged by their success in this direction these game bandits proceeded to invoke the initiative, demanding that all wild game in California be placed on sale in the markets. By this time the people of California were thoroughly awakened to the danger and in various ways, principally by publicity, they succeeded in July, 1914, in making the market-men and members of this society, surrender. They failed in their petition by ten thousand votes. This leaves the Californians to vote on the referendum on the 3rd of November; there is still the danger that it may be carried and that as a result an army of market hunters will arise and the wild ducks will be a thing of the past on the Pacific coast.[1]

To illustrate the devastating nature of their brigandage in making their political deals to accomplish their end, the agents of this so-called Protective Association, when they reached the Port of Los Angeles, promised to put in their initiative a clause whereby the Santa Catalina Fish Reserve law would be revoked. I merely mention this to show that these men, all of whom were business men of San Francisco, would not hesitate to strike down the interests of another set of men or utterly repudiate the opinions of the National Government and the various experts who have expressed their views on the subject. I will, however, state that the secretary of this institution, when I explained the situation to him, gave me his word that he would remove it from the bill, which he did later on, and then came the defeat of the entire petition owing to the fact mainly, that the Hotel Men's Association of Southern California repudiated it and stood with us.

I have mentioned this as it seems to me it may be of interest to the distinguished members of this society in illustrating the point that there is a vital need in this country of public education, on the subject of the economic value of the fisheries. I mean by this that the masses of the people are absolutely ignorant of the great fundamental questions relating to this subject and that only this can explain the fact that an association of this kind could have secured 33,000 signatures to a petition

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[1] They won by 8,000 votes, but we carried southern California by a large vote—58,000.—C. F. H.

Note: In 1914 the Santa Catalina Fish Reservation was again thrown open to netters on the ground of class legislation, and the work is being done all over again in the legislature of 1915, with the possibility of defeat by the combinations of the fish market men of Los Angeles and San Francisco.—C.F.H.

which the experts of the Department of Agriculture said meant extermination of the animals referred to by the petition. I have been so impressed with this that during the present season I have organized, with the cooperation of many distinguished men and women throughout the country, a society which we have called the "Wild Life Protective League of America," one of whose objects is to see that lectures are given in the public schools on the economic value of the fishes and the necessity of game laws, that the great game and food fishes of the country may receive adequate protection.

That I may not seem to be devoting this diatribe entirely to California, I beg to call your attention to the serious condition which holds in the Chesapeake bay where I am informed by Mr. Linthicum, a distinguished advocate of protection from Maryland, that the great and valuable shad fisheries of that region are practically doomed to extinction and that, despite the protest of the United States Fich Commission and the officials of the various adjoining states, these fishermen persisted in hauling their nets to the very limit of destruction. The enormity of this particular situation may be realized when it is known that the men were told that if they would permit ten per cent of the shad to pass up the river, its normal condition would be preserved. The absolute danger of the situation may be appreciated when it is understood that one day's haul by these men fifteen years ago produced more fish than the entire haul of the seasons of 1913 and 1914. In a word, the mendacious ignorance of the net-haulers is so extraordinary that it is evidently the duty of every citizen to take the matter in his own hands and encourage the Government to take charge of the great fisheries of the country and see that they are properly cared for and protected. Practically little is known of the fisheries of the Pacific coast, but it is well known that they are disappearing very much faster than they should, and by the time Los Angeles has one million inhabitants, the price of seafood will have become so high that it will place fish beyond the reach of the poor man who has a right to include it among the cheapest of food supplies.

To return to the thought that suggested this paper, if one year's protection of the island of Santa Catalina can produce such interesting results, it is very evident that all authorities should be invoked to give all our waterways adequate protection.

EFFECTS OF CERTAIN METALLIC SALTS UPON FISHES

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Contribution from the United States Fisheries Biological Station, Woods Hole, Mass.[1]

It is not the purpose of this paper to give details, but simply to show certain general results which have been obtained during the course of investigation.

In the experiments upon which this paper is based, the small shore minnow or killie-fish (*Fundulus heteroclitus*) was used. This is a hardy fish and is plentiful in the waters of the Woods Hole district. Because of the abundance and hardiness of Funduli, they are well suited to experimental work. The fact that these fish are killed by certain salts is almost sufficient evidence that any other, more delicate, species would also be destroyed by them, only more rapidly.

Salts containing nearly all of the heavy metals have been used in the course of these experiments, but only a few will be dealt with in this article.

Conditions during experimentation were kept as nearly normal as possible in the laboratory. From five to ten fish were placed in battery jars of about two gallons capacity filled with sea water, to which was added sufficient of the salts to give the desired concentration. A constant stream of air was passed into the solutions, sufficient to supply the amount of oxygen needed, but not enough to super-saturate the media and cause the fish to succumb to "air sickness." The solutions were changed at least every forty-eight hours to insure freedom from products of metabolism, but experiments have shown that the fish would live in a healthy condition even if the water was changed only once a week, provided that no toxic substances were present.

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[1] Published by permission of the Commissioner of Fisheries.

The temperature of the solutions ranged from about sixty-eight to seventy-four degrees Fahrenheit, which was not greatly different from the temperature of the water in the harbor. Records show the water there to range from about sixty-four to seventy-four degrees, during the period of the experiments.

The fish were fed during the experiments just before the solutions were changed, and sea mussels were used as food.

Experiments performed using copper sulphate showed that the fish absorbed the copper. While still in a healthy condition, the fish were taken from the solutions containing the copper, thoroughly washed, and water run through the alimentary tract to insure the removal of all copper not absorbed into the tissue of the fish.

After having been in a solution containing thirty parts to the million for forty-eight hours, it was found that the fish had absorbed .00079 per cent of their wet weight, or .0035 per cent of their dried weight.[1] The copper was determined by drying the fish to constant weight after washing, and then analyses for the copper made on the dried sample. About fifty copper determinations were made upon fish from varying concentrations of copper sulphate, and it was found that the fish would absorb the copper proportionally to the concentration of the solution, and also to the time exposed.

Copper chloride was used as well as the sulphate in some of the experiments, but it appears that not as much copper was absorbed in a given time from solutions of copper chloride, as from solutions of copper sulphate containing the same amount of copper. The sulphate also is apparently much less toxic than the chloride. In solutions of the sulphate, thirty parts to the million, it was impossible to keep the fish for much longer than ninety-six hours, but in solutions of the chloride of the same concentration the fish succumbed in a much shorter period.

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[1]For detailed results see *Jour. Biol. Chem.*, Vol X, No. 4, May, 1912.

The question arises: Do these fish retain or eliminate the copper after a time? This may be partially answered by the following:

One hundred fish were placed in copper chloride solution containing thirty parts to the million, for two hours. At the end of this time twelve were taken for immediate analysis. The remainder were placed in running sea water, and after fourteen days ten more were taken for analysis. After twenty-five days had elapsed another sample of ten were taken for analysis. The three analyses agreed very closely, and seemed to show that even though removed from the source of pollution the copper content of the fish did not diminish.

During the experiment twenty-one fish died in the running water, the most of them (seventeen) during the first four days. The copper seems to have an accumulative effect.

Nickel chloride, ferric-ammonium-citrate, and potassium-di-chromate were also used, and analyses of the fish made after having been in various concentrations of these salts in sea water for different periods of time. None of these salts appeared to be toxic to the fish, however, and they could survive in concentrations of about two hundred parts per million for a week or two. This concentration was about the maximum used, and the time the longest that the experiments were run. Analyses showed that the fish had absorbed the metals nevertheless. That they were non-toxic may have been due to the fact that the salts in sea water were antagonistic to those employed. This is sometimes the case, as Loeb has shown.

Among other salts used in sea water and found to be non-toxic, were cobalt chloride, manganese chloride and zinc sulphate, but mecuric chloride, cadmium nitrate and sodium arsenate were found to be highly toxic. Analyses of the fish exposed to these salts, just mentioned, have not been made as yet so it is impossible to draw further conclusions.

An interesting point was found when a land-locked pond was discovered to contain a large number of this same species, *Fundulus heteroclitus.* The pond was located on one of the islands near Woods Hole, and so situated that it was possible for a very high tide to wash into it during a storm. Information that this happened every two or three years, was obtained from Mr. Vinal Edwards. It is highly probable that the Funduli were carried into the pond in this manner, and gradually accustomed to the fresh water. The water from this pond was fresh enough to be nearly drinkable and showed a density of only 1.0008. The Funduli taken from this source lived well in fresh water (hydrant water).

Although of the same species, these fish were more delicate than those taken from salt water, which might be expected; as they had less of the elements to resist than if they had been in the open waters, where they would be tossed about by the waves, and exposed to the rougher conditions there found. The scales of these fish were thinner and of a softer texture than those of the fish taken from salt water, and the fish were somewhat smaller than the average size of those used in the before described experiments, which only seemed to indicate that they were younger.

As might be expected the salts were much more toxic to these fish in fresh water than to the same species in salt water. This tends to the confimation of the belief that the salts in sea water were antagonistic in the experiments in which it was the basic media used.

Lead nitrate proved to be fatal within twelve hours at a concentration of three parts per million; aluminium sulphate, which is often used in the process of removing suspended matter from drinking water, was fatal within thirty-six hours at a concentration of fourteen parts per million, and in five days at a concentration of seven parts. It was impossible to use these salts in sea water on account of the insoluble precipitates which were at once formed. Zinc sulphate was fatal within forty-eight hours at a concentration of ten parts per million, but was non-toxic in sea water. Copper sulphate was fatal within ten hours at a concentration of four parts; cadmium nitrate within thirty-six hours at six parts, while nickle and cobalt chloride were fatal within five days when as much as sixteen parts were used, and manganese chloride in six days at twelve parts per million.

It is needless to say that in these experiments duplicates have been run which closely agree, and that control experiments have also been made to eliminate doubt as to the effect of confinement in the jars in which the expriments were performed. The controls showed that the fish would live almost indefinitely under the conditions to which they were subjected, provided that none of the toxic salts were added.

We see that many substances are toxic to salt-water fish and many others to fresh-water fish. These contaminations may find their way into small streams and fish ponds, also fish may be subjected to them during transportation if the containers have these metals in their composition, for many kinds of waters have a great solvent action upon them. Further work is being carried on along these lines in which the effect of lime, coal-tar products, and factory wastes is being studied, and it is hoped that sufficient work will be completed in the near future to show the necessity of protecting our fish from these pollutions, to which many are now subjected.

A DESCRIPTION OF THE YOUNG STAGES OF THE WINTER FLOUNDER

(*Pseudopleuronectes americanus Walbaum*)

By W. E. SULLIVAN,
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The winter flounder (*Pseudopleuronectes americanus* Walbaum) is of interest for two reasons: First it is typical of the group of flat-fishes or flounders in its metamorphosis; second, it is a fish of great commercial importance. The flounders, as is well known, undergo a peculiar metamorphosis. The young, so far as has been ascertained, are symmetrical and swim upright; the adults on the contrary show a lack of symmetry, most marked in the position of the eyes and in the distribution of the pigment, and swim on their sides. These facts at once make the flounders of interest, and have made them objects of observation for half a century or more. Their commercial importance has resulted in the perfection of methods for their artificial rearing, and this insures a ready and abundant supply of material.

Review of Literature. This has been abbreviated as much as possible and incorporated in the text. There are some papers, however, that require special mention.

Agassiz's papers are the first works of importance on *P. americanus*. There are two things that have led me to believe that in the second paper Agassiz was not dealing with the winter flounder. The size of the fish at metamorphosis, as given by Agassiz, is much greater than I found to be the case and there are many inexplicable discrepancies in the plates.

In the text we find "The young flounder has already attained a considerable size before any signs appear of the change of the position of the eye on the left side; * * * and before the young fish shows the least tendency to favor one side over the other. Not until the young fish is fully three-eighths of an inch in length can the first slight difference be perceived in the position of the two eyes (when seen from above), the left eye being somewhat in advance of the other." In all the fishes that I have examined the metamorphosis is practically completed before the fish has reached this size. The measurements given by Wiliams correspond to my own, and I think they may be taken as typical for this species.

Williams found a fish that metamorphosed at 14 mm. and tentatively called it *Limanda ferruginea* Storer. This may have been the species that Agassiz was studying. I have not examined the young of this species and Williams was not sure of his identification, and this is simply given as a suggestion as to the species Agassiz was working with.

When we turn to the plates we find that there is not only a difference in the size of the species but also that the time relations between the eye migration and the development of the tail are different from the conditions in *P. americanus.* In the species figured here the tail development is relatively much more rapid. It is probable that the development of the tail as described by Agassiz (1) is for another fish. It would seem that the same error would be made in both cases. The value of the work as far as it relates to the development of the tail is not impaired but it is probably the tail of a fish other than *P. americanus.*

Material and Apparatus. The sources of my material were the Rhode Island Hatchery at Wickford and the United States Hatchery at Woods Hole. The material collected at Wickford is referred to as Lot 1 and Lot 2. Lot 1 consists of fry that were hatched from eggs stripped from the female and fertilized March 26. In this lot there was also a small number hatched from eggs fertilized April 7. The difference in the time of fertilization will account for the differences in the rate of growth for this lot. The fishes in lot 2 are from females that were allowed to spawn and the eggs fertilized by males kept in

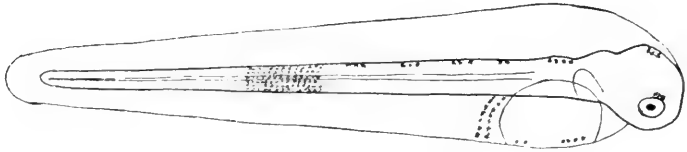

FIG. 1

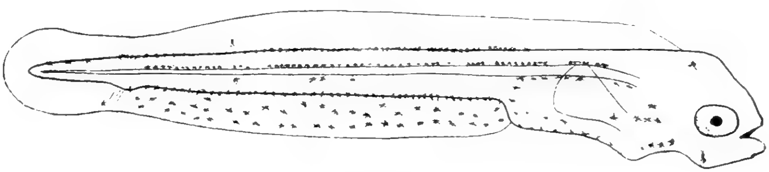

FIG. 2

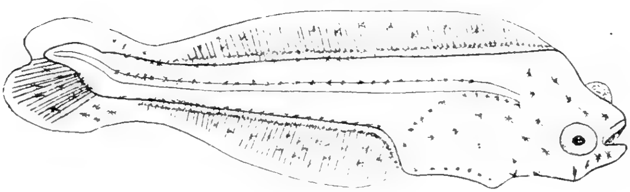

FIG. 3

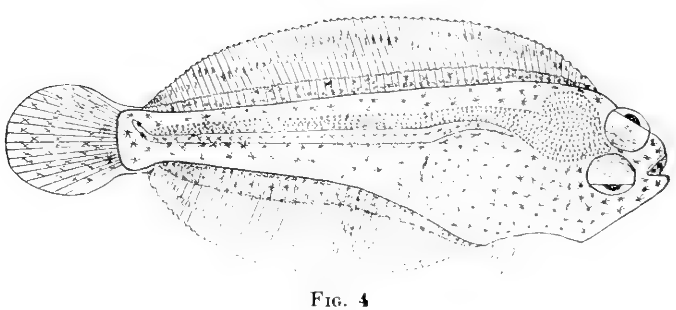

FIG. 4

EXPLANATION OF FIGURES

Figure 1. P. americanus at hatching (3.5 x 0.525 mm.).
Figure 2. P. americanus at twelve days (5.0 x 0.724 mm.).
Figure 3. P. americanus at six weeks (5.8 x 1.33 mm.).
Figure 4. P. americanus at eight weeks (6.5 x 2.75 mm.).

the same car. The extruded eggs were observed for the first time on April 15. The first of the fry appeared April 22.

The conditions under which the fry were hatched and reared approached very nearly natural conditions. The apparatus and the principles involved have been fully described by Dr. A. D. Mead in his papers on lobster rearing. The larger lots were hatched and reared in the rearing boxes in which the screens over the windows were replaced by sand filters. This was made necessary by the minuteness of the fry.

In rearing small groups for close observation a slightly different type of apparatus was used. The young were hatched and kept in cheese-cloth cylinders. The cylinders were about two feet deep and one foot in diameter. These were either fastened to the sides of the rearing boxes or allowed to float free. The rearing box in either case simply served as a breakwater. These cylinders were first designed by Mr. Barnes of the Wickford Hatchery. No difficulty was experienced in keeping small numbers in shallow dishes in the laboratory. The dishes were in all cases covered to keep out the dust and the water was changed every second day.

At Woods Hole the fry were taken directly from the rearing jars and kept in shallow dishes in the laboratory or in cheese-cloth cylinders in the harbor. In the latter case storage cars were used as breakwaters.

In describing the young of the winter flounder, four stages may be chosen that will show all the diagnostic characteristics for the purposes of identification from the time of hatching to the end of the second month. Stage 1 is the young fish at hatching and the description for this stage would apply equally well to the earlier stages in general. Stage 2 shows a fish of twelve days. It differs from Stage 1 in that the yolk is completely absorbed, the fin rays are beginning to appear and the pigment has a much wider distribution. Stage 3 is a fish of about 40 days and can be taken as representative of all fishes in which the eyes have reached the position shown in

Figure 3. Stage 4 is two months old and shows the condition at the end of metamorphosis.

Stage 1 (Figure 1). The length of the fish at hatching is 3.5 mm.; the greatest depth is 0.525. It is so translucent as to become almost transparent when placed in a glass dish. Only the pigment spots and the eyes are in evidence. It can be studied most effectively at this time by placing it against a white opaque background, that is, by the use of a white-enameled dish. The group of dark pigment spots shown on the posterior half of the body is characteristic for this fish. The only other patch of pigment of appreciable size lies over the rectum just posterior to the yolk. As in most young fishes at this stage the notochord, the digestive tract, the heart, the brain and the auditory vesicle can be clearly seen. The notochord is present as a straight tube. The dorsal, anal and caudal fins are represented by an unbroken finfold.

For several days after the hatching the external appearance of the fish remains the same. The changes that one observes first are the absorption of the yolk, the increase in pigmentation and the modification of the finfold. The even curves so conspicuous in the young stages become replaced by angles and the appearance of the fish is altered in consequence. The absorption of the yolk is very gradual and the period involved varies with the water temperature. At Woods Hole, where the average temperature was 39.5 degrees Fahrenheit, it extended from twelve to fourteen days. At Wickford with the higher temperature the period was shortened perceptibly, never extending over eight or nine days. The other processes of development showed much the same relationship to the water temperature, that is, in general the development is much more rapid at the higher temperature.

Stage 2 (Figure 2). The fish represented by Figure 2 is twelve days old. By this time it has reached a length of 5 mm. The yolk is completely absorbed and the young fish has come to depend entirely upon plankton for its food. The boundaries of the finfold correspond very closely to the boundaries of the fins of the adult, although as yet the caudal fin is not differentiated. There is a slight thickening on the postero-ventral surface at a point where the first of the fin rays are to appear. The notochord is still straight and the eyes are still symmetrical. The pigmentation as shown in the figure is quite different from that at the time of hatching. The patch shown at the angle of the lower jaw is very characteristic, as are the four large pigment spots just ventral to the heart. There is a line of pigment along the dorsal side of the notochord and corresponding lines along the dorsal and ventral borders of the body. The spots along the ventral border are much more expanded than those forming the other lines. The patches on the abdominal region and over the heart are not as constant as the others mentioned. The dorsal finfold is either unpigmented or has a few scattering spots with no constant arrangement. In the ventral finfold the pigment is conspicuous and fairly regular. Here the spots form two lines that are practically unbroken. All the pigment so far described is black or brown as seen with transmitted light. Mingled with the black pigment of the ventral finfold are a number of small red asters of irregular distribution.

Between the second and third stages what we may call the more critical changes take place. The external changes are the migration of the eyes, the development of the fin rays, and the differentiation of the caudal fin. Accompanying the differentiation of the caudal fin is the upward bending of the notochord. The migration of the eyes is usually referred to as a very rapid change, consuming only a few days at the most. While it is only a question of interpretation as to what should be included in that period, I would favor including at least all those stages between the end of the second week and the end of the eighth week. Properly I think it should include the period extending from the time of fertilization to the completion of the metamorphosis. To refer to it as occupying only a few days is entirely misleading if not erroneous.

Stage 3. (Figure 3.) The type represented in Figure 3 averages 5.8 mm. in length. The fish from which the drawing was made was six weeks old, but, due to the variation in the rate of growth and development, there are found between the ages of five and seven weeks many fishes that have reached this stage. The features most in evidence at this time are the change in the position of the eyes, the well-developed fin rays, and the upward bend in the posterior part of the notochord. The left eye has reached at this time what may be described as a median dorsal position. About half of it can be seen from the right side. The right eye has taken a position slightly ventral to its former position. The upward bend in the posterior part of the notochord is very marked at this time. This bending of the notochord seldom begins before the end of the fifth week in living specimens. It has been pictured in younger stages, but I think this is due to the fact that the drawings were made from preserved material and that living specimens were not used for comparison. Unless great care is taken in the killing and fixing there is a distinct tendency for the posterior part of the fish to bend upwards. This is also true of fishes dying in dishes or rearing cars. Knowing that the notochord does eventually bend upward one might be led to interpret the upward bending of the posterior part of the fish as the upward bending of the notochord or at least indicative of it. The caudal fin rays are now well developed and the original finfold is notched just dorsal to the last caudal ray. The diphycercal fin of the early stages has now reached the heterocercal type. The part ventral to the notch is to become the caudal fin of the mature fish. Otherwise the outer line of the finfold is still unbroken and the fins are not entirely differentiated. The pigment distribution is shown in the figure.

From this time on the changes simply accentuate the processes already under way. After the sixth week the pigment on the left side tends to diminish in intensity.

Stage 4. (Figure 4). The fish here represented is about eight weeks old. At this stage the young fishes have an average length of 6.5 mm. and an average depth of 2.75 mm. Most of the characteristics of the adult are present. The eyes, as shown in the figure, have taken the adult position; both are now functional on the right side. The caudal fin is practically separated from the dorsal and ventral fins but in most cases a slight remnant of the old finfold can still be observed. The fin rays of the dorsal and ventral fins are sufficiently developed to give a broken margin to the fins. The pigment is much more diffuse than in the earlier stages. The brain and spinal cord are now distinctly outlined superficially by the pigment spots over them. The fish is at this time very similar to the adult except for the asymmetry of the mouth. The mouth at this stage is symmetrical and in fact remains so for a considerable period. Only a slight degree of asymmetry can be seen in a fish of several centimeters.

In the later stages there is a gradual loss of pigment on the left side and a gradual increase of pigment on the right side. In a fish 8 mm. long the upper or dextral side is completely pigmented while the left side has lost its pigment with the exception of a few scattered spots, about twenty in number, in the region of the snout. At what time these spots are lost I do not know. They are entirely absent in a fish of 20 mm. and are probably lost considerably earlier.

Behavior of the young fish. There has been much speculation as to the cause of the turning of the flat-fishes and the relation of the migration of the eye to the question of turning. In regard to this I can only say that I learned nothing in my study of the fishes through the period of metamorphosis that threw any light on the question. The study of the segmentation of the egg in other genera has added nothing. I think it would be interesting and possibly enlightening if the chemicals that produce the Cyclopean eye in the "normal-eyed" fishes were applied to the flat-fishes. I am convinced that the migration of the eye is but an external manifestation of the turning and is in no way the cause of the turning.

Observations on the young fish at rest strengthen this belief.

The fry are not strong swimmers, using "strong" to convey the idea that they maintain themselves in motion for long periods. It has often been remarked by those handling the fry in the MacDonald jars that the fish are found not only near the surface but throughout the entire depth of the dish, due to the fact that their swimming is spasmodic. Observation shows that the young fishes will suddenly cease swimming and sink to the bottom of the dish. After a short rest they will swim toward the surface again. We may use a typical case from a series of observations to illustrate this point. A fish of eight days was kept under observation for a period of ten minutes. During that period it stopped swimming twenty-three times. Five times it came to rest on the bottom of the dish; the other times it resumed swimming before reaching the bottom. After the observation the fish was kept in continuous motion for thirty minutes and at the end of the period showed no signs of fatigue. The intermittent swimming is characteristic of the fry and is not due to fatigue.

In the younger fishes, those under ten days, preference is shown to neither side when they come to rest. Extended observations on a large number of fry, taken either as individuals or in groups, showed that in a given number of times they would come to rest on the right side fully as often as they did on the left. This statement refers only to the cases where a large number were observed for a long period, a period of not less than an hour, or where an individual was kept under observation for a longer time. My first impression, gathered from casual observation in isolated cases, was that the fry favored the left side during this earlier period. After the tenth or twelfth day there is a tendency to favor the left side, and a fish of two weeks will come to rest on that side seventy-five times out of one hundred. Even after the eye migration has proceeded for some time the fish will occasionally come to rest on the right side. All of this, however, I regard as simply a number of interesting observations that throw little if any light on the question of turning.

The young fry are strongly phototropic, and we should expect to find, and do find, the greatest number near the top and sides of the dish. Occasionally, when the source of light is such that a ray will run from the top to the bottom of the dish, the young fry cluster around this ray in the form of an inverted cone.

Escape from the egg capsule. For a day or more before hatching the young fish has the power of movement within the capsule. The movement is brought about by a series of contractions comparable to a peristalsis. The contractions are most marked in the posterior part and tend to push the fish forward. Through this movement the rupture of the capsule is brought about. The plane of rupture as observed in a number of cases is at right angles to the long axis of the body. The posterior half of the capsule then comes to lie on the back of the fish, dorsal to the head and body proper. The added weight dorsally turns the fish on its side, and in this position it struggles until freed from the capsule. This is usually accomplished in a period extending not over ten minutes.

Food of the young fry. Until the yolk is absorbed the young do not seek other nutriment. Indeed, for several days after the absorption of the yolk was completed no food was found in the gut of the fishes examined. The absorption of the yolk after hatching is entirely through the vascular system. At what time the direct connection between the gut and the yolk is lost I am not able to say. There is no trace of a connection at hatching. That the young do not depend on outside food until after the yolk is completely used up is further substantiated by the fact that they may be kept in the MacDonald jars used at the Woods Hole Hatchery for a period of two weeks, or the period during which the fry are nourished by the yolk. Beyond that time it is not possible to keep them. As is well known, the mechanism of the apparatus and the size of the jars are such as to prevent the admission of food material in sufficient quantities to maintain life. The difficulty referred to above is undoubtedly one of feeding. In the fishes up to three weeks the only food found in the gut is made up of diatoms. A little later the smaller crustacea are found, and in the fishes that have completed metamorphosis Isopoda were invariably present. That in some cases at least the older fry eat the young is made plain by the fact that those in stage 3 were seen eating the younger fry.

RATE OF GROWTH

Measurements for Lot 1

The length and greatest depth are given in millimeters. Both Lot 1 and Lot 2 were fixed in Zenker's fluid and preserved in alcohol. The measurements are for preserved specimens:

May 4.	May 11	May 18	May 25	June 5
4.3 x 0.50	4.7 x 1.25	5.4 x 1.46	5.0 x 1.66	5.0 x 1.75
5.0 x 0.63	5.0 x 1.25	5.5 x 1.25	5.0 x 1.90	5.5 x 1.90
5.0 x 0.75	5.2 x 1.00	5.5 x 1.60	5.3 x 2.00	5.5 x 2.10
5.2 x 0.80	5.2 x 1.66	5.6 x 1.33	5.4 x 1.70	6.1 x 2.00
5.3 x 0.75	5.5 x 0.80	5.8 x 1.50	5.7 x 1.75	6.1 x 2.10
5.5 x 0.75	5.5 x 1.70	5.8 x 1.66	5.7 x 1.85	6.2 x 2.10
5.5 x 0.83	5.6 x 1.66	5.9 x 1.48	5.8 x 1.66	6.2 x 2.10
5.6 x 0.88	5.7 x 1.75	6.0 x 1.25	6.0 x 2.00	6.4 x 2.10
6.0 x 1.10	5.8 x 1.41	6.0 x 1.33	6.4 x 2.12	6.5 x 2.33
6.1 x 1.20	6.3 x 2.53	6.0 x 2.10	6.5 x 2.20	7.0 x 2.40

Measurements for Lot 2

May 3	May 4	May 5	May 6	May 7
4.3 x 0.60	4.3 x 0.63	4.5 x 0.63	4.8 x 0.50	4.3 x 0.66
4.3 x 0.60	4.4 x 0.64	4.7 x 0.60	4.8 x 0.60	4.5 x 0.50
4.4 x 0.60	4.6 x 0.65	4.7 x 0.60	4.9 x 0.66	4.5 x 0.63
4.4 x 0.66	4.7 x 0.63	4.9 x 0.62	5.0 x 0.60	4.8 x 0.60
4.5 x 0.54	4.8 x 0.57	4.9 x 0.62	5.0 x 0.63	5.0 x 0.64
4.5 x 0.63	4.9 x 0.60	5.0 x 0.60	5.0 x 0.66	5.0 x 0.69
4.5 x 0.64	4.9 x 0.63	5.0 x 0.60	5.0 x 0.68	5.2 x 0.70
4.8 x 0.60	5.0 x 0.63	5.0 x 0.66	5.0 x 0.74	5.2 x 0.75
4.8 x 0.60	5.0 x 0.68	5.1 x 0.68	5.2 x 0.68	5.3 x 0.75
4.9 x 0.66	5.2 x 0.66	5.7 x 0.75	5.3 x 0.68	5.6 x 0.90

May 8	May 9	May 10	May 11	May 12
4.5 x 0.63	4.8 x 0.66	4.5 x 0.60	4.6 x 0.80	4.5 x 0.69
5.0 x 0.69	4.9 x 0.60	5.0 x 0.72	4.7 x 0.68	4.9 x 0.75
5.0 x 0.78	5.1 x 0.70	5.0 x 0.75	4.9 x 0.84	4.9 x 0.80
5.1 x 0.66	5.3 x 0.75	5.0 x 0.78	5.0 x 0.75	5.0 x 0.87
5.3 x 0.76	5.3 x 0.90	5.1 x 0.70	5.0 x 0.81	5.0 x 1.00
5.5 x 0.85	5.5 x 0.72	5.2 x 0.87	5.0 x 0.85	5.0 x 1.10
5.5 x 0.85	5.5 x 0.90	5.4 x 0.97	5.0 x 0.86	5.1 x 1.10
5.5 x 0.90	5.8 x 1.00	5.4 x 1.10	5.0 x 0.90	5.2 x 1.00
5.6 x 1.00	5.9 x 1.00	5.1 x 0.90	5.1 x 0.90	5.2 x 1.30
6.0 x 1.10	6.0 x 1.20	5.1 x 0.92	5.1 x 0.92	5.6 x 1.20

May 14	May 15	May 29	June 5
4.5 x 0.60	4.8 x 0.70	4.7 x 1.10	4.5 x 1.20
4.6 x 0.63	4.8 x 0.75	4.8 x 0.83	4.5 x 1.25
5.0 x 0.60	5.0 x 0.84	5.0 x 1.10	4.6 x 1.60
5.0 x 1.00	5.0 x 0.85	5.0 x 1.10	5.0 x 1.00
5.2 x 0.66	5.1 x 0.91	5.0 x 1.20	5.0 x 1.12
5.2 x 0.83	5.1 x 1.00	5.1 x 1.50	5.0 x 1.33
5.5 x 0.75	5.1 x 1.00	5.1 x 1.50	5.0 x 1.33
5.5 x 0.80	5.1 x 1.10	5.2 x 0.98	5.3 x 1.43
5.6 x 1.10	5.3 x 1.00	5.2 x 1.50	5.5 x 1.50
5.8 x 1.10	5.6 x 1.34	5.2 x 1.52	6.0 x 2.17

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PRELIMINARY INVESTIGATIONS FOR THE SYSTEMATIC STOCKING OF STATE WATERS

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Introduction.—This paper considers one phase of fish propagation, that broad subject which forms the ultimate aim of the activities of the American Fisheries Society. Its purpose is to sound a note of warning, not necessarily of alarm, to persons who are satisfied with the present conditions and methods of fish propagation, by pointing out certain important facts which have been overlooked in the past, but which are essential for the best development of our inland waters.

Although its nature renders the subject of general interest, the facts are presented solely from the standpoint of the State Fish Commission. The paper deals with the selection of suitable grounds for stocking, and the text of its message to each state is "know thyself." Unless a state fish commission has a thorough knowledge of its waters, the environment in which the fry and fingerling fish are to be placed, promiscuous stocking will eventually lead to considerable loss. Extensive hatchery production increases rather than decreases this error. A systematic method of stocking, based upon an accurate knowledge of the waters to be stocked and a satisfactory method of distribution are essential for the success of a state commission, and form the basis for the entire system of fish propagation.

Several years ago it was evident in Massachusetts that the haphazard methods of the past should be abolished and that a definite system of stocking should be adopted, in order to obtain the best financial results. Under intelligent stocking, whereby fish are put into waters suitable for their best development, it may be estimated that the production of the inland waters of Massachusetts may be increased to at least tenfold over its past output. In order to accomplish such a result, it was necessary to obtain a new perspective, and in this paper the preliminary steps which led toward this goal are described. The application of these facts is general, but all the illustrations, and specific examples are drawn from Massachusetts. The writer is not familiar with the work of other state commissions, particularly the investigations not published in the annual reports. For that reason all criticism, favorable or unfavorable, is directed to conditions in Massachusetts, and applies only to other states when similar conditions exist.

Natural Abundance.—Nearly every state in the Union possesses many beautiful lakes, ponds and streams, capable of producing an abundance of food and game fish, and in most cases, as in Massachusetts, but few of the many thousand acres of waterways are producing anywhere near their maximum or even normal possibilities. Therefore, it is important, both in the interests of sport and as a source of food supply, that these latent assets should be developed for the benefit of the public.

In Colonial days, when a relatively small population was scattered along the sea coast, leaving the inland waters in their primitive, uncontaminated condition, the abundance of salt and fresh water fish was far in excess of the needs of the colonists, thus giving rise to the fallacy which has been handed down zealously to the present generation, that "Nature would always provide an abundance of fish." Even in this era of conservation this mistaken idea is still deeply rooted, especially among the marine fishermen of our shore towns, and it can only be eliminated by the complete exhaustion of the natural supply, or by the education of the general public.

Decline.—With the advance of civilization great changes have taken place in our waterways. Many times the balance of nature has been overthrown and a new equilibrium established. With the increase in population the coastal streams were first invaded, cities were established on the larger rivers, and various manufacturing industries were scattered along the smaller streams. In order to supply water power numerous dams were constructed, in most instances unprovided with suitable fishways, thus preventing the passage of such fish as the salmon, shad, striped bass, alewife, smelt and white perch up the coastal streams to their spawning grounds. In this way not only the supply of these fish has been depleted, but the commercial sea fisheries have been indirectly affected by destroying a food supply which attracted the larger predaceous fish to the shores. Manufacturing wastes and sewage, particularly in central Massachusetts, have totally ruined many streams, and have seriously depleted the supply of fish in others by rendering the water unfit for fish life. Numerous legislative measures have been enacted in the past, but the decline has steadily continued, since these laws were either inadequate, or, as was more often the case, not enforced. Likewise, overfishing has seriously depleted local supplies, and in Massachusetts has accelerated the general decline which is so marked in the Merrimac, Charles, Taunton and Connecticut Rivers.

Soon after the establishment of the Massachusetts Department of Fisheries and Game, in 1866, salmon and shad hatcheries were located on the principal rivers as long as any native fish remained; but during the last twenty years brook trout have formed the main output of the state hatcheries. These fish, reared in variable quantities, were indiscriminately dumped into ponds or streams at the request of individuals, who filled out brief descriptions of the waters in question. Lack of funds make it impossible to examine these waters, and reliance had to be placed on the judgment of unskilled observers. In many cases this hit-or-miss stocking was successful, in others a failure, resulting in financial loss.

The chief objections to indiscriminate stocking may be enumerated as folows: (1) Stocking private ponds and streams from which the public are excluded. (2) Intentional distribution of fish by the applicant in other waters than called for by the petition. (3) Stocking badly polluted streams in which the young fish cannot exist. (4) Putting fish in brooks which become dry in the summer. (5) Introducing fry or small fingerlings into streams containing large numbers of voracious fish, and conversely introducing coarse fish into trout waters. (6) Stocking where conditions are unfit for the life and spawning of the particular species, or where there is a deficiency of food. (7) Utilizing poor streams to the neglect of more suitable waters. (8) Lack of systematic and consecutive stocking. (9) Financial loss from stocking in unsuitable quantities.

The method of stocking in vogue in Massachusetts until the last few years has been of questionable value, results have been inconsistent, ponds and streams have been stocked with wrong species of fish, and considerable money has been expended without completely satisfactory results. The methods of propagation have not been entirely adequate to offset the increasing causes of decline, such as pollution, dams without fishways, illegal seining, liming and dynamiting. Hand in hand with propagation should go proper restrictive laws, which *must be enforced.*

Stocking.—The stocking of inland waters has three essential parts: (1) The rearing of fish at the hatchery with its expense, labor and numerous attending problems which have caused it to be considered the entire solution of fish propagation. (2) The successful distribution of the young fish, with the difficulties of transportation, and resulting methods for the successful handling of large and small quantities. (3) The selection of the waters into which the fish are to be placed. In this regard our perspective has been at fault, since first of all it is important to obtain a thorough knowledge of the waterways as a ground work upon which to establish an intelligent system of stocking. The need is the same in all states, and the results should approximate those expected in Massachusetts.

The benefits derived from the proper development of the inland waters are: (1) Increased facilities for sport and recreation. (2) More business from vacationists. (3) A larger food supply. (4) New cottages and pleasure resorts upon our inland waters, developing taxable property.

Biological survey.—The first step toward forming a systematic basis for future stocking is a biological survey of the inland waters. A complete biological survey would include a detailed study of each pond or stream with its intricate correlation of plant and animal life extending not over one, but over several years. With the state commission the extent and thoroughness of such a survey is necessarily limited by expense and practical results. In Massachusetts the following plan of work has been followed in order to obtain the necessary information for practical stocking with the least expenditure of time and money, and for this reason completeness has been sacrificed. Nevertheless, a thorough biological examination of the important waters in any state is of special value when carried on in a systematic way for a series of years, especially when it is connected with experimental work upon fish in typical waters.

Three years ago Massachusetts began a survey of its inland waters in order to obtain the necessary information for systematic stocking. For this work a method of obtaining a knowledge of the ponds and streams at a comparatively slight expense was evolved. The work was divided into four parts, and was carried on during the summer months, when time and funds were available. The first step, a study of the ponds and lakes, was followed by an investigation of the coastal streams up which the alewives, or branch herrings, once ran in large numbers, while the third was the classification and description of the smaller brooks and streams. The fourth, as yet incomplete, comprised a study of the fishing potentialities of the larger rivers, and was intimately connected with that great bugaboo of anglers—pollution.

This preliminary study by no means completes the problem. Succeeding it should come more careful and detailed work, designed to ultimately increase the supply of food and game fish by: (1) A study of the food, growth, spawning and habits of the different species of fish inhabiting various waters. (2) The determination of the species best adapted to certain classes of water by an experimental study of typical waters. There are, therefore, two parts—first, the preliminary general work, consisting of an extensive biological survey of the waters in regard to their general conditions to form a guide for future stocking, and a classification of these streams and ponds into certain groups, according to the similarity of the natural environment; secondly, an intensive study of various typical waters, representing the groups above mentioned, as regards the effects of the natural conditions upon fish life. In such bodies of water records of temperatures, amount of food (plankton) and general changes which concern the problem of fish life should be followed for a number of years. The work on these typical waters should serve as a basis for interpreting the conditions in other waters of a similar nature.

(1) Ponds.

The Massachusetts law provides only for stocking natural ponds over twenty acres in area, excluding all artificial ones. For this reason the survey was limited to the natural ponds over twenty acres, in all about 800. These ponds were examined in a rapid but comprehensive survey by representatives of the state commission. This work was carried on during three summer months for two years by four biological students. The entire cost was less than two thousand dollars, the greater part of the expense arising from traveling, owing to the inaccessibility of many ponds. Each man examined approximately one hundred ponds in seventy-five days, an average of one and one-third ponds per day. The size and importance of the body of water made considerable difference in the amount of time devoted to the examination, the small and less important receiving a rapid survey. At best the examination was hurried and superficial, but it achieved the practical object of providing an inventory of the state ponds, and an available working knowledge of the various bodies of water.

The field equipment of the surveyors consisted of a rucksack, a net of silk bolting cloth for towings, hand lens, bottles, vials, formaldehyde, maximum and minimum thermometer, sounding lines and lead, and record blanks. Reports were written at approximately two-week intervals, while the towings and other material were sent to a central laboratory for microscopical examination. As light an equipment as possible was given the field worker, since in many cases he had to traverse the ground between one pond and the next by walking. Numerous difficulties, such as lack of boats, inability to find the ponds, changes in the maps, and lack of transportation facilities retarded the work.

Certain ponds in various parts of the state, from Berkshire to Barnstable Counties, were selected for type study. The other ponds of the state were placed in these representative classes, each pond falling into the group for which its environment was best adapted. The types under observation were large and small ponds, both deep and shallow, in which the conditions, as regards the species, growth and abundance of fish were quite different. From the study of the type ponds, and from classification of the surveyed ponds, practical deduction as to the species and amount of fish for the individual ponds of the state could be made.

In the survey work the following information concerning the physical characteristics of each pond was obtained in order to insure the proper classification for each type:

Name. The name of the pond is a variable and confusing factor. Usually a pond has several names, according to the various maps upon which it is recorded, and often these listed names are unknown in the immediate vicinity where local titles are in vogue. To facilitate the identification of any body of water for public information or for stocking, the primary essential is the recording of all the names by which the pond is known.

Location. The situation of the pond as to the ease or difficulty of access from railroad stations or nearest villages, as well as the hotel and boating facilities, were recorded for use in future shipment of fry or fingerlings, and as a source of information to fishermen.

Area. No actual survey of the area of the ponds was made, the size being measured from maps or taken from old records.

Depth and bottom. Soundings were so made that the contour lines, giving the depths, could be charted on diagrams of the ponds, and from these measurements, the average and maximum depths were ascertained. The sounding lead was equipped to take samples of the bottom soil, but, unfortunately, on hard or mossy bottom no soil could be gathered by this method, and the nature of the bottom could only be estimated in shallow water or from the character of the shores.

Water. The color of the water was listed as either clear, green or brown. The turbidity was expressed in feet, the number representing the distance below the surface at which a white four-inch circular disc would disappear from view. By means of a maximum and minimum thermometer the temperature at the bottom was taken in various parts of the pond to determine the presence of springs. In the deepest part a series of readings were taken at intervals from two and a half to five feet to determine the thermocline (described by Dr. E. A. Birge of Wisconsin), or point where the temperature drops rapidly. Deep ponds have three layers of water—a surface layer, in which the temperature to a depth of fifteen to twenty feet remains approximately the same as at the surface; a middle layer, or thermocline, in which there is a rapid fall, and a bottom layer of uniformly low temperature. The extent and nature of these three layers, which vary in different ponds and at different seasons of the year, are of importance as regards fish life from the standpoint of food and oxygen.

Shores. The shores around the pond were classified as woodland, the kinds of trees being noted, and whether fields were cultivated or uncultivated, such as pasture, meadow and marsh land. The height and slope of the shores and character of the beaches were likewise noted. Cottages, hotels, gunning stands, ice houses, etc., were recorded as indicating the popularity of the pond as a pleasure resort.

Inlets and Outlets. The inlets and outlets with the volume of water, temperature, amount of sediment and pollution, such as manufacturing waste or sewage, were described. The presence of a dam at the outlet indicated that the pond had either been raised above its original area or that it was wholly artificial. In certain instances it was practically impossible to definitely determine whether a pond thus raised was originally a state pond.

Fish. Information concerning the different species of fish was obtained from fishermen and people living in the immediate vicinity, who were acquainted with the pond. In the rapid survey it was manifestly impossible to obtain this information in any other way, and for this reason the question of the quantity of the fish and the present production of any pond was only determined in a very general way, as the term "good fishing" is but relative, varying with locality.

Fish food. The study of fish food was undertaken in two ways: (1) The examination of the stomach contents of various species, both of the small and the large fish, under various conditions, and at different seasons. (2) The determination of the character and amount of the floating organisms (plankton) in the different ponds by means of a silk bolting cloth net.

(2) Coastal Streams

The second step was a survey of the coastal streams in connection with the alewife or branch herring fishery. Formerly the alewives ran up these streams in great numbers each spring to spawn in the fresh water ponds. In this work the coastal streams and their tributaries were examined by a representative of the state commission. Every dam, obstruction, fishway, cranberry bog, mill, or possible source of pollution was accurately charted and described. The physical characteristics of the streams, and the animal and plant life were recorded. The method of catching the alewives, the history of the fishery from old records, the possibilities of restocking were studied for the purpose of formulating proper measures for the development of this fishery.

(3) Inland Streams

The third step in the survey of the inland waters comprised a record of the smaller streams. It was manifestly impossible from the standpoint of time and expense for any one man, or even several men, to attempt to personally examine a large number of brooks. The solution of the problem was achieved by enlisting the services of the various state fish and game wardens, each covering a district with which he was thoroughly familiar, especially in regard to the streams. The employment of men, for the most part not trained scientists, necessitated simplifying the examination, but many practical points concerning the various brooks were obtained. Many of these wardens had been stationed for years in their districts, and in the course of their duties had become personally familiar with most of the streams.

Each warden was given typewritten instructions as to the desired information, and the manner in which he could co-operate was explained by a personal interview. The warden, in connection with his regular duties, gradually accumulated the necessary data, and after several months was able to describe with the aid of a map every stream in the district. Naturally more information was available upon some brooks than on others, as certain wardens showed greater aptitude in the work. In addition, many important facts were obtained from local rod and gun clubs.

The information thus obtained was systematized and recorded in the form of a card catalogue (8x6 in. cards), in which the names of the brooks were arranged alphabetically. Each stream had two cards, one a record of the various fish, with which it had been stocked in the past, the other a typewritten description, comprising the information obtained from the wardens.

Information upon each brook was compiled on the following plan:

(1) The collection of all names, general and local, under which the brook is known, is essential for reference to locate petitions for stocking, and answer requests for information.

(2) The location of the brook by towns or sections of a town is necessary for identification, as two brooks with the same name often may be found in the same town. The brook is then charted properly and named on the U. S. Geological Survey maps, which are cut into small numbered maps of a suitable size for filing with the cards.

(3) The source, whether in spring, swamp, bog, pond or elsewhere is noted; likewise into what body of water the brook flows.

(4) The length and direction of its flow; the width and depth of the stream at certain places along its course; the character of the land through which it flows, *i.e.*, meadow, tilled land, pasture, swamp, hard wood, etc.; the rate of flow, volume and clearness of water, the presence of springs and character of the bed.

(5) The abundance or scarcity of vegetation, with the names of the various water weeds known to the examiner.

(6) The nature and character of any pollution, whether sewage, sawdust or manufacturing wastes, and a description of the source of this material.

(7) It is important to know whether the land bordering the brook is posted and the public denied the right of fishing, in order that no private brook may be stocked by the state.

(8) Information as to whether the stream dries up during the summer is an important consideration in stocking.

(9) The species of fish in the brook, the results from past stocking, if any, and the popularity of the stream with fishermen.

(10) The opinion of the warden as to whether the brook is worth stocking, with what kind and size of fish, and what places afford the most desirable points to liberate the fish.

The method of obtaining information recommends itself for its cheapness, the entire expense consisting of the salary and traveling expenss of the person compiling the information, and for clerical services. Nearly every state employs a force of deputies, who are available for collecting this information, and a record of its brooks can be conveniently and cheaply obtained in a similar manner. Likewise, the same plan may be applied to the ponds, instead of the more complete examination previously described in this paper. In any event, it suggests a convenient plan for compiling practical information upon public waters.

The records, it is true, show frequent errors, and in many particulars are incomplete, owing to lack of detailed information on certain streams, but these gaps can be filled in the future, since each warden is supplied with duplicate records in order that he may correct or add to the information at hand. In this way he will know exactly the information on file at the central office, and can receive shipments of fish or definite orders without any mistakes arising from a confusion of names. It is believed that the compilation of these records will be a great aid to Massachusetts in carrying forward a definite and intelligent policy of stocking. Not only will the state department be in a position to dispense information to numerous fishermen, but it can more readily classify the petitions for stocking.

But the program for the future considers a broader application than a mere bureau of knowledge. It aims to utilize this information so that a plan of systematic stocking may be devised whereby the commission will no longer wait, as is now often the case, until a petition for stocking a stream is received, but will know for several years ahead just what brooks are to receive their stated allotments of fish. With the proper knowledge at hand a system of stocking will be devised whereby the results may be followed in different brooks, where the right species and number of fish will be placed in suitable waters, and where every dollar of the state's money will yield its maximum value. When such results are accomplished state commissions may feel justified in increasing the output of their hatcheries to meet a larger demand.

(4) Pollution.

The fourth step will be the examination of the rivers. Since these streams are greatly polluted by sewage and trade wastes, this investigation will be confined chiefly to the pollution problem, and an effort will be made to stock with hardy species of fish those streams which have not become veritable sewers. Exactly how this problem will be solved has not yet been determind, but it will be along the line of least resistance, by first eliminating the unnecessary pollution, which can be avoided at a slight expense. By cleaning up the single cases of pollution, and preventing new sources, part of our streams may be saved. Later areas of greater pollution may be considered, but the problem is difficult, and may never be satisfactorily solved.

Summary

This paper has endeavored to show:

(1) The need of a new viewpoint in stocking state waters.

(2) How the defects of former methods may be remedied by a proper selection of the inland waters, a problem long considered of minor importance.

(3) The necessity of a preliminary survey of state waters as a basis for future stocking.

(4) That such a survey may be made in a relatively short time, and at a slight expense.

(5) That the future development of state waters demands a definite program of systematic stocking.

NOTES ON THE REARING OF SALMON

By H. B. Torrey and D. E. Lancefield,
Reed College, Portland, Oregon.

I.

Raw versus Cooked Beef Liver as Food.

Finely ground beef liver has long been highly esteemed by fish culturists as a food for salmon fingerlings, in spite of its cost. The custom has been to feed it raw. That this has been so is due partly to the widespread belief that raw foods more closely approach the natural food of the species in the wild state, and are accordingly more satisfactory; partly because, in the absence of definite tests, no good reason has appeared for assuming the added expense of preparation which cooking would entail. It is a common practice to soften refractory tissues, such as the bones and cartilages of fishes, with superheated steam. But this method of preparation would be quite superfluous for beef liver, unless it could be shown that cooking would actually increase the efficiency of the liver fed.

We have attempted to find a definite answer for this problem. Our experiments are not concluded, so that the results so far obtained must be considered tentative.

The method of investigation consisted in dividing a given lot of Chinook salmon that were just beginning to take solid food through the mouth into two numerically equal groups. These were placed side by side in separate troughs, the flow of water, temperature and all other conditions being as nearly as possible the same with the single exception of food. One group was fed on raw liver, the other on an equal daily weight of cooked liver. The weight of twenty fish was taken at the beginning and at the end of the experiment, the average weight per fish obtained in each case and the average gain per cent. in weight during the elapsed time. Four pairs of groups are tabulated.

Amount and condition of beef liver fed daily	No. of fish	Date of weighing	Average weight of 20 individuals	Gain in weight
1. 10 grams raw	1800	Mar. 1	.465 grams	
		Apr. 2	.525 "	13 per cent.
2. 10 " cooked	1800	Mar. 1	.465 "	
		Apr. 2	.590 "	27 " "
3. 20 " raw	2000	Mar. 1	.500 "	
		Apr. 2	.625 "	25 " "
4. 20 " cooked	2000	Mar. 1	.500 "	
		Apr. 2	.875 "	75 " "
5. 30 " raw	2000	Mar. 1	.535 "	
		Apr. 2	.555 "	4 " "
6. 30 " cooked	2000	Mar. 1	.535 "	
		Apr. 2	.795 "	48.6 " "
7. 40 " raw	345	Apr. 5	1.13 "	
		Apr. 19	1.35 "	
		May 19	1.96 "	73.5 " "
8. 40 " cooked	345	Apr. 5	1.13 "	
		Apr. 19	1.48 "	
		May 19	2.36 "	108.85 " "

It will be seen that in each case the fish fed on cooked liver gained weight faster than the others. Excluding from consideration Nos. 5 and 6 on account of the abnormally small gain of the fish fed on raw liver, the fish fed on cooked liver gained in weight from 1.48 (Nos. 7 and 8) times to twice (Nos. 1 and 2) and three times (Nos. 3 and 4) as much as the others in the same time. Including Nos. 5 and 6 the results would be still more strikingly in favor of cooked liver as food.

To find the efficiency of the food per unit of cost, it is necessary to take into account certain losses that took place in the process of grinding and cooking, and in the elimination of tough connective tissue unsuitable for food. In ten weighings, the raw liver lost, in preparation, an average of 33 per cent. of its original weight. Similarly the cooked liver lost 43 per cent. of its original weight. This means that for every 100 grams of raw liver available for food, but 85 grams are available after cooking, showing a loss in weight of 15 per cent. in the cooking.

Expressed in a slightly different way, cooking the liver adds 17½ per cent. to its cost. This increased cost is much more than offset, however, by the gain in results of from 48 to 200 per cent.

II

Factors Other Than Food That Influence the Development of Salmon Alevins.

Seven uncovered glass dishes, each 9 cm. in diameter, were each supplied with 150 ccm. of spring water. On January 3rd Chinook alvins, just hatched, were distributed among them as follows: Dish 1, 3; dish 2, 5; dish 3, 10; dish 4, 15; dish 5, 20; dish 6, 25; dish 7, 30. All lived, without change of water, until January 23rd, when all the fish in dish 7 died.

On January 24, all in dish 6 died, several of them having begun to show clear signs of diminishing vitality by January 16.

On January 24, 3 individuals in dish 5 died, and the others seemed so feeble that the water was changed. By February 15, 19 had died, the rest two days later.

On February 2, 14 of the 15 in dish 4 died, the last dying the next day.

On February 1, the fish in dish 3 were observed to be less lively than at first. On February 15, 8 died; on February 17, the other two.

Of the fishes in dishes 1 and 2, all lived until March 23, when they were killed by a rise in temperature of the water, the dishes having been exposed inadvertently to the sun all day. Up to this time they had been active and healthy. A growth of algae in the dishes led to a change of water in both dishes on February 21. It is probable that they would have lived indefinitely had they not been subjected to the abnormal rise in temperature on March 23.

Notwithstanding their apparent health and nervous activity, the individuals in dishes 1 and 2 were much behind those of the same age that had remained in the hatchery troughs in running water. While the yolk sacs of the latter had been absorbed by March 1, the yolk sacs of the former were still prominent when they died, three weeks later.

The water in the dishes used was 2.5 cm. deep, with a surface 9 cm. in diameter, and a volume of 150 ccm. Under these conditions 30 fish lived for almost three weeks, in a quantity of water equal to 5 ccm. per fish. With 30 to 50 ccm. per fish, the latter lived much longer; but their rate of growth was materially retarded in correlation with a diminished rate of absorption of the yolk sac—that is, a diminution in food supply.

The volume of water per fish is thus seen to be a factor in development. It is also true that the amount of surface exposed to the air per unit of volume, or the shape of the body of water, exerts a definite influence upon the result. Five fish in an open bottle filled to the neck with 55 ccm. of water with a surface 1 cm. in diameter died over night, January 7-8. In troughs where the water is being renewed several times an hour, we have compared the rate of growth of fishes in water at depths varying from 7 to 14 cm., but have found no significant difference in the rate of their growth.

ON SOME DISEASES OF FISHES

By G. A. MacCallum, M.D.
New York, N. Y.

Through the kindness of the director, Dr. Townsend, and his assistant, Dr. Osburn, of the New York Aquarium, I have had the opportunity of performing several hundred autopsies upon fish of many different kinds which have died in the Aquarium during the last three years, and it is at their request that I outline here the types of disease encountered. A similar privilege has been granted me by the director of the United States Bureau of Fisheries Laboratory at Woods Hole, Mass., during each summer, and it is instructive to compare the conditions found in freshly captured, free-living fish with those occurring in fish which have been for some time in captivity. Probably no statistical studies could be made in this way, because in the ocean diseased fish might not be taken in the proportion in which they actually occur, either because they fall out of the shoal, or because of their sluggishness they are destroyed by other fish. On the other hand, for the same reasons they might be taken in excess by other methods of fishing. On the whole it is rare to find in free swimming fish such extremely advanced diseased conditions as are occasionally encountered in the protected tanks of the Aquarium.

My attention has been directed throughout this work especially to the worm parasites of these fish and reports concerning the structure and systematic relations of many of these with statements as to the damage occasioned by them have already been published. In addition to a brief review of their influence upon fish in confinement, the present paper is intended merely to indicate the general character of the other diseases met with, but not really studied. This may be particularly useful in showing what a great field for research lies there. Of the worm parasites, which include representatives of most of the groups of trematodes, nematodes and cestodes, many have been found in small numbers inhabiting the intestines and other internal cavities without producing any obvious disability in the fish. In cases in which this infection was more external, however, the worms by their very numbers and by their blood-sucking habits had a much more serious effect. This was particularly striking in the case of the ectoparasites of the trematode group, especially in the several forms of *Microcotyle,* which live on the gills of such families of fish as the *Chaetodontidae* (Butterfly fishes), and Angel fishes, 90 per cent of which in captivity die of *Microcotyle* infestation. The same may be said of many of the Salmonidae which suffer from infestation of *Octocotylidae,* etc. These worms, at any rate in those fish living in confinement, increase in such numbers that the gills are in many instances thickly covered with them —and not only do they, with their surrounding slime, impede the access of water to the gills but they drain away the fish's blood to an extent that generally ends in a fatal anaemia. Another striking example of extreme infestation is found in the intestine of such fish as *Roccus lineatus* (Striped Bass), at times so infected with *Echinorrhynchus proteus,* a nematode which embeds its hooked proboscis in and through the gut wall in such numbers that the whole mucosa is covered thickly with their hanging bodies. Not only is an intense inflammation set up by these embedded hooks, but the function of the mucosa is precluded. Still this seems to be less fatal than the infection of the gills. The occurrence of larval forms of various digenetic trematodes and cestodes encapsulated in the muscles and other tissues of fishes are well known and sometimes productive of disablement of the host, although at times the most extreme infection may exist without obviously hurting the fish.

Of the diseases caused by the unicellular sporozoa of the class Myxosporidae, so well known through the work of Gurley and others, relatively little has been seen in this series of autopsies, and of this disease very many more cases have been seen in those fish taken fresh from the sea.

Evidently the tanks of the Aquarium have escaped infection since it is well known that the most fatal epidemics are from this cause, often leading, in the Great Lakes to the death of countless fish. They commonly infect the muscles and subcutaneous tissues, producing tumor-like swellings which project under the skin and may break down into great ulcerations. Sometimes they show only in the form of small whitish nodules in the internal organs, at others in large nodular masses like white tapioca or sago which fill the abdominal cavity, being attached to the peritoneum and the internal organs. The escape of the parasites from ulcers and from dead and decomposing fish spreads the disease and the most drastic measures are necessary if this is to be prevented. The fish which I have found to suffer most from this disease were perch, flounders, alewives, smelts, hake, pickerel and some of the minnows.

Certain bacterial infections have, however, caused the loss of many fish in the Aquarium in the course of the past winter. In these there appeared peculiar ulcerations of the skin, which in a short time so progressed as to cause the death of the fish. They are sometimes numerous and large and often burrow under the skin or even ulcerate into and through the bones, including those of the head. The ulcer usually shows a dirty gray slough which discharges pus. The neighboring scales are loosened and the skin discolored. Apparently these ulcers begin as abscesses beneath the skin, and after death the liver, spleen and kidneys show scores of small abscesses scattered throughout their substance. Cultures were made by Prof. Zinsser, of Columbia University, who found a bacillus growing best at low temperatures, which, when inoculated in pure culture into normal fish reproduced the disease even to the extensive ulceration of the skin. In both the original lesions and in those experimentally produced the bacillus was demonstrated in smears and in sections. This study is still under way and will be published when completed. As far as I know, this disease affects only the fish in the Aquarium, not those taken freshly from the sea, and it seems obvious that rigid disinfection of tanks, etc., would easily stamp it out.

Many of the fish in confinement show upon autopsy a great distension of the gall bladder sometimes with generalized jaundice. It is usually found to be due to narrowing of the common bile duct by inflammation of its mucosa, although it is sometimes caused by blocking of the duct by parasites. It is not easy to give an explanation of this. A number of examples of the peculiar affection of the thyroid so much studied by Gaylord, Marine and Lenhart came to my attention. As is well known, it is even yet a matter of dispute as to whether this enlargement of the gland which may affect the isolated fragments of thyroid tissue scattered so widely in the tissues of the fish is to be regarded as a malignant tumor or not. It is at least destructive of the lives of many fish in hatcheries of trout, but Marine thinks it merely a modification of the gland caused by unsuitable food and over crowding, and especially by lack of iodine-containing food. Gaylord thinks it cancerous.

A few more definite tumor growths have been encountered, one which produced a rounded protuberance on each side of the dorsal fin of a *Neomaenis griseus* (Gray Snapper). These proved on section to be a hard fibroma composed of very dense fibrous tissue with relatively few cells. Two fish, a red hind and a pickerel, died after an affection of about three months during which the soft tissues of the lower jaw and part of the tongue were wholly destroyed leaving the bones completely bare as far as the angle of the mouth. This was at first thought to be an epitheliomatous growth but sections of the margins of the tissue showed no tumor and the nature of the process is obscure. A large snook (*Centropomus undecimalis*) was observed for a long time in the Aquarium with a large tumor on the tip of its lower jaw, which may possibly have been of the nature of the thyroid enlargements. Unfortunately it was not studied at autopsy. Another, a black grouper (*Mycteroperca bonaci*) showed at autopsy a firm nodular mass constricting the rectum which was greatly dilated above the structure. There were many adhesions and inflammatory products in the neighborhood. Again through an accident the tissue was lost so that the exact nature cannot be stated. In large *Cynoscion regalis* (Squeteague) there was found a tumor of the testis about 15 mm. x 15 mm. x 10 mm. This was sectioned, but not yet studied.

Fragmentary as these notes are, representing only incidental observations of conditions not carefully studied except in the case of the worm parasites, they are given to indicate what an extensive field for study presents itself in the pathological conditions found in the fishes at the Aquarium.

STRAY NOTES FROM PORTO RICO

By J. T. Nichols,
American Museum of Natural History, New York City.

The writer has had the good fortune to spend the better part of the past July studying the fishes of Porto Rico in the interest of a biological survey of that island which is being forwarded by the New York Academy of Sciences and the Insular Government. The material collected has not yet been studied, and indeed a discussion of the detailed scientific results obtained would be out of place here. Certain observations, however, he has had in mind to talk over with members of the American Fisheries Society, and these are herewith presented.

The Silk Snapper, *Neomaenis vivanus,* is a deep-water, yellow-eyed representative of the more familiar Red Snapper. Evermann and Marsh in Bulletin XX of the U. S. Fish Commission for 1900, speak of it as one of the important food fishes of the island, but say that it was not common in Porto Rican markets during their visit, though Mr. Oscar Riddle found it quite common in the San Juan market at certain times. On July 13 of this year it was exposed plentifully for sale in the San Juan market. As Evermann and Marsh were on the ground in winter, the difference may be a seasonal one. The data at hand are as yet quite insufficient to determine this. A herring, *Sardinella sardina,* not listed in the U. S. Fisheries Bulletin referred to, but found abundant this summer at San Juan, also may be of seasonal occurrence.

The Barracunda or "Picunda" is one of the more favored food-fishes in Porto Rico. The waters of San Juan harbor are unfortunately badly polluted, and the fish from near there consequently looked on with suspicion, this species less so, because it is thought to feed exclusively on active live food. In Cuba the Picuda is looked on with much disfavor. Large individuals especially are considered sometimes to be poisonous, but in Porto Rico nothing detrimental was heard about the species.

The fresh-water fish fauna of Porto Rico is very scant even considering the limited fresh waters of the island, and it may be advantageous to introduce game or food species as the demand for fish exceeds the supply and much salt-cod is marketed. At Guanica a large shallow lake, with edges plentifully grown with water plant and containing Top Minnows, *Poecilia,* in abundance, has the disadvantage that its waters at times doubtless reach a high temperature. Near Guayama sizable lakes have recently been made for irrigation purposes by damming back the stream. One of these lakes visited seemed notably barren of plant and animal life and probably some food would have to be introduced before larger fishes would thrive.

It is interesting that at one point on the island, Isabella, the common aquarium goldfish is found. From there some specimens have been brought to a small pond on the Governor's place in the hills above Guayama where they are doing well and breeding. The goldfish is primarily a cold-water fish and its introduction in the tropics is interesting.

THE USE OF SALT IN SEPARATING UN-FERTILIZED FROM EYED EGGS

By G. H. THOMSON,
Estes Park, Colo.

The use of salt for the separation of dead eggs has been tried successfully in the Government salmon hatcheries on the Pacific coast, but I have never heard of this method being applied to the eggs of the Brook Trout. Any method that will avoid the tedious picking out of individual eggs, which is the usual way of getting rid of them, is desirable to save labor and time. The results of my experiments with the eggs of the trout may therefore be of interest to fish culturists.

During the last winter the hatchery was filled with brook trout eggs, and when these reached the stage when the embryos began to show and the eggs could be handled without danger, I began these experiments. When the dead eggs have reached a certain stage and with the salt solution at the proper density, the separation becomes a very simple matter. As the living eggs settle to the bottom while the white eggs remain at the top, the latter can be removed in a dipnet by the hundreds instead of one at a time. The live eggs may then be returned to their trays without injury.

The white eggs cannot be separated by this method when they begin to turn, for then they have nearly the same specific gravity as the live eggs, but if they are left for three or four days, according to the temperature of the water, they will float readily.

With the aid of a hydrometer I found 36 degrees to be about the right density for the salt solution and then by making a preliminary test of a few eggs the water could quickly be brought to the proper density for use. If the salt solution is too dense all the eggs will float, but if the density is too low they will all settle to the bottom.

For the work of separating the eggs I use a wooden bucket in which is fitted a wire screen on which the live eggs can be quickly removed after the dead ones have been skimmed off. When I have everything ready I remove the trays from the hatching trough and let the water drain off so as not to dilute the salt solution. Then with the aid of a feather I remove the eggs from the tray into the solution. If the density is right, the live eggs settle at once to the bottom while the dead ones remain at the top and are quickly removed. The live eggs are then returned to the tray. Three or four days before I intend to use the salt I wash the eggs by shaking the trays, in order to turn all the dead ones white that I possibly can. Even then there will be some that will not turn at this time, so that after using the salt solution it may appear that one is not getting results, but careful observation will show that all have been removed that are near the danger line of fungus.

The time consumed in handling the eggs is not determined by the number of dead ones removed, but by the time required for handling the trays, putting the eggs into the solution and replacing the good ones in the trays. I found that nine trays of 5,000 eggs each could be handled in 36 minutes. Where the condition of the fertilization of the eggs required the removal of 66 2/3% before the hatching was over, I proved that one man can do more work in one day than six can accomplish by picking the eggs out one at a time. And the eggs are left in better condition, for all the sediment is removed, even that which the shaking and washing will not remove, and the eggs are left perfectly clean and clear.

If a mistake is made in handling the eggs in the salt solution, they cannot be handled again the same day, for they will not separate again until they have been for some hours in fresh water.

Care must be taken to have the salt solution the same temperature as the water of the hatchery, to avoid injury to the eggs.

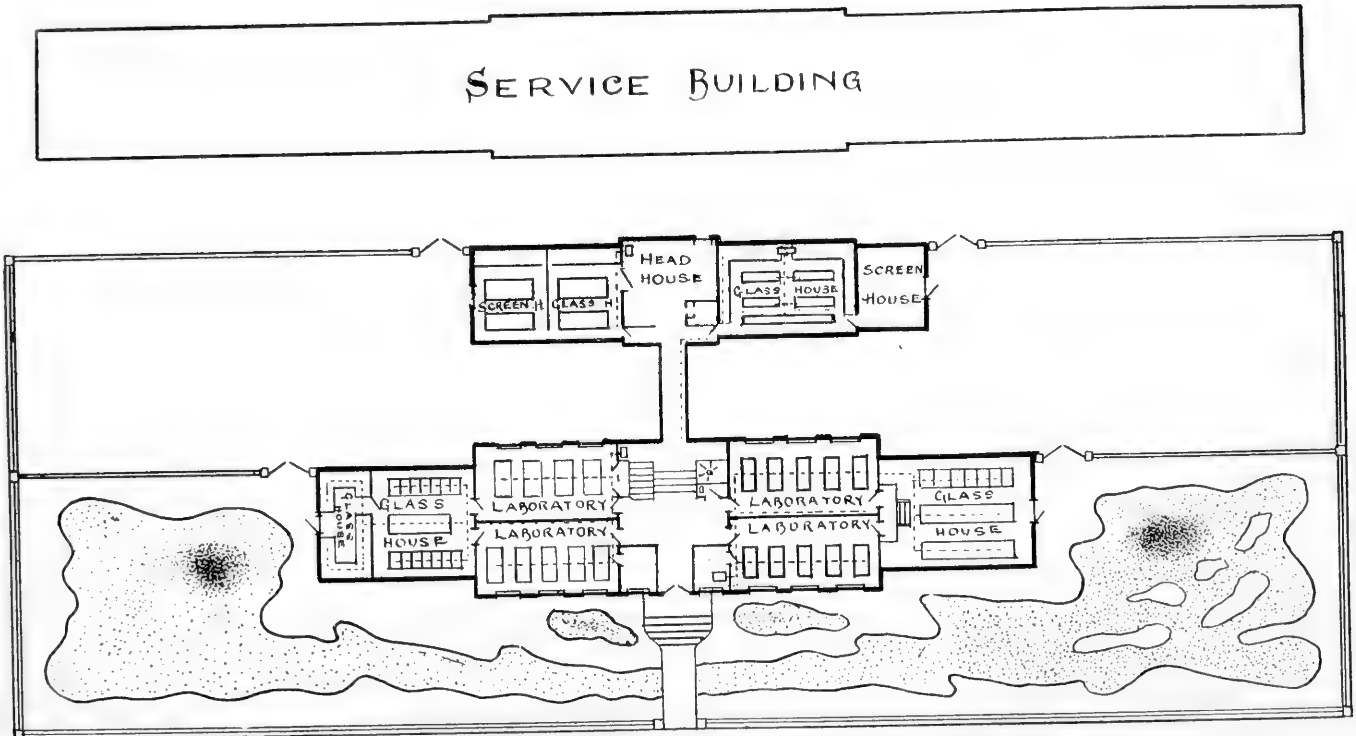
It may be asked if there are not many live eggs removed with the dead ones. Only when I handled them near the hatching period when the eggs could not be allowed to remain in the solution for the time required for proper separation. In this case I took a sample and found two ounces of live eggs in a total of twenty-five ounces of eggs removed. Even then I saved a vast amount of time and labor by using the salt solution.

I have experimented a little with the green eggs, but without satisfactory results.

All the eggs that I had in the hatchery last winter were handled by myself, single-handed, in the eyed stage, and this summer I have handled over 800,000 of the rainbow and black-spotted trout with equally good results, so I no longer dread the work of picking out the white eggs at the eyeing stage. The salt solution properly used will save a great deal of labor and expense in the operation of a hatchery. There is no reason why we should not progress in practical fish culture as well as in other lines of industry.

NOTICE OF MEETING

The next Annual Meeting of The American Fisheries Society will be held in San Francisco, California, on September 1-4, 1915. Members are urged to attend if possible, and are requested especially to keep the date in mind in connection with the preparation of papers for this meeting.



PLAN OF PROPOSED VIVARIUM BUILDING, UNIVERSITY OF ILLINOIS, URBANA, ILL.

TRANSACTIONS

of the

American Fisheries Society

"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

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CONTENTS

AN EXPERIMENTAL PLANT OF INTEREST TO FISH CULTURISTS

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It is my intention to call to your notice a new movement in connection with the investigation of problems concerning fish culture. The plan has been formulated at the University of Illinois, and it is hoped that it will be carried to completion very soon. The prominence of the fisheries industry and fish culture, the importance of general problems involved in the life and habits of fish, and the growing interest in fish conservation have led to a consideration of the need of determining the fundamental principles connected with the home life of the fish, their reproduction, growth, and adult life under normal conditions. Many years of study on fish problems are recorded in the publications of national and state commissions, bureaus, and societies of various kinds. The greater part of this activity has been connected with taking and guarding the spawn, and raising the young. Between the United States government, and the various state organizations, many experiment stations are devoting their entire energies to the problem of obtaining fish eggs, hatching young fish, and replanting them in the various waters. The amount of work that has been devoted to this problem is enormous, and the total expenditures for such purposes, if brought together and summed up, would reach a figure calculated to astound even one most familiar with the question, and with the actual financial expenditures of these various stations.

Many have come to appreciate, and doubtless you in this organization most of all, that these stations are doing a rather one-sided work. I would not be understood as minimizing in the slightest degree the splendid results that have come from their activity, or the ability and care that a multitude of superintendents and helpers have devoted to make their operations successful; but they have thus far contented themselves with the consideration of a single phase in the activity of the fish. They have depended on more or less general, and often imperfect statements concerning the natural conditions of reproduction, while they have been entirely ignorant of the other factors in the environment of the fish. So far as I know, the consideration of other factors in fish life has been limited to somewhat fragmentary and periodic studies by individual men connected with various fish bureaus and stations,—to the work of a few state surveys (notably the Illinois Natural History Survey, and the Wisconsin Natural History Survey), and to the work of the United States Bureau of Fisheries. The latter deserves prominent mention in this connection. Under the direction of the present efficient Commissioner of Fisheries, the scientific work of the Bureau has been carried on with increasing success for a long period of years; and the results are augmented by the efforts of numerous regular and special scientific investigators. These form a substantial foundation for our knowledge of fish life and habits. Certainly every member of this Society hopes that the work of the Bureau may be continued and extended along these lines already so well inaugurated; and that our national Congress may be favorable to granting adequate sums for the prosecution of this work. Its fundamental importance cannot be questioned; its brilliant successes cannot be doubted.

But, with all this, the situation is as yet rather poor when we compare conditions as they exist in the fisheries field, with those in agriculture. In every state one or more agricultural experiment stations are maintained for the continuous and exclusive investigation of agricultural problems. Experiments on plants and animals are inaugurated and followed out for long periods of time, giving opportunity for the study of complete cycles of existence, and for the determination of the factors which influence favorably and unfavorably the development of all sorts of living things. Such an experiment station has not as yet been established to deal with the problems of the fisheries. The famous Woods Hole Station, established through the efforts of the distinguished United States Commissioner of Fisheries, Spencer Fullerton Baird, comes perhaps the nearest to meeting the conditions that obtain in agriculture; yet the force of scientific investigators is at work there only during a portion of the year, whereas the rest of the time the plant is utilized as a hatchery.

In my opinion, the tendencies of our universities are in a certain degree responsible for this neglect of aquatic life. In the various college laboratories of departments of natural history, experiments of the most diverse kinds are being carried on constantly. Most of these experiments concern problems of a rather theoretical character. It is the effort of pure science to establish and analyze conditions for existence in the broadest sense, and all groups of animals serve only so far as they are adapted for the testing of theoretical questions, or are related to problems of economic importance to the community. The agricultural interests are fundamental and their importance has served to direct the attention of scientific men to the wisdom of determining the features that they have desired to have investigated. Recently there has been a movement in our universities to inaugurate a more careful study of the conditions under which animals and plants actually live and the importance of individual factors among these conditions for the welfare of the organism. The Board of Trustees of the University of Illinois has voted to spend a sum of money in the construction of a plant for experiment work on animals. Strictly speaking this is to be devoted to an effort to solve all problems of animal existence, both such as are related to terrestrial existence affecting prominently the land animals with which the agriculturist works, and such as concern aquatic existence being thus of first importance to the fish culturist. An examination of the plan will show the general way in which these problems are to be attacked, and the particular advantages for such an attack that are offered by the proposed installation. (See Fronstispiece.)

A tract of land, about 130 x 350 feet, has been purchased, on the edge of the campus. It is proposed to erect in the center of this plot a vivarium building with greenhouse wings and to construct on the land in front of the house a culture pond for fish work. An examination of the sketch plan given here will illustrate the essential features in the construction of the house. It is a rectangular structure with a hallway running through the center, from north to south and opening into four laboratories, one at each corner. East and west from the main house project glass houses of ordinary greenhouse construction, which will be utilized for growing animals, but will of course hold plants although these are introduced only for the purpose of furnishing food and shelter for the animals, or to give to the culture animals as nearly as possible the same conditions as they find in the outside world. A similar greenhouse construction projects from the rear of the laboratory structure. Considering the division of space, one may see that each of the four large laboratories has a greenhouse directly connected with it. This plan leaves the north one-third of the block, which lies next the interurban railroad track, to be utilized as a university storehouse, for unloading freight, receiving supplies, etc. It has nothing to do with our project.

It is important to notice the general equipment of the laboratories proper. Each one of them is to be supplied with three sorts of water supply,—the city water (which in this case is very hard), rain water which will be drawn from a cistern constructed on the property near the building, and sea water from an enclosed salt water system, entirely within the building. Each of the greenhouse extensions communicating with a laboratory is similarly supplied, but with less permanent installations for holding the water, so that it may be possible to modify the conditions when demanded by any new experiment. The laboratories and greenhouses have also a supply of cold brine for refrigeration, taken from a plant in the basement. Direct and alternating electric currents are available in every room, but illuminating gas is kept out of the main laboratories because in previous experimental buildings, it has been found particularly fatal to the continued normal support of animal life. The number of connections planned for each laboratory is ample to allow of the installation of various electric and water appliances useful in conducting experiments of any kind on the animals under control.

The basement of the building is utilized for the necessary machinery involved in the various installations. This includes, in the first place pumping machinery to run the salt water system, and a second system to drive the city water or the rain water systems. The basement also contains a refrigerating machine and some other incidental machinery such as the compressor and regulator for the air machine from which the compressed air is distributed to each of the laboratories under the proper pressure condition. The cases and tables in greenhouses and laboratories need no special comment. They are of the usual laboratory type. The greenhouse wings are of standard construction, but on the greenhouse benches are placed either movable or fixed aquaria. Most of these can be readily modified at will in position and size, but one set of salt water aquaria and another of fresh water aquaria on the other side are fixed installation. In planning for these the Supervising Architect, Professor J. M. White, has utilized every possible means of securing information concerning plants of recent construction; and visits have been made to various city aquaria and university plants where aquaria have recently been established or have proved effective in operation. On the land around the house, the plan shows a pond laid out. It has the general shape of a dumb-bell, with a very long, narrow neck. Each one of the enlargements at the end of the connecting neck has an area that is precisely one-tenth of an acre. Dimensions of such diminutive proportions provoke a smile from the fish culturist. It is in his opinion nothing but a "mud hole,"—and yet let me assure you, *without the mud.* A weir and gate which can be tightly closed is located at the central point in the neck of the dumb-bell; consequently, the two ponds can be operated together or modified independently, since the water supply is absolutely independent. We can operate one side with rain water and the other with city water. We can modify water conditions of one without affecting in the least those in the other; or if desired, the two may be joined by an open connection such as to insure relative, if not absolute, uniformity in the two parts.

In one of these plants has been incorporated a suggestion that we owe to the kindness of Superintendent Dwight Lydell, of Michigan. In one of the two ponds has been constructed a series of small islands. The area and location of these have been planned so exactly that the shoreline of the east pond is just twice as great as the shoreline of the west pond, but the water area and the water volume are substantially identical. A small bridge thrown over the neck that joins the two ponds gives entrance to the experimental laboratory building. The whole tract of land, including buildings and ponds, is to be surrounded by a cat and boy proof fence, far enough from the outer edge that no combination of bamboo pole and bent pin can possibly prove successful in robbing the experimental ponds of their treasures.

Each pond has a kettle with a maximum depth of 12 to 13 feet. The outlet from the kettle is surrounded by a box from which a plank bridge extends to the shoreline. An inlet is located in the communicating neck, and one inflow point is located on each side of the gate separating the two ponds. In this installation attention has been paid to the fact that in this region it is not possible to use water, lavishly. It is in one sense the dryest point in the state of Illinois, for it lies on the height of land between Chicago and the Gulf. Several of the rivers of this region originate as tiny streams, within a few miles, or less, of the very point where this plant is located. There are now in the county no lakes and very few permanent streams of any size. Extensive drainage ditches have eliminated surface moisture, but even before their construction the territory was without any permanent water bodies. It is important to consider the bearing of this upon the experiment under consideration. A fish pond is being built where, within the knowledge of man, no pond has ever existed before. A unit for existence of water life is being constructed in a county where such units have not existed under natural conditions. In a region where temporary pools of water have heretofore furnished only possibilities for aquatic existence, we are constructing a permanent aquatic unit, and planning to test in it the conditions of existence for various organisms, especially the fish.

Because of the fact that no large supply of flowing water is available, and what we use will come from tanks, cisterns, or wells, we are compelled to use it continuously; and a plant will be installed to circulate the water. The general plan in mind is to take the water from the outlet box by means of a small pumping apparatus, and turn it back again through the inlet. This inlet pipe will be raised above the surface of the water, so that the water inflow will be aerated in coming out and falling into the pond, again. Starting absolutely from the beginning, it will be possible to keep a record of the time at which each addition is made to the pond, and of all the material, either plant or animal, of perceptible size that goes into it. Of course, it will be impossible to control the wind and dust, and all of you are aware that the microscopic life of the water is probably carried in the form of spores or resting stages in the dust. No doubt many things will be brought into this pond that will surprise the recorder, and it is possible that in this way some information may be gained regarding the stocking and restocking of water bodies with the minute plant and animal life. It will also be impracticable to control the insect life, but apart from these, we shall be able to determine the origin of any element and to know that all increase or decrease is dependent on conditions which we fix. In other words, in a new and definitely circumscribed environment the conditions will be under control so far as possible, and all of those under control will be definitely measured and recorded.

Evidently the possibilities of experimentation are present here as they could not be in a larger plant. They are also to be attacked in a very different fashion. In one sense, they are not at all the problems that concern the practical fish culturist, who receives from state or national authorities a definite sum of money and is expected to show the hatching and planting of a commensurate number of young fish. The primary object of this plan will be experimentation and that will be carried out on a purely biological basis. Studies will be made on all the various types of organisms with a view to determining the most favorable conditions of existence. That means as regards the fish the effort will be made to ascertain what factors modify the number of fish, the rate of growth, the rapidity and perfection with which they reach the adult condition, how different kinds of food affect them, how differences in the environment of temperature, chemical constitution, and vegetation, as well as other living things which are in the water, but do not constitute a part of the food, will influence their welfare. In this field, we are very fortunate at the University of Illinois in having as a member of the staff Dr. V. E. Shelford, whose valuable contributions to the study of the fundamental conditions of aquatic existence are very well known. It is hoped that taking advantage of these important researches, it may be possible to determine their relations in a practical way to the problems of the fish culturist.

The general arrangement of the plant favors the easy transfer of the fish at any time from the pond to the aquaria within the greenhouse or the laboratory of the vivarium, where they can be kept under a much more limited environment and examined more closely and constantly, as well as subjected to artificial influences and the experimental environment of the laboratory. The small size of the plant and the ease with which one of the little ponds can be run off makes it possible to alter the environment rather quickly, by changing the water, adding some chemical, or cleaning out some type of vegetation. In every way, it seems to furnish possibilities of culture such as have not been given or utilized anywhere else, so far as I know.

Now, this has a very definite and practical bearing, and I was much interested to see the way in which the Board of Trustees of the University of Illinois treated the original discussion when the idea of such a plant was presented to them. One of the distinguished members of the Board is a gentleman whose repute as a fisherman and angler is very high. He is said to be able to tell more stories than any other man in the state of Illinois, on the subject of catching fish. He immediately seized this pond as one of the things that would interest the state, and became still more interested when I told him that this pond of water was just what any farmer could have in his front yard, precisely the same as he plants a garden there, and if we could work out principles which would show the man on the farm who wants a little lake where lakes do not exist—I am not talking about Wisconsin, Minnesota, Michigan or Northern New York; I am talking about a place where natural bodies of water do not exist,—if we could tell the farmer how to establish a little lake in his front yard, that would keep itself fresh and sweet, and that would produce for him some fish out of which he could derive pleasure and obtain perhaps some profit, we would be doing him a real service. The support which the mere outline of the report received from the Board of Trustees, and from a conference of the State Agricultural Society, which was in session at the University, showed that if the plan could be worked out, there was no question about the support of the state for more extensive experimentation.

The objects of the plan, then,—as stated briefly, and this lays before you the main points in the scheme,—are (1) to establish a plant so simple that it can be duplicated in every respect by any man, anywhere, (2) to work out the proper environment for most efficient fish production so that the individual anywhere may let the pond produce the fish itself, (3) to eliminate the work that a man in such a situation would not be able to perform, and then (4) to combine with these, of course, the determination of the fundamental conditions of existence that are favorable and unfavorable for fish life. Naturally this study concerns not merely the fish, but the smaller animals, such as insects, etc., that constitute the food for the fish, and also still other forms, like the microscopic organisms which are so abundant in the complex of life, and so important.

PROCEEDINGS OF THE FORTY-FOURTH ANNUAL MEETING

The Forty-third Annual Meeting was held in the New National Museum at Washington, D. C., on Wednesday, Thursday, Friday and Saturday, September 30 to October 3, 1914.

Wednesday, September 30, 1914.

The meeting was called to order at 10:30 A. M., by the President of the Society, Professor Henry B. Ward of Illinois University, Urbana, Ill. Hon. Wm. C. Redfield, Secretary of the Department of Commerce, was then introduced. After welcoming the members of the Society to Washington and presenting some interesting reminiscenses, Secretary Redfield proceeded to discuss some of the needs of the United States Bureau of Fisheries as follows:

ADDRESS OF SECRETARY REDFIELD.

"In the first place, our methods provide no easy way of bringing before Congress and the public the needs of the service. In this respect I think our government is one of the most backward. I cannot go myself before Congress to present these needs. If I were a cabinet minister in England, France, Germany or Austria, I could. In every country where they have a responsible ministry, access is direct between the legislative authorities and the executive department. I may write a letter to the President asking him to transmit in his message to Congress something that I wish to bring before that body and the country, but the President's message is necessarily limited in scope, confined to important matters and must be brief. I might go before a congressional committee, particularly the Committee on Appropriations, but their work is done under pressure, in very limited time, without any opportunity for personal touch away from the committee table, and there is no time to place before them long communications. The House Committee on Fisheries and the Senate Committee do all in their power, but the House Committee is also the Committee on Merchant Marine, which is a very exacting subject, so that the question of fisheries gets the small end of it. It remains to take up the subject with the individual chairmen, but they cannot give their whole thought, nor even connected thought, for a long time; or to take it up with individual congressmen or senators and interest them in the matter, but they also have other things to do. If our cabinet ministers had the privilege of a place upon the floor, without a vote, and could present their views and answer questions, we should overcome, at a singe stroke, much of the difficulty that stands in the way. If I could go before Congress on behalf of the Bureau of Fisheries, and say that such things should or should not be done for such and such reasons, the knot which ties our hands would be cut, but oftentimes the effort to get the facts before the people who have to deal with them is a very real difficulty.

"Now, coming to other matters of practical effect, the Bureau of Fisheries has not the apparatus to do the work which it ought to have. Any private concern equipped as is the Bureau of Fisheries, would go out of business in a very short time. Through the kindness of an all-seeing Providence the building in which the Bureau is housed continues to stand! It is a makeshift; a second-hand outfit; not complete for the purpose; not suited for the purpose; and that it gets along so well is largely due to the splendid spirit of the men who operate it. They work under a serious handicap.

"We ought to have an aquarium. We have only the beginnings of one. Some day we may get an aquarium commensurate with the dignity, power and usefulness to the United States of this great service and thus afford the opportunity for study which such an aquarium would make possible.

"Do you realize that we do not get money enough to buy new apparatus, but have to buy second-hand and use it as long as it will last? Do you realize that no private business would think for an hour of running on such a basis as some of our services are compelled to run upon? One of our vessels is a second-hand yacht. It was a very good one, when it was built, for inland waters, when it did not blow. But that vessel is supposed to navigate the rough waters of the North Atlantic in Winter time. We have tried for three years to have that vessel replaced, but cannot get the money. We have another second-hand craft, one of the most agreeable pleasure boats of her kind, but unfortunately, she, too, has to go to sea. Why cannot we have once in a while the privilege of a new ship? We would be content if we had the price of one tenth of a battleship for the entire fleet!

"Come with me for a moment to the coast of Alaska. There is not much of it,—only about twenty-six thousand miles, a little more than Gulf, Atlantic and Pacific coasts put together. For many thousands of miles of this coast which we are supposed to inspect and for the inspections of eighty-seven canals and a number of streams required by law to be closed and which we were supposed to keep closed, we had four men and no vessels. Now there is a beautiful situation for a great and practical people! We did not know, we could not know, and for years have not known whether the regulations were violated there or not, for we had no means of finding out. If you were running a fish cannery there, this was the method of inspection; you would get a letter from the inspector, saying that he was going to inspect your cannery and would you please send your boat and get him; and that has been the only way in which access has been possible to those places which we wished to inspect.

"Now I have put before you certain very plain pictures. That is the kind of extravagance we have had in the Bureau of Fisheries! Now we protest that this situation is wholly wrong. Scientific men, men of energy and enthusiasm, cannot be expected to work with inefficient tools. It is wasteful to the highest degree. Wise expenditure is the truest economy. There is no business man who does not know that to stint productive investment is to lose money. I do not believe for an instant that the American people care whether this government spends a million or two more or less, by itself considered, but I do think they care mightily whether that money is productively spent so as to bring them what they have a right to expect in economic and efficient service. Productiveness arising from spending is the sole basis of economy, and to send men to sea in unseaworthy ships, to equip a great bureau with a building which is hopelessly out of date and to require it to do that which it is ridiculously without the means of doing, may be miserly, but it is not economy."

Secretary Redfield further deplored the fact that all attempts to secure an appropriation for the services of a pathologist in the Bureau of Fisheries have been unavailing, and continued; "I wish that copies of the papers on the diseases of fishes presented here could be sent to each member of the Appropriations Committee of the House of Representatives with a personal letter from a lot of you, indicating the seriousness of this matter and that this means the adoption of measures of the same ordinary common sense in treating this important article of food, that have been already adopted with reference to the examination of beef, or to looking after the health of animals affected by tuberculosis and affecting the milk supply. The adoption of such measures is a matter of common sense.

"If an attitude of sympathetic consideration for the great work in which you have a part, which we have at heart and which it is our duty to perform, can be created, much will be gained. I hope that out of this meeting there may come something that will awaken a practical sympathy on the part of men who are anxious and willing to do what is right, but who do not know as well as you what the circumstances require."

At the completion of Secretary Redfield's address the regular business of the Society was resumed.

President Ward announced the Committee on Program for the meeting, to consist of Dr. Geo. W. Field, chairman, and Messrs. Dwight Lydell of Michigan and Jesse Mercer of Georgia.

REGISTERED ATTENDANCE.

The following members were in attendance at the meeting, sixty-two in number:*

Adams, Wm. C.
Alexander, M. Leigh
Beal, F. J.
Bean, Barton A.
Benson, Jno. T.
Blackford, Chas. M.
Bower, Seymour
Bowers, Geo. M.
Brown, Ernest C.
Casselman, E. S.
Clark, E. D.
Cobb, Eben W.
Cogswell, L. M.
Crampton, Jno. M.
Crandall, A. J.
Detwiller, Jno. Y.
Downing, S. W.
Dunlap, I. H.
Dyche, L. L.
Embody, Geo. C.
Fearing, Daniel B.
Fearing, Mrs. Doniel B.
Field, G. W.
Filkins, B. G.
Finley, Wm. L.
Geserich, L. A.
Graham, Geo. H.
Harron, L. J.
Hay, W. P.
Hayford, Chas. O.
Hoxsie, F. D.
Hubbard, Waldo F.
Johnson, Robert S.
Keil, W. M.
Kendall, W. C.
Kraiker, Carl
Lee, W. McDonald
Lydell, Dwight
Lydell, Mrs. Dwight
Marsh, M. C.
Mercer, J. E.
Moore, Jno. D.
Morton, Wm. P.
Neal, Walter I.
Nichols, John T.
Osburn, Raymond C.
Palmer, T. S.
Porter, R.
Radcliffe, Lewis
Smith, H. M.
Speaks, Jno. C.
Stapleton, M. F.
Struven, Chas. M.
Thayer, W. W.
Titcomb, John W.
Vandegrift, S. H.
Wallace, Jno. Henry, Jr.
Ward, Henry B.
Ward, J. Quincy
Welsh, W. W.
Willard, C. W.
Woods, John P.

NEW MEMBERS.*

The following applicants, forty-one in number, were elected to membership in the Society:

Alaska Packers' Assn, Patron
Anderson, T. T.
Annin, Howard
Beal, F. J.
Bolton, C. C.
Bordenkecher, R. R.
Briggs, A. B.
Brown, Ernest C.
Brown, Ernest Clive
Coffman, J. N.
Crampton, John M.
Conger, Geo. C.
Davidson, J. O.
Dimick, F. F.

*For addresses see membership list.

Forsyth, Robert
Gammeter, John R.
Garcelon, Wm. F.
Greene, John V.
Harris, Fred N.
Kavanaugh, W. P.
Kraiker, Carl
McDonald, E. B.
May, Jacob
Mercer, Jesse E.
Moore, John D.
Myers, I. S.
Nightingale, H. W.
Osborn, A. L.
Russell, Geo. S.
Smith, W. A.
Stone, Dr. Willard J.
Struven, Chas. M.
Stryker, Thos. H.
Tillman, Robt T.
Torrey, Prof. Harry Beal
Vogel, J. C.
Vandergrift,, H. D., Life Member
Wallace, John H., Jr.
Washburn, Prof. F. L.
Wolters, W. B.
Work, Gerald

President Ward then called for the reports of the Recording Secretary and the Treasurer, which were given as follows:

REPORT OF THE RECORDING SECRETARY.

To the officers and Members of the American Fisheries Society:

The most important as well as the heaviest work that has fallen to the office of the Recording Secretary has been that of editing and publishing the annual Transactions for the year 1913, the Boston meeting. As the Secretary was not present at that meeting and as he had had no previous experience in this Society's work the labor was necessarily somewhat greater that it otherwise would have been. However, the volume was distributed by July 15. The contract was let to Clark & Fritts of New York City, as the lowest of a number of bidders, and 800 copies were ordered printed.

By a resolution adopted at the Boston meeting, free rein was given to the Secretary and Publication Committee in the matter of editing. The general opinion expressed at that meeting was that the discussions should be cut down in printing to mere essentials. Following this plan, the records of the business meetings, etc., were made to cover only 38 pages, which is the lowest record for this century at least. I believe that an inspection will show that nothing essential has been omitted.

The directory of members was printed in small type, thus saving another ten pages.

These cuts have permitted the publication of more scientific matter without increasing the size or cost of the volume. Thus the 1913 volume, while actually 12 pages smaller than that of 1912, contains 10 pages more of scientific matter.

The Secretary takes this opportunity to thank the members of the Publication Committee for their support during the progress of the work. It was not found necessary to reject entirely any paper presented for publication, but some of them were cut down or otherwise amended, the author's consent being gained in each case.

The sale of back numbers of the Transaction was referred at the Boston meeting to the Secretary and Treasurer in conjunction with the Executive Committee. Upon canvassing the situation it was discovered that the total average cost of producing and mailing the Transaction for a number of years back, has been about $1.50 per copy. (This amount of course covers stenographic and other work in connection with the proceedings.) The cost of the 1910 number on this basis was about $2.00.

The secretary wishes to call the attention of the newer members especially to the fact that there is an abundant supply on hand of the volumes from 1904 to the present, and to suggest to them that here is a good opportunity to add to their libraries much valuable literature on fishery matters, and at the same time to add to the Society's funds.

During the year reports have been sold to the amount of $51.50.

Back volumes of Transactions in the hands of the Secretary are as follows:

1876—1	1900— 3	1907— 85
1884—1	1901— 1	1908—117
1895—2	1902— 4	1909—135
1896—1	1903— 0	1910—113
1897—3	1904—61	1911—127
1898—4	1905— 1	1912—229
1899—1	1906—92	1913—230

It will be seen from this table that there are only two scattering copies in the Secretary's file back of 1895 and that there is no copy of the 1903 number. There should be in the hands of the Secretary a complete file of the Transactions, to be kept intact as the property of the Society. The Secretary would offer the suggestion that if any of the older members of the Society have such back volumes which they no longer require, it would be an excellent thing to donate these to the Society.

The Secretary, in carrying on the work of his office has expended the following amounts:

Postage	$72.13
($46 of this for mailing Trans.)	
Expressage	20.55
(mostly for material in hands of the former Secretary)	
Typewriting	12.28
(copying scientific papers)	
Sundries	4.45
Total	$109.41

The Secretary has kept in mind the financial difficulties under which the Society has been laboring and has endeavored to keep his expenditures as low as possible, often at the expense of much personal labor and time. When the Treasurer is no longer embarrassed by a deficit, much of this can be hired done, thus making the duties of the Secretary less onerous. The occasional assistance of a stenographer in conducting the correspondence would especially lighten the work, but until the finances are in better condition even this has been dispensed with.

The deaths, within the year, of the following members has been reported:

Honorary member.

Dr. P. P. C. Hoek, Scientific Fishery Adviser of the Dutch Government, 1906.

Active members.

1872, Prof. A. S. Bickmore, American Museum of Natural History, New York City.

1901, T. J. Blakeslee, New York City.

1913, Austin Cook, Woonsocket, R. I.

1910, Thos. M. Darrah, Wheeling, W. Va.

1875, Dr. Theodore N. Gill, Washington, D. C., an authority on the morphology, classification and natural history of fishes.

1900, J. J. Hogan, Madison, Wis., life member and member of the Wisconsin Board of Fish Commissioners.

1903, Mr. E. C. Lambert, Manchester, N. H.

1899, Mr. Chas. H. Moore, Detroit, Mich.

1910, Mr. Overton W. Price, Washington, D. C., member of the National Conservation Association and a member of the Committee on Foreign Relations of this Society.

1899, Mr. Henry T. Root, Providence, R. I., formerly President of this Society during the year 1904-5.

The membership has been increased since the 1913 meeting by 33 members up to the beginning of this meeting. The active membership is now over 600 though it is probable a number of these will have to be dropped in the near future for non-payment of dues. It is useless for us to carry dead wood on our membership list and we must not deceive ourselves by the size of our list, even though it is certain that our Society now has more members in good standing than ever before. Every member of this Society should organize himself into a committee of one to push the work of the Society, to make it known to his friends and especially to increase the membership. When it is seen that New York and Massachusetts have more than 60 members each, so that the two of them have one-fifth of all the active membership of the Society, some one must have been at work, and when the little city of Akron, Ohio, with no unusual fishery interests, has nine members of the 29 listed for

Ohio, some one there must have displayed great activity in spreading the gospel of fisheries work.

It was moved and carried that this report be accepted.

REPORT OF THE TREASURER.

To the American Fisheries Society:

I herewith submit my Annual Report as Treasurer from September 8, 1913 to September 30, 1914.

RECEIPTS.

1913-14			
	Balance in Treasury	$ 241.54	
	Sale of Reports	17.50	
	Donations	41.00	
	Life Membership fee	25.00	
	Yearly dues	847.00	
			$1,172.04

EXPENDITURES.

1913			
Sept. 11	Sundry expenses, Boston meeting	$ 2.70	
" 25	C. J. Butler, envelopes	21.36	
Oct. 28	Jeanette Soule, stenography	180.00	
Dec. 5	J. J. Colley, packing books, etc.	10.00	
" 5	R. C. Osburn, Sec'y, express etc.	16.21	
" 5	W. E. Roberts Co., publishing 1912 Transactions	600.87	
" 8	Irving Press, printing	25.10	
" 17	J. H. Murphy	1.00	
1914			
Feb. 23	R. C. Osburn, Sec'y, postage, etc,	23.33	
May 19	F. A. Ringler Co., engraving	2.70	
June 27	Henry B. Ward, telegram	1.00	
July 18	Clark & Fritts, publishing 1913 Transactions	400.93	

July	25	H. D. Allen, postage, etc.	8.08	
Aug.	8	C. J. Butler, P. M., envelopes	10.68	
Sept.	17	J. C. Hall Co., receipts	6.75	
"	19	H. B. Ward, telegrams, etc.	2.10	
"	19	R. C. Osburn, Sec'y, postage on Transactions	68.07	
"	19	R. C. Osburn, Sec'y, salary for year	50.00	
			$1,429.88	
Sept.	30	Balance due Treasurer		257.84
				$1,429.88

Respectfully submitted,

C. W. WILLARD, *Treasurer.*

Westerly, R. I., Sept. 30. 1914.

To the American Fisheries Society:

I herewith submit the Annual Report of the Permanet Fund of the Society.

Received from Alaska Packers' Ass'n Patron fee $50.00. This amount is deposited with the Industrial Trust Company as Permanent Fund of the American Fisheries Society, and is drawing interest at the rate of four per cent.

Respectfully submitted,

C. W. WILLARD, *Treasurer.*

Westerly, R. I., Sept. 30, 1914.

Moved and carried that this report be referred to the Auditing Committee.

The Treasurer was asked to comment on the financial condition of the Society and pointed out that "while there is a balance of $257.84 due the treasury, the Society would not have been in arrears if it had not been for the fact that it was necessary to pay for the 1912 Transactions as well as for the 1913 number, thus adding more than $600.00 to the amount. The coming year we will not have to pay two years' bills, so that by the next meeting we may again have a balance on the right side of the ledger."

The Recording Secretary explained further that the difference in the cost of the Transactions for the two years was not quite as great as it appeared in the report, since the cost of mailing, nearly $50.00, was made a separate item in handling the 1913 Transactions. Nevertheless, there was a very considerable decrease in the cost of publication. He stated, further, that if the increase in the number of life members had been as great as in the preceding year, the Society would be entirely out of debt.

PRESIDENT: I think it is proper for the Chair to express the appreciation of the Society for the work of these two officers. Most of you know that a few years ago, by a complication of circumstances we fell into financial difficulties. The Society is evidently well out of this now, however, and it has never been more active, more thoroughly and vitally interested, as may be seen from the number of papers presented by the members for this meeting.

Most of you know that a Pacific Fisheries Society has been organized on the Pacific Coast and that a very successful meeting was held in August. At that time I received the following telegram addressed to the American Fisheries Society in my care:

"The Pacific Fisheries Society, in its first annual session, sends greetings to its sister society.

(Signed) JOHN N. COBB, *Secretary.*"

Knowing that you would wish it done, I took the liberty, without waiting for formal action, of sending a reply in the name of the Society:

"The American Fisheries Society extends greetings and congratulations to its new sister organization on the splendid outlook for its future.

(Signed) HENRY B. WARD, *President.*"

It is also proper that I should call attention to the work done by the Local Committee in arranging at a rather late date such a splendid program for this meeting. The program speaks for itself and I do not need to comment on the indebtedness we feel to each member of that committee, and particularly to its chairman, Dr. Hugh M. Smith.

We have received a considerable number of invitations for the meeting of next year from various cities, Springfield, Mass., Detroit, Mich., Buffalo, N. Y., San Francisco-Calif., Oakland, Calif., St. Louis, Mo., Atlantic City, N. J., and Chicago, Ill.

MR. M. L. ALEXANDER, of New Orleans: Mr. President, if I may be permitted at the proper time, I wish to present an invitation to this Society to meet in New Orleans.

PRESIDENT: This is the proper time and the invitation will be considered by the Committee on Time and Place of Meeting when that committee meets.

DR. HUGH M. SMITH, Commissioner of Fisheries: If I am in order, Mr. President, I would like to give notice of the death of Dr. Theodore N. Gill, which occured in this city on the twenty-fifth of September, 1914. Dr. Gill has been an active member of this Society since 1875, and, as you all know, took great interest in our work and was one of the foremost authorities on fishes in the world. I will not say anything more at this time, but I hope that a suitable memorial may be prepared for publication in the Proceedings of the Society.

PRESIDENT: May I suggest that in recognition of the great services of Dr. Gill in the work for which this Society stands and to science in general, we should now, by a rising vote, make a matter of record of the notice and of the regrets which are felt by this organization. (All the members present arose.) This will be entered on our minutes and the matter referred to the Committee on Resolutions for more formal action.

We have at hand the report of one of the standing committees of the Society, that of the Publicity Committee, by Mr. H. Wheeler Perce, Chairman, of Chicago. In the absence of Mr. Perce I will ask the Secretary to read the report.

The report, in the form of a letter to the President was read:

PRESIDENT: While it may not be wise to publish this report, since it is purely tentative, there are in it some suggestions so good for the Society and for the organization of its activities that I should like to see it referred to some committee, say the Executive Committee, for consideration. If it seems wise they can report on certain of these recommendations at a subsequent session.

MR. JOHN P. WOODS, of Missouri: I move, Mr. President, that this report be accepted and referred to the Executive Committee.

The motion was put and carried.

PRESIDENT: Before we adjourn I wish to announce the Committee on Time and Place of Meeting. The Chair will name Messrs. Fearing of Rhode Island, Woods of Missouri, and Downing of Ohio.

The session was then adjourned.

Wednesday, September 30, *Afternoon Session.*

Prof. L. L. Dyche, State Game and Fish Warden of Kansas read a paper entitled "Notes on the New Kansas Fish Hatchery and the First Year's Output." For this paper and the discussion which followed, see Trans. Am. Fish. Soc., Vol. XLIV, No. 1, pp. 5 to 12, Dec. 1914.

The reading of papers terminated at this point and the session adjourned to meet in the large lecture hall, where the Bureau of Fisheries exhibited a series of moving pictures on "The Salmon Industry of the Pacific Coast," illustrating the methods of taking and canning Salmon.

Thursday, October 1, *Morning Session.*

The entire morning was taken up by the reading and discussing of three papers in the following order:

Mr. M. L. Alexander, New Orleans, La., "Notes on the Habits and Commercial Importance of the Paddlefish." See Transactions, Vol. XLIV, No. 1, pp. 73-78, Dec., 1914.

Dr. Wm. C. Kendall, Washington, D. C., "Taxonomic and Fish Cultural notes on the Chars or Trouts of New

England." See Transactions, Vol XLIV, No. 2, pp. 97-108, March, 1915.

Mr. M. C. Marsh, Buffalo, N. Y., "The Feeding of Trout in Relation to Thyroid Tumor." See Transactions, Vol. XLIV, No. 1, pp. 13-19, Dec., 1914.

The session adjourned at twelve o'clock.

Thursday, October 1, Afternoon Session.

PRESIDENT: According to the constitution and the custom of the Society the President is required to name the members of the Publicity and Editorial Committees. I therefore beg to submit the following:

Committee on Publicity:

Mr. H. Wheeler Perce, Mr. Geo. H. Grahm, Dr. T. S. Palmer and Mr. G. E. Jennings.

Committee on Publication:

Dr. Tarleton H. Bean, Prof. Bashford Dean and Mr. John T. Nichols.

The following papers were then read and discussed:

Mr. Lewis Radcliffe: "Progress in the Culture of the Diamond-Back Terrapin, with exhibition of specimens." See Transactions, Vol. XLIV, No. 1, pp. 33-36, Dec., 1914.

Mr. Lewis Radcliffe: "Notes on some North Carolina Sharks and Rays, with exhibition of specimens." See Transactions, Vol. XLIV, No. 1, pp. 37-40, Dec., 1914.

Mr. Wm. W. Welsh: "Demonstration of Some Modern Oceanographic Apparatus as Used by the Bureau of Fisheries." The speaker commented on the use and special value of the instruments shown.

Mr. John W. Titcomb: "The Use of Copper Sulphate in Destroying Obnoxious Fishes." See Transactions, Vol. XLIV, No. 1, pp. 20-26, Dec. 1914.

President Ward then introduced Hon. J. Charles Linthicum, Member of Congress from Maryland, author of a bill to place migratory fish under Federal control, who addressed the Society on the topic, "Why the States have been Unable to Protect our Food Fish."

ADDRESS OF THE HON. J. CHAS. LINTHICUM.

"When one reflects upon the numerous difficulties the separate commonwealths have experienced in securing and enforcing protective measures, when he realizes that for over a hundred years these individual states have been struggling with this problem, during which time—in the majority of instances—they have failed to secure satisfactory regulations, he will be convinced that the National Government alone is the only power that can effectively cope with the situation.

"The causes of the failure upon the part of the states to protect their food fish may be divided into three classes:

1. Insufficient laws.
2. Inefficient administration of these laws,
3. Conditions beyond the jurisdiction of the state to control.

Insufficient Laws.

In many states I find that the administration of laws for the protection of food fish is entrusted to the head of a Fish and Game Department. Too often the general inclination of such officials is to treat the subject as a sporting proposition and to give it more attention from that standpoint than from the point of view of the commercial fisherman. While the sporting end of the proposition concededly merits attention, in a majority of cases the real interests of the people are centered in its commercial aspects. The commercial fisheries thus neglected by the official who should be primarily interested and whose duty it is to initiate legislation for their protection and development, wane and languish and eventually cease to be an important economic asset.

But even where state officials realize the importance of protecting the commercial fisheries (and this protection involves legislation curtailing some rights at present enjoyed) such legislation is sure to meet with formidable opposition. When such fights come before the legislature the fishermen are usually in possession of the sympathy and votes of those members from their particular section.

We are apt then to witness the employment of log-rolling and filibustering tactics to defeat legislation for the general good. Under such conditions the equitable solution of the problem rests with those members whose constituents are not directly affected by the proposed legislation. For example, it is said that members from the interior counties of Virginia have given that state the best fish and oyster laws the Old Dominion ever enjoyed.

The disposition upon the part of state officials to deal leniently, even gently, with violators of state laws, is too well known to require comment from me. And where a specific individual is the wrong-doer and the great imperceptible body of the people are the sufferers the inclination to leniency on the part of such officers is apt to be unduly magnified.

When a reformative measure is contemplated by one state, which entails the co-operation of another, we have found it next to impossible to secure its passage, for the reason that there is no officer who can pledge his state to do its share toward the correction of the situation requiring joint remedy. And when one state proceeds to enact a measure, the success of which depends upon the joint action of other states, and the other states fail in their part, the state which has taken the lead invariably feels that it has been aggrieved and imposed upon and future efforts for reform inevitably suffer a set-back.

It required more than one hundred years of dickering upon the part of Maryland and Virginia to concur in measures for the protection of the oyster beds in the Potomac river before satisfactory legislation was finally agreed upon.

We should bear in mind that the natural resources of the state are equivalent to so many dollars in the bank placed there by an all-wise Providence. Every state ought to know the extent and value of these resources within its dominions. It ought to inventory them as correctly as possible, check off withdrawals, keep tab on their increase or decrease and conserve and protect them in the same systematic and methodical manner in which it accounts for and protects its other treasures.

But this is not done. I find that many of our coast states do not require licenses to operate line, gill, or pound nets, and for that reason their officials are unable to tell how many of these nets are in operation in their waters. Others do not require from the licensed fishermen reports of their catches, in consequence of which they are unable to tell whether or not the fish in their waters are increasing or diminishing. For illustration, an official at the head of the Fisheries of the State of Rhode Island confessed that "the absence of a law making fishery returns compulsory prevents the securing of accurate data in fisheries." Now the squeteague, one of the four principal fishes of that state, has decreased considerably; yet no accurate data are obtainable by which to determine the percentage of decrease, or the causes which have produced the same.

In Connecticut the catch of shad has decreased in the past ten years over 70%, that of bass, over 86%, and that of the pickerel over 54%. The Superintendent of the State Board of Fisheries attributes this decrease to the pollution of water and streams running dry.

The Chief Game and Fish Warden of Delaware writes:

"I regret that no statistics are available. We are just beginning to work on fish protection in Delaware. Our warden service is less than a year old and from lack of funds has been able to do nothing but preparatory work with our food fish industry."

And yet the four principal fish of Delaware are the trout, shad, menhaden and sturgeon—a most valuable series. It will be remembered that the catch of the last named fish brought over one million dollars annually to the fishermen of Delaware until unregulated fishing destroyed the fisheries.

It will be noted from the excerpts quoted that the insufficiency of laws is blameable for the losses enumerated.

Rhode Island fails to require its fishermen to make returns of their catches, in consequence of which that state is sustaining an undetermined loss.

Connecticut suffers from a river pollution which she has not stopped; Delaware is crippled by a lack of funds to do anything but preparatory work. I might recite other similar cases, but those mentioned are sufficient to make clear the necessity of legislation which will, without fear or favor, apply the remedy needed in any specific case.

Inefficient Administration.

Many states suffer the lack of capable officers in charge of their fisheries. Regardless of how conscientious and well-intentioned an official may be, if he possess not the knowledge and ability to fully discharge the duties of his office, the state is bound to be injured. More than one state has found that a well-paid, competent officer in charge of its fisheries is the most excellent investment a commonwealth can make. With good laws and capable, determined men to enforce those laws, the profits in the fisheries will prove a source of never-ending congratulation. Experience has shown that it is as difficult for the states to get good men as it has been for good men to get in the service of the states.

But the mere getting of good men is not the solution of the problem. These men must be made independent of influences which would paralyze their activities for good. They must be placed beyond the reach of those who, resenting the fearless discharge of their duty, would seek to wreak an unworthy venegance. Happily, many of our states have already done this, and it will be found that in those states wherein the men having charge of the fisheries are protected in the discharge of their duty, there is a better, more just and more equitable enforcement of the law and improvement of conditions, than in those states where these precautions have been neglected.

Indeed, I have found opposition to federal regulation of our fishes arising under conditions that cause me to suspect that it is mainly inspired by the fear that national officials will enforce the law in a way that would not be attempted by state officials. I likewise find that, for the very same reason, many commercial fishermen would like to see our Government take charge of our fisheries, believing that with Federal control there would be an enforcement which would do equal justice to all.

Under present conditions, a noteworthy situation arises. States bordering the same body of water are intimately concerned in the passage and enforcement of good laws by each other. If one state fails to enforce its laws and, by reason of this failure, its fishermen take from this joint water more fish than would be their natural share, they not only wrong their own commonwealth, but are perpetrating a wrong against the neighboring state, which, through enforcing the law, prohibits its own fishermen from getting as much as those of the other state. Thus we see a premium placed upon the violation of law, the guilty rewarded and the innocent punished. Now, if the Federal Government controls the situation and the laws are laxly enforced, the hardship does not fall with greater severity upon one state than another, nor would one state reap a disproportionate benefit at the expense of another. Under such a situation, the inefficiency of the states becomes discriminatory, while inefficiency under national supervision would be non-discriminatory.

Conditions Beyond The Jurisdiction of The States to Control.

One of the principal reasons making for national control of our fisheries is the existence of conditions which one state has not the jurisdiction to control. For instance, fishermen in Pennsylvania who get their living from the waters of the Susquehanna are indignant at the lack of regulations restricting Maryland fishermen to seasons and conditions of fish-taking that will allow the fish to ascend the river to where they live. Maryland fishermen want the fisherman of Virginia restricted in order that fair proportion of the fish may get to the waters of the upper Chesapeake. The same complaint is heard in Massachusetts regarding Connecticut, and the Superintendent of Fisheries of New York attributes the decrease "which has occurred in the Hudson and Delaware rivers to the miles of nets along the Jersey shore preventing the shad and herring from finding their way farther up the river."

Now we all know that notwithstanding the desire which moves the citizens of the several states to fair dealing in their relation with their fellowmen, it is always a difficult matter to convince the legislative body of a state that it should deprive its citizens of what are regarded as certain inalienable rights for the purpose of giving an equitable deal to the citizens of some other state. While the fish are coming his way, the fisherman is content and apt to view almost humorously the complaints of those not so fortunate as himself, but when the situation is reversed, and his own state is powerless to help him—when the sense of justice of another state must be depended upon,—then conditions become almost unbearable. Innumerable waters which flow to the coast pass through the jurisdiction of several states, yet those states nearest the coast have invariably assumed the attitude that they have the right, by reason of their fortunate location, to preempt the wealth which may enter those waters from the sea. To induce them to recede from that conviction would be an effort as hopeless as the tower of Babel.

I am glad that a brighter, more equitable day is dawning. The nation has laid down the doctrine that what is essential to the happiness and well-being of all should be equitably shared by all. It has declared against monopoly and discrimination whether that monopoly and discrimination be in matters of tariff, the possession of coal mines and hydraulic power sites, or what not. Those who have given thought to the subject and supplemented that thought with a thorough study of the situation, become more convinced each day that the equitable enjoyment of our fisheries will never be reached under a system of state supervision. The Federal Government alone possesses the power to handle the situation under regulations that will do impartial justice to all; that will preserve to posterity the fisheries of the nation, a resource whose value is becoming constantly greater by reason of the increasing use of fish in the daily diet of our people."

At the close of Congressman Linthicum's address the Society adjourned to the large auditorium for a moving picture exhibition illustrating "Salmon Culture on the Pacific Coast, as practiced by the U. S. Bureau of Fisheries."

Friday, October 2, Morning Session.

The session opened with an address by Mr. John P. Woods, President of the Missouri State Fish Commission on the topic "What mean these American Fisheries Socity meetings?" Mr. Woods dwelt upon the value of the meetings to the membérs and upon the necessity of assisting, through the medium of the Transactions, the "large army of laymen throughout the country who desire more knowledge of fishes and fisheries." He suggested that a campaign for a larger membership should be organized. "A decided two-fold benefit would manifest itself, in the strengthened financial condition of the Society which would permit it to publish to a greater extent, and more especially in arousing the entire people to support the many good measures for the protection and propagation of fishes which we now find it difficult to pass and enforce. The sacrifices of science would then be less in vain and the benefits derived would be far-reaching and valuable beyond the power of the mind to grasp."

Mr. Wood's address precipitated a discussion of ways and means of assisting the Bureau of Fisheries to secure proper equipment and appropriations along the lines indicated by Secretary Redfield's address and the furthering of Federal control as suggested by the remarks of Congressman Linthicum.

Mr. Graham of Massachusetts moved that a special committee of five members be appointed to confer with Secretary Redfield and Commissioner of Fisheries H. M. Smith and to report at the business meeting on Saturday morning. Carried.

Later it was moved and carried that President Ward act as Chairman of the committee and be empowered to appoint the other members.

Mr. Graham, of Mass.: Secretary Redfield came here and outlined the needs of the Bureau of Fisheries and practically asked us to assist in furthering legislation in aid of the Bureau. Many of the members would like to do something, but if one man in Missouri and another in Massachusetts, etc., each operates along his own line and according to his own ideas, nothing will be accomplished. We must have concerted action, we must have a plan to work on, and that is the only way in which we can get results. I believe that a committee of five men could be selected to work out some plan of operation whereby every man in the Society, and every fish and game commissioner may be able to assist.

Mr. Crampton, of Connecticut: I heartily endorse the sentiments expressed by the last speaker. In my State the shad industry has been a very important one, but there has been great pollution of the streams and this year I am sorry to say that the shad fishery has been a total failure. Action must be taken by the Federal Government relative to our fisheries, there is no question about that. The Italians with us have been exceedingly destructive to the fisheries, by catching small fish. I have seen a seine seventeen feet deep and eighty-one rods long, with a pocket having a mesh smaller than a lead pencil. Thousands of barrels of small fish have been taken and sold by measure to be made into soups, etc., and this has been outside of my jurisdiction. The statement made by Congressman Linthicum is correct,—Federal action must be taken and we should hasten to co-operate with the Government in putting a stop to such waste. The weakfish has entirely disappeared from our waters, I have not known of a striped bass being caught this year, and the sturgeon has entirely disappeared from the Connecticut River.

Mr. Alexander, of Mississippi: It seems to me that it is eminently proper than this Society should go on record as recognizing the recommendation of Secretary Redfield, and I believe that a committee should be appointed to consider these recommendations and report to the

Society for its endorsement. Mr. President, I move that a committee of five be appointed.

MR. SPEAKS, of Ohio: This is a very important subject, and, considering the interests of Ohio, I think it should be discussed at greater length than time will permit today. I want to say frankly that I am in favor of Federal control to a certain extent, but if the bill now pending in Congress were passed in its present form, it would mean the elimination of at least fifty per cent of our fishing interests in Ohio. I think our Ohio fishermen are perfectly willing to have Federal control of our commercial fisheries, but the coast states are more interested in this subject than we are in Ohio.

MR. GRAHAM: Unless I am mistaken, the motion made by Mr. Alexander has to do only with the recommendations of Secretary Redfield and not the address of Congressman Linthicum, concerning Federal control of migratory fishes. Secretary Redfield's plea was for better equipment, new buildings, more men, etc., something that no state and no fishing industry could object to in the least.

MR. WOODS, of Missouri: It seems to me that we should know more fully what Secretary Redfield has in mind. If we can get from him and Commissioner Smith a good idea of just what is necessary, we should be able to formulate some program, uniform in character, to work on for the support of the Bureau of Fisheries. Many of us are state fish commissioners and we are all representatives to a certain extent of our respective states and we are all anxious to go to our Senators and Representatives in Congress if we can present something of value which will be uniform in character.

MR. ADAMS, of Massachusetts: It seems to me that Mr. Woods has made a very practical suggestion. Let this committee obtain the facts with regard to the needs of the Bureau, if Secretary Redfield and Commissioner Smith are ready to state them, and give them to us in some form which will enable us to help them produce results. Then we can go to our respective Representatives in Congress and provide them with the facts and the needs of the Bureau. By this means we shall have completed a scheme of education for these men, so that when they return to Congress and fisheries matters are brought up they will thoroughly understand what the plan is. But if it is not presented in proper form and easily accessible we cannot expect a busy Senator or Congressman to give the matter the attention it deserves. He should have at hand the information and the assurance that the plan has the practical backing of this Society and he will know that he is not working in a way that will lay him open to criticism.

The motion made by Mr. Alexander was amended to read:

Resolved: That a committee of five members be appointed to consult with Secretary Redfield and Commissioner Smith in regard to the needs of the Bureau of Fisheries and to report at the business meeting on Saturday morning. Carried.

Moved and seconded that President Ward act as chairman of the committee and be empowered to appoint the other members. Carried.

The Society then passed to the reading and discussion of papers, and President Ward called upon Professor Dyche to open the discussion of the paper presented by Mr. John W. Titcomb at the previous session and which had been postponed. (See Transactions, Vol. XLIV, No. 1, pp. 24-26, Dec., 1914.)

The paper by Prof. Geo. C. Embody was then read and discussed: "Fish Meal and as Food for Trout," (see Transactions, Vol. XLIV, No. 1, pp. 57-60, Dec., 1914).

A motion to adjourn and to meet again at two o'clock was carried, after which a special "marine products" luncheon was partaken of by the members of the Society and their friends at the New Willard Hotel.

Friday, October 2, Afternoon Session.

The President called the meeting to order and then, in the absence of the Vice-president, asked Mr. Seymour Bower, of Michigan, to take charge of the meeting.

MR. BOWER: It was decided at the close of our last session that the first order of business for this afternoon should be the reading of the paper by our honored President, and I have the pleasure of introducing to you Prof. Henry B. Ward, of the University of Illinois.

The paper by President Ward, entitled "An Experimental Plant for the Study of Fish Culture on a Small Scale" was read and discussed. (See TRANSACTIONS, this number, pp. 169-178.)

At 3 o'clock the session was adjourned to give place to a meeting of the National Association of Fish and Game Commissioners, in which many of the members of the American Fisheries Society were especially interested. All members were invited to be present during the address of Senator Geo. P. McLean, of Connecticut, on "The Federal Control of Migratory Birds," and also to witness a series of motion pictures illustrating "Results of Game Protection in Oregon" shown by Mr. Wm. L. Finley, Commissioner of Fish and Game for that State.

Saturday Morning, October 3, Final Session.

The final session came to order for the transaction of such business as remained for the consideration of the Society.

PRESIDENT WARD: Your Chairman has been requested to present a proposed ruling to regulate publication. The object of this ruling is to give the Publication Committee the authority of the Society to act in certain cases, while reserving by the first part of the resolution, the right of the Society to pass upon matters which might involve it in any way.

Resolved: That papers which are controversial and do not add to a knowledge of any question by furnishing new evidence shall not be published except after special action by the Society at a regular meeting. Otherwise the Publication Committee may, if finances permit, accept for publication papers not read at the annual meeting.

Shall this be adopted as a by-law or rule of instruction for the committee?

A motion to put this into effect was duly made and seconded and without discussion, was passed by the Society.

PRESIDENT: The Secretary has a matter to bring up, which is in his hands, and I will ask him to present it to you.

SECRETARY OSBURN: The members who were present at the last meeting at Boston, will remember that the preparation of an index to the first forty volumes of the TRANSACTIONS of the American Fisheries Society was announced by our present Vice-President, Mr. Fearing. This has been completed, final copies prepared and submitted to the Secretary. This is a careful piece of work, covering 136 typewritten pages and involved an immense amount of work. It includes all matters published during the first forty years of the Society's work and is therefore a ready reference to everything issued up to and including 1910. In order that I might have definite information for you with regard to the cost of publication, I submitted sample pages to the printers of our last volume. Their estimate for publishing this index in the same form as our TRANSACTIONS, so that it can readily be bound up with them, is $215.00. I have no doubt that it can be issued at a somewhat lower figure. I believe that this index will be extremely useful in libraries as well as to individuals who desire to look up any articles published in these volumes. It should not be issued in connection with any other volume, but should be separate so that it can be inserted in the series at the end of the forty volumes that it is meant to cover.

PRESIDENT: This matter is before the Society for discussion.

MR. TITCOMB, of Vermont: We are certainly very much indebted to Mr. Fearing for this manuscript and I sincerely hope the Society will take steps to have it published, but we should give our publishing board plenty of time to issue it properly.

DR. T. S. PALMER, of Washington, D. C.: I fully realize what this work means as I happened to be a member of a committee which has published such an index. It should certainly be published. There is one point which I hope has been considered in its preparation and that is the entry of every author's name in full, and where possible the date of his birth and death, to follow modern bibliographical usage and because libraries need this information. The amount of $200.00 could easily be arranged in some way. The work should not devolve on the regular officers, but let the Secretary select a committee to do the work and simply oversee it.

MR. GRAHAM, of Massachusetts: It seems to me, Mr. President, that it will be quite an undertaking to get some one to do this work. Moreover, it will involve an expenditure of over $200.00 and we ought to know where that is coming from before we spend the money, for the treasury is not in a flourishing condition. I think the condition of the treasury hardly warrants the publication at present.

PRESIDENT: That certainly is a good business suggestion. We have recently been through a campaign in which some of us have been interested in the attempt to clear the Society of debt, and, while we sympathize fully with what Dr. Palmer has said, we cannot but appreciate the financial difficulty. It occurs to me that we do not wish to raise the money here this morning and that it may be impracticable to come to a final conclusion. Our Publication Committee is authorized to do certain things if finances permit. I offer the suggestion that this matter be referred to that committee to secure the publication if possible.

A number of members offered to contribute to a fund for the publication of the index.

The suggestion was also made that a number of the earlier volumes of the Transactions, now impossible to obtain, be re-issued, as it would make the index much more desirable.

PRESIDENT: The question has been discussed pretty thoroughly, but we have no motion before us. Will some one propose a definite solution of the problem?

MR. GRAHAM: It seems to me that this should be referred to the officers of the Society and the Executive

Committee. They will know whether the condition of the treasury will permit the publication. I make that motion.

MR. TITCOMB: I suggest that it be referred rather to the President, Secretary and Treasurer, as such a committee will be less scattered and less unwieldy.

MR. GRAHAM: I accept the amendment.

Motion seconded.

PRESIDENT: The motion has been made to refer this matter to a special committee, consisting of the President, Secretary and Treasurer, with power to act.

The motion was put and carried.

Vice-president Fearing presented a resolution to the effect that the Committee on Publicity be appointed by the President for each meeting a short time before the annual meeting each year. After some discussion this resolution was passed.

President Ward then called for the report of the Auditing Committee.

Report of the Auditing Committee.

To the Members of the American Fisheries Society:

The Auditing Committee has carefully gone over the vouchers of the Treasurer, together with his report, and find the same to be correct.

(Signed) GEORGE H. GRAHAM,
J. QUINCY WARD.

Moved and seconded that the report of the Auditing Committee be accepted and that the thanks of the Society be extended to them for their work. Motion carried.

Report of Special Committee on Needs of the Bureau of Fisheries.

To the Members of the American Fisheries Society:

The Special Committee appointed yesterday begs to report that it has carried out, so far as possible in the time given, the directions of the Society and desires to recommend:

1. That its title be made, Committee on Relations with National and State Governments.

2. That it be authorized to incur the necessary expense involved in carrying on its work.

3. That it be permitted to call upon other members of the Society for aid in matters which seem to require their services.

(Signed) HENRY B. WARD,
M. L. ALEXANDER,
JOHN W. TITCOMB,
WM. C. ADAMS,
WILLIAM L. FINLEY.
Committee.

After some discussion the Society voted to adopt this report and approved the recommendations of the committee.

Report of the Committee on Resolutions.

(Presented by L. L. Dyche, Chairman.)

I. WHEREAS, the passing of Dr. Theodore Nicholas Gill removes from our midst another of that group of scientists remarkable for breadth of view, encyclopædic knowledge and sympathy for research in all forms, therefore, be it

Resolved: That the American Fisheries Society, mindful of the great loss it has sustained, enter on its records the following brief statement of the work of its distinguished member: Theodore Nicholas Gill, born March 21, 1837, in New York City, died September 25, 1914, at Washington, D. C., contributed to humanity as a teacher, first as Adjunct-Professor of Physics and Natural History, 1860-61, then as Lecturer and Professor of Natural History until 1910, when he was made Emeritus Professor of Zoology, in George Washington University. As an Associate of the Smithsonian Institution he won distinction in investigation exemplified in such honors as President of the American Association for the Advancement of Science in 1897, and membership in the National Academy of Sciences and the American Philosophical Society.

He was an authority on the morphology of fishes and mammals, and his numerous writings are conspicuous contributions in the history of the development of knowledge of these groups of animals.

His kindly presence, and his contributions by papers and discussions were conspicuous in the meetings of this Society, of which he was a member since 1875, nearly forty years.

II. WHEREAS, death has also removed, in the person of Henry Theodore Root, one of that body of men who have labored long and diligently in the cause of conservation of natural resources, and especially for the propagation and preservation of fish and game, be it therefore

Resolved: That the following record of the life and work of this valued citizen be entered on our minutes: Henry Theodore Root was born October 5, 1830, and died July 24, 1914, at Providence, Rhode Island. A member of the American Fisheries Society since 1899, he was chosen its thirty-fourth President, for the term of 1904-05, and presided at the meeting held at Atlantic City, New Jersey.

In 1883 he became a member of the Inland Fisheries Commission of Rhode Island and served on that board until 1910, when he resigned. From March 8, 1906, until his resignation in 1910, he was President of the Rhode Island Fish Commission. He had also served in the Rhode Island State Legislature.

For many years a leader in the business and in the state policies of Rhode Island, he creditably carried important civic responsibilities. As President of the State Fish Commision his sturdy purposefulness demonstrated the identity of science and common sense when applied to the service of the state.

III. Be it resolved that the thanks of the Society be extended to the local committees for their work in preparing the program and for the entertainment provided during the course of this meeting.

On motion duly made and seconded, the above resolutions were passed and approved by the Society.

Mr. Graham, of Massachusetts: Mr. President, it seems to me that this is the proper time to consider the question of this Society meeting in conjunction with the Association of Game and Fish Commissioners each year. We have many interests in common and many members belong to both organizations. This year there has been some hitch in the arrangments and the members of the Commissioners' Association feel that they have had too little time for their meetings. I wish to offer the suggestion that a committee be appointed from this Society to confer with the officers of the Commissioners' Association as to time and place of meeting and other matters of interest to both societies, to prevent any misunderstanding in the future.

Moved and seconded that the President, Vice-president and Secretary of the American Fisheries Society form a committee to confer with a similar body of the Association of Game and Fish Commissioners on matters of interest to both societies. Motion carried.

Report of the Committee on Time and Place of Meeting.

President Ward: The Committee on Time and Place of Meeting will now render its report.

Mr. Alexander, of Louisiana: Mr. Chairman, I am going to ask the privilege of postponing the report of this committee, because I understand that it is not a unanimous report and I believe that for the harmony of its work this Society's actions should be as unanimous as possible. I also understand that the city I have the honor to represent, New Orleans, has received a majority of the votes of the committee. If this committee will withdraw its report, I am going to ask the consent of the Society to withdraw the invitation of the city of New Orleans for the convention of 1915.

The committee retired for a few moments for further consideration of the question.

Mr. John P. Woods, of Missouri: Mr. Chairman, I represent a majority of the committee as previously divided on this question. But as the gentleman from New

Orleans wishes the majority report to be withdrawn we are glad in the interests of the Society to accede to his request, although it is not a distinct pleasure to do so.

MR. FEARING, of Rhode Island,representing the minority of the committee, then presented the following report:

The Committee on Time and Place of Meeting begs to report that offers to entertain the Society at its 45th annual meeting were received from Atlantic City, Chicago, St. Louis, Detroit, Niagara Falls, Buffalo, Springfield, New Orleans, Oakland and San Francisco. The committee having met after Mr. Alexander's withdrawal of New Orleans as the meeting place for the forty-fifth annual meeting, voted to recommend San Francisco, California, and the time as September 1 to 4, inclusive.

(Signed) DANIEL B. FEARING of Rhode Island,
JOHN P. WOODS, of Missouri,
S. W. DOWNING, of Ohio.

Committee.

MR. ALEXANDER: Mr. Chairman, I move the adoption of the report. Before the motion is put, however, I beg the privilege to state that we in New Orleans looked forward with a great deal of pleasure to entertaining this Society the present year and were much disappointed that we did not have the privilege. At some future date we hope to have that pleasure. The State of Louisiana is, I believe from investigations that have been made, richer in actual resources than any other state in the Union. We have wonderful silver mines yielding twenty millions of dollars annually, we have the greatest salt mines in the western hemisphere, we have six of the greatest oil fields and the greatest gas fields in the United States; we have forty-seven hundred miles of water-ways teeming with choice fishes in great variety and the richest oyster producing territory in the country; we have twenty-eight millions of acres of the richest soil under the sun, with great sugar, cotton and rice fields, and we have the beautiful city of New Orleans. There has been much ignorance and many false impressions with regard to our State in other parts of the country and we wanted you, who come from all parts of the United States, to visit us and learn something of our people and of our wonderful resources. I felt if I laid these facts before you, you would stand with me in regard to this invitation. However, I believe that this year many of you desire to take advantage of the great opportunity to attend the San Francisco Exposition, and we do not wish for any reason to create antagonism in the ranks of this Society. When you do come we wish you to come freely so that we may have the pleasure of entertaining willing guests, and it is for this reason that I have withdrawn the name of the City of New Orleans for holding the convention of 1915.

PRESIDENT WARD: Mr. Alexander, in the name of the Society, I beg to express to you our appreciation of your remarks. Such broad-minded and generous policies will bring success both to the great State which you represent and to this small, but as we believe, important, American Fisheries Society.

The motion having been made and seconded, it was unanimously voted that the 1915 meeting be held in San Francisco on Sept. 1-4, 1915.

Report of Committee on Weights and Measures of Whitefish.

MR. DOWNING, of Ohio: I have a report on weights and measures. As chairman of this committee I measured and weighed one hundred fish of each sex,—

PRESIDENT WARD: I have understood that the committee as a whole has had no meetings. It occurs to me that the other members might object to the presentation of a report, even by the Chairman, if the matter has not been fully discussed. This is a matter of great importance.

MR. TITCOMB, of Vermont: We are pressed for time at this meeting and this matter should be discussed very fully. I am sure that whatever Mr. Downing would give us would be to the point, but we should not be able to thresh the matter out. I move that the Chairman of this

Committee secure the approval of the other members of the committee, by correspondence, if necessary, and report later.

This motion, being seconded, was unanimously carried.

Report of the Committee on Nominations.

MR. CASSELMAN, of New York: The Committee on Nominations begs to present the following nominations for officers of this Society for the year 1914-15:

President, Daniel B. Fearing, of Rhode Island;

Vice-President, Jacob Reighard, of Michigan;

Recording Secretary, Raymond C. Osburn, of New York.

Corresponding Secretary, Chas. H. Townsend, of New York.

Treasurer, Chas. W. Willard of Rhode Island.

Vice-Presidents of Divisions.

Fish Culture, Dwight Lydell, of Michigan;

Aquatic Biology and Physics, Henry B. Ward, of Illinois.

Commercial Fishing, Jefferson F. Moser, of California;

Angling, H. Wheeler Perce of Illinois;

Protection and Legislation, T. S. Palmer of Washington, D. C.

Executive Committee.

Geo. W. Field, of Massachusetts, Chairman;

L. L. Dyche, of Kansas;

N. R. Buller, of Pennsylvania;

J. Quincy Ward, of Kentucky;

Henry O'Malley, of Washington;

Ernest Schaeffle of California;

John P. Woods, of Missouri.

(Signed) E. S. CASSELMAN,
M. C. MARSH,
EBEN W. COBB,
SEYMOUR BOWER,
JOHN W. TITCOMB,
Committee.

Mr. Graham, of Massachusetts: I move that this report be accepted and that the Secretary be instructed to cast one ballot for the entire list.

The motion was seconded and carried, whereupon, the Secretary having cast the ballot, the President declared the gentlemen named to be elected.

President-elect Fearing was introduced and made a brief address.

The Committee on Nominations presented the following recommendation: *Resolved*: That the Vice-presidents of Divisions be required to make a report at each annual meeting.

This was sustained by vote of the Society.

Mr. Titcomb, of Vermont: It may become necessary for a re-adjustment of the time for holding our meeting in order to meet with other societies, or for other reasons. I move a reconsideration in the matter of time of holding the meeting and the absolute determination of the date be left to the Conference Committee after consultation and correspondence.

Motion carried.

The President thereupon declared the meeting adjourned.

In Memoriam

A. S. BICKMORE

T. J. BLAKESLEE

AUSTIN COOK

THOMAS M. DARRAH

THEODORE N. GILL

J. J. HOGAN

E. C. LAMBERT

CHARLES H. MOORE

OVERTON W. PRICE

HENRY T. ROOT

3.19

TRANSACTIONS

of the

American Fisheries Society

"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

VOLUME XLIV, NUMBER 4

1914-1915

Edited by The Recording Secretary

SEPTEMBER, 1915

Published Quarterly by the Society

NEW YORK, N. Y.

CERTIFICATE OF INCORPORATION OF THE AMERICAN FISHERIES SOCIETY

We, the undersigned, persons of full age and citizenship of the United States, and a majority being citizens of the District of Columbia, pursuant to and in conformity with sections 599 to 603, inclusive, of the Code of Law for the District of Columbia, enacted March 3, 1901, as amended by the Acts approved January 31 and June 30, 1902, hereby associate ourselves together as a society or body corporate and certify in writing:

1. That the name of the Society is the AMERICAN FISHERIES SOCIETY.

2. That the term for which it is organized is nine hundred and ninety-nine years.

3. That its particular business and objects are to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish; with power:

a. To acquire, hold and convey real estate and other property, and to establish general and special funds.

b. To hold meetings.

c. To publish and distribute documents.

d. To conduct lectures.

e. To conduct, endow, or assist investigation in any department of fishery and fish-culture science.

f. To acquire and maintain a library.

g. And, in general, to transact any business pertinent to a learned society.

4. That the affairs, funds and property of the corporation shall be in general charge of a council, consisting of the officers and the executive committee, the number of whose members for the first year shall be seventeen, all of whom shall be chosen from among the members of the Society.

Witness our hands and seals this 16th day of December, 1910.

SEYMOUR BOWER	(Seal)
THEODORE GILL	(Seal)
WILLIAM E. MEEHAN	(Seal)
THEODORE S. PALMER	(Seal)
BERTRAND H. ROBERTS	(Seal)
HUGH M. SMITH	(Seal)
RICHARD SYLVESTER	(Seal)

Recorded April 15, 1911.

AMERICAN FISHERIES SOCIETY

Organized 1870

The first meeting of the Society occurred December 20, 1870. The organization then effected continued until February, 1872, when the second meeting was held. Since that time there has been a meeting each year, as shown below. The respective presidents were elected at the meeting, at the place, and for the period shown opposite their names, but they presided at the subsequent meeting.

PRESIDENTS, TERMS OF SERVICE, AND PLACES OF MEETING.

1.	William Clift	1870-1872	New York, N. Y.
2.	William Clift	1872-1873	Albany, N. Y.
3.	William Clift	1873-1874	New York, N. Y.
4.	Robert B. Roosevelt	1874-1875	New York, N. Y.
5.	Robert B. Roosevelt	1875-1876	New York, N. Y.
6.	Robert B. Roosevelt	1876-1877*	New York, N. Y.
7.	Robert B. Roosevelt	1877-1878	New York, N. Y.
8.	Robert B. Roosevelt	1878-1879	New York, N. Y.
9.	Robert B. Roosevelt	1879-1880	New York, N. Y.
10.	Robert B. Roosevelt	1880-1881	New York, N. Y.
11.	Robert B. Roosevelt	1881-1882	New York, N. Y.
12.	George Shepard Page	1882-1883	New York, N. Y.
13.	James Benkard	1883-1884	New York, N. Y.
14.	Theodore Lyman	1884-1885	Washington, D. C.
15.	Marshall McDonald	1885-1886	Washington, D. C.
16.	W. M. Hudson	1886-1887	Chicago, Ill.
17.	William L. May	1887-1888	Washington, D. C.
18.	John H. Bissell	1888-1889	Detroit, Mich.
19.	Eugene G. Blackford	1889-1890	Philadelphia, Pa.
20.	Eugene G. Blackford	1890-1891	Put-in Bay, Ohio.
21.	James A. Henshall	1891-1892	Washington, D. C.
22.	Herschel Whitaker	1892-1893	New York, N. Y.
23.	Henry C. Ford	1893-1894	Chicago, Ill.
24.	William L. May	1894-1895	Philadelphia, Pa.
25.	L. D. Huntington	1895-1896	New York, N. Y.
26.	Herschel Whitaker	1896-1897	New York, N. Y.
27.	William L. May	1897-1898	Detroit, Mich.
28.	George F. Peabody	1898-1899	Omaha, Neb.
29.	John W. Titcomb	1899-1900	Niagara Falls, N. Y.
30.	F. B. Dickerson	1900-1901	Woods Hole, Mass.
31.	E. E. Bryant	1901-1902	Milwaukee, Wis.
32.	George M. Bowers	1902-1903	Put-in Bay, Ohio.
33.	Frank N. Clark	1903-1904	Woods Hole, Mass.
34.	Henry T. Root	1904-1905	Atlantic City, N. J.
35.	C. D. Joslyn	1905-1906	White Sulphur Spgs., W. Va.
36.	E. A. Birge	1906-1907	Grand Rapids, Mich.
37.	Hugh M. Smith	1907-1908	Erie, Pa.
38.	Tartleton H. Bean	1908-1909	Washington, D. C.
39.	Seymour Bower	1909-1910	Toledo, Ohio.
40.	William E. Meehan	1910-1911	New York, N. Y.
41.	S. F. Fullerton	1911-1912	St. Louis, Mo.
42.	Charles H. Townsend	1912-1913	Denver, Colo.
43.	Henry B. Ward	1913-1914	Boston, Mass.
44.	Daniel B. Fearing	1914-1915	San Francisco, Calif.

*A special meeting was held at the Centennial Grounds, Philadelphia, Pa., October 6 and 7, 1876.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC.,

Required by the Act of August 24, 1912, of the TRANSACTIONS OF THE AMERICAN FISHERIES SOCIETY.

Published quarterly at New York, N. Y., April 1, 1915.

Editor, Raymond C. Osburn, The Aquarium, Battery Park, New York, N. Y.

Managing Editor, None.

Business Managers, None.

Publisher, American Fisheries Society, The Aquarium, Battery Park, N. Y.

Owners, American Fisheries Society, The Aquarium, Battery Park, New York, N. Y.

An incorporated society with about 600 active members. President, Daniel B. Fearing, Newport, R. I.; Vice-President, Jacob Reighard, Ann Arbor, Mich.; Recording Secretary, Raymond C. Osburn, The Aquarium. Battery Park, New York, N. Y. Treasurer, Chas. W. Willard, Westerly, R. I.

Known bondholders, mortgagees, and other security holders, holding 1 per cent or more of total amount of bonds, mortgages, or other securities, None.

RAYMOND C. OSBURN, *Editor.*

Sworn to and subscribed before me
this 29th day of March, 1915.

WILLIAM H. WOLFRATH, JR.,
Notary Public, No. 4081.
(My commission expires March 30, 1916.)

EDITORIAL

THE SAN FRANCISCO MEETING

The Forty-fifth Annual Meeting of the American Fisheries Society was held at San Francisco, Cal., on September 1-4. Although the attendance was somewhat smaller than usual the meeting was full of interest and the membership of the Society was increased by the election of three new patrons and about seventy-five new members.

Prof. Jacob Reighard, of the University of Michigan, was elected President of the Society for the year 1915-16, and Dr. Geo. W. Field, State Commissioner of Fisheries and Game for Massachusetts, Vice-President. The names of the remaining officers and the members of the various committees appear, as usual, on the back cover page.

A full account of the proceedings of the meeting will appear in a later number of the Transactions.

The next annual meeting—the forty-sixth—will be held in New Orleans, La., and the date is set for October 16 to 19, 1916.

PACIFIC FISHERIES SOCIETY

Our sister society of the Pacific Coast held the second annual meeting at San Francisco on August 9-11, 1916. An interesting meeting is reported. The following officers were elected for the coming year: President, Mr. Henry O'Malley, Oregon City, Ore.; Vice-President, Prof. Trevor Kincaid, Seattle, Wash.; Second Vice-President, Prof. Chas. L. Edwards, Los Angeles, Cal.; Secretary, Mr. John N. Cobb, Seattle, Wash.; Treasurer, Mr. Russell Palmer, Seattle Wash.; Chairman of Executive Committee, Dr. Barton W. Evermann, San Francisco, Cal.

Portland, Oregon, was selected as the next meeting place, but the date is not yet fixed.

A CORRECTION

Mr. M. L. Alexander, of New Orleans, has called the attention of the Editor to an error on page 211 of the June number of the present volume. There are, of course, no silver mines in Louisiana, and "mineral wealth" equal to $20,000,000 annually should have been the statement. Also, instead of "six of the greatest oil fields," one should read sixth in the production of oil, although Mr. Alexander informs me that his State has now advanced to third place in this respect. The Editor takes the first opportunity to relieve Mr. Alexander of the responsibility for these misstatements. The stenographic report and the Editor's absence in Porto Rico at the time of publication are sufficient to account for the slip.

THE TILE-FISH

After an absence of many years, following the great marine catastrophe of 1882, whatever it was, that nearly destroyed the species, the Atlantic Tile-fish is again on the market in large quantities. All hail to *Lopholatilus chamæleonticeps!*

LIST OF MEMBERS, 1914--1915

Showing Year of Election to Membership

Honorary Members

The President of the United States, Woodrow Wilson.
The Governors of the several states.
Alabama, Charles Henderson.
Arizona, George W. P. Hunt.
Arkansas, George W. Hays.
California, Hiram W. Johnson.
Colorado, George A. Carlson.
Connecticut, Marcus A. Holcomb.
Delaware, Charles R. Miller.
Florida, Park M. Trammell.
Georgia, John M. Slaton.
Idaho, Moses Alexander.
Illinois, Edward F. Dunne.
Indiana, Samuel M. Ralston.
Iowa, George W. Clarke.
Kansas, Arthur Capper.
Kentucky, James B. McCreary.
Louisiana, Luther E. Hall.
Maine, Oakley C. Curtis.
Maryland, Philip L. Goldsborough.
Massachusetts, David I. Walsh.
Michigan, Woodbridge N. Ferris.
Minnesota, W. S. Hammond.
Mississippi, Earl Brewer.
Missouri, Elliot W. Major.
Montana, Samuel V. Stewart.
Nebraska, John H. Morehead.
Nevada, Emmet D. Boyle.
New Hampshire, Rolland H. Spaulding.
New Jersey, James F. Fielder.
New Mexico, William C. McDonald.
New York, Charles S. Whitman.
North Carolina, Locke Craig.
North Dakota, L. B. Hanna.
Ohio, Frank B. Willis.
Oklahoma, R. L. Williams.
Oregon, James Withycombe.
Pennsylvania, M. G. Brumbaugh.
Rhode Island, R. Livingston Beeckman.
South Carolina, Richard I. Manning.
South Dakota, Frank M. Byrne.
Tennessee, Thomas C. Rye.
Texas, James E. Ferguson.
Utah, William Spry.
Vermont, Charles W. Gates.
Virginia, H. C. Stuart.
Washington, Ernest Lister.
West Virginia, Henry D. Hatfield.
Wisconsin, E. L. Philipp.
Wyoming, John B. Kendrick.

'08 Antipa, Prof. Dr. Gregoire, Inspector-General of Fisheries, Bucharest, Roumania.
'06 Besana, Giuseppe, President of the Lombardy Fisheries Society, Via Rugabello 19, Milan, Italy.
'09 Blue Ridge Rod and Gun Club, Harper's Ferry, W. Va.
'93 Borodine, Nicholas, 10th Linie 5, Petrograd, Russia.
'12 Calderwood, W. L., Inspector of Salmon Fisheries for Scotland, Edinburgh, Scotland.
'04 Denbigh, Lord, Colonel of the Honorable Artillery Company, London, England.
'89 Fish Protective Association of Eastern Pennsylvania, 1020 Arch St., Philadelphia, Pa.
'01 Fryer, Charles E., Supervising Inspector of Fisheries, Board of Agriculture and Fisheries, London, England.
'04 Hofer, Prof. Dr. Bruno, Biological Research Station for Fisheries, Munich, Germany.
'04 Kishinouye, Dr. K., Imperial Fisheries Bureau, Tokyo, Japan.
'08 Kitahara, Dr. Tasaku, Imperial Fisheries Bureau, Tokyo, Japan.
'88 Lake St. Clair Shooting and Fishing Club, Detroit, Mich.
'04 Lawrence-Hamilton, Dr. J., M. R. C. S., 30 Sussex Square, Brighton, England.
'04 Matsubara, Prof. S., President Imperial Fisheries Institute, Tokyo, Japan.
'09 Nagel, Hon. Chas., St. Louis, Mo.
'95 New York Association for the Protection of Fish and Game, New York City.
'08 Nordqvist, Dr. Oscar Fritjof, Superintendent of Fisheries, Lund, Sweden.
'01 Peck, Hon. George W., Milwaukee, Wis.
'06 Perrier, Prof. Edmond, Director Museum of Natural History, Paris, France.
'92 Southside Sportsmen's Club, Oakdale, L. I., N. Y.
'06 Steindachner, Prof. Dr. Franz, Royal Natural History, Museum, Vienna, Austria.
'92 Vinciguerra, Prof. Dr. Decio, Director Royal Fish Cultural Station, Rome, Italy.
'06 Von Grimm, Dr. Oscar, Inspector-General of Fisheries, Petrograd, Russia.
'08 Von Kadich, Dr. Henrich, Department of Forestry and Domain, Vienna, Austria.
'06 Von Pirko, Franz, President Austrian Fishery Society, Vienna, Austria.

Corresponding Members

'84 Apostolides, Prof. Nicoly Chr., Athens, Greece.
'87 Armistead, J. J., Dumfries, Scotland.
'04 Ayson, Charles L., Hakataemen, Oamaru, New Zealand.
'04 Ayson, L. F., Commissioner of Fisheries, Wellington, New Zealand.
'09 Flegel, Chas., Canea, Crete.
'08 Higginson, Eduardo, Consul for Peru, New York City.
'97 Jaffe, S., Sandfort, Lustringen, Germany.
'84 Landmark, A., Inspector of Norwegian Fresh-Water Fisheries, Christiania, Norway.
'84 Marston, R. B., Editor of the Fishing Gazette, London, England.
'09 Mohsin, S. M., Bengal Fisheries Department, Calcutta, India.
'89 Olsen, Dr. O. T., Grimsby, England.
'08 Poiteau, Charlney, Lommel, Belgium.
'84 Raveret-Wattel, C., Director of Aquicultural Station at Nid-de-Verdier, 20 Rue des Acacias, Paris.
'09 Riedel, C., Bergstedt, Germany.
'84 Sars, Prof. G. O., Christiania, Norway.
'84 Solsky, Baron N. de, Director of the Imperial Agricultural Museum, Petrograd, Russia.
'10 Stead, David G., Fisheries Department, Sydney, New South Wales, Australia.
'89 Trybom, Dr. Filip, Stockholm, Sweden.

Patrons

'14 Alaska Packers' Association, San Francisco, Calif.
'15 California Wire Cloth Company, San Francisco, Cal.
'15 Chas. F. Mattlage Company, 335 Greenwich St., New York City.
'15 J. K. Armsby Company, San Francisco, Cal.

Active Members *

LIFE MEMBERS INDICATED BY ASTERISK (*).

'10 Acklen, Joseph H., Department Game, Fish and Forestry, Nashville, Tenn.
'13 Adams, Wm. C., Commissioner of Fisheries and Game, Boston, Mass.
'01 Ainsworth, G. G., U. S. Bureau of Fisheries, Leadville, Colo.
'10 Aitchison, W. W., 5 Wabash Ave., Chicago, Ill.
'04 Alexander, A. B., U. S. Bureau of Fisheries, Washington, D. C.
'98 Alexander, George L., Grayling, Mich.
'13 Alexander, M. L., Pres. Louisiana Conservation Commission, New Orleans, La.
'06 Alford, Jabe, President State Board of Fish Commissioners, 29 W. Dayton St., Madison, Wis.
'08 Aller, H. D., U. S. Bureau of Fisheries, Washington, D. C.
'08 Anderson, August J., Box 109, Marquette, Mich.
'13 Anderson, Carl A., U. S. Bureau of Fisheries, Manchester, Iowa.
'12 Anderson, Frank, 1331 East Seventh Ave., Denver, Colo.
'92 Anderson, J. F., Bastad, Sweden.
'14 Anderson, T. T., Liggett and Myers Tobacco Co., St. Louis, Mo.
'78 Annin, James, Caledonia, N. Y.
'14 Annin, Howard, Caledonia, N. Y.
'09 Ansley, H. M., New Orleans, La.
'10 Anthony, A. W., Ironsides, Ore.
'12 Antoine, Charles, 340 So. Wabash Ave., Chicago, Ill.
'15 Arnold and Winsor Co., 14 Boston Fish Pier, Boston, Mass.
'11 Arthur, S. E., 4345 Washington Ave., St. Louis, Mo.
'10 Asbury Park Fishing Club, John F. Seger, 703 Cookman Ave., Asbury Park, N. J.
'84 Atkins, Charles G., U. S. Bureau of Fisheries, East Orland, Me.
'03 Atwood, Anthony, 73 Waterest St., Plymouth, Mass.
'15 Atwood, Irving M., 31 Boston Fish Pier, Boston, Mass.
'10 Augur, W. A., 33 Fulton, St., New York City.
'10 Avery, Amos W., 47 Arch St., Greenwich, Conn.
'06 Avery, Carlos, Hutchinson, Minn.
'92 Ayer, F. W., Bangor, Me.

'01 Babcock, John P., Provincial Fisheries' Department, Victoria, British Columbia.
'12 Babcock, William H., 520 The Rookery, Chicago, Ill.
'10 Bacon, Chas. R., Chief State Bureau of Shell Fisheries, Haddonfield, N. J.
'12 Bailey, Howard S., Equitable Building, Denver, Colo.
'15 Baker, Boies and Watson Co., 38 Boston Fish Pier, Boston, Mass.
'15 Balch, Howard K., 158 W. Austin Ave., Chicago, Ill.
'11 Baldus, Ignatz, 901 Daly St., Indianapolis, Ind.
'13 Baldwin, Marcus D., Montana Fish and Game Commission, Kalispell, Mont.
'01 Baldwin, O. N., U. S. Bureau of Fisheries, Louisville, Ky.
'98 Ball, E. M., U. S. Bureau of Fisheries, Washington, D. C.
'13 Ball, Frank H., Grand Lake Stream, Me.
'10 Ballard, S. Thruston, Louisville, Ky.

*See also appended list of names received too late to be included in this part.

'05 BARBOUR, THOMAS, Museum of Comparative Zoology, Cambridge, Mass.
*'12 BARNES, EARNEST W., Supt. R. I. Fisheries Experiment Station, Wickford, R. I.
'10 BARNES, ORLANDO F., Roscommon, Mich.
'10 BARRON, JAMES T., 1006 Yeon Bldg., Portland, Ore.
'86 BARTLETT, DR. S. P., U. S. Bureau of Fisheries, Quincy, Ill.
'12 BAUER, A., 25th and Dearborn Sts., Chicago, Ill.
'14 BEAL, F. J., State Commissioner of Fisheries, Plymouth, N. H.
'05 BEAMAN, D. C., 739 Equitable Bldg., Denver, Colo.
'04 BEAN, BARTON A., U. S. National Museum, Washington, D. C.
'84 BEAN, DR. TARLETON H., State Fish Culturist, Capitol, Albany, N. Y., and 1 Madison Ave., New York City.
'01 BEEMAN, HENRY W., New Preston, Conn.
*'13 BELDING, DAVID L., Biologist, Mass. Dept. of Fisheries and Game, Boston, Mass.
'13 BELL, J. C., Alaska Packers' Association, San Francisco, Calif.
'12 BELLOWS, I. H., 732 Fullerton Ave., Chicago, Ill.
'80 BELMONT, PERRY, 580 Fifth Ave., New York City.
*'13 BENSON, JOHN T., Director, Zoological Garden, Boston, Mass.
'13 BENTON, A. W., M. D., 208 S. Jefferson St., Neosho, Mo.
'13 BERG, GEORGE, Indiana Fish Commission, Indianapolis, Ind.
'06 BERKHOUS, JERRY R., Pennsylvania Fish Commission, Torresdale, Pa.
'13 BICKFORD, W. M., Missoula, Mont.
'13 BICKLEY, CHAS., 56 Robbins St., Waltham, Mass.
*'97 BIRGE, DR. E. A., State Board of Fish Commissioners, University of Wisconsin, Madison, Wis.
'13 BLACKFORD, CHAS. MINOR, M. D., Staunton, Va.
'13 BLAIN, JAMES, Missouri State Fish Committee, Springfield, Mo.
'13 BLAMEY, JOHN F., Whitman, Mass.
'01 BOARDMAN, W. H., Secretary, Board of Inland Fisheries Commissioners, State House, Providence, R. I.
'14 BOLTON, C. C., 7016 Euclid Ave., Cleveland, Ohio.
'12 BONFILS, FREDERICK G., *The Denver Post,* Denver, Colo.
'02 BOOTH, DEWITT C., Spearfish, S. D.
'11 BORCHERDT, RUDOLPH, Department of Game and Fish, Denver, Col.
'14 BORDENKECHER, WILLIAM, R. R. 19, Haughville Station, Indianapolis, Ind.
'90 BOWER, SEYMOUR, Superintendent Michigan Fish Commission, Detroit, Mich.
'00 BOWER, WARD T., U. S. Bureau of Fisheries, Washington, D. C.
'99 BOWERS, GEORGE M., Martinsburg, W. Va.
'10 BRADLEY, GEORGE J., Minnesota Game and Fish Commission, St. Paul, Minn.
'10 BRAMHALL, J. W., 415-417 E. 8th St., Kansas City, Mo.
'01 BRASS, JOHN L., Michigan Fish Commission, Drayton Plains, Mich.
'14 BRIGGS, A. B., Ashaway, R. I.
'10 BRIGGS, DR. BENJ. M., 106 Willoughby St., Brooklyn, N. Y.
'03 BRITTON, F. H., Vice-President and General Manager, St. Louis Southwestern Railway, St. Louis, Mo.
*'05 BROWER, J. F., Pennsylvania Fish Commission, Holmesburg, Pa.
'14 BROWN, ERNEST C., 52 Vanderbilt Ave., New York City.
'14 BROWN, ERNEST CLIVE, Copake, N. Y.
'98 BROWN, GEORGE M., care Pere Marquette R. R., Detroit, Mich.
'04 BROWN, G. W. N., U. S. Bureau of Fisheries, Homer, Minn.
'10 BRUCE, THOMAS H., 56 Ash St., Waltham, Mass.
'92 BRUSH, DR. E. F., Mount Vernon, N. Y.
'10 BRYAN, PROF. WM. ALANSON, College of Hawaii, Honolulu, H. T.

'05 Buck, William O., U. S. Bureau of Fisheries, Neosho, Mo.
*'04 Buller, A. G. Pennsylvania Fish Commission, Union City, Pa.
'12 Buller, G. W., Pleasant Mount, Pa.
*'12 Buller, Nathan R., Pennsylvania Fish Commission, Harrisburg, Pa.
'12 Burke, Thomas F., Colorado Fish and Game Commission, Denver, Colo.
'07 Burnham, Chas. W., U. S. Fisheries Station, Louisville, Ky.

'11 Caldwell, E. E., Chief Warden and Commissioner, Illinois Fish Commission, Havana, Ill.
'13 Callaway, Fuller E., 207 Broad St., La Grange, Ga.
'10 Callaway, W. A., care Armour & Co., Brook and Main Sts., Louisville, Ky.
'12 Campbell, Walter E., Altamosa, Colo.
'12 Capell, Arch. T. P., U. S. Bureau of Fisheries, Leadville, Colo.
'02 Carter, E. N., U. S. Bureau of Fisheries, Bullochville, Ga.
'97 Caspersen, Bjorn, U. S. Bureau of Fisheries, Yes Bay, via Ketchikan, Alaska.
'07 Casperson, Thorgrim, Supt. Hetta Hatchery, Sulzer, Alaska.
*'03 Casselman, E. S., Lake Delaware, N. Y.
'13 Casting Club de France, Place de Concorde, Paris, France.
'07 Catte, Eugene, Langdon, Kan.
'13 Chambers, F. W., Salt Lake City, Utah.
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CONSTITUTION

(As amended to date)

ARTICLE I

NAME AND OBJECT

The name of this Society shall be American Fisheries Society. Its object shall be to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; the uniting and encouraging of all interests of fish culture and the fisheries, and the treatment of all questions regarding fish, of a scientific and economic character.

ARTICLE II

MEMBERS

Any person shall, upon a two-thirds vote and the payment of two dollars, become a member of this Society. In case members do not pay their fees, which shall be two dollars per year after first year, and are delinquent for two years, they shall be notified by the treasurer, and if the amount due is not paid within a month thereafter, they shall be, without further notice, dropped from the roll of membership. Any person can be made an honorary or a corresponding member upon a two-thirds vote of the members present at any regular meeting.

The President (by name) of the United States and the Governors (by name) of the several states shall be honorary members of the Society.

Any person shall, upon a two-thirds vote and the payment of twenty-five dollars, become a life member of this Society, and shall thereafter be exempt from all annual dues.

Any library, sporting or fishing club, society, firm or corporation may, upon two-thirds vote and the payment of the regular annual fee, become a member of this Society and entitled to all its publications.

Any person, society, club, firm or corporation, on approval by the Executive Committee and on payment of $50,00, may become a Patron of this Society with all the privileges of a life member, and then shall be listed as such in all published lists of the Society. The money thus received shall become a part of the permanent funds of the Society and the interest alone be used as the Society shall designate.

ARTICLE III

OFFICERS

The officers of this Society shall be a president and a vice-president, who shall be ineligible for election to the same office until a year after the expiration of their term; a corresponding secretary, a recording secretary, an assistant recording secretary, a treasurer, and an executive committee of seven, which, with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session —four to constitute a quorum.

In addition to the officers above named there shall be elected annually five vice-presidents who shall be in charge of the following five divisions or sections:

1. Fish culture.
2. Commercial fishing.
3. Aquatic biology and physics.
4. Angling.
5. Protection and legislation.

ARTICLE IV

MEETINGS

The regular meeting of the Society shall be held once a year, the time and place being decided upon at the previous meeting, or, in default of such action, by the executive committee.

ARTICLE V

ORDER OF BUSINESS

1. Call to order by president.
2. Roll call of members.
3. Applications for membership.
4. Reports of officers.
    a. President.
    b. Secretary.
    c. Treasurer.
    d. Vice-Presidents of Divisions.
    e. Standing Committees.
5. Committees appointed by the president.
    a. Committee of five on nomination of officers for ensuing year.
    b. Committee of three on time and place of next meeting.
    c. Auditing committee of three.
    d. Committee of three on programme.
    e. Committee of three on publication.
    f. Committee of three on publicity.
6. Reading of papers and discussion of same.
    (Note—in the reading of papers preference shall be given to the members present.)
7. Miscellaneous business.
8. Adjournment.

ARTICLE VI

CHANGING THE CONSTITUTION

The constitution of the Society may be amended, altered or repealed by a two-thirds vote of the members present at any regular meeting, provided at least fifteen members are present at said regular meeting.

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TRANSACTIONS

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The American Fisheries Society

Organized 1870—Incorporated 1910

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CONTENTS

ON SOME QUANTITATIVE PHYSIOLOGICAL CHANGES IN THE PACIFIC SALMON DURING THE RUN TO THE SPAWNING GROUNDS

BY PROF. C. W. GREENE,

From the Department of Physiology and Pharmacology, Laboratory of Physiology, University of Missouri.

Among the anadromous fishes, the various species of Salmonoids are probably the largest and most important from an economic point of view. It is now well known (Evermann), that the Pacific salmon of the different species of the genus, *Oncorhychus,* after they reach maturity in the sea and make the run up the rivers to the spawning grounds in the cold fresh-water streams, invariably die after spawning. The Atlantic salmon, *Salmo salar,* and the Pacific steelhead, *Salmo gairdneri,* are supposed after spawning to return to the sea again for another period of feeding and development.

It is further well proven by the researches of the United States Bureau of Fisheries that the species of *Oncorhynchus* take no food during the run to the spawning grounds. The king salmon apparently ceases feeding upon entering the brackish waters in the region of the mouths of the rivers, and the long run against swift current and mountain torrents, amounting in the case of the Columbia River and its tributaries to as much as 700 to 1,000 miles, is made absolutely without food.

During my work I have found that many, if not the majority, of the individuals of the king salmon enter fresh water (at least in the Sacramento and the Columbia River basins) at a period when their reproductive organs are relatively immature. During the run from the mouths of the rivers to the spawning streams and the sojourn immediately following, the greater portion of the mass of the reproductive organs is developed. The two principal facts, namely (1), the expenditure of the large amount of energy without external food, and (2), the development of one set of organs at the expense of material derived from other organs, form a unique biological experiment in nutrition. The experiment is unusually favorable also because of the fact that it is carried out in nature under conditions that must be assumed to be normal and natural for the animal itself. The source of the material from which is derived, first, the energy represented by the journey against the swift currents of the rivers, and second, the material used in the construction of the reproductive organs, forms the basis for the work of which the present brief report is only a small part.

This problem was attacked many years ago by Miescher, whose classic work on the Rhine salmon is well known. Later it was again resumed by Noel-Paton, working under the auspices of the Scottish Fishery Board and on the same species, *Salmo salar*. The Atlantic salmon, however, while it makes the run in fresh water without food, nevertheless is supposed to live to return to salt water where it again begins to feed. It remains to be seen whether or not the changes are as profound and as exhaustive as are found in the king salmon of the Pacific.

In 1906, after a series of preliminary studies extending through three summers, I made an exhaustive collection of samples of king salmon from the Sacramento River basin, California. This collection began with the sea-run fish caught while feeding at Monterey Bay and at Bolinas Bay, California. It included a series of samples taken from brackish water at Black Diamond on the Sacramento River, and closed with a similar collection from the spawning grounds of the McCloud River at the U. S. Fishery at Baird, California.

It is obvious that where marked changes are in progress in a series of animals upon which comparisons are drawn, some standard must be chosen as the basis of this comparison. In the case of the salmon the supposedly mature fish at the feeding grounds just before entering the fresh water is taken as a standard against which are determined such changes as may have occurred in specimens from the stations at the head of brackish water and at the spawning grounds.

Noel-Paton has assumed the rule that similar solids are to each other as the cubes of similar dimensions. The dimension assumed to change least in the salmon is that represented by the length, i. e., the skeleton. If one assumes that the skeletal axis does not change in length while the various organs are being consumed in the migration, then the length measurement can safely be taken as the basis of comparison. My preliminary figures indicate that the method of comparison by the cubes of the lengths can not apply to the king salmon. Within narrow limits the variation in weight is closely proportional to the length. For the present illustration I have chosen salmon of nearly uniform lengths, thus eliminating the errors arising from computation. All have been reduced to the standard length of 860 millimeters.

A comparison of salmon from the three stations is made along two lines: First, as regards the changes in the gross amount of nutritive substances represented by the weight of the various organs; second, the change in the percentage composition of the primary chemical constituents of these same organs.

Unquestionably the muscle or flesh of the salmon forms the great store-house of nutritive material, especially of the fat. However, the skin, the liver, the digestive organs and probably the skeleton also serve as supplementary stores of energy-giving material. The figures representing these changes may be computed from two points of view. First, from the point of view of the intrinsic interest of a strictly scientific problem; second, from the point of view of the commercial, i. e., economic value of the food material represented by the salmon industry.

The individual fishes chosen are two females and one male from each station, namely, *the sea, the head of brackish water, and the spawning grounds of the Sacramento basin.* The comparison is made on the basis of total length, i. e., from the tip of the nose to the base of the tail. The muscle or edible flesh, representing by far the greater volume of available nutritive material for either the fish or for man, is alone presented. The data include the length, weight, weight of muscle, total dry substance of muscle and certain percentage relations. The figures are represented in table I.

In table II it is seen that the average total weight is actually greater at the Black Diamond Station at the head of the brackish water, than at Monterey on the feeding grounds. The former fish are 11% heavier than the average Monterey standard. On the other hand, the Baird salmon have dropped in weight to 75% of the weight of the standard Monterey salmon.

The comparison above is made on the basis of total weight of the specimens. If the total weight of the muscle only is taken into consideration, the balance is still in favor of the Black Diamond salmon. The average weight is 7,220 gms. for the Black Diamond fish as against 6,836 gms. for the Monterey fish. This is an advantage of 105.6% so far as weight goes. At Baird the weight of the muscle has fallen to 3,311 gms. When the weight of muscle is taken in comparison with the total weight of the fish, however, it appears that the muscle of the Monterey fish weighs 67.8% of the total weight of the fish, the Black Diamond 64.4%, while the Baird specimens weigh 44.0%. These figures apply to the gross mass of the muscle.

When the total dry substance of the muscle is figured in per cent. of the total (wet) muscle then we have 38.3% for the Monterey fish, 35.7% for the Black Diamond, and 26.0% for the Baird. The weight of the dry muscle averages in the three cases, 2,616 gms. for the Monterey fish, 2,581 gms. for the Black Diamond fish and 682 gms. for the Baird fish.

These last figures, that is the percentage of dry muscle substance of the total muscle, and the total dry weight of muscle, bring out one striking comparison between the Monterey and Black Diamond fish. The point is

TABLE I.

Sacramento Salmon

Preliminary table exhibiting the basis for computation of the *commercial* and *food values* of the king salmon from 1. *salt water*, 2. *head of tide water*, and from 3. *the spawning grounds* in the Sacramento Basin.

		Actual Length & Weight		Computed to standard length of 860 mm					
Locality collected	No. & Sex	Total length tip of nose to tip of tail mm	Total Actual weight gms.	Weight reduced to standard lenghth of 860 mm gms.	Weight of wet muscle gms.	Muscle % of total weight	Weight of muscle dry gms.	Dry muscle % of total weight	Weight of nutritive substance in % of total weight of standard sea fish
Salt Water									
Monterey Bay	725 ♀	860	10,000	[illegible]	7,007	70.1	2,736	27.3	
Monterey Bay	705 ♂	860	10,100	[illegible]	6,551	65.0	2,158	21.1	
Bolinas Bay	[illegible] ♀	906	10,700	[illegible]	6,906	68.0	2,625	25.8	
Average		875	10,267	10,080	6,836	67.8	2,616	25.9	25.9
Head of tide water									
Black Diamond	875 ♀	878	10,550	10,330	6,613	64.3	2,219	21.5	
Black Diamond	877	860	11,150	11,150	7,426	66.5	2,710	24.3	
Black Diamond	879 ♀	928	13,000	12,050	7,584	63.0	2,813	23.3	
Average		889	11,567	11,177	7,220	64.4	2,581	23.1	25.6
Spawning grounds									
Baird	916 ♀	878	7,650	7,493	3,023	40.3	562	7.5	
Baird	939 ♂	875	7,300	7,159	3,461	48.3	779	10.9	
Baird	938 ♀	915	8,450	7,942	3,449	43.4	704	8.9	
Average		889	7,800	7,531	3,311	44.0	682	9.1	6.8

this, while the total mass of the muscle is greater, as was shown of the total body weight, yet the total mass of the dry substance has remained almost constant. In fact, the percentage of dry has dropped slightly, from 25.9% to 23.1%. This, along with the water determinations, shows that the *apparent increase in weight* of the Black Diamond fish over the sea forms at Monterey is not due to an increase by actual growth, but rather is *due to a taking on of water.* The substance of the dry muscle figured in per cent. of the total weight of the fish falls under that of the standard Monterey salmon by 2.8% as just shown. In the Baird salmon, the dry muscle is only 9.1% of the total fish. Furthermore, if these figures be converted into percentages of the standard weight for the particular lengths selected then they read: Monterey fish 25.9% of the standard, 25.6% for the Black Diamond fish, and only 6.8% for the spawners at Baird.

I have computed the percentage of dry substance of muscle without making any distinction as to the composition of the material. Of course, the actual nutritive value of the salmon flesh is found in the dry substance. This has been shown to decrease remarkably in the individual specimens during the migratory run. But when the chemical composition is taken into consideration it is obvious that the actual food value represented by the dry substance is found primarily in the fats. The fact is, the fat runs from 15% to 20% in the down river forms, but only 1% to 2% in the spawning ground salmon.

These three sea salmon of the table have an average of 15.6% of protein and 18% of fat in the muscle. At the head of brackish water the fat has already decreased somewhat both in percentage composition and in absolute amount. On the spawning grounds, in contrast with feeding sea salmon, the protein has dropped to 14.4% while the fat is almost entirely gone, 1.6%. See Table III.

One gram of fat represents a fuel value of over twice that of one gram of protein, i. e., 9,300 Calories for fat

TABLE II.

Sacramento Salmon

A comparison of average values from the *sea*, the *head of tide water*, and the *spawning grounds*. Reduced to uniform standard length of 860 millimeters.

				Wet Muscle			Dry Muscle		
	Length	Weight	Percentage of standard weight	Weight of wet muscle	Percentage of standard weight of wet muscle	Percentage of standard fish	Weight of dry muscle	Percentage of standard weight of dry muscle	Percentage of standard fish
Sea	860	10,080	100 %	6,836	100 %	67.8 %	2,616	100 %	25.9 %
Tide water	860	11,177	110 %	7,220	105.6 %	71.6 %	2,581	98.7 %	25.6 %
Spawning grounds	860	7,531	74 %	3,311	48.4 %	32.8 %	682	26.1 %	6.8 %

TABLE III.

Showing the protein and fat in percent of wet muscle:

Salmon number	Protein percent	Fat percent
705 ♀	15.0	17.4
725 ♂	15.8	18.6
754 ♀	15.9	18.0
Average	15.6	18.0
875 ♀	16.7	12.4
877 ♂	17.1	15.1
878 ♀	16.8	16.3
Average	16.9	14.6
946 ♀	12.9	1.1
939 ♂	15.8	2.4
938 ♀	14.4	1.3
Average	14.4	1.6

and 4,100 Calories for protein. It is shown that the dry muscle substance in the Baird salmon muscle, which was only 6.8% by weight of the standard fish, is composed almost wholly of protein. The loss of the fat reduces the true nutritive or fuel value of the flesh of the Baird spawners to 2.3%, i. e., one-third of an equal weight of flesh from the standard salmon. In a word, the 6.8 dry pounds of apparent good food per hundred pounds of fish has dropped off two-thirds in quality.

To sum up this statement, the food material of the salmon stored in its muscles when it begins its run to the spawning ground is represented by 25.9% of the total weight of the fish, whereas at the end of the spawning run it is represented by about one-third of 6.8% or 2.3% of the total weight of the fish, a loss of between 84% and 85% of the stored material.

This material which is consumed from the muscles is supplemented by additional material from the skin, from the visceral organs, such as the stomach, intestines, pyloric caeca, and to some extent from the liver. The greatest changes in these latter organs are to be found in the visceral mass in which the weight decreases from an average of 265 gms. in the Monterey fish to 33 gms. in the Baird fish, i. e., one-eighth of the original amount. The weight of the liver, even in fish of the same length, varies extremely from all stations, hence no very reliable data can be derived from the study of this organ. The total weight of the skin and the viscera in fish from Monterey is in round numbers 400 gms. or about 4% of the fish weight. The absolute amount of nutritive substance furnished by these organs is small in comparison with that supplied by the muscles.

The disappearance of nutritive substance in these changes is to be accounted for, as was said in the beginning, by the expenditure of mechanical energy and by the growth of the reproductive organs. The distribution of materials as between these two factors is a most interesting story in itself.

WHAT WE CAN DO TO PROMOTE FISH CONSERVATION

By Charles Minor Blackford, M. D.,
Staunton, Virginia.

Perhaps no country in the world possesses more societies and associations for the promotion of various ends than does the United States, and yet the small success that attends the labors of these organizations must attract the notice of anyone who looks into the matter. In every state, in many counties and in every city or large town, we find medical societies and other scientific or semi-scientific bodies that are trying to teach the people at large how to better their physical condition, and yet in many cases, their influence is negligible. It was only after the brilliant object lessons given by the altered hygienic conditions in Havana and on the Canal Zone, that the mass of our intelligent people became convinced that the mosquito is anything more than a trivial nuisance and that the house fly is a menace to life, although the medical societies had been preaching these facts to unheeding ears for several years. When the truth was brought home to the people, however, they grasped the situation, and the tables of mortality already show the results of the campaign now being waged against these domestic enemies.

The reason why these bodies of learned and experienced men have so small an influence on the people around them may be summed up in the single word, ignorance. This popular ignorance and its twin offspring, prejudice and vanity, must be overcome before any marked results can be effected. Mere legislation will not accomplish much. Along our special line, the conservation of fishes, there is ample legislation—indeed in some instances there is too much—but the legislation is not accomplishing its end and we should try to find out why it is not doing so. Many of the laws on the statute books are not wise and would not accomplish anything if they were enforced, but the principal reason is lack of enforcement, and it is here that ignorance and its offspring, prejudice, come into play. One of the wisest of the writers on law has said that "He who knoweth the law and knoweth not the reason of the law, knoweth not the law; for the reason of the law is the life of the law," and we must teach the mass of the laiety the reason of the law if we wish to put life into the law and get hearty co-operation in its enforcement.

The greatest obstacle that we encounter in doing this is the vanity of the American people. For more than a century it has been a mark of so-called patriotism to claim that the resources of our country are inexhaustible, and anyone who called attention to the danger of extravagant wastefulness, was considered an hysterical alarmist or almost a traitor. In consequence of this foolish talk, we are now seeing the end of our forests, and geologists are estimating with alarming accuracy, the length of time that will elapse before our stores of iron and coal will be exhausted. National and state governments are frantically taking steps to check the ruthless destruction of these reserves of natural wealth before it is too late, but their efforts will bear scanty fruit unless the people be shown that the wonderful wealth of our country is not limitless. When this is grasped, and not until then, conservation will become an accomplished fact.

When America was first being settled by Europeans, the abundance and variety of the fisheries of both the salt and fresh waters made a deep impression on the colonists. The Grand Banks fisheries played no small part in causing the adjacent continental shores to be colonized, and the fishes along the coasts and in the rivers supplied the colonists with a large part of their food during the earlier years of the settlements. The widespread belief that this resource was inexhaustible led to such reckless destruction that the fisheries began to decline, and about the time of the Civil War the shad catch had diminished to such an extent that its restoration was one of the main reasons for the establishment of the United States Commission of Fish and Fisheries, the predecessor of the present Bureau of Fisheries. Following the example of the National Government, many of the states have established commissions charged with the duty of restoring or increasing their respective fisheries, and it is a part of the duty of our Society to aid these commissions in the accomplishment of their task.

This can best be done by arousing the interest of the people in the work, and as said above, this can only be done by spreading abroad knowledge of the economic value of the fisheries and showing that in preserving them, something more is intended than merely restricting the rights of the fishermen. Our Society can do good work in this direction, both as individuals and as an organization, and I want to make a few suggestions as to how we may go about it.

At the meeting of the Fourth International Fishery Congress, held in Washington in 1908, O. M. Dennis, former State Game Warden of Maryland, gave some reasons for the failure of fish protective legislation, and among them he placed the selfish jealousy of sportsmen and commercial fishermen in regard to bills introduced by either class. He said that this being true, "The country members of the legislature, as well as the fishermen themselves, look with suspicion on any measure presented to the legislature which has for its purpose the protection of fish and game when such measure is presented by city men." Unfortunately this is true, and it is not confined to Maryland by any means. The antagonism between country men and city men is so widespread as to be almost universal, and among the rural population there is a general opinion that game protective laws are designed to furnish sport for city men at the expense of the rights of the country people. For this reason the game laws are very commonly looked on as something very much like acts of tyranny, and disobedience of them is regarded somewhat in the light of heroism. It should be remembered that laws are but the crystallized expression of public opinion, and if there be no public opinion favoring a law, or if public opinion be opposed to a law, merely placing a legislative act on the statute book will not produce any result. It is therefore necessary to create an enlightened public opinion in favor of laws for the conservation of fishes, and when this is done the enforcement of the laws will be both easy and effective.

Our Society can aid in the development of this public opinion both as a collection of well informed individuals interested in this movement and as an organization. Our members come from many of the states of the Union, and among them are state and national officials, college professors, commercial fishermen, scientists and sportsmen; in brief, every aspect of the fishery question is represented among us. We are not sectional and we have no selfish nor class interests to serve, and consequently we are in better position to spread the knowledge of fish life among the people than would be any trade organization or even a purely scientific society. As individuals it would be well for us to write papers for the press; not merely for the big city papers, the sporting magazines and the fish trade journals, but for the country weeklies that go out among the masses of the rural population. If we were to write articles that are scientifically accurate; that are interestingly put, and above all, are not "in a tongue not understanded of the people," many of our members would be surprised to see how eagerly they will be read and what an effect they will produce. One of the main reasons that societies such as ours have so little effect on public opinion is that the subjects that we discuss and the language in which we discuss them are uninteresting and unintelligible to most of the people outside of our own narrow circle. It is hard for us, who have given much of our time and effort to the acquirement of a special line of knowledge, to appreciate that what is merely elementary to us is an unknown and fascinating world to many intelligent men outside of the ranks of professional naturalists. How many of these people could tell how a fish egg is impregnated and how it develops? How many can tell anything of the life history of even the commonest fishes? The knowledge—if indeed it can be called knowledge—that most persons have of such subjects is a mass of traditional lore, resting on misinformation as a basis, that is so far from the truth that to call a tale a "fish story" is equivalent to saying that it is false. By putting the known facts of fish life clearly and accurately before the intelligent people of our country, we would make hundreds of practical students of the natural history of fishes where none are to-day, and nearly every one of them would become an active aid in the conservation movement.

Another method of advancing our purpose is to have our members give talks before school children. Many, if not all, of the school superintendents will welcome the chance of having some well-informed man or woman give one or more talks—we need not dignify them by calling them lectures—before the children on this subject, and by so doing the interest of the coming generation will be aroused. The recent Boy Scout movement offers another opportunity. Teach these boys how the black bass or the brook trout spawn; if possible show them some of the eggs during their development, and the boys will become ardent protectors of the spawning fish and not destroyers of them. They will see that the despised city sportsman is a pretty decent kind of fellow after all, and they will teach their parents and their neighbors the value of fish conservation.

Finally, what can we do as a Society to arouse greater interest in our avowed objects? We can take a hint from one of our sister societies, the National Geographic Society. We should remember that there is nothing in which any intelligent man is interested that may not be made an object of interest to any other intelligent man if it be properly put. We are far too prone to discuss technical matters that are of great interest to us as biologists and fish culturists, and to forget that these topics, although of great value, are of no interest to the masses unless we try to make them such. At first glance it would seem that there are few subjects less interesting than the cold, bare facts of geography, but by putting these facts attractively, the National Geographic Society has built up one of the most entertaining magazines in the country, and has enrolled a membership of thousands. We might do something of the same sort. We might try to issue a magazine of popular ichthyology that would cover the scientific, the commercial and the sporting sides of our subject, and by having the articles written simply, clearly and accurately, spread the influence of our Society throughout the land. We would replace the ignorance and misinformation that now prevails by clear, concise and accurate knowledge, before which the obstinacies and prejudices that now oppose us would disappear. We would enlist thousands of eager students of all ages and sexes to battle for fish conservation, and we would make our Society a power in the land. Many of our members are easy and graceful writers, and I feel certain that enough of them would be willing to contribute articles to such a journal that would make it authoritative and valuable as well as interesting and entertaining, and, should the experiment succeed, we would have the consciousness of having performed a valuable service to our country.

FISH PARASITES AND THE PUBLIC HEALTH

By Prof. Edwin Linton,
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It had not been my intention to prepare a paper for the annual meeting of the American Fisheries Society this year, but certain recent happenings, of which the parasites of fishes were an important factor, suggest that I again discuss this question. Three years ago I presented a paper to this society on "Cestode Cysts in the Flesh of Marine Fish and their Bearing on Food Values,"* in which I fondly hoped, but vainly as it appears, that any fears which might have existed, either active or dormant, in the public mind respecting the effect of parasites in fishes used for food, would be dispelled.

In June, of the present year, the Department of Public Health of the City of New York condemned certain cargoes of butterfish amounting to many tons, thirty I have been told, on account of the alleged presence of parasites in the flesh. I was asked by the United States Bureau of Fisheries to have an interview with the New York health authorities concerning this matter of the butterfish. The interview was granted and held in the offices of the Department of Health for the City of New York on June 21, 1915. Previous to this interview I had supposed that the parasites to which objection had been made were the minute cysts of the cestode *Otobothrium crenacolle.* I had already discussed the bearing of this parasite on the food value of the butterfish in the paper cited above, and was prepared to give additional evidence of the harmlessness of this parasite even if eaten by man in his fish diet. I was much relieved therefore upon being assured by the officials that they had not objected to the butterfish on account of the cestode parasites. A new charge, however, was

*Trans. Am. Fish. Soc., for 1912, pp. 119-127.

brought against the butterfish, viz., that large numbers of them had nematode worms in the flesh.

Now, as it happens, I had examined large numbers of butterfish for flesh parasites in the past ten years and, having found their flesh free from nematode parasites I was not at all disposed to believe that butterfish had suddenly become parasitized in this way. I was familiar with the fact that nematodes are of common occurrence on the viscera, especially on the pyloric caeca, of the butterfish, an affiliction shared with the butterfish by many other species of fish to a greater or less degree, and suggested that nematodes seen on the viscera had been mistakenly referred to the muscle tissue. This created an issue, an *impasse* in truth, which could be resolved only by an investigation to see how the facts lay. Accordingly some butterfish were sent for and brought from the market. A fish was opened. Nematodes were found on the viscera, but none in the flesh except a few that had been carried thither by the knife used in opening the fish. The remaining fish were opened more carefully with the result that nematodes, so far as they were present at all, were found only on the viscera.

Detailed results of the examination of butterfish for nematode parasites are given below.

Before taking up the discussion of the particular case afforded by the butterfish I shall discuss briefly the general question of the effect on food values of the presence of representatives of different orders of helminths in food fishes. Preliminary to this, however, I shall ask indulgence for a few remarks on the general subject of parasites. The late Joseph Leidy, many years ago, made an interesting contribution to science in a paper entitled *A Fauna and Flora within Animals.* The title alone was a valuable gift to popular knowledge. That paper showed that there exist in nature large numbers of species of animals and plants which pass all, or an important part, of their existence within the bodies of animals. The indweller is called a parasite or guest; the animal which harbors the indweller is called the host.

The successful completion of the round of life of many of these parasites requires that the host which harbors one stage of the parasite be eaten by a host in whose alimentary canal the parasite will find conditions favorable for its further development. As a rule the number of species of animals which are fitted to become the final host, that is the host in which the parasite becomes adult and produces eggs, is limited. Thus in the case of the flesh parasite of the butterfish, although the butterfish is eaten by all the larger carnivorous fish that swim the waters with them, they develop only in the sharks, and in an exceedingly small number of species of shark. To make the question still simpler, it may be said that when a blue fish, for example, eats a butterfish that is harboring cestode cysts in the flesh, it utilizes as food the cestode cysts with their contents in the same manner and doubtless with equal benefit as follows the assimilation of a similar quantity of proteid material from the muscular tissue; while a hammerhead shark which eats a butterfish containing these cestode cysts in the flesh, instead of digesting the larva that will be liberated from the cyst, furnishes the proper conditions for that larva to develop, and he will have in a short time the adult cestodes in his spiral valve. There is no reason to believe that the butterfish cestode will develop in man; on the contrary there is very good reason to believe that it will not develop in any warm-blooded animal. Furthermore, all helminth parasites are killed in ordinary cooking and the tissues of which they are composed are doubtless as nutritious as are those in which they chance to be embedded. Again, the popular mind should be taught to discriminate between the animal and vegetable inhabitants of living animals and those which may make their appearance in the flesh of animals after they are dead. The latter, when they are the larvae of insects for example, that is maggots, create unpleasant sensations and suggest spoiled meat, or meat that has not been properly cared for; when bacteria, they are associated with the disturbing phenomena of putrefaction. In either case food so infected is justly viewed with suspicion, and health authorities are remiss if they allow such conditions to exist.

It cannot be emphasized too strongly that insect larvae in meat, or putrefactive changes have nothing in common with cases of animal parasitism. The helminth parasite, in the alimentary canal particularly, or in the tissues of its host, in somewhat less degree, requires that the animal which harbors it be living. They do not, as a rule, long survive the death of the host. Living nematodes on the viscera of a butterfish in the market, therefore, are no indication that the flesh of the butterfish is not perfectly fresh and wholesome.

Cestodes.—I do not recall any cases of cestode parasites of fishes in this country which, like *Bothriocephalus latus,* found larval in certain European fishes, develop in man.* If such exist the habit of eating only cooked fish which prevails here precludes any possibility of man's becoming the final host. With the exception of the butterfish, the marine food fish that I have examined are prevailingly free from cysts in the flesh. In the butterfish a small cyst, about one millimeter in diameter is found. If the back-bone of a fish which has these cysts in the flesh be removed it will carry away with it practically all of the cysts, which, save in an occasional highly infected individual, are limited to the immediate vicinity of the back-bone, where they are, for the most part, lodged in the spaces between the vertebral spines above and below. On account of their small size and resemblance to small fish roe there is nothing unpleasant in the sight of these cysts, if they would be distinguished at all, an exceedingly unlikely event. As stated above there is no reason to think that these cysts can develop in man, or indeed in any warm-blooded animal. The New York health authorities are right in making no objection to the use of butterfish as food on account of cestode cysts in the flesh.

*It has been brought to my attention since this paper was written that *Bothriocephaluslatus* has recently made its appearance in Wisconsin, where it has evidently been introduced from Norway.

It is not necessary to discuss the possibility of man's becoming the secondary host, that is of harboring cestode parasites in the encysted stage, as, even where such possibility exists, which is certainly not true in the case of the butterfish cestode, infection would not be incurred from using fish as food.

It is interesting to note that the percentage of butterfish having considerable numbers of cysts in the flesh has been diminishing in the Woods Hole region during the past six years. The percentages of butterfish with numerous cysts in the flesh for the years 1909-1914, inclusive, are 48, 29, 36, 15, 13, and 12; the smallest number of fish examined in any one year was 416, in 1910, and the greatest was 948, in 1912. The results of the examinations this year thus far show a rather marked diminution in the number of parasitized fish from that of last year.

Trematodes.—Fortunately trematode parasites are not at all common in fishes in situations which render them liable to be ingested with parts used as food. In marine food fish I have not found them in the flesh, although they often occur in small cysts on the skin and especially on the fins. They may be recognized as small specks of black pigment, sometimes, especially on the cunner and tautog, in large numbers. As fish are ordinarly prepared for the table, such encysted trematodes are removed. There is nothing unpleasant in the sight of these skin parasites, unless they occur in very great numbers, not a usual happening, and nothing is to be feared from them, so far as at present known, even if they be eaten uncooked. The natural final host of those whose life history has been made out is some fish-eating bird. Fishes in fresh water lakes are more liable to infection in this way than are the fishes of the sea.

Nematodes.—Parasites of this order are found in the alimentary canals of many species of marine food fishes, especially in some of the larger kinds, such as the swordfish, cod, haddock, etc. They are also found encapsulated on the viscera of most species of fish, sometimes in large numbers. But in the flesh of food fish they are of infrequent occurrence.

While nematodes in food are not necessarily injurious, even if taken in uncooked food, there is a natural and justifiable prejudice against them as an article of diet. Certain of them, as is well known in the case of trichina of pork, may be inimical to health or even to life itself. That there should have been uneasiness, therefore, occasioned by the noticing of the presence of nenatodes in a food fish is not a thing to be marvelled at. But that the health authorities of New York did not inform themselves of the true nature of this case is regretable to say the least.

ALLEGED OCCURRENCE OF NEMATODES IN THE FLESH OF THE BUTTERFISH.

Now what are the facts with regard to the occurrence of nematode parasites in the flesh of the butterfish? That they occur on the viscera and especially on and among the pyloric caeca is certain. That they were found in the flesh, except as they were carried there by the knife used in opening the fish, from which lodgement they would have been removed in washing the fish in preparation for the table, there is much more reason to doubt than to believe. The New York health authorities were requested to forward to the Bureau of Fisheries examples of butterfish containing nematodes in the flesh. In response to this request suspected fish were sent, but no nematodes could be found in their flesh.

Since my interview with the New York health officials I have gone over my notes of examinations of butterfish for flesh parasites with the following results: It should be noted in the first place that the butterfish which were examined for parasites in the flesh were examined for the purpose of making a record of the frequency of occurrence of cestode cysts. As the examinations were made a record was kept in columns with the headings: "No cysts seen," "very few," "few," "many," "numerous," "very numerous." In order to determine to which column of the record the fish under examination should be referred, the fish, having been split open with a sharp knife inserted near the middle of the back, thus had the flesh of one side separated from the skeleton. In many cases only one or two cysts are found, and as these cysts are only about one millimeter in the longest diameter, careful attention had to be given in order to make the record as exact as possible. Now the nematodes which are of such common occurrence on the viscera of the butterfish are about 12 millimeters in length, and are, moreover, of a reddish brown color. They are therefore much more conspicuous objects than the cysts, which do not differ much in color from the muscles and bones with which they are associated. If nematodes were at all common in the flesh of the butterfish, therefore, they would most certainly have been detected in this search which began in the summer of 1904 and has been continued each season since. Most of the examinations were made in the months of July and August. These are supplemented by examinations made by Mr. Vinal N. Edwards in the months of May, June, September and October. The examinations were made on different dates throughout the season. Thus my record shows that in the season of 1912 there were 948 butterfish examined for flesh parasities on 23 dates in July from the 4th to the 31st, and on 10 dates in August from the 1st to the 23d. In 1913 butterfish were examined on 30 dates from June 30th to August 29th; in 1914, 785 were examined on 32 dates from July 10th to September 9th. Besides these I have records of examinations made by Mr. Edwards of 416 butterfish on 21 dates in May, June, September and October. The total number of butterfish which I have examined for flesh parasites in successive years from 1904 to the present time is 5,992; in the last eight years the smallest number for any one year is 416.

Mr. Edwards reports that he has found no nematodes in the flesh of butterfish. My own record of finds of nematodes in the flesh of butterfish is as follows: On

August 6, 1913, one nematode was found in the flesh of the side of a butterfish. It was 29 millimeters in length, much larger than those found on the viscera.

On July 14, 1915, one nematode was found in the flesh of a butterfish. The fish had been opened by another worker in the laboratory and had been lying for some time before I examined it. The length was 29 millimeters. It is a different species from that which is found on the viscera. Another nematode of the same species as the last was found in the flesh of the side of a butterfish on July 14, 1915. It was 32 millimeters in length.

These three nematodes make up the total found in the flesh of the butterfish to date. In each case they would have been detected without much doubt if the fish had been split open in preparation for the table. This record of three nematodes found in three butterfish out of nearly 6,000 butterfish examined especially for flesh parasites over a series of years is a very remarkable one. Very few of the species of animals used for food can show such a favorable record after having been subjected to such a rigorous test.

The occurrence of immature, encapsulated nematodes on the viscera, and especially on and among the pyloric caeca of the butterfish is common, but in this the butterfish is not exceptional. About 20% of the butterfish that I have examined this season have had many of these nematodes on the viscera; about 40% had none; the remaining 40% had few, often only one or two were found after very careful search. Fish were left unopened from one day to the next, and variously tested to see if the nematodes on the viscera showed any tendency to enter the flesh. None did so.

That there is nothing new or exceptional in the occurrence of nematodes on the viscera of butterfish is abundantly proved by records made in previous years. For example, in the Bulletin of the U. S. Fish Commission for 1899, p. 279, under the butterfish the following statement is made:

July 21, one—numerous nematodes on viscera. July 23, one—enormous numbers of immature nematodes on and among the pyloric caeca. August 10, three—serous coat of pyloric caeca with large numbers of immature nematodes. August 22, four—numerous small, immature nematodes found on pyloric caeca.

Also on p. 453 of the same volume the following statement under the butterfish is made:

Immature nematodes. Very abundant. Found in the majority of specimens examined in 1899 and 1900; small, pale red; particularly abundant on pyloric caeca—length 13 millimeters.

This record is introduced here to show that there is nothing in the nature of a seasonal epidemic in the occurrence of nematodes on the viscera of the butterfish. Further, it should be said, those who have given attention to the distribution of animal parasites could furnish just as impressive figures for many of the species of animals used for food.

A careful consideration of the facts above recorded will I am sure, convince any unprejudiced person that the New York health officials were mistaken in their supposition that the nematodes of the butterfish were in the flesh.

If there is any one who would allow my find of three small nematodes in the multitude of nearly 6,000 fishes to prejudice him against the use of an excellent food fish, he should not only become a vegetarian, but should make a microscopic examination of any fruit or vegetable salads, or mushrooms that may come on the table if he wishes to escape the possibility of an occasional nematode finding sanctuary in his fastidious insides.

CONCLUSIONS.

1. Helminth parasites in the alimentary canal and on the viscera of animals used for food are of frequent occurrence.

2. Occasionally they occur in the flesh of the animal, as in the well-known cases of trichina in pork, and the encysted stages of tape worms in beef and pork.

3. Many of the parasites found in mammals will develop in man. Only one species occurring in fish is known to develop in man.

4. Ordinary cooking kills these parasites.

5. Flesh which contains helminth parasites must not be confused with flesh in which insect larvae are develing, or which is "spoiled."

6. The flesh of food fish, especially of marine food fish, is exceptionally free from nematode parasites.

7. There has not been and there is not now any rational justification for the wholesale condemnation of any species of food fish on account of animal parasites.

8. The influence of the departments of health might well be directed towards encouraging the public to use such wholesome food material as the mussel, *Mytilus edulis,* and certain of the sharks and rays, now not much used for food in this country; assuredly they should not without certain knowledge use their power in such a way as to banish wholesome food from the market.

Naturally I should be most loath to criticize the action of any health officials, knowing how thankless is the task they have to perform in their efforts to care for the public health, and how their every act exposes them to criticism from some quarter or another.

But, as is evidenced in the action of the New York Department of Health in the matter of the butterfish, there may arise occasions wherein the interests of the public demand that the facts in the case be made known.

THE RELATIONS OF COMMERCIAL AND SPORT FISHING—FAIR PLAY

By H. Wheeler Perce, *Chicago, Ill.*

Anglers should never lose sight of one very vital fact which confronts them in any efforts they may make toward the conservation of game fishes and that is the large importance and great value of the strictly commercial fishing industries.

At the same time the anglers are entitled, without question, to a proper consideration of their requirements and proper provisions for the continuance of conditions of a satisfactory nature. Good, clean, out-door sport is an absolute necessity in the making of good, clean citizens and is so recognized by all countries of higher civilization. In fact, the higher the civilization, the keener becomes sport and the more is sport appreciated and encouraged. In the greater nations of the world sport plays a conspicuous part and as the scale is descended, sport becomes less and less a factor in national life. By sport is meant healthy, invigorating, mind-resting recreation, involving physical effort in varying degrees, skill, the training of the muscles, the eye and the brain as well, along channels that would otherwise remain inert, and not mere amusement, the casual looking on at something which simply entertains, interests or excites. So-called "sport" involving gambling and its attendant feverish lust for "something for nothing" has no part in any consideration of recreative sport strictly as such. More especially is the need of true sport appreciated as our civilization and business activities become more and more intense and it is in our largest and busiest centers that men feel the greatest need of something that offers them relaxation from the strain. To very many men, angling is the ideal recreation and it is very likely no sport is as much beloved by its devotees, from the sturdy, bright-eyed boy with his penny hook, a pole cut in the brush and a can of worms, to the grizzled veteran, the hero of many a tale, told and untold, with his delicate bamboo weapon of exquisite make and so many different patterns of beautifully tied flies that he has to consult a dictionary on the subject before he can tell you the names of them all. Probably there is no more democratic set of men on earth than is embraced in the fraternity of anglers. Rich and poor, high and low, the statesman and the "hired man," clergyman, lawyers, doctors, merchants, farmers, mechanics, clerks, all kinds and conditions of men "go-a-fishing" and all alike love the sport and love it more and more as their years increase. May and December rub shoulders in the fellowship of angling and the patriarch with silvery locks can be seen with his grandson at his side on many a stream or lake, both with eyes alight with the fires of enthusiasm.

And the sport is not only democratic but is essentially very widespread, for there is hardly a corner no matter how remote, of our beloved country, that does not contain its quota of anglers. If the census enumerators were to name them in their lists the legion disclosed would be a vast surprise to those who have given but casual thought to the subject. And this army of anglers buy things designed for their use, and catering to their needs constitutes no mean industry in this age of industries. Again, if the casual observer will give the matter thought, he will be surprised at the sum total in dollars spent by the anglers of this country on their sport, and every dollar spent by them means a dollar earned by someone else in supplying the wants of the angler.

The best of this is, that every dollar spent by the angler yields him an adequate return in improved strength, revived vitality, refreshed brain, keener faculties, clearer vision and better health. The only man who loses out is the doctor.

The angler was, is and always will be. He exists by nature, by precedent, by right and by choice. He is "born, not made." The character of his sport is calculated to assist in making him a good citizen. Surely it takes him along "paths of peace" and "ways of pleasantness" and unfolds to him the loveliness of nature without a knowledge of which any man is "poor indeed."

The roystering rowdy, who goes on an alleged fishing trip as a cloak to a drunken revel is no angler. He is only a lying ruffian and sport for love of sport has no place in his sordid make-up.

The charge has been made that the angler kills his prey. True, and just so long as society kills in order that it may eat, just so long is the angler entitled so to do, provided he makes it his bounden duty and sees to it carefully, that every fish is eaten which he has killed.

It would seem a perfectly fair premise that the angler is entitled to his share of the best consideration and effort that our lawmakers are giving and making in the interest of all of the people, but he should always remember that others are entitled to their share as well.

While the presence of coarse fish, in some of the waters, seems to the angler a menace to his sport, and while they are a menace to some degree, he should always remember that many kinds of such coarse fish constitute a cheap food product, always a desirable thing, particularly with food stuffs soaring higher and higher in cost.

The fishing industry is something of very considerable importance, and, when measured in money, runs up into millions. This means work and wages for men, shelter, clothes and food for them and their families. It means industry and thrift and all that goes with intelligent labor, rightfully applied in developing the resources of nature. It means business and profit, enterprise and progress.

It ranks in character with farming, mining, manufacturing, merchandising, all the great basic things that mean so much in this great country, and around it should be thrown all the protection that the wisest minds and most beneficent laws can give. If the commercial fisherman in a spirit of larger enterprise is liable to overstrain the resources of nature, he should be protected against himself. By the very nature of the thing, fishing is different from other industries in that the individual can do great harm to others by unwisely and excessively drawing upon the source of supply.

If a farmer overstrains his land—he alone suffers—but the waters are so undubitably a community interest that certain restraints are necessary in order that all may benefit and what is now a source of profit to all be not rendered barren for all. The seeds planted by a farmer yield a harvest at the point of planting, but fish planted, so to speak, at one point may be harvested miles away and hence it becomes the province of the state to do the planting or stocking and to the fisherman is left but the harvesting.

He should never forget this fact and should conscientiously respect and obey the wise injunctions against undue depletion of the waters. The fishing industry has the dignity of being probably man's oldest calling, it secures a valuable food for the people, it has its literature, its stories, its songs and legends. It is respectable and should be honored by all, and in no less a degree should those engaged in it remember the rights of others than industrial fisherman.

The angler should always respect the rights and privileges of the commercial fisherman, and he, in his turn, should render no less consideration to the rights of the angler.

And the law maker: He has a dual responsibility and should never fail in giving of his best in the interests of all concerned. Paternalism on the part of the state, may have its defects—certainly it has its limitations—but in the conservation of such natural resources as are offered by the waters of a state, paternalism, in some degree, becomes a necessity, if the best results are to be obtained. Such paternalism should be wisely and carefully exerted with an eye to the rights and requirements of all. No law maker should, through a desire to conciliate some small and selfish part of his constituency, stand in the way of a wise enactment in the interest of the many. It may be hard, it may even seem right to him and to those who urge his mistaken course—but his mind should always remain open to the logical appeal of the many as against the clamor of the few.

Let the entire fish situation be placed on a plane of fair play. Let the angler demand and receive fair play and at the same time, play fair himself. Let the commercial fisherman demand and receive fair play and himself play fair in return and let the law maker play fair and see to it that every one, as far as possible, and consistently with his rights, gets fair play.

MORE ABOUT THE PADDLE-FISH

(*Polyodon spathula*)

By M. L. Alexander.

President, Conservation Commission of Louisiana, New Orleans, La.

Further experiments with this species, commonly called "spoon-bill cat," were carried on in White Lake, La., during March, 1915, by E. A. Tulian, Superintendent of our Fisheries Department, in compliance with instructions issued by the Conservation Commission of Louisiana. These studies were made more especially with a view to obtaining more knowledge of the spawning season and habits of this fish; and whether it could be safely and successfully held in retaining ponds during this season.

Owing to various conditions over which the Commission had no control, we were obliged to make these studies on rather a more limited and economical basis than we had originally intended. Because of this, the work was somewhat less thorough and efficient than it would otherwise have been. At the same time, however, we consider the information gained as being rather instructive and valuable. Therefore I have decided to briefly outline this work to you and trust that it may be found of some little interest and use to the members of the American Fisheries Society, and others interested in fish culture and fisheries matters in general.

During the latter part of February and fore part of March of this year, the temperature of both weather and water averaged very much colder throughout Louisiana than was usual for this period. As a result the temperature of the water in White Lake did not exceed 62° Fahr. until after April 1st. From the 5th to the 8th of March, inclusive, the weather averaged somewhat warmer than later in the month. The water temperature for this period stood at 60° Fahr. On the 9th it dropped to 50° and remained at this temperature until the 13th, when it slowly began rising. From the 14th to the 31st, inclusive, it ranged mostly between 58° and 62° Fahr. This excessive cold had the effect of retarding the spawning season at least two weeks beyond that of a normal season.

Our first day's fishing this year, March 6th, resulted in the capture of a considerable number of this species. Among these were eight females containing eggs, and three unripe males, but no spent females or males. One of the females contained mature eggs which were seen to be running from its vent when this fish was lifted from the seine into the boat, and as it flapped about in the boat before it could be transferred to the live car. This was witnessed by Capt. Fred Portie of Grand Chenier, La., who lifted the fish from the seine, Mr. Ernest Barbe of Lake Charles, La., and Mr. E. A. Tulian of our Commission. Two of the males would have matured within the next few days, and one of these was killed and cut open with the hope of obtaining sufficient mature milt with which to fertilize the ripe eggs, or a portion of them at least. However, the milt was found not to be sufficiently advanced for this purpose. The matured female and two others with eggs, as well as two immature males, together with several others were later tranferred to an enclosure for further observations.

Our second and third day's fishing was on the 9th and 10th. Among the day's catch two spent females, eleven unripe females and three males not yet matured, were found. Both the immature females and males were transferred to our enclosure to be held.

From March 1st to the 10th, inclusive, there was such continuous heavy wind that our seine could only be hauled on the three days mentioned above. After the 10th, for various reasons, no further seining operations were attempted until the 22d.

Fishing operations were resumed, however, on this date, and among the catch of that day were found two females from which the eggs ran freely as they were lifted from the seine into the boat, and one ripe male from which the milt could be stripped. These fish were taken from the seine by Capt. Oliver Vaughn of Lake Arthur, La., but Mr. Ernest Barbe of Lake Charles, La., also saw both milt and eggs as they came from the fish. Unfortunately Mr. Tulian was detained at our headquarters in New Orleans on this date and as none of the employees on the ground understood the method of artificially fertilizing and hatching fish eggs, the matured milt and eggs could not be utilized. However, the three fish were transferred to a very small enclosure and held until Mr. Tulian's arrival, three or four days later, when he immediately examined them and found all three spent.

Because of continuous heavy winds the seine could not be hauled from the 22d until the 26th. On the latter date, however, seining operations were continued and resulted in taking seven spent females and six spent males, one female with mature eggs running from its vent, and two unripe males. For various other reasons, and owing to bad weather and the fact that no immature females had been taken during the day we decided to suspend further fishing operations.

The Superintendent of our Fisheries Department and a couple of other employees remained at White Lake until afternoon of the 30th. During the last days there, the fish which had been transferred alive to the enclosure at our camp were caught and a number of the more desirable specimens killed and opened. Every fish which had been empounded, except one, was found alive and in fine condition; the only external injury observed being a slight wearing away of the tail or a few minor scratches on the bill of three or four specimens. Twenty of the fish taken from the enclosure had been confined there twenty-three days. The roe of the unripe females and organs of all the fish opened were perfectly healthy and sound. Among these were a couple of immature males whose milt was absolutely healthy and normal.

The condition of these fish after so long a confinement is, I think both interesting and significant, inasmuch as it has been generally understood, I believe, that the paddle-fish when empounded in an aquarium or artificial pond usually lives only a week or ten days. We look upon the results attained as favorable indications that it probably will be possible to hold immature female and male paddle-fish until ripe, in properly constructed ponds, and then strip, fertilize and hatch their eggs artificially.

Judging from the experiments we made last year and again this, it appears quite certain that paddle-fishes work in schools when in the act of depositing and fertilizing their eggs. During the middle of the spawning period, a seine will invariably take a number of both mature and immature females and males, as well as recently spent ones, whenever any spawners are located by it. It has further been definitely ascertained that in White Lake during this period these fish are only to be found where the bottoms are of a somewhat hard and sandy character. Only an occasional fish could be taken when the seine was being hauled in localities where the bottoms are of a softer character. These are usually found in the bays and along stretches of straight shore-line.

The only fish we had to handle this year were those caught by an outfit and crew hired especially to catch paddle-fish for our operations. Therefore our studies were conducted with a very limited number of fish as compared to the number we secured last year when we were supplied by the commercial fishermen. This was caused by the fact that our close season on this species now extends from January 1, to July 15, of each year, therefore all commercial fishing is suspended.

The condition existing this year made it a rather expensive proposition to our Commission, and this contributed to further curtail the scope of our experiments. However, it is our intention to again conduct experiments next year, and on a more extended scale. At that time, we will probably also extend our field of operations so as to take in additional territory. Lake St. John in Concordia Parish, this State, is possibly as well, or even better stocked with paddle-fish than White Lake. The fish grow considerably larger here, and, it is thought likely, spawn later as this lake is much further north than White Lake.

Another element which added to the curtailment of our experiments was the conditions found in and around the large enclosure where we empounded the fish. These were such as to make it almost impossible to get them out for examination from the day they were put into it until they were finally fished out at the close of the season.

While at work at White Lake, our employees obtained and preserved a few rather interesting specimens. Among these was the egg sac, etc., of a ten-pound female paddle-fish, caught when in the act of spawning. This still contained a portion of the mature eggs, some of which were in the oviduct. Another specimen is the egg sac, etc., of a female of about the same weight which was also depositing eggs when caught and which still held a few mature eggs. All of the internal organs of an eight-pound female which had just recently finished depositing her eggs, as well as those of a twelve-pound spent male, were preserved. The milt, etc., of an eight-pound unripe male was also preserved.

I attach herewith copy of a report on a microscopic examination of the stomach, etc., of a paddle-fish, made for us by Percy Viosca, Jr., B.S., of Tulane University. This, I think, may be found interesting and useful.

NOTE ON THE VISCERA OF *POLYODON SPATHULA*

Specimen—8 lb. female, after spawning, caught at White Lake, March 28, 1915.

Gill rakers long and numerous: clean and practically free from microscopic organisms. Only one copepod observed.

Stomach large (U-shaped). Contents, examined under compound microscope, found to contain: Protozoa (one large flagellate especially numerous), small crustaceae (copepods and the like), filamentous algae, cyst-like bodies (probably protozoa or spores of algae).

Duodenum (small intestine), two inches long. Receives ducts of liver and pancreas and in addition, the duct of the appendices pyloricae. The latter are confluent in this species, into a single large, lobose diverticulum which opens by a single duct near the pyloric valve. It contained some of the same contents as the duodenum. It has doubtless been formed, phylogenetically, by several smaller pyloric caeca becoming confluent at the base.

Colon (large intestine), four inches long. Possesses a well developed spiral valve.

EFFORTS TO RIPEN STRIPED BASS, 1915

By J. P. SNYDER, *Supt. U. S. Fish Hatchery, Cape Vincent, N. Y.*

Last spring Mr. John Fitzhugh decided to try to ripen striped bass at his slide in the Roanoke river near Weldon, North Carolina. At this slide each year the female fish captured would furnish more than a hundred million eggs could they be held in confinement and ripened. To this end Mr. Fitzhugh built a suitable and comfortable houseboat for the use of his watchmen and anchored it to the slide. He also made a live-car about 12 ft. long by 4 ft. deep and 4 ft. wide. This he fastened to the side of the houseboat. This car was built of ⅞-inch pine boards and was made watertight with the exception of a couple one-inch holes bored in the ends of the car. Over these holes he tacked fine wire cloth as some one told him he would have to keep out of the car the little eels that ascend the Roanoke river in vast numbers during the month of May. No provision was made for the transfer of the fish from the slide to the live-car with as little injury to them as possible, so they were permitted to kick around on the slide until they had weakened sufficiently to permit their being picked up by the gills and in that way carried to the live-car. As watchmen he had two negroes.

These fish begin spawning as soon as the water reaches 68 degrees Fahr. and usually the most and best eggs are taken within the first 48 hours after that temperature is reached. This occurred last spring on April 25th and during the last week in April twenty large female bass, together with a lot of males, were placed in the car. More bass were available but there wasn't room in the car for all that were taken. Yet in spite of these very unfavorable conditions four of the bass ripened. One of those that ripened cast its eggs in the live-car. The eggs from one turned out badly as only about 25% of them produced fish. From the other two —one that ripened after being in the car 12 hours and one after 24 hours confinement—more than two million good eggs were taken and fertilized with milt from male fish held in the car. Most of the fish penned, however, developed fungus and soon died.

I arrived at Weldon on May 2d and the next day visited Mr. Fitzhugh at his slide. I found the water in the car very filthy as there was no circulation through it. As it was too late in the season to build a suitable car of slats with rounded edges we cut out part of each end of the car and over the openings thus formed we tacked wire cloth. Suitable nets or netting for handling these fish alive cannot be purchased at Weldon so we got a large piece of burlap out of which we made a net for handling the fish in the live-car and just back of the water rushing through the slide we placed another large piece of burlap. This piece of burlap was kept damp by spray from the swiftly moving water and large fish coming upon the slide were immediately wrapped in it and in that way carried to the live-car. At that time the water in the river was very low, clear and warm, registering 76 degrees; too warm to get the best results with these eggs and too low for fish to get above the slide so that but ten female fish were available for tests during my detail of two weeks there. The result of these tests are herewith presented in tabulated form and further explained in the "remarks" that follow. No tabulated data was kept of the tests made before my arrival.

REMARKS.

(a) I examined this fish at 10 a. m. May 10th. At that time she seemed soft enough to be ripe but no eggs came from her. At 3 p. m. on the same day Mr. J. E. Moody and I examined her and found her ripe and that she had already cast about half her eggs. The eggs remaining in her were taken and fertilized with milt from male fish that had been held in the pen. After

EXPERIMENTS IN RIPENING STRIPED BASS AT FITZHUGH'S IN ROANOKE RIVER NEAR WELDON, N. C., 1915

Date	Test No.	Size of Fish	Time of Capture	Condition when Captured	SUBSEQUENT EXAMINATIONS					
					Time	Condition	Time	Condition	Time	Condition
May 7	1	7 lbs.	6 a.m.	Fairly soft abdomen	May 8 9 a.m.	No change	May 10 10 a.m.	Sick and later died	—	—
7	2	20 lbs.	7 p.m.	Hard abdomen	do	No change	do	No change	May 11 9 a.m.	Hard. Showed signs of sickness and was removed
8	3	8 lbs.	6 p.m.	Soft abdomen	May 9 3 p.m.	No noticeable change	May 10 10 a.m.	No change died late in afternoon	—	—
8	4	7 lbs.	3 p.m.	Very soft abdomen	May 10 10a.m.	Very soft	May 10 3 p.m.	Ripe. Had already cast about half its eggs. See remarks (a)	—	—
9	5	20 lbs.	10 a.m.	Very hard	do	Hard	May 11 9 a.m.	Hard	May 12 3 p.m.	Hard and was taken from car
9	6	30 lbs.	5 a.m.	Very soft	May 10 3 p.m.	Apparently nearly ripe	May 10 9 p.m.	Ripe. See remarks (b)	—	—
10	7	8 lbs.	11 a.m.	Very soft	May 11 9 a.m.	Very soft	May 12 9 a.m.	Ripe. See remarks (c)	—	—
10	8	7 lbs.	3 p.m.	Very hard	do	Very hard	do	Very hard. Was taken out of car	—	—
10	9	7 lbs.	9 a.m.	Hard	May 12 9 a.m.	Hard	May 13 Noon	Hard	May 14 Noon	Hard. Was taken out of car
11	10	40 lbs.	1 p.m.	very soft abdomen almost ripe	May 9 3 p.m.	Sick. See remarks (d)	—	—	—	—

they were expanded they were taken to the hatchery. They turned out to be a fine lot of eggs and produced a good percentage of fry. The fry were normal in every way.

(b) This fish was caught in a net by Mr. W. H. Clanton. She was placed in the boat and immediately taken to the live-car. I examined her at 3 p. m. and found her very soft. At 9 p. m. I again examined her and found her ripe, seemingly just right. A half hour later Messrs. Henry Grant and J. E. Moody and I took her eggs. Unfortunately in cutting her open Mr. Moody cut too deep and opened the membranes containing the eggs and the fish in her struggles lost most of the best eggs in the boat, while quite a little blood got in the pan with the eggs that were saved. The milt from several male fish was used but only about 25% of the eggs expanded and only about 10% of these produced fish. Those failing to expand seemed normal in every way. They separated nicely and were normal in size and color but showed no signs of expanding even though they were given every chance to do so.

Mr. Roberts reported that only a small percentage of the eggs taken from a large fish at Fitzhugh's slide on May 28th expanded. He knew of no reason for it.

Four years ago Mr. Walter Harrison caught a large ripe fish in a net and although the eggs seemed in perfect condition they would not expand. Other fishermen have reported this same condition.

(c) This fish was examined by me on May 11th but no eggs came from her. The next day she was examined by Mr. B. M. Camp who reported that she had ripened and had already cast almost all of her eggs. Mr. Camp has had long experience in taking these eggs and I have every reason to believe what he told me. This verified what little experience we had last season.

(d) The fish came upon the slide at a time when no one was there to remove her to the box and before being put in the box or car she had badly bruised herself on the slide. Two hours later I examined her. She was nearly ripe, but sick and soon died. I am convinced that had she been placed in the live-car soon after coming on the slide she would have ripened. There were a number of large fish caught previous to my arrival at Weldon that undoubtedly would have ripened had the car had proper circulation and had the fish been removed to it without injury.

I might mention here that one million five hundred thousand eggs taken from a fish caught by Mr. Henry Grant were fertilized by milt from male fish held in confinement. Otherwise these eggs would have been lost as no other male fish were available at the time.

None of the tests were ideal as all the fish, male and female, were held in one live-car and it was impracticable to examine any one fish without seining up the whole bunch. This was injurious to them for in their struggles in the net their sharp spines cut each other and fungus soon developed, other unfavorable conditions were the frequent handling of all of them to keep track of the condition of one or two nearly ripe, the continuous presence of men around the car which was fastened to the house boat, and the small depth of water in the car, but two feet.

RECAPITULATION.

1. Seven of the thirty fish penned ripened in confinement.

2. All of these seven had very soft abdomens when penned.

3. The eggs from three of these gave splendid results, comparing favorably with the results obtained from eggs taken from ripe fish caught in nets.

4. The eggs from two others produced a low percentage of fry. This was disappointing, but the same thing has often happened with eggs taken from fish caught in nets.

5. Two of the fish ripened and cast their eggs between examinations. In confinement they cast their eggs within a few hours after ripening. This makes

by themselves so that they can be examined frequently without disturbing those not quite so far advanced. This we were not prepared to do.
it necessary that all fish nearly ripe be placed in a car

6. None of the hard or green fish, that had hard firm abdomens when caught, ripened or showed any signs of ripening in confinement.

CONCLUSIONS.

1. Striped bass nearly ripe will ripen in confinement.

2. The eggs from some of those that ripen in confinement will produce good results.

3. Striped bass that ripen in pens cast their eggs within a few hours after ripening.

4. All or nearly all the eggs ripen at about the same time.

5. Milt from male striped bass held in confinement seems as potential as that from fish not confined.

THE FISH FARMER IN ACTION

Snap-Shots by Bux.

One who lived in a great city and had waxed fat, not by iniquitous appropriation of the unearned increment of which he found himself unable to deprive his landlord, but solely by means of the legitimate 25%, which he lawfully collected from his service to his fellow men in buying and selling the necessaries of life, read a scrap of paper during one of those moments of seclusion from the world, which offer all from kaiser to peasant an opportunity to improve their minds, and what he found recorded seemed good to him. That he should thus have read when another might have simply done the other thing shows him a man who knew an opportunity when he saw it. So when he read that a fish might yield 9,000,000 of eggs at one delivery he said, "Why bother with a paltry 25%? Back to the land for me and put it under water as soon as I get there."

So he bought him a farm and dug him a pond and when the rain had filled it he dumped in all the fish, his congressman friend could get a paternal government to provide. Then with a stub of pencil and the back of an envelope he sat down to figure and to wait. He is still waiting, and the envelope is fuller of figures than the pond is of fish.

STOCK FARMING.

But enthusiasm is contagious and his farmer neighbor beholding said, "I will go and do likewise," as it is the way of farmer neighbors to say and to do. "But why bother to build a fish pond? I have a wood-lot where no grass is and there is no underbrush nor low limbs but much shade, and fresh air abundantly. I will fence it tight and into it turn my breeding stock of cattle and they will be no more care to me than my neighbor's fish are to him. I may not get 9,000,000% but 100 or even 50 are as much as a conscientious farmer ought to desire when he has only to wait instead of working for it." Having to calculate the probable expense of re-shingling his hog-pen he did not waste envelopes and wear out his mind trying to figure up the result to be expected from the wood-lot experiment, but determined simply to wait. He too is waiting still, not having found out that the cattle are dead.

"SEE THE FARMER SOW HIS SEED."

Said another: "Two bushels of seed are enough for my field, but I have other things to do than to scatter it, and moreover the wind and the rain do that and every living thing from the chick just hatched to Old Scratch himself takes a dig at what I plant, so I will just empty the sack in the middle of the field and save myself much work."

But the harvest was slender, for lo! most of the field had no seed and where the seed was the plants crowded one another to death.

THE ROUNDUP.

The season being come a ranchman went forth with his helpers to drag home by the tail his cattle and calves. But many difficulties arose and progress was slow. So he said, "Nay let us rather build a corral at the spring and when the cattle come to drink we will shut them in." And they did so and gathered them all without tearing up the turf and without damage to any tails. And an honest fish farmer, seeing, said to himself, I will gather my stock where they wish to be and will no longer set myself in array against them. But because they did not go down to the spring to drink he must find other causes and times and places for their gathering, and when he had found them he shut them in. *Verbum sat sapienti.*

TRANSACTIONS

of the

American Fisheries Society

"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

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CONTENTS

AN ANGLING LIBRARY AND SOME OF ITS TREASURES

BY DANIEL B. FEARING, *Newport, R. I.*

This library of books on angling, fishing, fisheries, and fish culture, now numbering over twelve thousand volumes and pamphlets in twenty different languages,* had its genesis in the year 1890 in the form of a scrap-book on trout and trout fishing. From that scrap-book began the collection of books entirely on trout and trout fishing, then were added books with chapters on those subjects and so on until the entire four heads mentioned above were gradually drawn in and the library began to grow.

It is, of course, an easy matter to obtain the commoner run of books on angling, that is to say, the popular books of the day. Most of them, it would seem from careful collation, are stolen goods taken from other and earlier writers of "pot boilers" on the same subject.

As the date of publication goes further back, one would naturally suppose the value would correspondingly rise, but this is not so. There are many angling books with an imprint of before 1800, that are priced in English and Scotch second-hand bookseller's catalogs at less than one shilling and six pence or two shillings, and when sold at auction, are usually lumped in one lot of from half a dozen to a dozen and sold for perhaps half a crown the lot.

The foundation stone of an angling library is naturally the first five editions of Izaak Walton's, "The Compleat Angler," the editions that were printed before his death. Of these five, the first, printed in 1653, THE FIRST WALTON, stands at the head.

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*Chinese, Danish, Dutch, English, Finnish, Flemish, French, German, Greek, Hindostanee, Hungarian, Italian, Japanese, Latin, Norwegian, Persian, Portuguese, Russian, Spanish, Swedish.

It is the most charming pastoral in the English tongue, of which Richard Le Gallienne speaks so feelingly, "To keep this in his little library he had undergone willingly many privations, cheerfully faced hunger and cold rather than let it pass from his hand; * * * perhaps, after Robinson Crusoe, the most popular of the English Classics, * * * a pastoral, the freshness of which a hundred editions have left unexhausted, a book in which the grass is forever green and the shining brooks do indeed go on forever." Another lover of old Izaak has very cleverly adapted the remark of the celebrated Dr. Botteler of strawberry fame—"doubtless a better angling book there might have been, but such, doubtless there never has been yet."

It is doubtful if there is another book in English save "The Holy Bible" that has gone into so many editions. At this date, 1915, there are over one hundred and seventy different editions of "The Compleat Angler" (this collection boasts of over one hundred and sixty). Though the expression "Waltoniana" properly means anecdotes and stories by or concerning Walton, it has come by common usage to be understood as applying in any way to the art piscatorial and one finds it so used in the majority of the catalogs of booksellers dealing in old and second-hand books.

The story of the "First Walton" reads like a fairy tale. The first that is known of the "Compleat Angler" is a small advertisement in an old London newspaper, "The Perfect Diurnal * * * From Munday, May 9, to Munday 16, 1652," reading as follows:

" 'The Compleat Angler, or the Contemplative Man's Recreation,' being a Discourse of Fish and Fishing, not unworthy the perusal of most Anglers, of 18 pence price, written by Iz. Wa."

The author's name does not appear on the title page until the fifth edition published in 1676. The commendatory verses in the second edition, published in 1655, are, however, inscribed to "Mr. Izaak Walton."

Probably, no book published in the last three hundred years has so increased in value. Published originally at the price of eighteen pence, in Dr. Bethune's time (1847) he values a perfect copy at twelve guineas. A copy in the original binding, but a little soiled, was offered to the owner of this library in London in 1889 for forty-five guineas. Unluckily for him he was not at that time interested in angling books. At the sale of the Von Antwerp Library in London in 1907 Quaritch paid £1,290 for a copy in the original binding and in perfect condition. This copy formerly belonged to Locker Lampson and has a poem written in pencil by him on one of the alba. That copy is now in the library of J. P. Morgan. So high a price may never be reached again, but since that date several copies have sold for over a thousand pounds each.

A small book, some 5¾ by 3¾ inches in pristine binding, no one knows how many of this edition of 1653 were issued. As a friend has pleasantly written concerning it: "Its descriptions of nature, its sage reflections on manners and customs and the everyday problems of life, and, beyond all else, the genial humanity which show through its every page won for it quick popularity. It was a book to pick up in a leisure half-hour and skim with the assurance of a quiet pleasure which few volumes of today can convey. So it happened that the 'Compleat Angler' met with a ready sale in its first edition.

"Perhaps it was because of the low price at which it was sold, that copies of this little book of 250 years ago have disappeared so amazingly. Some were left in stage coaches, derelicts whose mission was ended after they had beguiled the weary hours of a journey; some were lost in garrets and some burned in house fires; others doubtless ruined by immersion in the streams of which the author loved to write; until to-day nobody knows how many have outlived the passage of the years."

Acknowledged by all lovers of English literature today as one of the classics of the English language, its constantly increasing value is due more to the desire of collectors of "First Editions" of the English Classics to possess a copy, than to the generally "poor but honest angler."

This library contains three copies of "The First Walton," two perfect and one imperfect. The first copies that left the press are distinguishable by several misprints which do not exist in later impressions. One of the most sought for of these misprints is that using "contention" instead of "contentment" in the last two lines of the verses by Sir Harry Wotton: "And, if Contentment be a stranger then I'll ne'er look for it, but in Heaven again."

The second of the copies of the "First Walton" in the library is a "contention" copy and has on its title pages the autograph of "J. Venables" in a contemporary hand. This is supposed to be the autograph of some member of the family of Col. Robert Venables, who wrote the third part of the fifth edition of "The Compleat Angler," of whom more anon.

This first edition was embellished by six very pretty engravings of the trout, pike, carp, tench, perch and barbel which were inserted in the text. The engraver to this day is unknown. They have been attributed to Pierre Lombart, a Frenchman and a noted engraver resident in England at that time and engaged in illustrating books. Faithorne and Vaughn have also been mentioned as possible candidates for the honor. The latter is known to have been employed by Marriot on other work.

It has always been the belief of collectors that these plates were engraved on silver, but that fact has never been proved and still remains a disputed fact in regard to this wonderful little book. The same plates were used for the first four editions and were re-engraved in reverse, by a less artistic hand, for the fifth edition. This fact has not been generally noted by bibliographers up to 1883, when it is mentioned by Thos. Westwood. Volumes could, indeed, have been written regarding this best loved of all angling books. Famous writers by the score have tried to bring new facts in regard to it before the eyes of a constantly increasing public.

The charm of Walton's honest writing never grows stale, one takes him up with as much pleasure in this twentieth century as in the days of his first appearance. As has been charmingly said of him, "The Companion of our boyhood, the delight of our mature years, when shall we look upon his like again? Fishers have increased and fishing books have multiplied, but where is the fisher blest with such a 'Heavenly memory' as our Izaak, and where is the fishing book so rich in honor and renown as his?"

The second edition, which appeared in 1655, was much enlarged, having been almost rewritten, and contained some one hundred and seventeen pages more, and four more plates, the bream, eel, loach and bull-head having been added. Commendatory verses by seven appreciative writers are given for the first time in this edition. Copies of this second edition, though not bringing as high a price as the first, are much more rarely met with. A little more than a hundred years after its appearance John Hawkins (afterwards Sir John) states in his "Life of Walton" in his edition of "The Compleat Angler," first issued in 1760, "The second I have never been able to see." This scarcity has continued to the present day and, while it is always possible for anyone to find a "First Walton" who is willing to pay the price for it, he would have to search for a considerable time to find a good copy of the second edition.

The third edition first appeared in 1661. This contained but few and unimportant changes. This edition again appeared in 1664 with a new title-page, and dated 1664. The latter date is much scarcer than that of 1661. The fourth edition appeared in 1668. "It is a mere paginary reprint of the third, with the exception of the 'errata' which are here corrected in the work."

The fifth edition was issued in 1676 and was called "The Universal Angler, made so, by Three Books of Fishing. The first written by Mr. Izaak Walton; the second by Charles Cotton, Esq.; the third by Col. Robert Venables." This is the fifth edition of Walton, the first of Cotton, and the fourth of Venables. Twenty pages were added to this edition and further improvements were introduced. This was the last edition published in the author's lifetime. "The union of Walton and Cotton has been perpetuated in all subsequent reprints, but Venable's treatise, which, though meritorious, belongs to another order of composition, has been excluded." Such is the History of "The First Five." The Angler's library that is built with these for a corner stone, is certainly founded upon one of the firmest rocks of English literature. Good copies of all five are in the library.

As previously stated the reprints of this famous book have been many, from absolutely facsimile copies of the "First Walton," of which there are several, two of them magnificent volumes in folio embellished with pictures by the greatest artists.

It would seem impossible for any thing new in regard to such a well-known book to be discovered, yet it was the great good fortune of the owner of this library to find in 1910 in the catalog of a well-known book auctioneer in Boston, a small Walton and Cotton published by Septimus Prowett in London, in 1826. It is a small 32mo. in its original violet unlettered cloth binding. Printed on thin paper, this copy seems to be unique. Diligent inquiry both in this country and abroad has failed to find another copy or even the knowledge of its existence. It is not known or mentioned by any of the bibliographers of Walton, or to any of the collectors of Walton that the owner has been able to find. Bought at auction in Boston, it came in a collection of trashy novels and other books of no value in a consignment from Maine and if it had not attracted the cataloger's eye by its size and the fact that it was printed on thin paper, it would have been put into a lot of "and ten others" and probably lost to sight forever. R. B. Marston, the editor of "The Fishing Gazette" of London, and undoubtedly the greatest living authority on Walton, has been most interested in this previously unknown edition, and in "The Fishing Gazette" of Dec. 30, 1911, he jokingly refers to it as follows: "So angling collectors, since you now know it, don't part with your copy of Walton by Prowett. Oh, Prowett! if you were now within hearing, you'd tell us, no doubt, you just made one for Fearing." This little volume, of course, after the "First Five" is one of the chief treasures of the library.

Scarce and interesting copies of Walton, some of which are indeed unique, are also to be found in the collection, a few of which have been mentioned on account of their rarity or interest as being unique copies. The copy of the first John Hawkins edition of 1760 is absolutely uncut and is in original or contemporary binding. It is the only copy in this condition of which the owner has seen or heard.

The first Major edition, London, 1823, is a large paper copy with the prints on India paper. This copy belonged to Bedford, the celebrated binder, was bound by him, and contains an autograph letter presenting it to him from John Major, the publisher.

Thomas Westwood in "Bibliotheca Piscatoria" speaking of this edition says: "The editor was Mr. A. Thomson, author of the 'Chronicles of London Bridge,' 1827, but the 'Introductory Essay,' a farrago of twaddle, was written by Major himself."

In 1833 was published "The First Rennie Edition," edited by James Rennie, A. M. This edition was reprinted without change by some twenty-five different publishers at various dates from 1834 to 1857. All but eight of these reprints are in the collection.

The year 1836 brought out the celebrated, so-called "Pickering Edition," two large 8vo, volumes printed by William Pickering, and edited by Sir Harry Nicholas. This was issued in two editions, one with plain plates, and one on large paper with the plates on India paper. The latter is the edition usually chosen by extra-illustrators for their labors. The library contains copies of both, also a copy extended to four volumes. The library is also the possessor of the full set of the actual drawings by Thomas Stothard, R. A., for this edition, done in color (with the exception of the "Front View" of the fishing house; in its place there is an unpublished drawing), and for which he made a special expedition to Dovedale.

One of the scarcest and most difficult Walton's to obtain is the German translation of "Ephemera's" Edition (Edward Fitz Gibbon), by I. F. Schumacher, published by P. Salomon & Co., Hamburg, 1859, the only translation of the "Compleat Angler" into a foreign language. Most of the copies of this German edition were destroyed by fire, and the book was never reprinted. The owner was over fifteen years in obtaining a copy, and in twenty-five years has seen but five copies offered at auction, and of these five one was the same copy appearing twice.

The one hundreth edition of the "Compleat Angler" is the Lea and Dove edition published in London in 1888. It is in two large volumes, folio, and is the largest Walton issued up to the present time. The editor is R. B. Marston, the proprietor and editor of the "Fishing Gazette of London." He has given us the most carefully edited and scholarly edition of Walton thus far published, and the reader will find in his notes all of interest that has been discovered concerning Walton up to the date of publication. Alongside of this, you will find for the sake of comparison, "The Compleat Angler," published by Henry Frowde in London (1900). It is known as the "thumb edition," being 2 x 1¾ inches in size. It is the smallest Walton known and also the smallest book in the collection.

In special or unique copies of Walton, the library has several worthy of note, one, a copy of the large paper second Bagster edition, 1815, extended or two volumes by the insertion of over one hundred and seventy old engravings, old portraits, colored views, sepia drawings, and colored drawings. The original drawings in sepia are of portraits unattainable otherwise and are all from authentic sources. They were done especially for this copy by Mr. J. E. Wheeler, a celebrated "Punch" artist. The whole is a record of Izaak Walton, his haunts and friends. All his favorite authors are illustrated by contemporary and rare portraits. Most interesting is a copy of Elliot Stock's facsimile reprint of the first edition, London, 1896, with a preface by Richard Le Gallienne. This edition strangely enough is not mentioned in Wood's "Bibliography." The copy is unique, Le Gallienne's manuscript preface, with corrected proofs by Le Gallienne of the same, consisting of ten pages, being inserted and signed at the end; together with Le Gallienne's correspondence with Elliot Stock concerning this preface, eight highly interesting autograph letters, making arrangements, stipulating as to his fee, etc.

One of the handsomest editions of Walton is the "Winchester" edition, published in London in 1902, in two quarto volumes. It is edited by George A. B. Dewar, and has an essay by Sir Edward Grey, with etchings by William Strang and D. Y. Cameron. This copy has been extended to four volumes with specially printed title-pages and illustrated by the addition of one hundred and fourteen extra illustrations. The illustrations consist of the complete series of thirty-one original pen-and-ink drawings by Strang and Cameron which are reproduced in the book as head and tail pieces. (Drawings by these two artists are exceedingly rare, both being excellent etchers. Almost all their work has been done direct on the copper, without preliminary drawings.) Also an extra set of the thirty full-page etchings, proofs signed by the artist (unpublished thus), and complete set in proof state on India paper of the beautiful plates and vignettes to Pickering's 1836 edition of the "Angler" mentioned above. It is most sumptuously bound in dark green levant morocco, very richly tooled after an original design, and inlaid on the sides with various colored morocco representing conventional river flowers, bulrushes, water lilies floating on the water, birds in the sky, etc., rich pictoral doubles inlaid in biscuit and other colored morocco showing scenes connected with Walton's life and "The Angler." Photographs of these doubles are inserted in each volume.

After the various editions of "The Angler" naturally come other books by Walton, or books concerning him and his works. A little 12mo. volume in original old brown calf, uncut, has on its title-page, the initials "I. W." and throughout the book are fifteen manuscript corrections and additions in the same precious autograph. It is a first edition of "The Life of Dr. Sanderson, by Izaak Walton, London, 1678," and was a presentation copy from him to "Jn. Merewether," whose autograph appears on the bottom margin of the title-page.

Walton wrote the preface to "Thelma and Clearchus," a pastoral romance by John Chalkhill, London, 1683. A new edition was published in 1820 by C. Whittingham. Following the preface are the verses of Tho. Flatman "To my worthy friend Mr. Izaak Walton on the publication of this poem." At end, in place of "finis" is a delightful touch: "And here the author died and I hope the reader will be sorry."

The first bibliography of "The Angler" was "The Chronicle of The Compleat Angler" by Thomas Westwood, London, 1864. The library owns two copies of this, one, the ordinary edition, the other, one of twenty-five copies printed on large paper. This was a presentation copy to Rev. H. N. Ellacombe, the author of "Shakespeare as an Angler," and has inserted two signed autograph letters to him from Westwood, a list of the various editions of Walton's "Lives," in his autograph, and a slip of "Errata."

A second edition of this was issued in 1883. Only two hundred copies were printed. It contained notes and additions by Thos. Satchell. This edition is very scarce though not generally known to be so. In a copy of "Twelve Sonnets and an Epilogue in memoriam, Izaak Walton, Obiit 15th, December, 1683," by T. Westwood (only twenty copies printed), presented to Elliot Stock, the publisher, is inserted an autograph letter from Westwood to Stock, saying: "I send you the Chronicle. It is a finished book in two senses, for a fire at the printer's has destroyed almost the whole stock."

Another scarce item is "The Tercentenary of Izaak Walton, by Andrew Lang, Printed for Private Circulation only, London, 1893." "A delightfully written appreciation of 'The Father of Angling' written by a master's hand." Only thirty copies were printed. "The Bibliography of Izaak Walton's 'Compleat Angler,' by Thomas Satchell (printed for presentation only), London, 1882." A limited number were printed with special title-pages. The library possesses No. 3, a presentation copy to H. W. Bentley, and Thos. Satchell's own copy with his book plate. In 1900 Arnold Wood published a "Bibliography of 'The Compleat Angler' from the first edition in 1653 until the year 1900," beautifully gotten up, with eighty-six photoengraved reproductions of title-pages. Eighteen copies were issued on Imperial Japanese paper and one hundred and two on Van Gelder paper. Copies of each are in the collection.

Two very scarce pamphlets in the library are copies of the Catalog of Editions of "The Compleat Angler" exhibition at the Grolier Club in New York on the three hundredth anniversary of Walton's birth in 1893; and a "Finding list of an Exhibition of Waltoniana," at the Rowfant Club in Cleveland, in 1896.

Of equal scarcity is "A catalogue of an Exhibition of Waltoniana," given at the Club of Odd Volumes in Boston in 1912. Of this, only one hundred and thirty copies were printed from type at the Merrymount Press, Boston. This is entirely an exhibit of the treasures of this library.

Amongst the autographs in the collection the first place is easily held by a holograph document of Izaak Walton, eleven lines signed with his full signature, and dated, "Octo'r 23, 1676"; a beautiful example of Izaak Walton's handwriting and a very rare autograph, as he rarely signed his name in full. Another beautiful specimen is twenty-five lines in Walton's autograph signed "Iz. W.," being Sir Henry Wotton's ode to spring quoted in the "Compleat Angler." Charles Cotton is represented by three lines signed "C-C-Ton," a curious form of Cotton's signature.

Of much greater rarity than the above are seventeen lines signed "Robert Venables." The owner knows of no other example in a Waltonian Collection. Venables was the author of Part III of the fifth edition of "The Compleat Angler." Of great interest also in the original probate copy of Izaak Walton's will, dated August 9, 1683, beautifully written on a sheet of vellum, nearly three feet square and with the greater portion of the old seal still attached to it. This treasure mounted in a silver frame with glass front and back occupies a prominent place in the library. The owner had twenty-five facsimile copies made for distribution amongst friends; also twenty-five transcripts of the same in clear English print.

Many more examples of Waltoniana could be mentioned were there time and space to describe them.

The manuscript was the first portable form of transmission of men's thoughts, and in the library are manuscripts on pages of vellum containing perhaps the earliest mention of fish-ponds and the culture or raising of fish for food. The old monks who were often, if not the authors, most certainly the scribes of the manuscripts, had the liveliest kind of interest in fish and its culture, since on their many fast days, the church allowed them fish food.

The earliest manuscript in the collection is undoubtedly a copy of the work of Bartholomaeus Glanville, "De proprietatibus rerum"—concerning the nature of things. It was written in 1300. This portly volume was formerly owned by the University of the Sorbonne in Paris, and was loaned to the students and scholars of Paris for a stipulated sum of money per day. This was quite on the principal of the modern circulating library. The work is in Latin and was the encyclopaedia of the middle ages. It contains one chapter on fish and fish-ponds. This is the earliest material on the subject in the library.

Of almost equal date is the manuscript of Pietro de Crescenze, "Ruralium commodorum," "of rural affairs." This work was produced repeatedly by all the early printers, and indeed, the earliest printed book in the collection, is the First Edition of Crescentius, printed by Johan Schuszler in 1471. Another early edition of the same work in the library is one printed in 1474 by the celebrated John of Westphalia, at Louvain, the beautiful old seat of learning in Belgium, only recently destroyed. This work was very popular in the Middle Ages and was translated into Italian, French and German, and a copy of each is in the collection. Crescenze wrote on fish-ponds and on how to make small ponds and inland lakes profitable. Books published before 1500 are known as "Incunabula," or "Books in their cradle." The library owns no less than fifteen of these specimens of the early bookmaker's art. First in value, naturally, comes the "Treatyse on the Art of Fysshing with an angle," from the "Book of St. Albans," by the legendary Dame Juliana Berners, and printed by the celebrated Wynkyn de Worde at Westminster, in 1496. This is the first book that treats of angling in the English language. The first printed book to contain an illustration of an angler using a float, was the "Dyalogus Creaturarum Moralizatus," printed at Gouda in 1480. The library contains copies of the 1482 and 1484 editions.

The earliest known treatise on fishing is a work in Flemish printed at Antwerp in 1492. A single copy only of this work is known to exist. It is in the library of Alfred Denison, who had a literal translation made of it and twenty-five copies printed for private distribution in 1872. The library possesses one of the twenty-five copies, also the original manuscript of the translation, together with the corrected proof sheets and revised proofs.

As regards fishing, probably the earliest mention of the subject in England occurs in "Magna Charta." The library owns a copy of this, published in 1556, which formerly belonged to Mary, Queen of Scots. It is in the original binding, showing the Tudor rose and crown. Books from Queen Mary's library are excessively rare, the late Queen Victoria even, never having been able to obtain one.

In 1651 was published a small volume called "The Art of Angling" by Thomas Barker. It is so scarce that this library does not own a copy. A reprint of it was published in 1820. Of this reprint 100 copies were issued, also four copies on straw colored paper and one on vellum. The library has one of the ordinary edition, two of the straw colored copies, and the vellum one. Anent this book and these copies, an interesting story, illustrating the smallness of the world, may be told. In one of the straw colored copies, which belonged to Thomas Gosden, the celebrated English XIX Century sportsman, bibliophile and binder of angling books, and was bound by him, is a note in his autograph: "There is also one reprint on vellum, which I have. T. Gosden." Is it not strange that after one hundred years these two little volumes should come together on one shelf, never again to be separated? This Barker was a cook, who, devoted to fishing, wrote his experiences. In his second edition, published in 1653, in the epistle dedicatory, he boasts of his skill and declares he takes as much pleasure in the dressing of fish as in the taking of them, "and to show how I can perform it, to furnish any Lord's table, onely with trouts, as it is furnished with flesh, for 16 to 20 dishes. And I have a desire to preserve their health (with help of God) to go dry in their boots and shoes in angling, for age taketh the pleasure from me."

The subject of fish cookery was one that occupied a good deal of attention in the old days when the church ruled the state and the eating of fish was compulsory upon rich and poor alike. Books of many pages have been written on the various methods of cooking one fish, not to mention all fish and shell fish. One author, a Frenchman, describes 150 different methods of serving the sardine. Another, an American lady, has written five hundred pages on "how to cook fish," in which she gives "ninety-five ways to cook shad" alone. Two separate American authors or compilers have given us, "One hundred ways to prepare oysters." The lady mentioned above also wrote a book entitled, "How to cook shell fish," in which she gives "215 ways to cook oysters," "130 ways to cook clams," "175 ways to cook lobsters," "85 ways to cook crabs," 40 ways to cook shrimps," besides numerous other shell fish. This author at the end of 303 pages of recipes for cooking shell fish, says in a note: "P. S. This is all we know about shell fish. If we should ever learn any more, it will appear in another book." There are over 100 books in the library on fish cookery, the oldest being a very scarce edition of "De Honesta Voluptate" published in Bologna in 1499 which contains 13 pages on the "Cookery of Fish." The owner has made a collection of scrap books, now numbering over fifty, a single volume containing recipes for cooking one kind of fish. The volume on trout has been extended to two and contains over 300 different ways of serving trout, and is by no means finished yet!

Among these books on fish cookery in English, French, German and Italian, is one small curious volume entitled, "Fish for Cats, by Dog," It was published without place or date and is a collection of recipes from old cook books. The author, under the pseudonym of "Dog," says that he wishes to "alleviate, in the smallest measures, the agonies of Lent in 1868."

Perhaps a quotation from the introduction to "A Handbook of Fish Cookery," by Lucy H. Yates, London, 1897, may fitly end these remarks on fish cook books. "Ignorance * * * will generally be found to be the cause of the aversion which many housewives have to the cooking of fish * * * the poorer classes still regard fish as 'nothing to make a meal of' * * * and many people who would really enjoy eating it are debarred from doing so by its being invariably badly cooked, or presented always in the same monotonous dress." The everlasting boil, broil, fry or bake, of the English and American cook, certainly makes one long for the delicate and tasty sauces and methods of preparing fish of our French and Italian cousins.

In 1758 there was published a book called "The Anglers." It was published anonymously, and consisted of eight dialogues in verse. This first edition is very scarce and even as far back as 1820 was so little known that the whole eight cantos were deliberately reprinted by Thos. O. Lathy without any acknowledgment whatever and called "The Angler." "This book is one of the worst cases of literary plagiarism known. It was palmed off on Gosden, the sporting bookseller, whose portrait by A. Cooper, R. A., is prefixed. He paid £30 for the copyright and also printed a single copy on vellum, at an expense of £10 for the vellum alone, as he himself states in a manuscript note to a sales catalog." Besides this copy on vellum, twenty copies were printed in quarto, in addition to the ordinary edition. The library owns the single copy on vellum, most expensively bound by Gosden himself and with his book plate and manuscript notes; also a copy of the quarto edition and of the ordinary one; also a copy of the original work of 1758. The original edition of 1758 has by now been exclusively attributed to Dr. Thomas Scott, a dissenting minister of Ipswich. The preface, entitled "The Bookseller to the Reader," contains a curious justification of angling, perhaps worth repeating: "To a man of any compass of thought and experience in the world it is well known that angling is not a mere recreation, but a business, a business which employeth most orders, professions and occupations among men. For instance, we booksellers angle for authors, and authors angle for a dinner or for fame. Again, doth not the lawyer angle for clients, the doctor for a fee, the divine for preferment, the statesman for secrets, the courtier for a pension, and the needy for a place? Further, what is he who offereth a bribe, but a fisher for another man's conscience? And what is he who taketh a bribe but the silly fish that is caught with the bait?"

In the 17th Century in England, men's minds were much more turned to religion than in the present, and many books were written on common every-day subjects that were really religious works. Of this class of book, the scarcest is "A Booke of Angling or Fishing," by Dr. Samuel Gardiner, published in London, in 1606. Of this book, only three copies are known to exist, one in the Bodleian Library, one formerly in the Huth collection, recently dispersed at auction, and its final purchaser not known, and the third is in this library. The history of this copy has been impossible to trace. It was discovered by the buyer for a London bookseller in the west of England. With others of its kind, the majority of which are very scarce, it may be called "Fishing Spiritualized."

The English poets contain much of interest to the angler, as many have written in praise or description of the sport. Among the earliest is Michael Drayton, from whom indeed Walton may have obtained his idea of the colloquial form of the "Compleat Angler." In Drayton's 6th "Nymphal," the subject is a discussion between a woodman, a fisherman and a shepherd, each holding to the superior merits of his own vocation. Drayton's other poems contain many allusions to fish and fishing.

William Browne in his "Britannia's pastorals" writes so charmingly of the angler that one feels he must have loved the art himself.

Our friend, Charles Cotton, of sainted memory, wrote "Poems on several occasions" in 1689, which are filled with his favorite subject and friend, angling and Walton. John Gay in his "Rural Sports," 1713, comes well into our list. Thomas Heyrick is another who wrote frequently on the subject and in one of his poems, "A Pindaresque ode in praise of angling," he not only praises angling, but abuses in vehement fashion those who do not angle.

"Windsor Forest," a poem by Alexander Pope, first published in 1713, contains the well-known lines beginning "In genial spring * * *. The patient fisher takes his silent stand." James Thomson in his "The Seasons" has a passage of nearly fifty lines which shows the skill of the angler equally with that of the poet. Many were the lesser lights who burst forth into poetry in praise of angling, and there are also many Italian, a few French, a very few German, many Latin and a few Greek poems that bear directly on our subject.

The later and more modern classical authors have, many of them, been admirers of the art of angling and many also anglers themselves. The seventh part of Washington Irving's "Sketch Book" contains his delightful appreciation of the art, called "The Angler." The library possesses a copy of the first edition in the original seven parts with the original paper covers bound in and an autograph letter of Irving inserted.

Sir Walter Scott in 1821 wrote a preface and notes for a new edition of Richard Franck's "Northern Memoirs," which first appeared in 1694. In the library, by the side of this edition, rests Scott's original manuscript.

Another interesting manuscript, is one of thirty-nine pages, entitled "My First Trout," written by Charles Dudley Warner and dated May 6, 1897.

George Washington, himself, was a keen angler, and a little pamphlet by Dr. George H. Moore, entitled "Washington as an Angler," has been extra-illustrated for the library by the insertion of a manuscript inscription of presentation from the author, many portraits of Washington, and a fine autograph letter signed by George Washington. Our good President Grover Cleveland was a keen angler and fisherman. He wrote a very clever little brochure entitled, "A Defense of Fishermen." A very few copies of this were privately printed for distribution among the author's friends (not over twenty at most were issued). The library has a copy, presented by the author, with a charming autograph letter to the owner, and signed by him, inserted. Other statesmen who were fishermen and who wrote on the subject were John Quincy Adams, De Witt Clinton and Daniel Webster. The latter was a noted trout fisherman, but his writings on the subject are entirely in the form of letters to various friends. The library owns the trout rod with which he was accustomed to whip the streams of Cape Cod in the latter years of his life. Andrew Lang, Weir Mitchell, and Dr. Van Dyke all loved the art, and presentation copies of the books they wrote are among the library's treasures.

The library is particularly rich in illustrated books, from what are probably the earliest known pictures of fish in the "Dyalogus," in 1480, mentioned above (the library has framed a woodcut, contemporaneously colored from a religious history of the world published several years earlier and said to be the earliest printed picture of fishing), to the most modern work of the illustrator and engraver of the 20th century. Among so many it is possible to mention but one or two. First, of course, would naturally come the water colors of Stothard mentioned above. Then perhaps comes Eleazar Albin's own copy of his work on "Esculent Fish," originally published in 1794, with 18 plates colored by hand. This copy has sixty full-page water color drawings by Albin. It was his evident intention, from the accompanying notes, to issue another volume, which, however, was never published, and these were the drawings he made for that purpose.

Mrs. Bowdich's "Fresh-water Fishes of Great Britain," London, 1828, a very rare and valuable work of which only fifty copies were issued, contains forty-seven plates of fish, drawn from life and colored by hand.

A copy of Elliot Stock's facsimile reprint of "Dame Barnes' Treatyse of Fysshing with an angle" belonged to Richard Doyle, and he began to illustrate it in color, but left it unfinished. The first few leaves have ten original, humorous and exceedingly clever illustrations in color by Richard Doyle and many other illustrations sketched out in pencil. This interesting book was bought by Thomas Satchell in 1885 at an exhibition of illustrators work in Bond St., London, and contains his book plate, a receipt for 50 guineas which he paid for it and an insurance receipt for the same amount on the book while on exhibition.

"The Fly Fishers Guide," by Geo. C. Bainbridge, London, 1816, is the author's own copy and contains his book-plate. It is one of ten copies in quarto cloth which were issued for presents and colored with greater care.

Another work, of which the owner has never seen another copy, is "The Fishing Costume" of Hartlepool, London, 1819, a very scarce book with six most charmingly engraved and colored plates.

Speaking of "The Genteel Recreation or The Pleasure of Angling, a poem," by John Whitney, London, 1700, and reprinted in 1820, "Bibliotheca Piscatoria" says, "100 copies were reprinted, copies of it are rare. The original edition does not appear to have been published." The library owns a copy and there is another copy in the New York Public Library. The library owns a copy also of the 1820 reprint. At the sale of the Heckscher collection the only book that Bernard Quaritch, the famous bookseller of London, bid on, was: "Certaine experiments concerning fish and fruite: practiced by John Taverner, Gentleman," London, 1600. That copy is in the library and is the only one the owner knows of in this country.

Another volume that seems to have almost disappeared is the "Ichthyologia Ohiensis; or, natural history of the fishes inhabiting the River Ohio, " Lexington, Kentucky, 1820. Of this book only eight copies are known to survive, one of which is in the library.

It would be possible to go on indefinitely, picking out books here and there that are unique or scarce, for it has been the policy of the library, whenever possible, to obtain a presentation copy of each book. Where that has not been possible, there have been inserted, when they could be found, autograph letters by each author, together with any interesting newspaper clippings such as notices of the book, obituary notices of the author, etc.

As regards the books published during the last six or seven years, many of the authors have been kind enough, knowing the library by reputation, to send complimentary autographed copies to it. Only one author has refused to put his autograph in his own book when requested by the owner of the library. The majority have done more and have added some sentiment or complimentary remark regarding the library. The kindly gentleman who refused hated Americans and wrote the gentleman who sent him the book to be autographed for the owner, "that he considered it a * * * piece of American impudence to ask such a favor." He little appreciated that as many, if not more, copies of his book were being purchased by those * * * Americans, as by his own countrymen. In over twenty-five years of ardent collecting this is only the second case of churlish rudeness the owner has met with. The other, it is sad to state, was a fellow countryman from the middle West. Besides the books on the subjects of the library, there is a very large collection of books on whaling. In the early part of the nineteenth century New York lawyers argued long and earnestly on the subject, "Is the whale a fish?" Though we all know now that it is a mammal, the subject is so nearly allied, always being referred to as "The Whale Fishery," that a most interesting portion of the library is taken up with that subject. This comprises colored and plain prints, engravings and etchings, photographs and charts, besides several hundred volumes in different languages, together with a few manuscripts and many log books. Among the manuscripts may be mentioned the original of "The Journal of a Voyage to the Northern Whale-Fishery * * * made in 1822 in the Ship Baffin of Liverpool, by William Scoresby, Jr.," and an appendix, with interlineations and erasures, bound up with the title-page and text of the first edition, published in 1823. Inserted, also, is a clipping concerning the manuscript from a Boston paper, of contemporary date. The old log books are of particular interest. They were usually written by the captain of the whaler, who used a wooden rubber stamp depicting a whale, and if said whale was killed, the stamp appears lengthwise on the page and in a blank space on his side was written in the number of barrels of oil he tried out; but if he escaped, a stamp showing only his tail was used perpendicularly.

In conjunction with this whaling collection, there is a complete collection of all the lances, spades, bombs and guns used in the capture and chase of the whale; also a very fine collection of scrimshaw, as the etched and carved work done by the whalers on whale teeth, is called. Many teeth are beautifully engraved with whaling scenes, battle scenes of the war of 1812, portraits, etc. Three very valuable ones, charming in design and color, are the work of Edward G. Malbone, the celebrated miniature painter, done in his youth. They represent the heathen gods and goddesses. The remainder of the set the owner has never been able to trace. Included amongst this scrimshaw is a fine collection of buskbones as worn by our ancestresses, made from whale bone and ivory and beautifully engraved; also a large collection of jiggers or pie crust cutters, also made from whale ivory by the whalers.

Another very interesting part of the collection consists of the prints, which number several thousand, all on the subject of angling or fishing, or containing persons angling or fishing. They date back from the earliest woodcuts to the latest work of the modern illustrator and engraver. There are many volumes of colored illustrations of fish alone, done by various artists in various lands, notably 246 examples done by a Chinese artist on rice paper and most artistically drawn and colored. The late Professor Agassiz told the owner he considered them the most beautiful examples of fish portraiture he had ever seen. As a companion to this is a book of Indian fishes drawn and colored by a native East Indian, but in no way so fine and noticeable.

The library contains probably a greater number of English "Acts" and French "Arrets" on the subject of "fisheries," together with Danish, Dutch, German, Italian, Norwegian and Swedish government acts and laws, with a few Russian, than any other single library. The library contains one superb example of the Finnish laws, in folio, each page engraved, print and borders of fish and game, made in 1709, with an English translation in manuscript on each opposite page done in 1720.

It contains a virtually complete set of the publications of the U. S. Bureau of Fisheries up to 1912, and almost complete sets of all the various state publications on the subject up to the same date. One interesting part of the library is the collection of illustrated post cards on angling, fishing, fisheries and fish, with many comic ones, amounting in all to nearly 5,000 examples, including a small volume of French ones, which play on the word "peche" and the verb "pecher," but which are not kept for general sight. Enough has been said, however, to bear out the motto painted over the fireplace in the library:

"Whatever the wind, whatever the tide,
Here is good fishing by this fire-side."

This motto was suggested to the owner after reading Eugene Field's delightful little essay on "Fender Fishing," in the "Love Affairs of a Bibliomaniac," and so, "To those who love quiet, virtue and angling—this for Farewell."

PROCEEDINGS OF THE FORTY-FIFTH ANNUAL MEETING

The Forty-fifth Annual Meeting of the Society was held at San Francisco, California, on September 1 to 4, 1915, in the Auditorium of the Young Women's Christian Association Building on the grounds of the Panama-Pacific International Exposition.

President Daniel B. Fearing called the meeting to order and introduced Hon. A. L. Cowell, and later Dr. B. W. Evermann and Mr. Ernest Schaeffle, all of whom made brief addresses of welcome.

ADDRESSES OF WELCOME.

BY A. L. COWELL,

Assistant Director of Congresses, Panama-Pacific International Exposition.

Mr. Chairman and Gentlemen: I feel highly honored at being permitted to express, in behalf of the President and Board of Directors of the Exposition and particularly the Department of Congresses with which I am directly connected, our extreme gratification at being able to welcome you within the grounds of the Exposition to this, your Forty-fifth Annual Session. I feel especially glad because of the fact that you represent so old an organization and so important a subject. There are comparatively few of the conventions and congresses that are meeting in San Francisco and vicinity this year which have maintained an existence of forty-five consecutive years. Therefore, we feel that you bring to us a certain amount of dignity and stability, which we greatly appreciate. Of course, the subject in which you are interested is one of extreme importance to all the members of the human race.

At the opening of the Exposition, there were two important facts set forth. One was that, as the Exposition is celebrating a great achievement of American genius in our own time, the completion of the Panama Canal which is a work of the present, rather than the anniversary of some event which happened hundreds of years ago, the Exposition should be a contemporaneous one. None of the exhibits in these palaces are entitled to be the subjects of award by the Jury of Awards unless they have been made since the St. Louis Exposition of 1904. Therefore, the viewpoint of the Exposition is essentially of the present.

We have sought to gather in these exhibit palaces the material evidences of the progress of mankind within the last decade. But we thought, also, that the Exposition should bring together not only the actual material proofs of the progress of mankind, but that it should present to the world the methods by which that progress has been made possible. In order to emphasize those methods and particularly to emphasize the work of the organized movements that are so characteristic of modern development, we tried to bring together as large a representation from the different organized bodies of men and women as possible. The result is that more than nine hundred congresses, conferences and conventions are meeting in San Francisco and vicinity during the Exposition period and we are glad to claim those conventions as a part of the Exposition itself, setting forth to the world the methods and the spirit of the organizations which have made possible the progress shown in our exhibit palaces.

There is one other distinctive feature of our Exposition which we like to emphasize and that is, that we have made the central purpose of it the idea of human service. We have tried, in gathering these conventions, to emphasize those ideas which make for the betterment and improvement of the human race, and which contribute to the sum total of human happiness, and we believe that your work contributes materially to this important end. We are therefore also glad to welcome you as an important factor in developing a great industry and a great branch of scientific knowledge, which is of the utmost importance to the human race.

Because of the importance of the industry which you represent, because of your long experience, and because of the fact that you bring to us a rich discussion of matters of vital importance to the human race and to the progress of mankind, we are especially glad to welcome you to this Exposition.

By Dr. Barton W. Evermann,

Curator of the California Academy of Sciences, San Francisco, California.

Mr. President and Members of the Association: I do not know just what I should say on this occasion more than that those of us who live in San Francisco and California and on the western coast are very glad that the Society is meeting in San Francisco this year. I believe this is the first meeting that the Society ever has held west of Denver, and it is particularly appropriate and gratifying that the meeting this year should be held in San Francisco at the time of this wonderful Exposition. I wish it were possible for all the eastern members to have come to this meeting, not only because of the interest which the meeting would have for them, but for the opportunity of seeing California, the western coast, and this marvellously beautiful Exposition.

Those on this coast who are particularly interested in matters of this kind are, of course, primarily the State Fish and Game Commission and the various commercial interests of the State, and doubtless they extend to you a very hearty welcome.

The California Academy of Science has in its organization a few members who are interested in such matters also, and, of course, they are deeply glad that you are here this year.

I am sure that the meeting will prove valuable and will grow in interest as the days go on.

By Mr. Ernest Schaeffle,

Executive Officer of the California Fish and Game Commission, San Francisco, California.

Mr. Chairman and Gentlemen of the American Fisheries Society: The Fish and Game Commission of this State is very glad indeed that the Society has seen fit to meet in California this year. We have sometimes deplored the fact that meetings of an organization so important as this could not have been held oftener west of the Rockies. Like a great many other organizations and people out here in the West, we feel that we are a long way from "home," a long way from the seat of certain forms of activity. For that reason we have been glad to get the society here this year. We know that you will profit by your visit with us. We feel particularly certain that the results of our discussions here will be of benefit to the California Commission and to the fishing interests of the West. And, like the other good people who come out here to visit us, we feel sure now that we will not have to wait so long to see the members of the Society here again individually and collectively. We feel that you will want to have another convention farther west than the Rockies, probably here in San Francisco, or in California, within the next five or ten years.

So I would say to you that the Fish and Game Commission, which I have the honor to represent, is very glad to welcome you here, and we hope that you will have a good time while with us. If there is anything that the Commission and its representatives can do, while you are here, or after you return to your homes, to aid the Society or the members individually in any way, we shall be very glad to have you call upon us at any time.

President Fearing called for the election of new members as the first business of the meeting.

The names and addresses of the Patrons, Life and Active Members elected, have already been published in the December, 1915, number of the Transactions.

REPORT OF THE RECORDING SECRETARY.*

To the Officers and Members of the American Fisheries Society:

Aside from the usual amount of correspondence, the chief duties of the Recording Secretary have been in connection with the publication of the Transactions. The change from an annual issue of one volume to the quarterly form, which all have noted, was authorized unanimously by the Council of the Society in November, 1914, and No. 1 of Volume 44 was issued in December.

The chief arguments in favor of the more frequent publication were, first, that the TRANSACTIONS would reach the members more frequently and thus have a greater influence in keeping awake their interest in the work of the Society, and second, that scientific papers could be issued without waiting for other matters, while the Proceedings of the Annual Meeting, the list of members, etc., would still appear about as early as formerly. In arranging material for publication, preference was given, as far as possible, to those papers read and discussed at the annual meeting.

The Secretary believes that the change is fully justified, as he has received many letters and other expressions of approval from the members and has yet to hear of a single objection.

Incidentally, the change to the quarterly form has made it possible to enter the TRANSACTIONS as *second-class mail matter,* thereby saving a considerable amount in postage. However, the extra cost of additional cover pages and envelopes and the work of addressing four sets of envelopes instead of one will consume a considerable part of what is saved in postage. It appears, then, that we have a quarterly journal at about the cost of our former annual volume.

In order that the TRANSACTIONS and other mail may reach the members promptly, the Secretary insists most emphatically that he should be informed at once of every

*In the absence of Dr. Osburn, this was read by President Fearing.

permanent change of address, a matter that is too often neglected.

The Index to the first forty volumes of the TRANSACTIONS, prepared by our President, has not yet been issued, as the finances of the Society have not warranted the expense. Moreover, certain additions to the text, suggested at the past meeting by Dr. T. S. Palmer, have not been completed, though they are under way. A plan is now under consideration to float the publication by subscription and it is believed that by this method the Index can be brought out the coming year without drawing on the funds of the Society.

There are now in the hands of the Recording Secretary numerous back numbers of the TRANSACTIONS of the Society for sale. From a former Corresponding Secretary of the Society there have been added to what was already in my hands, many volumes dating back from ten to twenty years ago. There is not a single copy of the 1903 volume in the hands of the Secretary, even for the Society's file, but, aside from this one year, full series as well as odd volumes can be supplied as far back as 1895.

The work of the Secretary has been carried on at a minimum of expense, the total amount being only $21.62, included in the following items:

Postage	$11.75
Expressage	6.77
Notary's fees	.75
Certified copies of the Articles of Incorporation	2.35
Total	$21.62

Since the last meeting twenty-four applications for active membership in the Society have been received and one active member, Mr. Geo. P. Slade, of New York City, has applied for life membership.

The Secretary would strongly recommend that an active campaign be undertaken at once to increase the membership of the Society. Many of the States, especially in the South, have only one or two members, and in a few cases none at all. Of the twenty-two applications received during the year only two have been from southern states. This is quite disproportionate and something should be done to increase the membership, especially in that section. On going over the applications for the past several years the Secretary has been impressed by the fact that a large percentage of the applications has resulted from the activity of a few members. This is a fine showing for those so engaged and should be encouraged, but the sporadic activity of a few members can not be relied upon and is by no means sufficient for the growth of the Society.

Respectfully submitted,

RAYMOND C. OSBURN,
Recording Secretary.

New York, N. Y., August 21, 1915.

Moved and carried that the report be accepted and printed.

REPORT OF THE TREASURER.

The report of the Treasurer was called for and presented by Mr. C. W. Willard, the Treasurer of the Society.*

DR. B. W. EVERMANN: Mr. President, I have received word that Professor Chas. F. Holder of Pasadena, Calif., is ill and unable to be with us.

On motion by Professor Ward, the following telegram was sent to Professor Holder:

DR. CHARLES F. HOLDER,
475 Bellefontaine Street,
Pasadena, California.

The American Fisheries Society, assembled at San Francisco, for its forty-fifth annual convention, learns with deep regret of your indisposition. Your presence and counsel had been looked forward to with pleasurable anticipation. Your absence will be deeply felt. The Society extends its sincere wishes for your speedy and complete recovery.

AMERICAN FISHERIES SOCIETY.

*According to the minutes, the Report of the Treasurer was accepted and referred to the Auditing Committee, who found it correct. However, the report is missing and therefore cannot be printed.—*Ed.*

President Fearing: If you will permit me, I would like to say a very few words in regard to the attempt to increase the interest and the usefulness of this Society. Now, it seems to me a very useless thing that there should be so many societies with virtually the same interests, and I would like, before this meeting is over, to see the Pacific Fisheries Society and the American Fisheries Society become one. It has been tentatively suggested, that they should become a Pacific branch of this Society. I see no reason why the same interest should not be taken when we meet as we expect to, in the Southland, at our next meeting, and a southern division be created, and in course of time a middle-west division. That would cover the whole country; and instead of having organizations that are antagonistic to each other, they ought to work together instead of apart. I merely suggest this for you to think about, and perhaps talk about at some later time.

Treasurer Willard: Mr. President, I wish to suggest an amendment to our by-laws so that there may be a Membership Committee, consisting perhaps of the Secretary and Treasurer and one other of the Society, possibly the President, who shall have the power to elect members upon application. As it is now, if we receive an application in October, soon after this meeting is over, that person does not become a member until the following fall.

Mr. Woods: Mr. Chairman, I would like to be heard on the subject of increasing our membership. I would not allow any city to have a meeting of the American Fisheries Society unless they would promise a membership of one hundred or one hundred and fifty. For instance, if St. Louis were selected as a meeting place for the Society, it should be contingent upon St. Louis's bringing in one hundred or one hundred and fifty names for members. Any man who would work could do it. We should be larger and have more funds to conduct our work with.

This committee suggested by the Treasurer is a good idea, and is going a long way towards increasing our membership and the interest in our Society.

MR. WILLIAM ALLEN of Louisiana: Mr. President, I would like to state that the plan just mentioned by Mr. Woods was adopted last year by the Southern Educational Congress with great success. The committee came to my city after the convention in Chattanooga, to look over the ground preparatory to deciding whether the next convention would be held there or not. It probably will be held there. But one of the conditions outlined by the committee was the number of members to be secured by the city in a limited time before the convention is held. It has worked well with other societies and will work here.

PROFESSOR HENRY B. WARD: Mr. President, these are practical suggestions of the greatest possible value, and to put them into form for definite action before a meeting of the Society is too far advanced, I move you that this meeting request Mr. Willard and Mr. Woods to formulate and present in precise phraseology the by-laws necessary to carry into execution the proposals which they have made. (Seconded by Mr. Schaeffle.) Carried.

TREASURER WILLARD: Mr. Chairman, before adjourning, may I make the suggestion that a committee be appointed to have in view the amalgamation of the American Fisheries Society and the Pacific Coast Fisheries Society. It seems to me that if you appoint a committee they will see the different members and perhaps be better able to bring some concrete suggestions later on in the meeting.

MR. HENRY O'MALLEY, of Seattle, Washington: As the newly elected President of the Pacific Coast Fisheries Society, I would like to say a word on the matter of joining the two societies. We have a little society out here of one hundred and fifty members at the present time. I do not want the idea thrown out that we are seeking any assistance, because we are on a good firm basis. Our constitution has been drawn along the same lines as that of the American Fisheries Society. Our objects are the same, and it is our intent to work in close harmony with the American Fisheries Society. The reason for our forming the Pacific Coast Society, primarily, was that there are a good many of us out here on this coast, our interests are here, we are a long ways from the body of the American Fisheries Society, and we do not get an opportunity to meet with them. Therefore, we formed our own little society of Pacific Coast members, and a good many of us belong also to the American Fisheries Society. I have belonged for a good many years myself, and still continue to have the same interest that I had before I was a member of the Pacific Coast Society. A good suggestion was made last night, that in issuing the quarterly, one number could be made a Pacific Coast number. Of course, I do not speak with authority from the Pacific Coast Fisheries Society, but I do know that this is a good idea, and I believe the Pacific Coast Society will probably look upon the matter with favor.

Moved and seconded that the President appoint two members representing each society to serve as a committee. Carried.

PRESIDENT FEARING: I will ask Dr. B. W. Evermann and Mr. Henry O'Malley to represent the Pacific Coast Fisheries Society and Mr. John P. Woods and Mr. Chas. W. Willard the American Fisheries Society on this committee.

Session adjourned.

Thursday, September 2, 1915.

President Fearing called the meeting to order and announced the appointment of the following committees:

FOR THIS MEETING.

Committee on Nominations: Mr. Henry O'Malley, Mr. Carlos Avery, and Mr. C. W. Willard.

Committee on Time and Place: Mr. Ernest Schaeffle, Mr. John M. Crampton, and Mr. F. W. Chambers.

Committee on Resolutions: Dr. Henry B. Ward and Mr. Henry Dean.

STANDING COMMITTEES.

Committee on Foreign Relations: Mr. George Shiras, Chairman, Dr. H. M. Smith, Dr. E. E. Prince, and Dr. George W. Field.

Committee on Relations with National and State Governments: Professor Henry B. Ward, Chairman, Mr. William C. Adams, Mr. M. L. Alexander, Mr. William L. Finley, and Mr. John W. Titcomb.

Committee on Publication: Prof. Bashford Dean, Mr. John T. Nichols, and Dr. Tarleton H. Bean.

VICE-PRESIDENTS OF DIVISIONS.

Fish Culture: Mr. Dwight Lydell, Comstock Park, Michigan.

Aquatic Biology and Physics: Professor Henry B. Ward, Urbana, Illinois.

Commercial Fishing: Captain J. F. Moser, San Francisco, California.

Angling: Mr. H. Wheeler Perce, Chicago, Illinois.

Protection and Legislation: Dr. T. S. Palmer, Washington, D. C.

These appointments are regularly made by the presiding officer and require no action by the Society.

MR. SCHAEFFLE: Mr. President and Gentlemen of the Society, I have the honor to announce that the Imperial Fisheries Bureau of Japan, through the Commission for the Exposition, has donated to the Society about one hundred catalogs of Japanese fisheries. I move that we extend a vote of thanks to the Japanese Imperial Fisheries Bureau for their courtesy.

Motion put and carried.

READING AND DISCUSSION OF PAPERS.

MR. W. O. BUCK, of Neosho, Mo., was called upon. His paper, *The Fish Farmer in Action,* has already been printed (TRANSACTIONS, Dec., 1915, pp. 46-47).

MR. JOHN P. WOODS, President of the Missouri State Fish Commission, presented an address on *Missouri Fish Heraldry.*

Most of Mr. Woods' remarks have been withdrawn from publication at his own request pending more complete studies. Briefly, the paper consisted of an outline of the work in fish culture carried on by the State of Missouri since the year 1879. The work began at that time with various species of indigenous fishes.

"Three of these have found special favor in very extensive cultivation in Missouri, viz.: Black bass (large mouth), crappie and sun perch (blue-gill sun-fish).

"Crappie are more delicate than the blue-gill (sun perch), but both are prolific breeders and contribute largely to the supply of food fish. One large lagoon in the St. Louis hatchery has been able for many years to fully supply the immense State demand for stocking with blue-gills, under the surprising conditions of no cultural care whatever, no artificial nesting, no assorting, no replenishment of breeders, no feeding, no attention, except prevention of poaching, and even under the handicap of the constant agitation of the water produced by public boating.

"The question of black bass cultivation has annually taken much of the time of this Society, but a majority decision has not yet been reached. The primary objection to this fish has been that of its intense greediness, to the extent of cannibalism. In such aggressive feeding, however, the growth of those that survive is facilitated. The State of Missouri long ago undertook to produce black bass in its hatchery waters and has been successful to the extent that it has been able to completely supply the demand in sizes ranging from advanced fry to fingerlings, and yet let the cannibals work.

"Plainly it would appear that to partly rear this species successfully on a large scale in hatchery waters, it is necessary to hatch a great many more than there is urgent need of. Of course, feeding and occasional sorting of sizes will increase the output, and such practice is recommended. Patience, suitable water and sufficient pond area are all that is needed for a satisfactory output. The success of Missouri in this particular respect dates back a number of years, but the results have not been made public."

Mr. Woods showed a number of bottled specimens illustrating the rate of growth of the large-mouth black bass.

The demonstration was followed by active discussion on the part of a number of the members.

Some Quantitative Physiological Changes in the Pacific Salmon During the Run to the Spawning Grounds.

By Professor C. W. Greene,

Laboratory of Physiology, University of Missouri

(see Transactions, Dec., 1915, pages 5-12.)

In the absence of Professor Greene, this paper was read by Dr. B. W. Evermann. In the discussion that followed the question was first raised whether the death of the Pacific salmon is due to loss of energy.

Dr. Evermann: In 1895, and again in 1896, I carried on experiments on Snow River, Idaho, for the two entire seasons, to determine whether the salmon actually died after spawning. We were situated so that we could examine closely every one of several hundred salmon that came to that region. Each of those seasons, not one of those salmon showed any scars or bruises upon arrival at the spawning grounds. They had done no fighting on the way up. When they got on the spawning ground, fighting to some extent and rubbing over the gravel in the beds resulted in some injuries of various sorts, but all of those injuries were received on the spawning grounds. But, although there were no marked changes in the external appearance of the fish from the time it left salt water until it arrived on the spawning grounds, there had been marked change in the muscles and different tissues of the body.

Mr. Henry O'Malley, of Washington: In the waters about Puget Sound, we find the humpback and dog salmon spawning at no great distance up the rivers. In fact, a great many dog salmon spawn in brackish water and run out into salt water, just the same as the others.

Mr. E. W. Cobb, of Minnesota: We have heard considerable about the great results obtained from the introduction of salmon into the fresh water lakes of the east. Do all of these die in the same way?

Mr. Geo. H. Graham, of Massachusetts: Mr. President, I feel that we have not experimented long enough with these fish to answer the question fully. The Chinook salmon were introduced into Lake Sunapee in 1904. The eggs were hatched out and the fry planted when small, during the summer, when the lake was alive with black bass. I believe very few of those salmon lived, but in three or four years, they began to catch them, weighing up to six and eight pounds. About 1909 or 1910, another lot was planted in the fall after the bass had gone into winter quarters. The next year two thousand were caught, and the year after that five thousand. Several specimens weighing fourteen to sixteen pounds and one between eighteen and twenty pounds have been taken.

There have been several reports of single dead salmon taken in Lake Sunapee. I think this is to be accounted for by fish breaking away in an injured condition from anglers. I maintain that if all died after they became mature, we should find hundreds of these salmon around the lake every season.

Now, as to rate of growth, the Massachusetts Commission, in 1912, planted ten thousand of these salmon in Lake Quinsigamond, near Worcester, with a screen at the outlet. Eighteen months from the time those fish were planted, we began to catch them, and six to eight hundred salmon were taken, running from a pound and a half up to five pounds. That was all gained in eighteen months, for there were no salmon there before. Two hundred were taken the first day of the open season this year, 1915. We intend to experiment with these fish, because we know when they were planted, and we believe that we will find out in three or four years just what these fish are doing in fresh water. We know already that they have been very successful from the standpoint of the sportsman. They grow rapidly, they are fine fish to eat, and there is no more gamey fish in the whole country. We can see very little difference between the chinook salmon in fresh water lakes and the Atlantic salmon or Sebago salmon.

Mr. Henry O'Malley, of Washington: Some years ago I took five hundred fingerlings of the chinook salmon and was curious to know what would become of them if held in the same water that the adult salmon naturally frequented for spawning. The fish were held in a pond and a large percentage of the males became mature as yearlings. The milt was used with perfect success to fertilize eggs from river salmon. These young matured salmon died in the pond. Some died at the end of the second year and the balance were nearly gone at the end of the third year. None of them lived to be four years old.

Mr. Graham: A year ago at Lake Sunapee, N. H., I found one male salmon, weighing five and a half pounds. As the milt was coming out of the fish, I shipped it to Dr. Tarleton H. Bean, who examined it and found it to be a mature fish three years old.

Efforts to Ripen Striped Bass, 1915

By Mr. J. P. Snyder, Cape Vincent, N. Y.

(see Transactions, December, 1915, pages 40-45.)

Read by President Fearing.

President Fearing: The greatest results that have ever been obtained in the history of the world in the introduction of fish into waters absolutely foreign to them, have been those following the introduction of the striped bass and the shad into the waters of California. This was done by the United States Fish Commission in 1879 and 1880. The men, instrumental in the work, were all members of this Society, and had the backing of the American Fisheries Society, so it is mainly due to this Society that California rejoices today in the abundance of these fishes.

It may be news to some of the members of the Society, even some of the California members, that there were only one hundred and thirty-five striped bass, and the biggest one weighed only half a pound. They were distributed in Suisun Bay, in 1879, and in 1882 there was a further shipment of about three hundred, none of them longer than nine inches. There was a closed law on them for a number of years, but in 1901, there were over a million pounds of striped bass sold in San Francisco alone. Mr. Schaeffle tells me that there is a record of a fish taken in California that weighed one hundred pounds, which gives us a little data as to the rate of growth of the striped bass. I may tell you that the greatest weight of the striped bass, according to absolutely authenticated record, on the Atlantic Coast, is but one hundred and twelve pounds, and you have already caught a fish of one hundred pounds here on the Pacific Coast. You owe that to your magnificent conservation. You have a close season for your fish, and a law that forbids the exportation out of the State. In the Atlantic States, there is no law against taking them when breeding. I have seen, myself, in Fulton Market, New York City, a female bass that weighed ninety-eight pounds, and had thirty-six pounds of spawn in her. That is the way to destroy food fish. You, here in California, have locked the stable door before the horse was stolen. It would be well if all our states would do the same.

Mr. J. Mailliard, of California: May I say something about the shad that you spoke of being introduced here? I do not think the people in California realize the number of shad there are in this State. They do not seem to be in the market, for some reason, although they are one of the finest fishes we have. The shad commence to run about the beginning of April, and continue until in June. There is no law, whatever, against catching them. They are taken with dip nets. Thousands and thousands of pounds of shad are caught along these rivers. The shad are so common they feed them to the chickens. They are the most prolific fish we have here, and I am sorry to say, are hardly appreciated, but the way they have increased is something wonderful.

Mr. N. B. Scofield, of California: The State of California did try, for four different years, to propagate the striped bass. The striped bass unfortunately changed its habits about the time the Commission started to experiment with them. I do not know what was the reason, unless the bass had not become well established in its habits, at the time the propagation was decided upon. Nearly all of the mature or spawn bass were coming from the neighborhood of Bouldin Island, on the San Joaquin River. The fishermen caught large numbers of these spawn bass, a great many of which appeared to be in a ripe condition, so a hatchery was established there. The first season they had very remarkable success and hatched several million fry. But after that year the bass got fewer and fewer at San Joaquin, and started to run at spawning time up the Sacramento. This still continues, very few going up the San Joaquin at the present time. In all the work that has been done, we have never discovered the spawning places of the striped bass in either the San Joaquin or the Sacramento River.

Mr. Schaeffle, of California: Mr. President, I would like to add a couple of practical comments relative to striped bass. This is now one of the three most important fishes in California. I rather take issue with our President when he says that we do not appreciate the striped bass, because I think the people do appreciate it very well; in fact, the people of the west, a few years ago decided to shut down the bars, and keep them home. Every state in the west—I do not know how far east—was drawing on us for their striped bass. In addition to the non-export law that we have had, I think about six years, we have had closed seasons. We have had a closed season of Saturday and Sunday on striped bass, shad and salmon for a great many years. As an experiment, a few years ago, a closed season was made in the spring, during what was then supposed to be the spawning season of the striped bass. That law would have worked splendidly, but unfortunately, wth the run of spawning bass in the spring, we have a run of salmon and a run of shad. The fish are caught in the same net. The law intended to protect one is inoperative, because in fishing for one of the other varieties, striped bass are caught and killed. That law was taken off at that time, and at the last session of the legislature, a law was introduced, but not passed, to make a closed season in the spring on salmon.

We have also had a number of other laws for the protection of the striped bass. We limit the size of mesh that can be used for taking the bass, with the idea of protecting the small fish under spawning size.

We regulate the kinds of nets that can be used for taking bass. For a great many years we have not allowed the set net. We have no traps in the waters. We have a law now that prohibits even the use of small mesh nets, that may be hauled on the beaches. This last legislature passed a very radical act at the recommendation of Mr. Scofield, of the Fish and Game Commission, under which the small sloughs and probable breeding grounds of the striped bass will be kept absolutely free from all kinds of nets. The main waters, say in the main Sacramento and San Joaquin Rivers, are open to the fishermen with nets. The side sloughs on the main portions of the river are closed. We feel that this will protect the spawning beds, and the young fish after they leave the spawning beds, and as they work down into the bays. I would like to say to that, in addition to having all these laws, the Commission has strenuously endeavored, for a great many years, to see that every one of these laws is religiously observed. We maintain a constant patrol of the waters in which the striped bass are found and taken by the fishermen. We have one large boat on the main bays here, and two boats on the Sacramento and San Joaquin Rivers, and we add to them at times. We also detail our field men or game wardens, to spend quite a lot of time along the streams. We have arrested hundreds of fishermen for violating these laws because fishermen do not always have our viewpoint. They think if the fish is in the water, it ought to be killed. We have had deputies killed in the effort to enforce these laws, but I think the laws we have at the present time are wisely framed and they are being more and more closely observed and rigidly enforced all the time by the Commission.

Mr. Mailliard referred to the fact that the shad are not appreciated in the State, although at times out in the country the people seem to be wiser. The shad is not appreciated, so it is taken in large quantities at times when there is no demand for them and dumped on the market. Great quantities are salted and shipped to China. We are not making good use of the shad. The Commission has endeavored to popularize this fish, but has had little success. We have endeavored to convince our people on the coast that our shad is just about as good, if not as good, as the eastern shad, but for some reason, in the past at least, the public has not taken to the fish. We hope to bring about a condition, though, in the near future, when the shad will be appreciated just as the carp is going to be appreciated.

What We Can Do to Promote Fish Conservation.

By Charles Minor Blackford, M.D., Staunton, Va.

(see Transactions, December, 1915, pages 13-18).

Read by President Fearing.

Following the reading of this there was a prolonged discussion as to the possibilities of broadening the scope of the Transactions so as to admit of the publication of short notes and news items, which was approved. The quarterly publication, instead of the former annual volume was considered a move in the right direction. Also the plan of admitting papers for publication at any time, without the formality of presenting them previously at an annual meeting, was considered favorably.

Session adjourned.

Friday, September 3, 1915.

President Fearing: Gentlemen, I wish to state that there is a report from Mr. H. Wheeler Perce, Chairman of the Publicity Committee, which did not reach me until this morning, and also a very short paper by Mr. Perce on "The Relations of Commercial and Sport Fishing—Fair Play." With your permission, before we proceed to business, I will read his report as chairman of the Publicity Committee.

To the Members of the American Fisheries Society:

Permit me, as Chairman of the Publicity Committee to report simply some general progress and to say that I still feel like reiterating the suggestions made at earlier meetings. I have still further reason to believe that a "whirlwind campaign" for members, by means of widely distributed invitations, would prove successful to a very gratifying degree. In line with this, let me state, that with the assistance of Mr. Merrill, I could furnish the Society with approximately 3,000 names, all more or less desirable prospects for membership in the Society. Surely, similar lists could be obtained from some source in all the states.

Again let me urge the advisablility of a magazine owned by the Society and circulated among its members only, in the same manner as the National Geographic Magazine.

The formation of State Chapters of the Society surely would prove a great advantage. There is an illustration of this in the formation of that splendid, new association of Pacific Fisheries, which probably could be to all intents and purposes, a portion of the American Fisheries Society.

I have every reason to believe that a National organization of at least 10,000 could be built up, if some modifications of this general scheme were adopted and I think the Society could be made into a popular one, without any danger to its present splendid standard of ethics and scope and type of work.

Respectfully submitted,

H. Wheeler Perce,
Chairman Publicity Committee.

The Relations of Commercial and Sport Fishing—Fair Play.

By Mr. H. Wheeler Perce, *Chicago, Ill.*

(see Transactions, December, 1915, pages 29-33.)

Read by President Fearing.

Owing the lack of time the following papers were read by title:

More About the Paddle-Fish (*Polyodon spathula*) commonly called the Spoon-billed Cat

By M. L. Alexander,
President, Conservation Commission of Louisiana, New Orleans, La.

(See Transactions, December, 1915, pp. 34-39)

FISH PARASITES AND THE PUBLIC HEALTH.

PROFESSOR EDWIN LINTON,
Washington and Jefferson College, Washington, Pennsylvania.

(see TRANSACTIONS, December, 1915, pages 19-28.)

Mr. Geo. H. Graham of Springfield, Mass., President of the National Association of Fish and Game Commissioners, extended an invitation to the members to be present at the meeting of this organization on the following week and to participate in the excursion to the California State Game Farm at Hayward.

This was warmly seconded by Mr. Ernest Schaeffle, Executive Officer of the California Fish and Game Commission.

A motion was made that a committee be appointed to meet a delegation from the Association of Pacific Fisheries on their arrival at Oakland at six o'clock. The motion was carried and Mr. Schaeffle was asked to select the committee.

REPORT OF THE COMMITTEE ON TIME AND PLACE.

Presented by the chairman of the committee, Mr. Ernest Schaeffle, of San Francisco.

Mr. President and Gentlemen: The Committee on Time and Place have duly considered courteous invitations to hold the 1916 meeting of the Society in Baltimore, New Orleans, Columbus, New York City, Buffalo, St. Paul, Washington, D. C., and Boston. It is the judgment of the Committee that the 1916 meeting for peculiar reasons, very satisfactory to the committee, be held at New Orleans on October 16, 17, 18 and 19, 1916.

We are very glad to report to the Society that Mr. Allen, representing the Conservation Commission of Louisiana, has promised to add one hundred and fifty new members to the Society in advance of and at the time of the 1916 meeting.

Mr. John P. Woods of Missouri: I move, Mr. Chairman, that the report be approved.

Seconded by Mr. Carlos Avery of Minnesota.

The motion was put and carried.

Mr. Wm. Allen of Louisiana: On behalf of the Conservation Commission of the State of Louisiana, and of those who joined in extending the invitation to this Society to meet there next year, I wish to express my pleasure that it has been accepted. I can assure you we will do everything we can to make a great big successful meeting of it.

President Fearing: We are now ready to consider the most important matter that has come up at this meeting, the possibility of amalgamation with this Society of the young strong Fisheries Society of the Pacific Coast.

Report of the Committee on the Amalgamation of the Pacific Coast Fisheries Association With the American Fisheries Society.

Presented by Dr. Barton W. Evermann, *Chairman.*

Mr. President and Members of the Society: Your committee has held two rather informal meetings, and has discussed in a very informal way the question that was delegated to it. I think all the members of the committee are agreed that good will come to the Pacific Fisheries Society and to the American Fisheries Society, both, if some sort of amalgamation or closer affiliation could be established, and all the members of the committee feel that it is desirable to adopt an amendment to the constitution and the by-laws, which would provide for such affiliation. There has been drawn up a draft of an amendment to the constitution, which would go in probably as a by-law, in these words:

Whereas, an enlargement in the scope and work of the Society is desirable, *Be it resolved,* That when organizations as a body, of interests similar to those of this Society, desire to obtain membership in the Society, that, upon the indication of such desire being formally presented, such applications shall be duly considered in the annual meetings of this Society; such admissions to be on terms mutually agreed upon.

The words "chairman" and "recorder" are suggested as suitable words for the leading officers of the section, so that there will be no confusion. The president or secretary will be of the American Fisheries Society, while we would speak of the chairman of the section, or the recorder of the section. It was thought that the sections might hold meetings other than annual meetings, and that the dates and places and all the details concerning those meetings, other than the annual meetings, should be left entirely in the hands of the section. The annual meeting of the section, however, should be approved by the American Fisheries Society, so as to prevent conflicts in the meeting of two or more sections. The dues, of course, would be the same in all sections of the Society, and one clause provides that an amount not to exceed one-half of the dues may be retained by the section for its local expenses, that one-half will go to the general society; but all the funds will be handled by the treasurer of the American Fisheries Society.

In order to get that amendment properly before the Society, this resolution has been drafted as a by-law and is submitted:

BY-LAW.

On presentation of a formal written petition signed by one hundred or more members, the Executive Committee of the American Fisheries Society may approve the formation in any region of a Section of the American Fisheries Society to be known as the —— Section.

Such a Section may organize by electing its own officers, and by adopting such rules as are not in conflict with the Constitution and By-Laws of the American Fisheries Society.

It may hold meetings and otherwise advance the general interests of the Society, except that the time and place of its annual meeting must receive the approval of the Executive Committee of the American Fisheries Society, and that without specific vote of the American Fisheries Society, the Section shall not commit itself to any expression of public policy on fishing matters.

It may further incur indebtedness to an amount necessary for the conduct of its work not to exceed one-half of the sum received in annual dues from members of said section.

Such bills duly approved by the Chairman and Recorder of the Section shall be paid on presentation to the Treasury of the American Fisheries Society.

After some further explantion by members of the committee, it was voted to accept the report of the committee.

Mr. Woods of Missouri moved, seconded by Prof. H. B. Ward, that the resolutions embodied in the report of the committee be adopted as by-laws, under Article II of the Constitution. Carried.

PROFESSOR H. B. WARD of Illinois: I feel that the occasion is ripe for the entering of another item on our minutes, and for taking another step towards the amalgamation of these two societies, concerning which so much has been spoken. It seems to me fitting and proper that our present President, who has done so much to bring about this thing that we all think will be a great step in advance, be requested by this meeting to write a letter to the Pacific Coast Fisheries Society, expressing the desire of the American Fisheries Society that they should be joined with us in the work in which we are mutually interested, and calling their attention to the fact that the present regulations of this Society provide for the continuance of their work, even though they become a part of our organization. I, therefore, move that this meeting instruct President Fearing to communicate officially with the Pacific Coast Fisheries Society, to that effect.

Motion carried.

PRESIDENT FEARING: Is the committee appointed to draft the by-law in regard to election of members ready to report?

Mr. Woods of Missouri, Chairman of the committee, presented the following:

BY-LAW

The President, Recording Secretary and Treasurer of the Society are hereby authorized, during the time intervening between annual meetings, to act on all individual applications for membership in the Society, a majority vote of the Committee to elect or reject such applications as may be duly made.

Moved and seconded and duly carried to incorporate this as a by-law under Article II of the Constitution.

COMMITTEE ON RESOLUTIONS.

Professor H. B. Ward, as Chairman, presented an informal report embodying expressions of regret at the loss by death of members whose names appear on another page. Also the thanks of the Society were tendered to members of the local committee and to the Young Women's Christian Association in whose hall the meetings were held.

The report of the committee was accepted.

Presentation of a Bronze Medal to the American Fisheries Society by the Panama-Pacific International Exposition.

By Hon. C. S. Scott, *of the Board of Commissioners of the Panama-Pacific International Exposition.*

Mr. President and Gentlemen: It affords me great pleasure to represent the President and the Board of Directors on this occasion, and to extend to you their greeting and welcome here within our midst. We want you to feel that you are at home, and we are simply extending officially a greeting and welcome.

In commemoration of your meeting here with us, and of this day, and on behalf of the Exposition and the Directors, and President Moore, I take great pleasure in presenting to you a medal, made of bronze, on which is inscribed: "The American Fisheries Society, Forty-fifth Annual Meeting, September 3, 1915." On the reverse side: "In Commemoration Panama-Pacific International Exposition, San Francisco." While this has no intrinsic value, it carries with it the best wishes that we can extend, in words or otherwise, for the future success of your organization.

President Fearing responded, expressing the thanks of the Society to the officers of the Exposition for their greeting and for the gift of the medal. The medal was placed in the hands of the Recording Secretary for preservation.

Treasurer Willard: Mr. President, in order to bring to a focus our informal discussion concerning the increase in our membership list and change in the Transactions, I wish to offer the following:

Resolved, That a committee be appointed, consisting of Mr. Daniel B. Fearing of Rhode Island, Mr. H. Wheeler Perce of Illinois, Dr. Chas. Minor Blackford of Virginia, Dr. Raymond C. Osburn of Connecticut, and Dr. Barton W. Evermann of California, whose duty shall be to consider and put into operation some plan to increase the membership, and to consider and adopt methods to increase the efficiency of the publications of the American Fisheries Society.

Being duly seconded by Mr. O'Malley of Washington the motion was put to vote and carried.

REPORT OF THE COMMITTEE ON NOMINATIONS.

Mr. Henry O'Malley, chairman of the committee, presented the following nominations for the elective officers of the Society for the year 1915-16:

President: Prof. Jacob Reighard, University of Michigan, Ann Arbor, Mich.

Vice-President: Dr. Geo. W. Field, Massachusetts Fish and Game Commissioner, Sharon, Mass.

Recording Secretary: Prof. Raymond C. Osburn, Connecticut College for Women, New London, Conn.

Corresponding Secretary: Dr. Chas. H. Townsend, New York Aquarium, New York City.

Treasurer: Mr. Chas W. Willard, Rhode Island Commission of Inland Fisheries and Game, Westerly, R. I.

EXECUTIVE COMMITTEE.

Henry O'Malley, Seattle, Wash., *Chairman*; H. Wheeler Perce, Chicago, Ill.; N. R. Buller, Harrisburg, Pa.; J. Quincy Ward, Frankfort, Ky.; Ernest Schaeffle, San Francisco, Calif.; John P. Woods, St. Louis, Mo.; Eben W. Cobb, St. Paul, Minn.

A motion was passed that the Secretary cast one ballot for the entire list, which, being done, the officers for 1915-16 were declared elected.

Professor H. B. Ward proposed a vote of thanks to President Fearing and the other officers of the Society for their efficient work during the past year. Carried.

President Fearing then introduced Hon. Charles A. Vogelsang, former Chief Deputy of the California Fish and Game Commission, and Member of the Board of Directors of the Panama-Pacific International Exposition, who addressed the meeting.

Address of Mr. Vogelsang.

"*Mr. Chairman and Gentlemen*: I have to ask your indulgence for appearing somewhat late, because I happened to be at another meeting. But I am nevertheless very glad to be here and meet you gentlemen who have to deal with one of the great economic problems not only in all the States of the country, but of the world. You have chosen to come here to California, to this Exposition which happens to be, in this year of 1915, the meeting ground of the nations of the world. In sharp contrast to things that are occurring elsewhere, San Francisco has this unique distinction: It is the one great peace capital of the world, where men from all nations are sitting down in friendly intercouse, exchanging ideas, giving from each country, and each state, that which makes for the general betterment of mankind.

"The Exposition, after all, is simply the tearing down of that sort of imaginary fence that stood between you and your neighbor. You would hear his talk; you would know something about what he was doing, but he was over there somewhere, and you wondered what sort of a peculiar fellow he might be. When that fence was removed, you would say, 'Why, he is quite the same as ourselves. He was born, perhaps, in a little different atmosphere, reared under a somewhat different environment, his training might have been different, but his hope and his desire is for the betterment of his fellowmen.' It has been my opportunity, and I appreciate very much the great opportunity I have had, to come into close contact with men from every part of the civilized world, and I find that while we differ somewhat in the methods of approaching things, sometimes in medicine, sometimes law, sometimes religion, that after all we are all heading for one common goal, the betterment of the race and the world in which we live.

"The year 1915 is fraught with more far-reaching and important events than any other year since the Christian Era began. Empires and kingdoms and principalities may change, but human nature always is the same. But whatever may be the world changes in the future, you have come here to this wonderful peace capital, where all is peace, harmony, beauty, and where you can exchange a hand-clasp and a smile with your brother, whether he comes from Patagonia or from the very northernmost lands, or from east or west, and we are all friends, working for the common good and with a common high purpose.

"On behalf of the Exposition and its representatives, I want to say to you, in the language of the old Spaniard from whom we have many beautiful things to remember: 'My house is your home.' Therefore, you are most welcome to our house."

President Fearing introduced the eminent ichthyologist, Dr. David Starr Jordan, Chancellor of the Leland Stanford University.

ADDRESS OF DR. JORDAN.

"*Mr. President, Ladies and Gentlemen*: I used to be a fisherman, and according to Isaac Walton it is good enough for any man to be on the right side of a man who knows fish. And I used to know fish at one time, and have always been interested in the problem of what would become of a man if he fell into a fish trap with several tons of salmon in the trap, whether he would swim on the backs of the fishes, or sink like a lead bullet to the bottom. I am much interested to know the solution of this problem, but have never felt personally like experimenting.

"I have been much interested in Dr. C. H. Gilbert's work on salmon, for the last two or three years, in finding that the age of salmon can be told by the concentric rings of the scales, just as you know the age of a tree by the rings in the wood. There are a good many of these rings in a year, but in the winter, when food is scarce, it appears that the salmon does not grow so rapidly, and the rings are close together; in the summer, when conditions are favorable for the growth of fish, the rings are farther apart, so that by noticing the number of spaces where the rings are wide apart, it is possible to tell the age of the salmon.

"The ordinary red salmon of Alaska grows usually to be four years old before it spawns. However, it sometimes spawns under age, and sometimes it goes beyond the four years. The king salmon spawns usually when it is four years old, but sometimes it runs on to five or six, and sometimes it spawns as young as one, or possibly two years. All these are reported in the scale, so that if you figure it out, you can find out from the fish all its history.

"In the habits of the salmon there are many unsettled problems, but one among the most remarkable things of natural history is, that the red or sockeye salmon, which is more abundant than all other salmon in the world put together, never spawn excepting in the water above a lake, and whether the stream running into the sea is a very short one, or whether it is a river like the Yukon, where they must run eighteen hundred miles before they come to a lake, in either case they go up a stream that has a lake, and do not go up a stream that has not.

"I closed my fisheries career with a very ambitious piece of work—the effort on the part of Canada and the United States to unify their statutes, so that the fisheries would be governed by the same laws on the Canadian side of the line in regard to salmon as they were on the United States side. I spent three summers at that work, and went over three times practically the whole length of the international boundary, and with my Canadian colleague and Dr. Evermann, who was with me all the time, and the aid of a number of others, we got out, as I remember, fifty-nine statutes on which we agreed. Most of these were relatively unimportant. Some of them were very important, and those were very difficult. It was almost impossible to frame any kind of statute around Puget Sound that would reduce the number of fishes caught without making it harder for the fishing companies to make the business pay. It is really a difficult problem to prevent people from catching fish. We were more successful around the Great Lakes, but ran against another problem—states' rights. The State of Michigan followed up our work there by passing a state law beginning with, "Whereas, all the fishes in the waters surrounding the State of Michigan are the property of the State, Resolved, so and so.' The purpose of that was to exclude, as far as they could by statute, all participation of the United States in those problems, making it a state problem, and not a national one. They adopted our recommendations almost without change, so that I think on the whole they were quite an improvement over ours, because they contained some things that we had not put into our regulations. When the regulations were all finished and came before the Government of the United States, all but ten were adopted, and these ten practically covered netting in the Great Lakes and in Puget Sound. Of course these particular ones that were omitted were in some ways least satisfactory, because they dealt with the problem of how to check the killing of fishes without interfering with the fishing industry, and any check is liable to have its injustices and its difficulties. One of the senators from Michigan, aided and abetted by various fishermen, objected to those netting regulations, on the ground of their interference with states' rights, and I understand that the senators from Washington were of the same mind. I understand also that the fisheries of Puget Sound have been showing a very distinct falling off.

"The red salmon grows to four years before it spawns, and, like all of our Pacific salmon, they die after spawning. As they reach the age of four years before they spawn, then whatever the fisheries may be of one year is determined by the number that spawned four years before.

"There has been on Puget Sound, for a great many years, one large run, with another large run four years later, and the three intervening runs are all very much smaller. That is apparently due to some period when a great run escaped, and this great run has been continued right along. We do not know what the reason really is, but we have supposed that all the weak runs might be made stronger, if we would allow the fishes to spawn, or to be spawned artificially, and properly planted.

The condition in Puget Sound is extremely difficult. Nearly all the salmon spawn in the Frazer River and its tributaries, and really all might be caught in the American waters before they get to Canada, for we have the first pull at them in the waters of the United States. The ultimate result was that the whole thing went by the board. There is a good deal of criticism now in Lake Erie over the failing of the fisheries, and I presume that some sort of regulation must be brought about in Puget Sound. Now, there's no way in which regulation can be brought about, except by the United States making a treaty with Canada, because the States of Washington and Michigan cannot make separate treaties with any country, and no agreement of any sort could have any validity unless it took the form of a treaty between the United States and Canada. Canada is now allowed to make her own treaties. I think the principle involved in this international commission, and in the attempts to unify the statutes, is a just one, yet it would involve a thing we have never had—a series of United States marshals looking after the fisheries on our side of all international waters. That is a matter that presents a good deal of expense and difficulty in itself. Any group of regulations, such as we proposed, would need a good deal of amendment, for they have to be tried out. You can hardly expect any outsider not interested in the fisheries business to realize all the various intricacies of the problem. You can not, on the other hand, expect the people themselves, most of whom are more interested in what happens immediately than in the long future of the fisheries, to work out those problems.

"A few representatives of the Alaska Packers' Association are here, and even if they were not present, I should like to make an exception of them, because they have striven very earnestly to work for the long future, as well as for any immediate profits to the companies themselves. I have not felt that was always true of all the companies operating in Alaska. There is a sentiment found in the Northwest sometimes, that 'whatever is not nailed down, is mine, and whatever I can pry loose is not nailed down,' and that idea contributes sometimes to the detriment of all kinds of fishes and animals.

"The matter in regard to the international fisheries stands now practically as it did before. We are in need of some law or agreement, governing the matter along the international line. It is not possible to make any law or agreement except by treaty between the United States and Canada, and this treaty should be in the form of unification of statutes. The methods by which they should be framed and enforced are more difficult in Canada than with us, but the principles involved on both sides of the line are much the same, and the only serious and fundamental difficulty seems to lie in Puget Sound, where neither the standards that we propose, nor any others that we can think of, seem to be permanently satisfactory.

"While sometimes our efforts along the line of increased efficiency and better methods with regard to fisheries may seem for the present unavailing, you can not expect to see any results or consequences of such efforts in your life time; but there is still much satisfaction in the endeavor, if you know that the cause you work for will some time be prolific of good."

At the close of Dr. Jordan's address the session was temporarily suspended in an informal reception to the speaker.

The session being reconvened, Dr. H. C. Bryant, in charge of research, publicity and education for the California Fish and Game Commission, delivered a lecture on the "Conservation of Fish and Game Through Education." Dr. Bryant's remarks were illustrated by moving pictures taken in 1914 by Mr. E. A. Salisbury, of the Educational Film Co., working in co-operation with the California Fish and Game Commission and the United States Biological Survey.

At the close of the lecture the Society formally adjourned.

In Memoriam

JOHN O. BABBITT
CHARLES L. BENNETT
C. H. BUSCHMAN
LEWIS LINDSAY DYCHE
BARTON D. EVANS
A. R. GRAHAM
CHARLES S. GRINDLE
JOHN F. GUNCKEL
J. P. HALLER
CHARLES FREDERICK HOLDER
A. W. KENYON
W. L. MAY
JAMES K. P. PURDUM
GERALD SHERWIN

EDITORIAL

New Patrons and Members: Following the San Francisco meeting in September, 1915, Capt. Jefferson F. Moser, Vice-President of the Division of Commercial Fishing, made a special canvass of Pacific Coast firms interested in one way or another in fisheries or in fishing supplies and apparatus, and succeeded in adding fifty patrons to the Society's roll. The money derived from this source is held as a separate fund and invested, only the interest being used. It therefore serves as a sort of permanent endowment. Following is the list of patrons added to our membership list since the last meeting:

SAN FRANCISCO, CALIF.

Henry F. Allen, (Agent, Crown Mills)	210 California St.
American Biscuit Co.	815 Battery St.
American Can Co.	Mills Building
Armour & Co.	Battery & Union Sts.
Balfour, Guthrie & Co.	350 California St.
Bank of California, N. A.	California and Sansome Sts.
Bond & Goodwin	454 California St.
California Barrel Co.	22d and Illinois Sts.
California Door Co.	43 Main St.
California Stevedore & Ballast Co., Inc.	210 California St.
Geo. W. Caswell Co., Inc.	530-4 Folsom St.
C. G. Clinch & Co., Inc.	144 Davis St.
Coffin-Redington Co.	35-45 Second St.
Crane Co., (C. W. Weld, Mgr.)	301 Brannan St.
Dodge, Sweeney & Co.	36-48 Spear St.
W. P. Fuller & Co.	301 Mission St.
Grays Harbor Commercial Co.	Foot of 3d St.
C. J. Hendry Co.	46 Clay St.
The Jones-Thierbach Co.	Battery & Merchants Sts.
The Linen Thread Co., (W. A. Barbour, Mgr.)	443 Mission St.
C. Nauman & Co.	501-3 Sansome St.
Pacific Hardware & Steel Co.	7th & Townsend Sts.
Pacific States Electric Co.	575 Mission St.
Pope and Talbot	Foot of 3d St.
W. S. Ray Mfg. Co., Inc.	216 Market St.
Schmidt Lithograph Co.	2d & Bryants Sts.
Schwabacher-Frey Stationery Co.	609-11 Market St.
Ship Owners' & Merchants' Tug Boat Co.	Foot of Green St.
The Sherwin-Williams Co.	454 Second St.
Standard Gas Engine Co.	1 California St.
Standard Oil Co. (of California)	Standard Oil Building
United Engineering Works	232 Spear St.
U. S. Rubber Co. of California, (W. D. Rigdon, Mgr.)	50-60 Fremont St.
U. S. Steel Products Co.	Rialto Building
Wells Fargo Nat'l Bank of San Francisco	Montgomery & Market Sts.
Western Fuel Co.	430 California St.
Western Meat Co.	6th & Townsend Sts.
White Bros., Hardwood Lumber	5th & Brannan Sts.

OAKLAND, CALIF.

Atlas Gas Engine Co., Inc. ....Foot of 22d Avenue

MT. EDEN, CALIF.

Oliver Salt Co. ....

ASTORIA, OREGON.

Columbia River Packers' Assn. ....

SEATTLE, WASH.

Puget Sound Navigation Co. ....

Smith Cannery Machines Co. ....2423 South First Avenue

BELLINGHAM, WASH.

Bloedel Donovan Lumber Mills ....

Burpee & Letson, Ltd. ....South Bellingham

First National Bank of Bellingham ....

Morrison Mill Co., Inc. ....

Morse Hardware Co., Inc. ....1025 Elk St.

BALTIMORE, MD.

The Fred H. Knapp Co. ....Arcade-Maryland Casualty Building

WEIRTON, W. VA.

Phillips Sheet & Tin Plate Co. ....

The Society can stand a great deal more encouragement of this sort and it is to be hoped that every member of the Society will take it upon himself to interest his friends and acquaintances in becoming members, or, better still, patrons of the Society.

The Recording Secretary will be glad to supply all the application blanks necessary to any member desiring them.

A new by-law, passed at the last annual meeting, permits the election of applicants to membership at any time. The President, Treasurer and Recording Secretary of the Society form the election board.

Publication of Papers: It seems not to be generally understood among the members of the Society that papers may be presented for publication at any time without waiting for formal presentation at an annual meeting.

The Editor will also welcome short notes and articles that perhaps would not be considered sufficiently imposing for presentation at a meeting. Such notes, brief reports on some work, notice of any discovery, important appointments, and other interesting items may be sent in to the Editor at any time.

New Societies: The writer of Proverbs complained in his day that "of the making of books there is no end." The same might with almost equal propriety be applied at the present time to the formation of scientific societies. However, this seems to be a necessary condition of the increase and specialization of knowledge and interests. Two societies recently formed will no doubt be welcomed by various members of The American Fisheries Society.

The Ecological Society of America was formally organized at Columbus, during Convocation Week, and begins work with a membership of more than a hundred. Officers were elected as follows: President, Prof. V. E. Shelford, of the University of Illinois; Vice-President, Prof. W. M. Wheeler, of Harvard University; and Secretary-Treasurer, Dr. Forrest Shreve, of the Desert Laboratory. It is the intention of the society to hold frequent field meetings for the study of ecological problems. Numerous members of the new society are well known for their work on various phases of aquatic biology.

The American Society of Ichthyologists and Herpetologists is a still more recent organization formed at the first general meeting held in New York City on March 8, 1916. The purpose of the society, according to the by-laws, is to advance the science of fishes, batrachians and reptiles. As the new society is likely to be much more technical than the American Fisheries Society and has a different purpose in dealing with fishes, it is not likely that the two societies will overlap in much of their work even in this group. Most of the officers are well known to our Society: President, Professor Bashford Dean; Vice-Presidents, Dr. Leonhard Stejneger, Dr. Barton W. Evermann and Dr. Charles R. Eastman; Treasurer, Mr. Raymond L. Ditmars, and Secretary, Mr. John T. Nichols.

At the first general meeting twenty-two papers dealing with various phases of the society's work were read. The little journal *Copeia*, which has been running a couple of years, has been adopted as the official publication of the society, and will no doubt be greatly enlarged.

TRANSACTIONS

of the

American Fisheries Society

"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

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CONTENTS

THE FISH AND FISHERIES OF NEW ZEALAND

By Professor Edward E. Prince, LL.D., D.Sc.,
Dominion Commissioner of Fisheries, Ottawa.

INTRODUCTION.

New Zealand is a land of contrasts. Almost everything to which an American or European is accustomed is there reversed. Midsummer there is midwinter here. The northern parts are warm, almost tropical, while the cold increases further south, and Stewart Island at the southern extremity of the Dominion, has a climate as cold as Scotland. The most characteristic birds are practically wingless, and do not fly. The typical forest trees do not shed their leaves, and the luxuriant bush and the extensive plains of New Zealand, have never had any four-footed animals living upon them until introduced by the white man. The fisheries are no exception, and while the waters of New Zealand are prolific in fish, the most familiar and important food fish are totally absent, no cod, haddock, herring or true mackerel being found there.

RESEMBLANCE BETWEEN NEW ZEALAND AND MEDITERRANEAN FISH.

The latitude being between the 34th and 45th South parallels, the climatic conditions resemble those of Spain, or Portugal, or the southern part of Italy, and the typical fish recall in many ways, those familiar in the Mediterranean, and sold in the markets of Naples, Messina, or Lisbon.

SURVEY OF NEW ZEALAND FISHERIES IN 1914.

It was my privilege two years ago to make a survey of the fresh-water and sea fisheries of New Zealand, at the request of the Government of that Dominion. My inspection was very complete, as I had all facilities afforded by the authorities for visiting every locality where fish occurred, and as very favorable weather prevailed during my lengthened cruises, I was able to make a complete survey in the five or six months allotted to the task.

I commenced my survey in April, the beginning of the New Zealand winter, and continued until the advent of spring, in the month of September. The beautiful government cruiser "Hinemoa," under command of the accomplished Captain Bollons, was used during my dredging, otter-trawling, drift-net and other experiments, and as Chief Inspector L. F. Ayson accompanied me, I had an unusual opportunity of making a full investigation of the fishery resources of New Zealand.

SCENERY.

It is not necessary to refer at length to the character of the country, for the scenic beauty of "Maoriland" is famous all over the world. Her snow-capped mountain ranges, running like a backbone through the whole country, and the vast glaciers and lofty peaks, are not excelled by the Swiss Alps, or by the Rocky Mountains of this continent. The fjords of the southwest coast are unexcelled for magnificent grandeur and tropical forest luxuriance, while the hot springs, geysers, and other volcanic phenomena are more wonderful and extensive than in any other part of the world.

From a fishery point of view the sheltered bays and romantic straits and extensive inshore fishing banks, are of the highest importance, while the picturesque lakes of which the larger in size exceed twenty in number, the swift flowing rivers, more than one hundred of them, provide the most favorable conditions for great and productive fisheries, and the scenery and the fertility associated with these waters, recall in many ways, the fishery conditions of Japan.

AREA.

The two main islands, with Stewart Island at the southern extermity, embrace an area of 103,581 square miles, and extend a length of about 1,000 miles, with a breadth varying from fifty to two hundred miles. The coast line, 4,330 miles, is indented by beautiful bays like the Bay of Plenty, Hawkes Bay, Golden Bay and Hauraki Gulf, etc., and the picturesque shores are washed by the open South Pacific Ocean on the east, and deep Tasman Sea on the west.

AREA OF AVAILABLE FISHING LIMITS.

I estimated the inshore waters, 10 to 30 fathoms deep, at not less than 20,000 square miles, while about 25,000 square miles range from 40 to 50 fathoms in depth, and outside these (10 to 20 miles from shore) the depth descends to 300 or 400 fathoms, and greater depths lie beyond. The inland lakes are famous for their exquisite beauty, the shores in most cases being backed by lofty mountains with forests of tree-ferns and giant kauri and totara trees, the beautiful red pine, rata and various birches or beeches. Some of these lakes are of considerable area, Taupo for example, 250 square miles, Te Anau, 132 square miles; Lake Wakatip, 120 square miles; the last descending to a depth of 1,300 feet in some places. The total area of the lakes including rivers, some of which like the Clutha or Molyneux are 150 miles long, approaches 15,000 square miles or about one-sixth of the area of the Great Lakes of this continent.

VALUE OF FISHERIES; NUMBER OF FISHERMEN, ETC.

The fisheries have not been developed to any great extent, the population of New Zealand being small (1,115,000), and the demand for fish limited, while the main outside markets have been those of Australia, to which considerable exports of fish have been made.

1,500 or 1,600 persons are engaged directly in fishing or handling fish, about 1,000 of these being actual fishermen, while the annual value of fish caught probably does not exceed $500,000, including about $200,000 worth exported, mainly to Australia.

It is remarkable that New Zealand imports, annually, fish to the value of $540,000, mainly from the British Isles, notwithstanding that her own waters are so productive, and many species of excellent fish are abundant.

NUMBER OF SPECIES OF FISH.

Over three hundred species of teleostean fishes have been described in New Zealand, but of these not more than thirty-five are regarded as food fishes, and even some of these are not in public favor, although in many cases exceedingly good table-fish.

BLUE COD OF IMPORTANCE ECONOMICALLY.

They belong very largely to the rough scaled spiny-finned kinds of which the red snapper and groper are types. Amongst the more important species must be counted the blue cod, *Parapercis colias,* Forster, which is in great favor, and though not a large species, is regarded perhaps as the best of the food fishes in New Zealand seas. There is a large domestic demand for it and cured and smoked it is exported in considerable quantities to Australia. Captain Cook called it the "coal" fish, and remarked on its abundance, and it is still very plentiful, and of widespread occurrence all along the coast, especially on precipitous rocky shores. They are caught in from 10 to 15 fathoms depth, and range from one up to five pounds, reaching ten pounds weight off D'Urville Island, Cook Straits, where the water is deep. Not at all resembling cod, and not belonging to the cod family, it is curious how it has acquired the name, especially as its colors are very brilliant; often a dark green along the sides marbled with brown and a patch of green over each eye, while the under side is greyish white. The fins are grey spotted with brown, and the dorsal fin, the first five rays of which are sharp spines, runs the whole length of the back. As already stated it is a delicious fish when smoked, but when very slightly salted, it is much in favor, and is of unusually excellent table qualities. Hardly less important is the gigantic Hapuka or Groper (*Polyprion oxygeneios*, Bloch) which is really a hugh sea-bass or sea-perch, and ranges from 40 to 50 or even 100 pounds in weight. It belongs to the order Serranidæ, and frequents depths of 60 to 90 fathoms, or even still deeper water. It is usually caught by baited hand-lines, but will frequently not take the bait in July, when the fishermen state that it is spawning. A still larger species occurs at greater depths outside, and is called *P. Americanus.* The gropers are, on account of their firm, white flesh, and their large size, exceptionally important from a commercial standpoint.

The Moki, which is one of the Latrididæ, though less esteemed than the groper, is an excellent food fish, and when smoked, is equal to finnan haddie. It is a handsome perch-like fish ranging from 2 to 19 pounds in weight, and frequents water 10 to 40 fathoms deep. There are two species, the more abundant being *Latris ciliaris,* Forster, which sometimes completely fills the fishermen's nets; but another species, *Latris lineatus,* Forster, is much larger, and specimens three feet long have been taken off Tairoa Head. Both are handsome perch-like fishes, silvery on the sides, and lead-colored with a golden sheen on the back.

THE SNAPPER A VALUED SPECIES.

One of the most familiar food fishes, and generally esteemed, is the snapper, *Pagrosomus auratus,* Forster. It is an active, handsome fish, and typical of the family Sparidæ, with a high back, markedly forked tail, serrated brilliant scales, and of a delicate rose color, fading into grey along the sides. The snapper is very widespread, abundant in the north and extending even as far south and west as Dusky Sound. It is plentiful near Auckland and Poverty Bay, especially around the weird eternally-smoking White Island. As many as 2,000 snappers are often taken in a single haul. On hotel bills of fare, in New Zealand, this red snapper is a favorite item, and the firm white flesh, and delicate, if not very marked flavor, cause them to rank high as food fishes.

CONGER, LING AND OTHER FISH WASTED.

Fine conger eels, sometimes of a striking yellow color, frequent the offshore waters, and specimens reaching a length of 6 or 7 feet are quite common. The species is *Leptocephalus conger,* Forster, and it is scaleless, but has very firm and palatable flesh. The conger eel is not eaten in New Zealand, and quantities are dumped overboard each season by the fishermen, and as on this continent are thus wasted; nor does the ling, *Genypterus blacodes,* one of the Ophidiidæ, fare better. Ling range from 10 to 20 pounds or over, and are common on the shores of South Island, but are not eaten, though the flaky flesh is white and salts well.

KINGFISH OR SO-CALLED BARRACOUTA.

The savage looking so-called Barracouta or Snoek, *Thyrsites atun,* Euphrasen, is abundant, three feet long and five pounds and over, in weight. Split and smoked, it sells readily, and large quantities are taken by the fishermen. Its abundance may be judged from the fact that two men will take 250 to 500 in three or four hours fishing. The name Barracouta, is sometimes given to two other fish, namely the king-fish, of the South Island, *Rexea furcifera,* Waite, and the fine silvery kingfish of North Island, *Seriola lalandii,* really the Yellow Tail or Amber Fish of Florida and the Carolinas. The former, which belongs to the Trichiuridæ, exposes two formidable canines on the projecting lower jaw, even when the mouth is closed, and it has thus quite a ferocious appearance. The latter, one of the Carangidæ, is remarkable for the size it may reach, some specimens being 40 pounds weight and 4 feet long; but usually they are smaller, 6 to 10 pounds in weight. Both of these fish are fine food-fish, but do not keep well in a fresh state. Great quantities of the South Island king-fish are split, salted and smoked for home and export trade.

TREVALLY AND OTHER KINDS.

Two fishes common in New Zealand waters are called Trevally, one, *Seriolella brama,* Günther, and the silvery sea-bream generally called the Warehou. The former attains a length of two or three feet (12 to 14 pounds weight) but those of smaller size are better flavored; and the sea bream, *Caranx platessa,* which occurs everywhere, often in enormous numbers ranges from 2 to 3 pounds in weight. The latter is a typical Caranx, whereas the Warehou belongs to the family Stromateidæ, to which the "dollar" fish and other familiar kinds belong. A very handsome species which recalls the salmon on account of its elegant shape and active rapidity in the water, is the Kahawai, *Arripis trutta,* Forster, 3 to 7 pounds or more in weight, greenish grey on the back with lead blue spots, white sides, and a dark elegantly forked tail. It occasionally ascends some of the northern rivers for 30 or 40 miles, and it is not surprising that the name "native salmon" has been given to it, though it belongs to the family Sciaenidæ, under which the sea-drum and many tropical and sub-tropical fishes are ranged. One familiar table-fish has a widespread range, namely the Terakihi (*Cheilodactylus macropterus*), a small elegant bass-like fish ½ to 1½ pounds in weight, though it may reach 6 to 7 pounds; but it is not very highly esteemed by epicures.

FROST FISH (LEPIDOPUS).

Of the less abundant fish, mention must be made of the remarkable Trichiurid, the frost fish or hiku, *Lepidopus caudatus,* Euph., 4½ to 5 feet in length, for which, however, no regular fishing can be carried on, on account of its erratic and peculiar mode of occurrence.

Each season quantities are taken after frosty nights in winter, being cast upon certain flat beaches, and writhing like silvery snakes, 4 to 5 feet long, may be captured by hand, hundreds at a time. The flesh does not keep very well, but it sells at high prices in the local markets, for it is regarded as one of the most delicious fishes in New Zealand waters. The cause of this suicidal tendency is a mystery. Possibly they are male fish, affected seasonally, as has been found to be the case with the pollock, and other marine species.

HAKE, RED COD AND OTHER KINDS.

The esteemed John Dory, *Zeus faber*, the hake, *Merluccius gayi*, sometimes called whiting, the mackerel, *Scomber pneumatophorus*, the sword fish, and a species of pilchard, are native to New Zealand waters. A small herring not to be compared with the herring of northern seas, also occurs. The small red cod, *Physiculus bachus*, Forster, 12 to 20 inches long and 2 to 5 pounds in weight, is very widespread, but vast quantities are thrown away by the fishermen because there is little or no demand for them. The fish is somewhat insipid, but it could be readily utilized on a large scale, for when smoked, its qualities are much improved, and it is one of the most plentiful of inshore fishes. They disappear for a season or two unaccountably, after one or two seasons of abundance.

WASTE OF FINE GURNARDS.

Hardly less abundant is the gurnard (*Prionotus*), of which three kinds occur, the commonest is of a brilliant red color with fine, firm flesh, but so little desired by the public that tens of thousands caught by the fishermen are thrown back into the sea. It is not inferior to the esteemed gurnards of Europe, but is usually wasted in large quantities each season.

FLAT FISHES OF VARIOUS SPECIES.

Of soles and flat fishes, there are many species. The New Zealand sole, *Peltorhamphus,* is very highly esteemed, while the so-called turbot, *Ammotretes,* and the brill and the lemon sole (*Pelotretis*) are very common and of very good quality, but the Megrim (*Caulopsetta*) and Sand flounder (*Rhombus solea*) though extremely abundant, are very much inferior in quality.

THE ESTEEMED MULLET.

Mention must be made of the Mullet (*Mugil*) which has been caught in large quantities in the northern estuaries, 150 dozen being taken at one "set" on the Kaipara River. It has also been canned, and like all the Mullet family, is a most delicate and delicious fish.

A curious Chimæroid fish is surprisingly plentiful. It is the Elephant Fish (*Callorhynchus*) and most grotesque in shape, though handsome, owing to its bright silvery coloration. The flesh is white and firm and might be utilized if public prejudice against the sharks and their congeners could be overcome.

LOBSTERS, OYSTERS, ETC.

Of the crustacea, the reddish spiny lobster, *Jasus Edwardsii,* is extremely abundant, and may be captured in enormous quantities along the shores generally. The flesh is not quite so delicate in flavor as the true lobster, but as in Cape Colony, there is ample scope in New Zealand for a lobster canning industry, the spiny lobster being not only extremely plentiful, but of large size. It must be added that there is practically no claw meat in this species as the nipping claws are very small.

The oysters of New Zealand are very remarkable as one kind is dredged in fairly deep water and another kind, the delicious and delicate rock oyster, is found coating the rocks over large extents of the coast. This latter oyster, *Ostrea glomerata,* Gould, is cup-like in form, and of extremely delicate flavor, but it must be fished for with a hammer and chisel as the bunches of these shellfish adhere firmly to the rocks, mainly in the northern waters of New Zealand. Deep-sea oysters occur especially in the Foveaux Straits in 15 or 20 fathoms, and are of considerable size and exceedingly good quality, though not equal to the rock oyster. They are scientifically called *Ostrea angasi,* Sowerby.

NEW ZEALAND CLAMS ARE SUPERIOR.

A most excellent clam occurs, especially on certain shores of the North Island, called the toheroa, a very delicate and delicious soup being made from these shellfish. Quite a fishing industry has been developed on the clam beds, which occur over considerable areas of the eastern shores.

A few words are necessary in regard to the fresh-water fish which were almost absent from the rivers and inland waters before the white man settled in New Zealand. The native fresh-water species are very few, and not to be compared with the fresh-water species of North America.

EELS, WHITE-BAIT AND OTHER NATIVE RIVER FISH.

Native eels (*Anguilla*) are extremely abundant, and indeed are a menace to superior fish, but the white-bait or small Inunga, is extremely abundant, and much esteemed as a delicacy on the table.* There are several species of so-called native trout or Kokopu (*Galaxias*), and they afford a small amount of sport, but they have been altogether overshadowed by the introduced species, namely the rainbow trout, European brown trout and the Pacific cutthroat trout.

*Locally stated to be the young of the New Zealand Smelt (*Retropinna*) and the so-called native trout (*Galaxias*), but the specimens examined by me were the young of the latter (*Galaxias*).

INTRODUCED TROUT, A GREAT SUCCESS.

These have established themselves thoroughly in New Zealand, and all of them reach a large size. Fish 5 to 7 or 8 pounds are quite common, and specimens have been taken in numbers weighing 25 to even 27 pounds. No fishing in the world can excel the trout fishing in such lakes as Taupo, Rotorua and Wakatipu. The Atlantic salmon, though repeated attempts have been made to establish it, has not been a success. A small proportion seems to have survived, and there are records of grilse being caught around the shores, but the introduction of this species must be regarded as unsuccessful.

QUINNAT SALMON ACCLIMATIZED.

It is otherwise with the spring salmon or quinnat of the Pacific Coast of America. This fine Salmonoid is now thoroughly established in several New Zealand rivers, and the fish spawn regularly each season, so that there is a great future in store for the Pacific species of salmon. Great credit is due to the head of the Fisheries Department, Wellington (Mr. L. F. Ayson), for his zealous and successful fish-culture work. The Acclimatization Societies too merit a meed of praise for their splendid efforts with fish and game.

WHALES, SEALS, ETC.

A closing word must be said about the wonderful whaling and sealing industries which have been carried on for a long period in New Zealand waters. Whales still occur and fur seals are also found, but both are in such diminished numbers, that their total extinction in the near future is to be feared. It is hoped that protective measures may be effectively enforced as the New Zealand Government has shown itself willing to carry out a wise policy in regard to certain native animals. It has extended its protective legislation to marine creatures in a unique manner.

"PELORUS JACK."

It is well known that a fine specimen of Risso's grampus, known the world over as "Pelorus Jack" was protected by special legislative enactment. This creature 14 feet long frequented Pelorus Sound in Cook Straits for over fifty years, and was accustomed to meet and accompany steamers, navigating through the sound. Tourists always looked out for "Pelorus Jack" and under parliamentary protection it continued unharmed until recently when it ceased to appear, and is believed to have been criminally killed, or to have died from old age.

PROMISING FUTURE FOR NEW ZEALAND FISHERIES.

The varied fresh-water and marine products of New Zealand, are such that a great future lies before the fishing industries, if they are developed and properly conserved. Fishing can be carried on all the year round practically, owing to the fact that there is no winter season in New Zealand and the hardships of winter fishing are unknown, though stormy weather, especially on the west coast is often a serious interruption. No systematic prosecution of the fishing industry has really been carried on on an adequate scale, and the limited markets and small local demand may partly account for this, though complaints are common in New Zealand that the people cannot get supplies of their own fish at reasonable rates. There is no reason why canning and curing industries should not be carried on upon a large scale, and New Zealand fishery products shipped to all parts of the world. Instead of importing preserved fish in large quantities as at present, New Zealand should export extensively. The government has indeed had in view a great scheme of fishery development, and my own report made in 1914, will no doubt offer much guidance in this future development.

PACIFIC HALIBUT FISHERY DECLINING

BY JOHN N. COBB, *Seattle, Wash.*

For the past two years the condition of the halibut fishery of the Pacific Coast has been a cause for concern on the part of those interested in its preservation. While the total yearly catch of halibut has been steadily on the increase for some years, thus apparently indicating a healthy condition, yet the reverse is really the case, the increase in catch being far from proportionate to the increase in the fleets operating, while it has been necessary to extend widely the range covered and to increase vastly the amount of gear used in order to secure this catch, thus showing that the reserve or capital stock of fish is being steadily depleted.

In showing the present statistical condition of the industry as compared with some years ago I have selected the years 1904 and 1914, a period during which the greatest changes and expansion in the industry have occurred, and have restricted the data to the Puget Sound fleet, which in both years comprised the greater part of the vessels working on the halibut banks, and the one for which the data are most complete. The catch per dory will be used for comparison as being the one most easily fixed.

In 1904, the Puget Sound fleet comprised 35 sailing schooners, with a net tonnage of 645, and operating 78 dories; 1 power schooner, with a net tonnage of 14, and operating 3 dories; and 3 steamers, with a net tonnage of 108, and operating 18 dories; making a grand total of 39 vessels with a net tonnage of 767, and operating 99 dories. This gives an average of 19.67 net tons to the vessel, and an average of 2.5 dories to the vessel. The catch of halibut by this fleet in 1904 amounted to 11,774,000 pounds, and this divided by 99, the total number or dories, gives an average per dory of 118,929 pounds. This catch brought the fishermen an average of nearly 3 cents per pound for first grade fish.

In 1914, the Puget Sound fleet comprised 90 power vessels, with a total net tonnage of 2,635, and operating 361 dories; and 7 steamers, with a total net tonnage of 1,118, and operating 92 dories; making a grand total for the fleet of 97 vessels, with a total net tonnage of 3,753, and operating 453 dories. This gives an average of 38.69 net tons to the vessel as compared with 19.67 in 1904, a gain in size of 19.03 net tons per vessel for 1914. An average of 4.67 dories to the vessel is also shown, an increase of 2.17 over 1904, when the average number of dories to the vessel was 2.5. The catch of halibut by this fleet in 1914 amounted to 43,305,805 pounds, and this divided by 453, the total number of dories, gives an average per dory of 95,597 pounds. The average price per pound of first grade fish received by the fishermen for this catch amounted to 4.7 cents.

The average catch per dory in 1904 was 118,929 pounds, while the average per dory in 1914 was 95,597 pounds, a decrease per dory in the latter year as compared with 1904 of 23,332 pounds, or about 20 per cent.

In considering this decrease per dory since 1904, the conditions in the former year, and for some little time after, should be taken into consideration. In 1904, there was a limited, but growing, demand for halibut, and as the fleet was more than able to supply this demand but few of the vessels were operated throughout the year. Of the fleet of 35 sailing and 1 power schooners, 11 operated only on the nearby banks, thus tying up or engaging in other business during a portion of the year, while 7 of the remainder fished for halibut in Alaska alone, presumably engaging in other fishing operations or acting as run boats in the salmon industry the rest of the year. Had the whole fleet engaged continuously in the industry throughout the year, as was the case in 1914, the average per dory in 1904 would have been vastly larger than it really was, thus making the decrease since much more pronounced than the figures indicate.

Twelve years ago the fleet was composed almost wholly of small sailing vessels, nearly all of which had their headquarters on Puget Sound, and which operated during the greater part of the year on banks lying within 400 miles of Seattle. During the inclement weather of late fall, winter and early spring a portion of these vessels made their headquarters in Southeast Alaska and fished on the banks in the protected waters of that region, shipping their catch down on the regular steamship lines.

Today the sailing vessel is unknown in the halibut fishery, having been superseded by vessels with twice the carrying capacity of those formerly engaged, the increase in size permitting them to carry double the number of fishermen and dories. These vessels are all powered with gas engines. Instead of getting its catch within easy steaming radius of Seattle, the fleet now fishes mainly on the Alaska off-shore banks, ranging from 800 to 2,000 nautical miles from Seattle. A greater amount of gear to the dory is set at present than was the case twelve years ago, while the introduction, several years ago, of the method of long-line fishing directly from the deck of the vessel permits fishing now in weather when it would not be safe to launch a dory.

Closed Season Proposed:—About two years ago, in the Pacific Fisherman, a journal devoted to the interests of the Pacific Coast fisheries, I called attention to the condition of the halibut fishery, and suggested that a closed season, say from November 15 to February 15, be established. Since then the demand for a protective measure of this sort has been steadily growing. About six months ago the Department of Naval Service of Canada, which department has charge of fishery matters in the Dominion, addressed inquiries to its own halibut fishermen and dealers, endeavoring to learn the exact status of affairs, and inquiring as to whether they favored a closed season. I am informed, through apparently reliable sources, that the large majority of the responses were favorable to the idea of a closed season of from one to three months.

The ideal time for a closed season is when the fish in question are spawning, and, fortunately, in the case of the halibut this comes during the winter months, when fishing is usually prosecuted at the greatest disadvantage. W. F. Thompson, in his Preliminary Report on the Life-History of the Halibut (Rep. B. C. Com'r of Fisheries for 1914, pp. 76-99), as a result of his study of the Pacific halibut, says, "It may be stated with confidence that the halibut breeds on this coast between the middle of December and the last of April or the middle of May." This, he states, may be subject to some variation, but is practically correct.

On February 21 a bill was introduced in Congress, which seeks to establish a closed season on the catching of halibut on the banks in the Pacific Ocean during the months of December and January, and prohibiting, under penalties, any violation of the act; also setting aside a certain area in Southeast Alaska as a nursery for halibut and prohibiting fishing in this restricted area at any time.

As Canadian vessels also fish on these same banks, and a closed season would not be of much value unless it included both nations, the act provides that it shall not take effect until Canada has enacted concurrent or essentially similar regulations governing its own people and vessels.

The fact that the halibut attains maturity slowly as compared with the salmons, for instance, makes it especially necessary that it should have some protection. Thompson's investigations (loc. cit., p. 93), show that "there are but relatively few halibut which mature during the eighth year of their lives, the chances being one in twenty-five against obtaining such a one, and there are fish still immature in the fifteenth year of their age. The eighth is, however, the age of a large proportion of the fish in Hecate Strait at the time of capture. In Hecate Strait but 14 per cent. of the female fish caught had completed their twelfth year and but 5 per cent. their sixteenth year. Off Kodiak Island 31 per cent. were beyond the twelfth year and 12 per cent. beyond the sixteenth. This increased percentage of mature fish may, of course, be characteristic of the banks which have been less intensively fished. However this may be, it is evident that a large majority of fish caught do not reach maturity."

So far as published, his investigations show that the fish from Hecate Strait and off Kodiak Island attain maturity at twelve years of age. He also states that he believes the maximum age attained by the halibut to be about twenty-five years.

The above shows plainly that a large proportion of the fish caught are immature, i. e., fish which have never spawned. As the halibut roe contains about 2,000,000 eggs as compared with say about 2,000 eggs in a salmon roe, this superabundance of eggs deposited by the halibut counterbalances in some degree the late maturity of the species. It is, plain, however, that the first object of the authorities should be so to protect the halibut that a larger proportion may attain to maturity, and the first step should be to prevent the catching of small halibut, knows as "chicken" halibut.

Early History of the Fishery:—The present extensive halibut fisheries of the Pacific owe their inception to the publication in 1886 of a series of very optimistic letters in the Cape Ann Advertiser, of Gloucester, Mass. The enterprising spirit of the New England fishermen prompted them to consider the matter favorably, particularly as they knew from the most reliable sources that halibut were abundant off Cape Flattery at certain seasons. The native fishermen had fished here for their own use (the surplus being sold to the whites living on the shores of Puget Sound) for many years previous.

The pelagic fur-seal fishery, which was then lawful and quite profitable, was another strong inducement for the eastern fishermen to make the venture of sailing "around the Horn," for some believed that this offered unusual opportunities for financial success, while they thought the period between sealing seasons might be profitably utilized by engaging in halibut fishing. The men who entered upon this experiment were among the most skillful, daring and adventurous of their class and, so far as catching fish was concerned, none could be found better fitted for the work.

In the fall and early winter of 1887, three schooners sailed from Massachusetts for Puget Sound. These were the Mollie Adams and the Edward E. Webster, of Gloucester, and the Oscar and Hattie, of Swampscott. The two former were owned by Capt. Sol. Jacobs, who had achieved fame as a mackerel fisherman, and who, after dispatching his vessels, crossed the continent in time to make the necessary business arrangements, pending their arrival. The Mollie Adams made a good passage and reached her destination without mishap; but the Webster met with an accident to her spars before rounding the Horn, put into Montevideo for repairs, was delayed, and finally arrived on the west coast late in the season.

The Oscar and Hattie reached Puget Sound some time later than the Adams, but in time to engage in the halibut fishery, upon which she entered, making her headquarters at Port Townsend. Owing to the want of a suitable market, and to the fact that the schooner had to go to Tacoma to ship her catch east, the fishery from this place was followed with loss rather than profit. The Oscar and Hattie carried 6 dories and a crew of 14 men.

About two-thirds of the catch was sold fresh and the remainder was fletched. The result of the season's work in 1888 was 240,000 pounds of fresh and fletched fish, with a value (at the prices paid the fishermen) of $7,600. The average price received for fresh halibut was 3 cents per pound, and for salt fish 3½ cents per pound.

The catch shipped east by the Oscar and Hattie was the first shipment so made, and it went forward by the Northern Pacific railroad. The ice used cost $22.50 per ton (more than five times the present cost of ice), and the high freight rates charged by the railroad took all the profit of the shipment.

On July 24, 1888, the schooner Mollie Adams left Seattle, bound north on a fletched halibut trip, the first one of its kind that had been undertaken on the Pacific Coast.

But few halibut were captured until the schooner arrived off the southern extremity of the Queen Charlotte Islands, where they were found in great abundance and of larger size than on the grounds off Cape Flattery. A few of those taken were estimated to weigh over 300 pounds each. About half of the number obtained were large enough for fletching, the remainder being used as bait or thrown away. The fishing was carried on in depths of only 30 to 45 fathoms.

On the morning of September 8, the Adams having "wet" all her salt, started for home with 150,000 pounds of fish. In the meantime, after a lot of trouble, her owner, Captain Jacobs, had arranged for a rate of $1.25 per hundred pounds for the transportation of the fish across the continent to Gloucester. After deducting expenses the members of the crew received $175 each, or at the rate of nine dollars a day for nineteen days' fishing.

It was soon found that Port Townsend was too remote from railroads for shipping purposes and in a very short time Seattle became the headquarters of the schooner fleet. The New England Fish Company, an American firm, soon after located at Vancouver, British Columbia, while the International Fisheries Company, located at Tacoma, Wash., put on fleets of steam vessels, and have since been important factors in the development of the industry.

Fishing Banks:—For a few years the fishing for the fresh markets was confined to Flattery Bank, located off Cape Flattery, at the mouth of the Straits of Juan de Fuca, and extending from close in shore to some twelve or fifteen miles off the cape, in depths of water ranging from 35 to 75 fathoms. From early in the spring until the middle of June halibut can be obtained on these grounds in paying quantities, but later in the season dogfish and sharks strike in, driving nearly all the edible fishes away.

The steamers early devoted their attention to the banks which had been discovered in Hecate Strait and Dixon Entrance. Later good grounds were found in the neighborhood of Cape Scott, on the northern end of Vancouver Island, British Columbia. Another, and for some years, one of the most prolific grounds yet discovered, lies off the northern end of Graham Island, between Rose Spit and North Island. All along this shore, for a distance of sixty miles, good fishing was found in from 25 to 40 fathoms for a number of years.

The chief objection to most of these banks was that they were in the vicinity of islands belonging to Canada, which government, for some years, harassed our fishermen in every way possible, and as a result of this condition of affairs and the gradual exhaustion of the Canadian banks, our fishermen began seeking new banks in Alaskan waters. Small banks lying in what are known as the "protected waters," i. e., the bays, straits and sounds dividing the numerous islands forming the greater part of Southeast Alaska, had been fished by both whites and indians for some years, but they were not prolific enough to justify the larger vessels resorting to them. During the winter of 1909-10 several of the steamers prospected the open waters between Cape Muzon and Sitka, with the result that halibut were found in great abundance throughout the greater part of this area. Off Forrester Island seemed to be the center of greatest abundance. Here an average depth of 80 fathoms is found for about four miles from shore; a little farther out it deepens to 150 fathoms. The first few cargoes from here averaged fifteen pounds to the fish, but the average soon dropped to fourteen pounds.

As these banks became depleted the fleet gradually worked its way north and west, first off Sitka, then on the Fairweather ground, then off Prince William Sound, and at the present time some of the vessels fish as far west as Portlock bank, near Kodiak Island.

It is probable that ultimately the larger vessels will be compelled to fish as far west as Unimak Pass. It is known that halibut are to be found, supposedly in limited numbers, on the famous cod banks in the section between Kodiak Island and Unimak Pass.

THE NEW ENGLAND FISHERIES, 1915

BY FREDERICK F. DIMICK, *Boston, Mass.*

The following notes from the Annual Report of the Boston Fish Bureau will be found of interest to our members:

Reviewing the fisheries of the year probably the most sailent feature has been the improvement in the mackerel fishery. The total catch of these fish on the northeastern coast of North America amounted to 138,466 bbls.—96,564 bbls. fresh, and 41,902 bbls. salt.

Among the impressive events of the year might be mentioned the introduction of the tilefish by the Bureau of Fisheries. The efforts of the Bureau to popularize this fish has met with splendid success. It seems almost incredible that fish of so much value covering an area of 70,000 square miles, 50 to 75 miles south of Nantucket, should not have been marketed before.

A subject coming before Congress is the destruction of the dogfish. These fish destroy the food fish, and hamper the operations of the fishermen. The amount of fish destroyed by man is but a drop in the bucket compared with the amount consumed by dogfish and other predaceous fish.

Too much importance cannot be laid on care in the preparation of fish for market whether fresh or salt. The new law in regard to the inspection of fish that went into effect in Canada on the first day of May, the object of which is to bring into general use a strong barrel of a standard size for marketing pickled fish, to raise the standard of curing and grading fish, should be a benefit to trade.

A bill has been introduced into Congress to limit the time that fish can be held in cold storage to three months, and contains other pernicious regulations. If this bill becomes a law it will increase the cost of living, and cripple the fishing industry.

FRESH FISH.

On March 30, 1916, the business at the Boston Fish Pier, where the fresh fish business of the city is conducted will have been in operation for two years during which time substantial progress has been made. The buildings in this part of Boston that comprise the Boston Fish Pier constitute a city by itself.

Groundfish:—The catch by the fleet that makes this port its headquarters shows an increase. In the spring and summer the fleet landed good catches of haddock. Codfish, however, have been in comparatively light supply. Receipts were decreased in the fall by a strike of the fishermen of the steam trawlers.

The fishing fleet numbered about the same as in the previous year, 330, of which 167 were sailing vessels, 13 steam otter-trawlers, and 150 boats of various kinds.

The catch of the Gloucester gill netters, that is largely received here, amounted to 7,400,000 lbs. compared with 8,500,000 in the previous year.

Prices of haddock, by months, ex vessel, have ranged about as follows: (Dollars per 100 lbs.)

	High	Low		High	Low
Jan.	$8.00	$2.00	July	$4.10	$1.10
June	5.50	1.25	Dec.	8.50	2.10
May	7.00	.90	Nov.	8.00	3.25
April	4.50	1.00	Oct.	6.90	1.50
March	6.50	1.25	Sept.	6.00	1.25
Feb.	8.00	2.00	Aug.	4.75	1.15

Some of the best stocks were:

Vessel	Captain	Stock
Pontiac	Ernest Parsons	$50,735
A. Piatt Andrew	Wallace Bruce	46,124
Commonwealth	Frank Watts	43,709
Mary C. Santos	Manuel C. Santos	43,000
Elizabeth W. Nunan	Frank Nunan	36,172
Natalie Hammond	Chas. Colson	32,970
Progress	Antonio King	32,000
Mary P. Goulart	A. Goulart	24,800

Mackerel:—The southern mackerel fleet got an early start, the first vessel sailing sixteen days earlier than the previous year.

The first trip of mackerel was landed April 9, schooner Rob Roy, at Lewes, Del., 3,240 mixed mackerel, caught 100 miles east by south from Cape Henlopen in 40 fathoms. First arrival at Chincoteague April 16; first catch at Chatham, April 20; at Seaconnet, April 20; near Yarmouth, N. S., May 14; at New York, from Carolina trap, March 24.

The first Cape Shore arrivals from the fleet were on June 7th, ten vessels having an aggregate of 430,000 fresh mackerel. Sales were made at 15 to 16 cents each for large, 8 to 10 for medium, and 4 to 6 for small. The first arrival the previous year was on June 8th, and sold at 17½ cents for large, and 8 cents medium.

The total receipts from Cape Shore were 781,000 fish, compared with 503,000 the previous year.

The total catch of fresh mackerel by the fleet amounted to 71,564 bbls. against 68,582 the previous season.

Foreign receipts of fresh mackerel show an increase of about seventy-five per cent.

Some of the best stocks by mackerel seiners were:

Vessel	Captain	Stock
Str. Lois H. Corkhum	William Corkhum	$33,200
Lottie G. Merchant	Ralph Webber	33,000
Monarch	John Seavey	28,884
Marguerite Haskins	Reuben Cameron	28,809
Arthur James	John Matheson	26,959
Rob Roy	Lemuel Firth	26,158

Herring:—The catch along the shore was a moderate one. The first seine herring were taken at Gloucester, April 25th. The first herring bait at the same place, April 1, 500 fish.

Swordfish:—Swordfish were in good supply during the season. The fleet comprised 42 sail, and fished mostly to the eastward but experienced much bad weather.

On July 20th there were 17 arrivals at the Boston Fish Pier having 1,126 fish from Georges, probably the largest number of swordfish ever landed in one day. Sales at 8 cents per pound.

Schooner Gladys B. Simmins, from Georges, the first arrival, June 21, twenty-six fish, sold at 20 cents per lb.; the first the previous year, schooner Virginia, 16 fish, June 24, sold at 21½ cents per pound.

Schooner Albert D. Willard, Capt. Fred Bickford, is high line of the swordfish fleet, having stocked $6,800, the crew sharing $270. In four trips this vessel landed 278 fish.

Halibut:—About 30 vessels engaged in this branch of fishing on the Atlantic coast, and made good stocks.

The catch on the Pacific coast was 33,133,313 lbs., compared with 41,825,575 the previous year. The average price paid the vessel this year was 5.7 per lb.; in 1914, 4.7.

A closed season in the halibut fishery is being agitated on the Pacific coast from November 15 to February 15, and it is reported that the fishermen are largely in favor of it with the hope of putting the industry on a more profitable basis, and conserving the supply for future fishing.

Some of the best stocks of vessels on the Atlantic coast were:

Vessel	Captain	Stock
Richard	Augustus G. Hall	$30,500
Rex	Robert Wharton	29,839

Tilefish:—The schooner Hortense that arrived at Boston Fish Pier, December 23, with 16,000 lbs. of tilefish, had the first trip of these fish ever brought into Boston by a fishing vessel fitted out especially for that kind of fishing. They sold at 4c per lb. The fish varied in size from 8 to 40 lbs. each, and were caught 90 miles southeast of New York on the western slope of the Gulf Stream.

FROZEN FISH.

Most all kinds of frozen fish have been in good supply, and large quantities have gone into consumption, including mackerel, salmon, halibut, herring, butterfish, haddock, whiting, etc. During periods of scarcity of fresh fish caused by bad weather it has been most always possible to obtain frozen fish of fine quality.

Herring:—Shore frozen herring have been in fair supply. Large shore herring from Maine of fine quality have been received, and were in good demand, as they compare quite favorably with Newfoundland fish. Blueback herring have been in good supply.

Newfoundland herring were in light supply and sold at high prices. The receipts the winter of 1914-1915 amounted to 12,990 bbls. compared with 15,090 in the previous season.

Smelts:—This kind of frozen fish is in good demand during the winter months. The mild weather in the fall put off the fishing operations and receipts were late in coming from Canada. The fish are running of small size.

Mackerel:—Frozen mackerel have been in good supply. During the summer when mackerel were plenty on the shore considerable quantities were put into the freezers.

The fresh mackerel netters fished later in the season than usual this season which was unfavorable to the distribution of frozen fish.

Other Frozen Fish:—Squid and whiting have been in fair supply. Squid have been exported to Canada and Newfoundland where the catch of these fish was a failure. Whiting have been in fair supply. Salmon and halibut have been in good supply.

SHELL FISH.

The first shipments from Nova Scotia for the season were received December 19, 1915, 499 crates, and sold at $25.00 per crate. The first, the previous season were received December 21, 260½ crates, and sold at $25.00 per crate for large, and $15.00 for small.

Total foreign receipts of lobsters were 43,943 crates as compared with 22,741 the previous year.

The latest information of the lobster fisheries of the Atlantic coast, covering the year 1913, shows the total catch and value of lobsters, as follows:

	Pounds	Value
Maine	7,670,667	$1,525,776
New Hampshire	301,710	108,560
Maine	1,524,389	290,423
Rhode Island	1,283,056	197,960
Connecticut	724,435	131,767
New York	435,811	81,783
New Jersey	301,349	54,155
Delaware	25,600	4,398
Total	12,267,017	$2,394,822

SALT FISH.

Mackerel:—The production of salt mackerel of the world owing to the small amounts cured in Ireland and Norway was the lightest on record.

Our first receipts of salt mackerel of any consequence came from Cape Shore. Ten vessels arrived from there, June 7th, having a total of 1,462 bbls. They counted from 180 to 200 fish to a barrel and sales were made at $8.00 per barrel. The total catch of the Cape Shore fleet amounted to 3,400 bbls., and sold from $7.50 to $8.50 per bbl.; the previous year 2,775 bbls., and sold at from $9.00

to $10.00 per bbl. The Cape Shore fleet numbered 19 sail, compared with 31 the previous year.

When the market was glutted with fresh mackerel considerable were sold for salting. The shore fish were of desirable size, but early in the season the demand was light owing to the unsettled conditions caused by the war.

Shore mackerel sold in July ex vessel at from $9.00 to $14.00 per bbl.; in August from $14.00 to $14.50; September $15.00 to $17.00; October $17.50 to $19.00.

A small fleet went to the North Bay, but were unsuccessful owing to bad weather.

The catch at the Magdalen Islands was the best for five or six years, but at other points in Canada the production was light.

The amount salted in Ireland was light owing to the good demand in the English markets for fresh mackerel. A large portion of the Norwegian catch was also consumed fresh.

The catch of salt mackerel of the leading countries of the world, compared with 1914, were as follows:

	1915		1914	
United States	19,691	bbls.	15,521	bbls.
Canada	26,281	"	24,277	"
Ireland	6,915	"	30,830	"
N'rw'y and Sw'd'n	12,211	"	35,512	"
Total	65,098		106,140	

Codfish:—The feature of the codfish trade has been the unprecedented demand for fish for export due to the conditions caused by the war. Good prices prevailed through the year.

The vessels engaged in the Bank fishery brought home good catches. The Cape North fleet although bothered some at first by ice in obtaining bait returned with good trips. The fleet made good catches of fish on the fishing grounds in the Gulf of St. Lawrence off Perce, Quebec, where codfish were abundant.

The first fare of trawl Bank codfish arrived at Gloucester, June 15, schr. Athelete, having 280,000 lbs., and sold at $3.50 per cwt. for large and $3.25 for small.

Schooner Athelete, Capt. Thos. Benham, is also high line of the codfish fleet, having stocked $19,500.

The catch of the leading countries of the world, compared with 1914, has been as follows:

	1915		1914	
New England	370,235	qtls.	354,526	qtls.
Pacific Coast	124,000	"	105,530	"
Nova Scotia, Lunenberg	227,243	"	154,065	"
Newf'd and Labrador	1,282,088	"	1,149,168	"
France	242,103	"	241,714	"
Norway	2,385,714	"	2,910,714	"
Total	4,631,383		4,915,717	

Hake, Haddock and Pollock:—Hake have been in light supply, and sold during the year from $3.1/8 to $3.75 per qtl., from first hands. Hake, haddock and pollock have been in good demand for export. Haddock have sold from $3,50 to $3.75 per qtl. Large Cusk from $4.25 to $5.25, medium from $3.25 to $4.00. Pollock from $2.75 to $3.50.

Herring:—Pickled herring, owing to the light importations as a result of the war, have been in light supply, and receipts have sold at unprecedented high prices. Canadian and Newfoundland packers have put up herring in the Scotch style that have been in good demand. The imports of herring into the United States for the ten months ending October were 51,404,992 lbs., valued at $2,017,686, compared with 65,343,563 lbs. valued at $2,141,884 for the same period in 1914.

Salmon:—Pickled salmon have been in light supply and sold at good prices as the amount cured on the Pacific coast was only one-third as much in the previous year.

Alewives:—Although the catch of alewives was good the amount cured was light and the end of the year finds these fish in short supply. Five hundred fish were taken at Edgartown on Feb. 25, the first catch at that place during the season, and was earlier than usual.

SMOKED FISH.

Box Herring:—These have been in good supply during the year and prices have ruled low. The supply that comes to this market is small in comparison with past years.

Bloaters:—Smoked bloaters have been in good supply as the Newfoundland fishery that supplies the fish for this article was quite successful. The receipts from the fleet the winter of 1914-15 amounted to 47 cargoes, 41,619 bbls. salt bulk, 4,489 bbls. pickled herring. The previous season there were 36 arrivals with 26,011 bbls. salt bulk, and 7,597 bbls. pickled.

The season of the winter of 1915-16 promises to be a successful one, and most of the cargoes were obtained at Bonne Bay.

The herring sold ex vessel at $5.25 per bbl. for salt bulk and $5.75 to $6.00 for barrelled herring, probably the highest prices ever paid.

Salmon:—The supply of these has been light, and they sold during the year at good prices.

Halibut:—The fleet engaged in supplying these fish only comprised two vessels. The schooner Maxine Elliot arrived Sept. 14, having 75,000 lbs., and reported fish scarce and weather conditions unfavorable.

Finnan Haddies:—The output of finnan haddies has been light as during the smoking season fish were in light supply and sold at high prices. The receipts from Nova Scotia have increased.

CANNED FISH.

Sardines:—These have been in good supply and sold at low prices. A large quantity went into consumption. The pack, which is estimated at 1,800,000 cases, has been largely distributed.

The pack in 1914 amounted to 1,600,000 cases. The end of the season of 1915 the pack was light, and prices advanced, and the new season will open with light stocks on hand.

Lobsters:—Owing to the light demand for export, the total pack in Newfoundland has been light. The total pack amounted to 5,579 cases, compared with 11,000 cases the previous year.

The total pack in Canada for the nine months ending December 31, 1915, amounted to 157,416 cases, compared with 145,200 the previous period.

Salmon:—The pack of salmon on the Pacific coast has been 7,998,601 cases, against 6,781,282 cases the previous year.

Clams:—Canned clams have been in fair supply, and the pack was an average one. Prices obtained for them was about the same as in the previous season.

THE WORK OF THE PENNSYLVANIA FISH COMMISSION

By N. R. Buller, *Commissioner.*

The Department of Fisheries of the State of Pennsylvania was organized under the provisions of the Act of April 2, 1903. The act authorized the appointment of a Commissioner of Fisheries and four other citizens of the Commonwealth, who together should constitute the Fisheries Commission. It also authorized the appointment of a clerk and stenographer and the Department was empowered to take charge of all hatching and fish cultural stations in this Commonwealth.

The duties of the Department of Fisheries are to provide for the protection and propagation of fish and to promote and encourage the development of the fishery interests; to obtain and publish information respecting the extent and conditions of the fisheries of the Commonwealth; and to make rules and regulations for the enforcement of all laws designed for the protection, extension and propagation of fish.

The Commissioner of Fisheries is the president and executive officer of the Fisheries Commission, and is also chief superintendent of all hatching stations and fish cultural establishments now existing or which may hereafter be established. He has full control, direction and management of all fish wardens, or water bailiffs, and of the work of the enforcement of the laws relating to the protection, propagation and distribution of fish. All fish wardens, constables, police, sheriffs and guardians of the peace, are required to make prompt report to him of all cases of violation of the laws relating to fish.

The Department has under its control six hatcheries which are devoted to the hatching and propagation of fish. These establishments are located in Erie, Centre,

Note—A portion of an address delivered before the Third Pennsylvania Welfare, Efficiency and Engineering Conference held at Harrisburg, November, 1915.

Wayne and Philadelphia counties and are each in charge of a superintendent, said superintendent being responsible for the operation of the hatchery to the Commissioner of Fisheries.

Experience has shown that economy in any business is only attained by the use of the latest and most improved methods, and the Department, since my incumbency, has devoted much time and labor to the rehabilitation of the hatcheries, to bring them up to the highest point of efficiency, so that they will be entirely up to date in every way for the propagation of fish, and when they are completed will be a credit to the Commonwealth. The old wooden structures are being replaced by substantial buildings of concrete, brick and steel.

The next factor is efficiency, because without efficient workmen, the best implements are no better than poor ones. It is here that the Department finds itself badly handicapped, on account of all the hatcheries being undermanned.

The work of the fish culturist is hard and the hours long, and it is only after years of training that a man attains that efficiency which is so essential in the propagation of fish. The men are now not only overworked, but are unable from the smallness of their number to get all out of the hatcheries that these would do if properly manned. Lack of appropriations accounts for this condition. Too much water running in a trough or battery would mean destruction to millions of eggs or fish, and the same would result from the stoppage of the water. Hence, the troughs and batteries must be under the constant and trained eye of some one all the time. The attendant must be always on the alert to detect the first symptom of trouble among his charges, and be ready at an instant to meet the trouble. Contagion spreads like wild fire and may undo the work of months. In shipping fish the messenger must be one who understands the habits of his charges, and see to it that the water is kept aerated and at the proper temperature, for without this only dead fish will reach the recipient. The messenger, it might be well to state, accompanies the fish from the time they are placed on the train in shipping cans at the hatchery, until the last can of fish is delivered to the applicant, oftentimes making it necessary for him to be on duty all night and part of the next day without any sleep. Each applicant is requested to report to the Department the condition of the fish when they are received. In this way the Department is in possession of much valuable information which assists it in its work.

It has been difficult to keep men in the employ of the Department owing to the inadequate salaries that the Department is able to pay under the appropriations made by the Legislature. As the men are trained by the Department and become efficient they are sought for and bought up by offers of a much higher salary than the Department is able to pay. The result is that the Department makes the man and some one else gets the benefit of the training.

What is true of the hatcheries is true of the *field work.* Field work is really as important as the work at the hatcheries. It means the gathering of the spawn from the fish in the natural waters that would otherwise be lost. The millions of eggs gathered at Erie would be entirely wasted were it not for the efforts of the Pennsylvania Department of Fisheries in collecting them, hatching them and planting the young fish in the lake. This is shown by the fact that the supply of fish is kept up and that the port of Erie, today, is the largest fresh water fish market *in the world,* yet Pennsylvania has only forty miles of shore line on the lake. The people of Pennsylvania should be proud of this distinction as it means much to the Commonwealth in the commercial and business world. The amount of nets set every day runs into hundreds of miles and the production of fish last year was 9.205,767 pounds, valued at wholesale at $393,700.48, or about 4½ cents per pound. These figures convey forcibly the value of the fish business in Lake Erie, where the city of Erie is only one of a number of fishing ports. The value of the boats and tackle used in taking the fish and the warehouses where they are handled runs into millions of dollars and gives employment to hundreds of men.

The most remarkable thing, however, in this matter and one in which the Pennsylvania Department of Fisheries takes pride is the fact that all this immense business is due to the artificial propagation of fish by this Department, by the United States Bureau of Fisheries and other State Commissions, and the whole restocking is done by saving the eggs which would be a waste product if it were not for the work of the hatchery men. There is not the slightest question in the mind of any fisherman as to the value of the work done by the Pennsylvania Department of Fisheries in this matter, because it was not many years ago, before the artificial propagation was taken up, that the catch of fish had so fallen off that the pursuit of fishing was no longer profitable.

The figures given above do not convey entirely the immensity of the business because they show the wholesale prices and the persons who use this large supply pay from 50 to 100 per cent. advance on these figures on account of freight and handling by the fish dealers. Taken altogether the fish industry at Erie is a most valuable object lesson as to the value of artificial propagation of fish in furnishing a very important food supply to the people. If Lake Erie, with the tremendous drain made upon it by the fishermen, can be kept stocked with fish, it shows that the other lakes and streams in Pennsylvania can also be restocked to their former productiveness if the hatcheries are worked to their full capacity and the fishermen observe the laws against wasteful and destructive methods of fishing.

Another duty which devolves upon the Department is the enforcement of the laws governing the protection of fish in our streams. The enforcement of the law comes under the small force of wardens which the Department is able to employ. The law allows the appointment of 30 citizens to act as fish wardens but unfortunately the Legislature appropriated only sufficient money to employ regularly ten men. This small force is expected to cover this great Commonwealth of ours with its numberless miles of streams and every warden is obliged to hold himself in readiness to go to any part of the Commonwealth on a moment's notice. This very largely increases the traveling expenses pro rata, because the men have to travel such long distances. It is hoped that the importance of this branch of the work of the Department will be realized and enough money appropriated to allow the employment of the 30 men. The wardens also have to look after the pollution of the streams and are now giving this their serious and careful attention. Under the provisions of the Act of May 1, 1909, the Department is given the authority to keep the streams clear of pollution, and this is the most serious and stupendous question which the Department is called upon to face.

Much time and thought has been devoted by the Legislature in the past half century of this Commonwealth and other states in making laws which would restore the streams to their original purity, prevent the wasteful and destructive devices from being used, and at the same time establish plants where fish can be raised artificially and used to restock the depleted streams. Yet the man who is fishing has found himself face to face with the fact that the laws do not enforce themselves, but can only be enforced by the consent and help of every citizen who believes that these laws are justified.

The common law which is the basis of our laws is merely crystalized common sense, evolved from the necessity and demands of the people for protection in property and personal rights. Around this there have grown up statutory laws which are enactments of the representatives of the people called for by the force of circumstances and by new conditions that constantly spring up. In most cases their proper enforcement demands that the public be taught their reason why and the benefit to be derived from their enforcement. This is largely true in the case of the laws governing the fishing which involve the protection of the fish and the clarification of the streams and the restocking of the same by artificial methods. As the population grew and the number of fishermen increased it became necessary that the rights of the people in the fish should be guarded by law in the same manner as the rights of the people in property are guarded. It is a self evident proposition to people who look into the matter that fish should not be taken during the spawning season, and while on the nest, or else there will be no supply of young fish to grow up and take the place of the larger ones which furnish the sport and food.

No sane person would take the setting hen from her nest to furnish a meal for the suddenly arriving guest, and the same should be true in regard to taking a fish which is guarding its nest, and at which time it is as easily caught as the hen on her eggs. The farmer who kills all his chickens before they reach the egg-laying period will in a short time have no eggs, and the same is true of the persons who take the small fish before they reach the size and age when they can reproduce themselves.

It is to prevent such wasteful destruction that the laws were formulated and if the people can be educated to understand the reasons for these laws, as set forth above, there will be as common an assent to their enforcement as there is to the laws protecting people in their rights of property.

The fish of the State are the property of the Commonwealth and are for the use and benefit of the whole people, not only as a very important food supply, but as a means of sport and recreation. The importance of laws protecting fish from wasteful methods of fishing are not new, as we find them to have been enacted in England as far back as the twelfth century. Having taught the people the importance of the laws protecting the fish so that they will propagate and multiply, it will be an easy matter to create an aroused sentiment of the absolute importance of keeping the waters of the Commonwealth pure and undefiled so that the fish may live and thrive therein. In fact public sentiment is aroused to such an extent at this present time that the Department is receiving complaints daily with reference to the pollution of some streams.

I have given this question of pollution of the streams much thought and the Department now has a plan of filtering refuse from the various manufacturing establishments throughout the Commonwealth which it will recommend and which it knows from practical demonstrations will absolutely prevent refuse from getting into the streams and which can be installed at a very moderate cost to the manufacturer or mine owner. I have had this filter system patented, paying for same out of my own personal funds, and will turn the patent rights over to the Commonwealth of Pennsylvania insofar as the Commonwealth is concerned. This system of filtration is the fruit of much thought and time given to it by one of the wardens of the Department, Mr. Albert, and myself and we know that it will do the work. The Department will be pleased and intends to furnish blue prints of this system to every manufacturer in this State and will insist upon it being installed as it has so much confidence in its practicability that it does not hesitate to recommend its installation. This system of filtration will take care of and purify refuse from tanneries, dye works, chemical mills, oil refineries, mines, nitro glycerine works and creameries. The Department has on file in its office scores of letters from manufacturers in this State who are only waiting for the blue prints to go ahead and install this system. The Department has found that the manufacturers as a whole are willing to cooperate with the Department in its work, which is very gratifying and now since it has something which it can stand back of it expects to accomplish much along this line of work. It is the biggest and most serious question the Department of Fisheries of Pennsylvania has to contend with today and, with the hearty co-operation of all those who are interested in the preservation of fish life in our streams, the Department expects to restore the streams to their former pure state so that there will be good fishing for all.

The Department of Fisheries is very much in earnest in its efforts to bring about the clarification of the streams, because its success in restocking the streams and waters depends almost entirely upon the ability of those waters to sustain fish life, not destroy it.

In order to interest the growing generation in the protection and preservation of fish life the Department has had prepared a Bronze Cabinent, known as "Bulletin Number 9," in which it has placed a number of vials containing some phases of the growth of the fish from the time it is in the embryo in the egg until it has started in the race for life. The specimens are taken, in one case from the trout as the representative of the game fishes of the Commonwealth, and in the other instance from the white fish as the representative of the commercial fish.

There is nothing more important in the eye of the Department than the enlisting of the rising generation as the friends of the fish. If the boys and girls of the Commonwealth can be shown how the fish lives, its habits, its instincts, and all the various phases of its life, they will become interested and incited by the interest, will be impelled to follow the study as they grow older. The more thoroughly they acquire an interest in the mysteries of the lives of the dwellers in the water, the more they will become convinced that the requirements of the laws which have been enacted to safeguard the fish are necessary for its protection in these days of constant growth in population. Describing the cabinet, a bulletin has been issued which tells of the characteristics, of the fish, where they differ, and of the growth from the embryo to maturity.

To the person who knows nothing of its life and habits, the fish represents only so much of a portion of man's food. But to one who studies the life of the fish and its habits, there is opened a volume as interesting as any upon the book shelves of the library.

The Department has had prepared a bulletin which treats of the capabilities of an acre of water in raising fish and is pleased to say that it is one of the most popular ones compiled by the Department. The co-operation of the farmers is needed by the Department, because if the farmers will take up the culture of fish they will be able to add largely to the food supply of the people, which in these days of high living is very essential. It has been said that it is not the "high cost of living," but the "cost of high living," which keeps the prices of commodities up, but I will leave that for you to decide.

NOTES ON ONEIDA LAKE FISH AND FISHERIES

By Chas. C. Adams and T. L. Hankinson.

"A systematic study of the water life of our State should be made without delay and with the utmost thoroughness in detail. * * * Information of this kind is greatly needed, and is received slowly because the number of observers in the field is very limited. New York has not done as much work in the study of the life histories of its fish as some other States, and yet the importance of its assets in this direction is out of all proportion to the outlay of effort and money devoted to biological surveys." Dr. T. H. Bean, Fourth Annual Report, New York State Conservation Commission for 1914, p. 333, 1915.

INTRODUCTION.

The New York State College of Forestry at Syracuse is located within less than an hour's trolley ride of Oneida Lake. This lake is the largest body of water wholly within the state. It has an area of about 80 square miles, of which about 13 are of shallow water, abounding in water plants, fish food, and suitable breeding places for a large number of species. From the standpoint of food and game fish this lake is one of great importance and there has been no comprehensive working plan for the lake toward which its management might be directed to produce the maximum amount of food and game fish. Thousands of people from Syracuse and the smaller neighboring towns fish there. This is a very important lake for eels and other food fish, and the frog industry is the most extensive in the state, and one of the most important in the United States. Clearly such a large lake should not be managed solely to the angling interests, but should produce an abundance of fresh food fish for this part of the state. There is as much reason for the *diversified use of the waters,* causing them to be used for recreation (picnics, boating, angling, etc.), for the production of food, as a part of the canal system (for transportation and for water storage) as there is for the diversified utilization of farm and forest lands (cf. Adams '16, Diversified Forestry, Jour. N. Y. State Forestry Associa., Vol. 3, pages 25-26). Economically, therefore, it is unwise to advocate the use of Oneida Lake primarily for angling as some enthusiasts are inclined to do. It should also produce much excellent food fish.

Considering the importance of this lake, it is strange indeed that so little accurate information is recorded about its fish, although a State Hatchery has been located upon its shores for several years. New York State has indeed been backward instead of leading in the study of its fresh water resources. This condition of affairs was soon realized, particularly with regard to Oneida Lake, when the college attempted to utilize it for field excursions and demonstrations in its courses devoted to training foresters in the elements of fish conservation, protection and breeding. It was early learned that the fish of the lake must be investigated carefully and in detail if a firm foundation is to be laid for sound instruction, and furthermore, if the best use is to be made of this resource at the door of the college. In addition to this educational problem, the college has other obligations which relate this lake study to its investigative work on the utilization of forest lands. Most forest lands contain, as in the Adirondacks and Catskills, a large number of lakes, streams and swamps which should be made to produce game and food fish. Thus on the investigative side this is the continuation of a policy initiated by Dean Hugh P. Baker when he published the paper by Professor W. M. Smallwood, entitled: "Preliminary Report on the Diseases of Fish in the Adirondacks," etc. (Technical Pub. No. 1, 1914, N. Y. State College of Forestry, Syracuse). As rapidly as possible the college will extend its investigations to other lakes and streams, and in this work it seeks the co-operation of local organizations wishing surveys made in their vicinity, as such assistance will hasten the progress of this kind of work.

In the study of Oneida Lake, naturally, the first step was to make a general inventory of its fish population and their associated animals and plants which directly or indirectly influence them. In August, 1915, work was begun, under the supervision of the senior author, and with the co-operation of the junior author, and Mr. Frank C. Baker, Zoological Investigator of the College. Mr. Baker made a special investigation of the molluscan life of the lake, as related to the fish, and the results have been published (Baker '16) as a bulletin by the college, to which the reader is referred for a summary of the American work on the relation of molluscs to fish, particularly as fish food, and for the results of a detailed study of the stomach contents of many Oneida Lake fish. This is an important investigation and the first of the kind ever made on Oneida Lake.

Up to the present time the western fourth of the lake has been examined, and the present paper is intended to indicate only the general phases of the study. The detailed results will be published by the college as a Technical Bulletin. In addition to the general inventory, an effort has been made to increase our knowledge of the relative abundance of the species, their habitats, habits, feeding and breeding grounds, food, enemies, and associated vegetation. Upon the basis of such a survey it is hoped that more detailed studies will be made which will ultimately lead to the intelligent management of this important lake. During the summer of 1916 these investigations will be continued.

PHYSICAL AND VEGETATIONAL FEATURES OF THE LAKE.

The physical features of the lake have recently been well summarized by Baker ('16) from which the following items are taken: The lake is 21 miles long with a maximum width of 5.5 miles, a maximum depth of about 55 feet, and the shores are generally low and bordered, particularly at the western end, by very extensive shallow water areas and swamps. The shore line is about 65 miles long. The area of the lake is about 80 square miles of which 6.8 square miles are not over 6 feet in depth, and between the 6-foot and 12-foot countours there are 6.2 square miles; the total shallow water area is thus

13.03 square miles, or 16 per cent. of the total area of the lake. The lake is thus both large and shallow and in striking contrast with other New York lakes and the Great Lakes, which also have but little shallow water.

The shallow waters are usually bouldery, particularly the projecting points, and in the bays sandy, with organic muds in the most protected coves. The shallow waters abound in vegetation, except upon exposed points and shores where wave action is too strong. On moderately exposed places water willow (*Dianthera*) and bulrushes (*Scirpus*) thrive, while in the bays a great variety of water plants abound, including *Valisneria, Castalia, Decodon, Myriophyllum* and many others. This lake is particularly favorable for the study of the relation of water plants to fish.

ANGLING ON ONEIDA LAKE.

It is seldom that a large inland city is located so close to a large lake abounding in game fish. The exceptional opportunities about Syracuse for anglers are much appreciated, as is shown by the large number of persons who belong to angling organizations. The oldest and largest organization, the Anglers' Association of Onondaga, has over 600 active members. This association has not only planted millions of fish, received from the Federal and State authorities, but has recently, in co-operation with the college, established a fish nursery at the College Experiment Station at Syracuse for rearing young fish to a favorable planting age. These facts are indicative of the character and amount of interest shown in the game fish.

If one attempts to summarize approved methods of angling in Oneida Lake, much divergence of opinion is found. The number of "best methods" is amazing. It calls to mind the difficulties encountered in any effort to determine the "best" in politics, automobiles, etc., because of the diverse personal preferences. As representative opinion, the following has been prepared, on request, by Mr. A. L. Bishop, President of the Anglers' Association of Onondaga, who states that: "The Oneida Lake game fish may be rated as follows in the order of their preference as game fish: Small-mouthed Black Bass, Pikeperch, Large-mouthed Black Bass, Yellow Perch, Pickerel and Bullheads. An approved method for angling for Pikeperch is to troll the bottom with a small spoon, attached by a copper wire leader 10-12 feet long; in June on stony bottom of moderate depth, in July in deeper water. Bass to be taken by still fishing, with live bait (crawfish, locally known as 'crabs,' and minnows), or with wooden bait with casting rod. Perch are taken by still fishing, live bait (minnows, 'crabs,' or worms) fish eyes, or scarlet ventral fin of the perch. Pickerel are largely taken with a large trolling spoon (larger than for Pikeperch), to a much less degree by still fishing, with minnows. Bullheads are taken at night with worms."

Without a knowledge of Mr. Bishop's preceding section, Mr. W. H. Weston, Division Chief Game Protector of the State Conservation Commission, has prepared the following statement, using information from a number of his wardens:

APPROVED METHODS FOR ANGLING ON ONEIDA LAKE ARE.

1. Pikeperch. Trolling spoon; bait, minnows; still fishing in shallow bouldery bars early in the season, later, in July and August, in deep water, with worms.

2. Small-mouthed Black Bass. A fish of uncertain habits in taking bait; crawfish or "crabs," minnows, worms, grasshoppers, and crickets are recommended. A trolling spoon, hauled very rapidly over bars in shallow water without a sinker and with a cotton line gives good results. At times fly fishing is successful.

3. Pickerel. Trolling, bait casting, with frog, minnow or wooden bait, at the surface or below it, is approved.

4. Large-mouthed Black Bass. Same methods as for Pickerel.

5. Yellow Perch. Still fishing, with bait of worms, small minnows, pieces of perch with skin removed, perch eyes, reddish ventral fin of perch, and by fly fishing.

6. Pumpkinseed. Still fishing with worms, or fly fishing.

7. Rock Bass by trolling spoon, or line baited with small minnows or "crabs."

8. Bullheads. Line fishing with worms, crab "tails," minnows (dead or alive). June the best month for fishing."

THE FISHERIES OF ONEIDA LAKE.

The large amount of animal food produced by the lake and taken in that vicinity is a subject not generally appreciated even locally. The eels and frogs easily lead in importance. At our request the food fish of the lake has been rated by Mr. Hiram N. Coville, a fish dealer living at Brewerton, at the outlet of the lake:

1. Eels.
2. Pikeperch, Yellow Perch, Bullheads and Pickerel.
3. Pumpkinseed, Black and Red-fin Suckers.
4. Rock Bass.
5. Catfish (the kind with a forked tail).
6. Oneida Lake Whitefish or Tullibee.

The Tullibee or Oneida Lake Whitefish is sold fresh or salted. For salting they are opened along the back, salted to draw the blood, then packed in dry salt. In this manner 400 to 500 pounds are salted each year of the four to five tons of whitefish handled. Pikeperch and Yellow perch are taken by "tipups" through the ice. Small minnows are used for bait for Perch in this ice fishing.

At the State Hatchery at Constantia special attention is given to Pikeperch, Small-mouthed Black Bass, Yellow Perch and Oneida Lake Whitefish or Tullibee.

EEL INDUSTRY.

We are indebted to Mr. C. F. Davison and Mr. H. N. Coville for the following items concerning their fish business. Eels are taken in various parts of the lake, but the main catch is made at Caughdenhoy, four miles down the Oneida River, just below the large dam, which controls the level of Oneida Lake. Here there are two rows of weirs, each consisting of three traps or pots. The eels when mature descend the river to spawn in the sea and are trapped on this journey. The eels are taken from the traps and stored in cages until a sufficient number has been accumulated to sell. These are sold at Brewerton to Davison and Coville, who smoke and market them. About 100 tons of eels are handled a year. Of these about three tons are smoked. About 300 pounds are smoked each week, from the middle of May to the middle to September, or in about 20 weeks. The eels are skinned, cleaned, split open, washed and salted, rinsed and hung up to drain for an hour or so in the smokehouse shanty. A wire screen is suspended below the eels to catch them in case any fall, as they are liable to do if cooked too rapidly, preliminary to smoking. A quick fire is started of corn cobs and sawdust to cook them and then the fire is converted into a slow smudge. By adding sulphur to the fire a rich brown color is given which greatly aids the sale. The time required for smoking varies greatly, from 4 to 15 hours. The causes for this great difference in time are not known. The smoked eels sell wholesale at 20 cents per pound, the undressed eels retail at 6.5 cents per pound, and the dressed unsmoked eels at 10 cents per pound.

The large catches of eels follow a strong east wind which, during July and August, blows toward the lake outlet. The average weight of individuals is about four pounds. Mr. Coville had one weighing 7¼ pounds, which was probably about 3½ feet long.

FROG INDUSTRY.

The frog industry about Oneida Lake is the most extensive in New York. It is conducted on a scale that is surprising to many persons, particularly to the people of Syracuse. The kinds of frogs concerned are almost exclusively Leopard Frogs (*Rana pipiens,* Shreber), Green Frogs, locally known as "Clinkers" or "Cow" Frogs (*Rana clamitans,* Lat.), the Pickerel or Swamp Frog (*Rana plaustris,* Le Conte) and rarely examples of the Bull Frog (*Rana catesbiana,* Shaw).

There are two important methods used in catching frogs. In one case men and boys tramp the borders of the lake and swamps and the upland fields, singly or in small parties, carrying clubs about three feet long. The frogs are flushed and as they alight a blow is struck with the club, killing them. In this manner from 600 to 800 frogs may be caught in a day, from July until the winter season sets in. Mr. H. N. Coville has taken early in August 1,276 frogs between 9 A. M. and 2:30 P. M. or 5½ hours of work. This is an exceptional record. It was during a drouth when the frogs had congregated in short grass, grass as short as in a closely cropped pasture. When the haying of timothy and clover begins early in July, the frogs leave the fields and go to the short pastures, just as during a drouth.

The second method of capture is by the use of screens. This is used in the fall when the frogs migrate from the fields and swamps toward the lake for hibernation. This migration is not regular, it takes place mostly at night, particularly during warm rains, after a light frost. Taking advantage of this migrating behavior, cheese cloth screens, about 18 inches high, supported by sticks, are placed along the shore to intercept the migrating frogs. At intervals of two or three rods, nail kegs, carbide cans, or post-hole like excavations entrap the frogs which, failing to surmount the screen, wander along it, and fall in the traps. The frog catcher has only to collect the frogs from those traps. Late in the season one may find various sized frogs, mice and other small mammals drowned and frozen in these small wells.

The screens have to be placed far enough back from the lake shore to avoid water rising to near the surface and thus destroy the traps. On swampy ground the holes are similarly obliterated by the water. To overcome this difficulty, Mr. A. W. Thierre, of Lower South Bay, has devised a trap of woven wire screen; with a one-half inch mesh. If this trap was placed at an opening in the screen, which is not the case, it would allow the undersized frogs to escape and to reach the lake and find proper winter quarters, while the screens tend to destroy both the smaller kinds of frogs and immature individuals of the larger species. This wire trap has an inclined surface up which the frogs crawl, and from which they fall into the trap cavity, and from which they seldom escape. Thierre also uses a large minnow box to store his frogs, until delivery to the dealers.

By means of the screens and traps a single night's catch may amount to about 500 pounds, from about a half mile of screen in a good locality. As much as $70.00 has been paid for a single catch.

Mr. Coville, who has had much experience in catching frogs, informs me that the frogs near the swamps are more abundant, but smaller than on the uplands. It takes from 40-50 swamp frogs to make a pound of frogs legs for market. Of the larger upland frogs it takes a smaller number, from 25-35, to make a pound of legs. The average for mixed lots, of swamp and upland frogs, range from 25-40 to make a pound of legs. Coville attributes the differences in the frogs of these two habitats to the more abundant food on the uplands, where there is more food and fewer frogs competing for it. Coville estimates that about 20,000 upland frogs, live weight, make a ton; about 30,000-40,000 of swamp frogs to the ton, and an average mixed lot will contain about 28,000 to 30,000 frogs. In the fall of 1915 Mr. Coville had on hand in his cages about five tons of frogs, or about 150,000 frogs.

These estimates of the relative differences between swamp and upland frogs are a rough measure of the degree of productiveness of the two kinds of land, and are probably surprising to most persons who naturally look to the swamp as the most favorable habitat for the frog. A valuable suggestion, bearing on frog breeding, is made by these facts. This is that a frog farm, if on swampy land, must provide for feeding the denser population or the frogs will be small, or it should provide for upland feeding grounds. Of course, part of the swamp frogs might be collected and taken to the uplands, after the Danish method of transplanting Plaice to better feeding grounds, and allowing them to grow, before marketing.

Davison and Coville conduct a gross business of about $15,000 per year in frogs alone. One customer bought between June 1, 1915, and March 1, 1916, $1,687.50 worth of frogs' legs. When sold per hundred, live weight, large and small, the price ranges from 30 cents to $1.50, or averages $1.05. The legs sell per pound, large and small, from 10 to 50 cents and average 35 cents per pound. An expert can dress between 15 and 16 hundred frogs per hour, but an average rate is about 1,000 per hour.

ANNOTATED LIST.

This list includes the species of fish, and the lamprey, known to occur in Oneida Lake. There are several collections which yet await critical examination, which will add several species to this list. Most of the data for this list is based on collections made by the authors during ten days of field work done between August 31, 1915, and September 10, 1915. To these have been added other records from collections made by the senior author before and since the joint collecting. A few published records have been used. The shallow water of the lake has been carefully examined from Constantia to Brewerton on the north shore, and from Brewerton to the mouth of Chittenango Creek on the south shore.

The brief annotations are necessarily general and the list simply shows our progress in finding the species present, but it will give a fair idea of the fish fauna of the lake, and some idea of its important fisheries.

Petromyzon marinus unicolor (De Kay), Lake Lamprey.

Evidently very abundant in the lake. They were frequently found on the under sides of our boats, to which they would attach themselves while the boat was in motion, and when the boat would stop they would release themselves. The many dead fish that we found in the lake frequently had lamprey marks upon them. Two cases were heard of lampreys attaching themselves to bathers, but the only harm done was the fright they occasioned. The following kinds of fish were found dead with lamprey scars upon them: Dog Fish, Eel, Carp, Common Sucker, Chain Pickerel and Small-mouthed Black Bass.

Amiatus calvus (Linnaeus) Dog Fish.

A large dead one was found in the water at Walnut Point with a lamprey injury on it.

Salmo salar (Linn.), Atlantic Salmon.

Recorded on the authority of Sir John Richardson (1836), who in his Fauna Boreali-americana says that they enter Oneida Lake in May and remain until winter.

Leucichthys tullibee (Richardson), Tullibee.

A number of specimens were obtained from the market. The fishermen report the fish common in certain deep areas of the lake. Those seen by us were all of marketable size and in good condition. Fall specimens opened contained many well-developed ova. They spawn late in the fall. Locally known as Oneida Lake Whitefish.

Anguilla rostrata (DeKay), Eel.

A large dead one was found with a lamprey scar. The important eel fishery is at Coughdenhoy, four miles down Oneida River, the lake outlet.

Cyprinus carpio (Linn.), Carp.

A number found dead in the lake and several were secured from Coville, the fish dealer, at Brewerton. There is much local prejudice against this fish. Only scaled specimens have been secured by us.

Moxostoma aureolum (LeSueur), Red Horse.

None were collected by us, but the species is recorded from the lake by Jordan and Evermann 1896 and Bean 1903, but market specimens from Syracuse and Brewerton have been secured. It is locally known as "Red-fin Sucker."

Catostomus commersonii (Lacepede), Common Sucker.

Small examples frequently found on the shoals of the lake with other small fish. A large fish of this species found dead with lamprey scars, near the mouth of Scriba Creek, Constantia. Specimens secured from the market at Brewerton in May contained a large number of nearly ripe eggs. A variable irregular red line along the side is quite distinct in some specimens.

Catostomus nigricans (LeSueur), Hog Sucker.

One in the College of Forestry collection, that was caught near Constantia, and others were secured from Coville, fish dealer, at Brewerton.

Ameiurus natalis (LeSueur) Yellow Bullhead.

Ten examples were taken by us close to the mouths of shoals having muddy bottoms, and from sluggish streams entering Big Bay.

Ameiurus nebulosus (LeSueur), Common Bullhead.

Taken in places similar to those frequented by the yellow bullhead. With this last species it seems to associate, but it is apparently more common and more generally distributed, at least in shallow water, than the yellow bullhead. A few were found in the creeks at Constantia. Many very small ones, under two inches in length, were caught in Shaws Bay; and some similar ones were found in an isolated pool a few hundred feet inland from Johnsons Bay.

Esox reticulatus LeSueur, Chain Pickerel.

Common, but our collecting methods were not of a kind to get many of them in the lake. One taken in shallow water of Shaws Bay and one from Big Bay. Many were in a portion of Frederick Creek, where they were about the overhanging banks of a part of the stream in woods and where the water was quiet and its depth near a foot.

Lucius lucius (Linn.), Common Pike.

A market specimen from Oneida Lake was seen Nov. 30, 1915, which weighed 14 pounds and was 38 inches long. Locally this is known as the Spotted Pickerel or Pickerel.

Ambloplytes rupestris (Rafinesque), Rock Bass.

Apparently common in the lake. Small ones under two inches in length were frequently taken on the shoals and in creeks entering the lake. In deep water, twelve to eighteen feet deep near Grassy Island, a number of large ones were caught in the trap nets.

Pomoxis sparoides (Lacepede), Calico Bass.

A small specimen from Lower South Bay, and other specimens from the market at Brewerton. Locally known as Strawberry Bass.

Lepomis cyanellus (Rafinesque), Green Sunfish.

A small one taken in a minnow trap set in Big Bay Creek, near its mouth.

Eupomotis gibbosus (Linn.), Common Sunfish, Pumpkinseed.

Abundant in the lake. The only sunfish found in the lake by us that was abundant. Many small ones were taken in shallow water, but they were in greatest numbers on shoals with much plant life. Many large ones were in the trap nets that we saw raised from deep water near Grassy Island.

Micropterus dolomieu (Lacepede), Small-mouthed Black Bass.

Small ones were frequently found on shoals and in creeks. A number were in the trap nets raised near Grassy Island. The species is propagated at the State Fish Hatchery at Constantia.

Micropterus salmoides (Lacepede), Large-mouthed Black Bass.

A few small ones taken on a few shoals and in creeks entering the lake. Not as abundant in the lake as the Small-mouth.

Stizostedion vitreum (Mitchill), Wall-eyed Pike.

Abundant in deep water. A number caught in the trap nets set near Grassy Island. Many were seen that had been taken by fishermen from the lake. All were large; no small ones were seen by us and none was found on the shoals. Spawns in the spring in Chittenango Creek in large numbers. Locally called Pike or Pikeperch.

Perca flavescens (Mitchill), Common Perch.

Abundant and very generally distributed. Small ones in considerable numbers on most shoals that we visited. Large ones numerous in deep water. Fished for extensively through the ice.

Roccus chrysops (Rafinesque), Striped Bass.

A few large examples in the College of Forestry collection from Constantia. A single young specimen was taken (No. 314) in shallow water in October.

Lota maculosa (LeSueur), Burbot, Ling, Lawyer.

A few specimens have been secured, from the vicinity of Constantia, from Syracuse and Brewerton markets. It has been taken in trap nets in very large quantities.

The following species of little or no economic value, except as food for other fishes, also occur in Oneida Lake or its tributaries: *Hybognathus nuchalis* (Agassiz), Silvery Minnow; *Pimephales notatus* (Rafinesque), Blunt-nosed Minnow; *Abramis chrysoleucas* (Mitchill), Golden Shiner; *Notropis heterodon* (Cope), Black-chinned Minnow; *Notropis cayuga* (Meek), Cayuga Minnow; *Notropis hudsonius* (DeWitt Clinton), Spot-tailed Minnow;

Notropis whipplii (Girard), Silver-fin Minnow; *Notropis cornutus* (Mitchill), Common Shiner; *Notropis atherinoides* (Rafinesque), Shiner; *Notropis rubrifrons,* Rosy-faced Minnow; *Semotilus atromaculatus* (Mitchill), Horned Dace; *Semotilus bullaris* (Rafinesque), Fallfish; *Rhinichthys atronasus* (Mitchill), Black-nosed Dace; *Exoglossum maxillingua* (LeSueur), Cut-lip Minnow; *Erimyzon sucetta oblongus* (Mitchill), Chub Sucker; *Schilbeodes gyrinus* (Mitchill), Tadpole Cat; *Schilbeodes miurus* (Jordan), Brindled Stone Cat; *Umbra limi* (Kirtland), Mud Minnow; *Fundulus diaphanus* (LeSueur), Barred Killifish; *Percopsis guttatus* (Agassiz), Trout Perch; *Labidesthes sicculus* (Cope), Brook Silversides; *Percina caprodes zebra* (Agassiz), Manitou Darter; *Hadropterus aspro* (Cope and Jordan), Black-sided Darter; *Boleosoma nigrum olmstedi* (Storer), Tesselated Darter; *Etheostoma flabellare* (Rafinesque), Fantail Darter; *Etheostoma iowae* (Jordan and Meek); *Cottus ictalops* (Rafinesque), Miller's Thumb.

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SEWAGE DISPOSAL BY FISH CULTURE

By M. C. Marsh, *Gratwick Laboratory, Buffalo, N. Y.*

In "Les Miserables" Victor Hugo said that France was pouring into the Atlantic Ocean a half billion of francs every year. Bemoaning the waste of all the sewage of Paris, his imagination, delighting in paradox, burst into this glorification of the burden of the sewers:

"All this; a flowering field; it is green grass, it is mint and thyme and sage, it is game, it is cattle, it is the satisfied lowing of heavy kine at night, it is perfumed hay, it is gilded wheat, it is bread on your table, it is warm blood in your veins, it is health, it is joy, it is life."

It is surprising that it did not occur to the novelist in this flight of fancy that it is also the fishes swimming in the brook, for now reality has gone even further and made "it" the fish in the market and on the table. Fish culture has been linked with sewage disposal. Agriculture had already effected, in broad irrigation, a partial saving of the waste of the great potential values in sewage. Now comes fish culture with the hope of making the product pay all the costs of the transformation.

Sewage disposal, always one of the great current problems, has slowly progressed and various means have been more or less perfected for converting the offense and possible danger of city sewage into a harmless and unobjectionable effluent. Sewage irrigation projects, by which the sewage is poured over a large acreage which is then cropped, are comparatively rare and almost never pay the cost of operation. Sanitary conversion of sewage into something unobjectionable, but not valuable is successfully but not universally practiced and the processes are cumbersome and expensive. Even now most cities discharge their sewage unaltered into lakes, rivers or the sea and let it go at that.

The Germans, ever efficient in ways and means, have taken the next step. They have sought to change the sewage into something valuable enough to pay the cost of the conversion, and on a small yet practical scale they seem to have succeeded. They invoke the aid of fish culture, use the sewage to rear young food fish to marketable size and persuade the market to buy them. This method has been developed by Dr. Bruno Hofer, the director of a government fisheries research station in Munich, Germany. Its practical use is best exemplified in Strassburg where a large pond system consumes a portion of the output of the city sewage in growing the German carp and other staple food fishes. Here the writer had the good fortune in May, 1914, to see this combined fish cultural and sewage disposal plant in operation.

As is well known, streams purify themselves finally of the sewage poured into them. The process is complicated and not thoroughly understood, but is known to depend upon a variety of conditions, such as temperature, rate of flow, oxygenation of the water, and to involve complicated chemical changes among which oxidations are of prime importance. Water bacteria in great numbers are necessary to the process and many higher forms of both animal and vegetable life play an essential part. A rather slow current is favorable to the abundance of these organisms and affords the necessary time for their action upon the sewage. In general then the slower the stream, other conditions being equal, the more minute life it is apt to contain and therefore the greater its sewage digesting ability or power to purify itself. Slow streams, however, have little comminuting effect on the gross particles of sewage, which requires therefore to be mechanically screened of the larger bodies in suspension in order that purification may proceed rapidly. If such sewage is evenly distributed throughout a slowly flowing stream containing a suitable fauna and flora, these latter digest and incorporate the sewage and increase thereby. If the stream is made a fish pond with a very slow current and conditions are under control and nicely adjusted, a profitable cycle may be established, consuming sewage on the one hand and produc-

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ing fish on the other. In brief, Dr. Hofer's method aims at the transformation of the organic but lifeless substances held in sewage into living organisms, the sewage being thus used up in the process. Of the living product the larger eats the smaller through a series of forms ending in marketable food fishes.

A brief description of the Strassburg sewage-fish cultural station should begin with emphasis on its location and the nature of the land put at its disposal. This is of fundamental importance for the economy of the experiment, which requires that such land shall be of little value for other purposes, otherwise overhead charges will make the business show a loss. When a level tract of suitable size and small value located below the sewerage system and yet high enough to turn its effluent conveniently into the drainage of the region, is available, the first essential is complied with.

The Strassburg plant takes a sewerage composed of all the wastes of the city, domestic and industrial, besides the street washings. A small portion of the total sewage is diverted from the sewerage system. It is first subjected to coarse filtration or screening, which frees the sewage of the larger bodies floating or in suspension. This process yields daily about five cubic yards of an almost worthless residue. A part of the remaining sewage is pumped to sedimenting tanks where it is cleared of a large portion of the remaining suspended matter. The sedimented matter is periodically drawn off from the bottoms of these tanks to drying beds and yields a fertilizer of some commercial value. The now partially clarified sewage is ready for the fish ponds. It is, of course, nearly all water—more than 99.9% of it. It still contains by far the greater part of foreign matter which characterized the original sewage; for two-thirds or more of the solid matter in sewage is in solution. In this country ordinary town sewage has at most one-tenth of one per cent. of solid matter, and usually much less. About half of this is inoffensive inorganic matter, of which about three-quarters is dissolved. The other half is vegetable and animal matter and over half of this portion is likewise in solution. It is this organic portion, whether suspended or dissolved, which makes sewage a hygienic or aesthetic offense, or both, as the case may be.

The sewage is now diluted with a considerable volume of clean water and distributed to shallow ponds of one or two acres in size, of which the best shape is somewhat rectangular and about twice as long as wide. The ponds convert a proportion of sewage representing about 6,000 of population, or that of about 800 persons per acre of pond area, which therefore covers between seven and eight acres. The sewage is let into the ponds at many separate places arond one end, a thorough distribution being of the first importance. The depth varies from twelve inches at the edges to twenty inches in the middle and three feet or more at the outlet. A slow current sets lengthwise of the pond and practically complete purification must be obtained before the outlet is reached. The borders of the ponds must be clear of trees or bushes hindering the free access of sunlight. In the ponds themselves certain water plants are provided—sweet-flag and manna-grass (Glyceria) near the inflow; Glyceria, Ceratophyllum and Myriophyllum in deeper parts, while undesirable plants are removed. The duck-weed (Lemna) for instance led to such interference with the growth of algae and consequent oxygenation by blanketing the surface that young ducks were introduced to feed upon the Lemna. They were thus reared upon the products of the ponds and when fattened just before marketing contributed appreciably to the profits of operation. They were moreover of some use in aerating the water.

The ponds are first prepared by supplying them from other waters with large quantities of crustacea, insect larvae (Chironomus abundant), mussels and snails. Cyclops and Daphnia and related groups are very abundant and important in this stock of minute life; in fact pits are used for breeding these small forms. The young fishes which it is intended to rear are introduced in such numbers as appear suited to the fish cultural capacity of the ponds. These are then maintained for two or three weeks by a flow of clean water and without sewage. After this preliminary period, the sewage is admitted to the ponds and its purification begins. The crustacea and other plankton multiply tremendously on this continuous influx of sewage which avails them as an unlimited food supply. In turn the young fishes find this minute life an abundant food suitable for their own rapid growth. The many forms of both animal and vegetable life which attain greater size are eaten by the older fishes. The species most commonly utilized have been the carp, tench and pike (Esox), but cat-fish, black bass, a flat fish and even the rainbow trout were contemplated as desirable food fishes which further experiment might show to be susceptible to this new method of fish culture.

The effect of the purification process can be seen very soon after the entry of the sewage. An appreciable cloudiness is caused in the water about the inflow end of the pond, due to the turbid sewage. This affects only a small portion of the pond, the turbidity soon disappears and the contents of the rest of the pond are clear enough to show plainly the vegetation and other organisms on the bottom. Progressively toward the outlet the water is more and more relieved of its sewage character until the effluent is said to be potable. The series of ponds and the disposal plant as a whole present a sightly appearance and resemble any well conducted fish cultural station. The process can not be said to involve a nuisance.

The purification process is rather delicately balanced and its successful and continuous operation depends on foresight and constant care. The various reactions are interdependent and must proceed with reasonable quantitative adjustment to each other, without which a preponderance of any one is able to disturb the co-operation of all. The most important index is the dissolved oxygen in the pond water, and daily estimations by color tests are made. Additional control is obtained by other chemical and bacteriological tests carried out every two weeks. The absolute and relative quantities of sewage and clean water admitted to the ponds, the quantity and distribution of the higher plants, which afford protection and attachment for many animals, and lurking places for yong fishes, the adaptation of the stock of fishes to the capacity of the pond, these are prime elements in the even driving of the process. They require constant supervision and regulation. Moreover the method as a whole, while it has been made workable by repeated modification through a long series of experiments, will be further perfected by the experience gained from continued use.

As is not difficult to infer, the introduction of fish from the sewage ponds to the market as table fish did not fail to encounter the opposition of natural prejudice, even in Germany where the carp, the principal species produced by this method, is in high favor and where the public is highly amenable to reason. It required an organized campaign of education by means of lectures and various authoritative propaganda. It was explained that the carp in its natural habitat sought the vicinity of whatever sewers were available, finding there its food most abundant; that the public had long been eating carp bred under similar and less well controlled conditions; that there was no offense in or about the sewage fish ponds, as anyone might see by inspecting them; that there was no logical or hygienic objection to the use as food of fish grown in them; and finally by serving them to a representative public, directly from the ponds, these fish were shown to compete in attractiveness with any other. The whole product of the ponds is disposed of without difficulty in Strassburg. The fish are taken alive in tanks of water to the city and the consumer may make his choice of an obviously fresh specimen, a fact which no doubt facilitates the sale. The income from the sale of the total products of the disposal plant suffice, according to the management, to pay all the expenses of the process and leave a small margin of profit. Exact figures are not available, but the attainment of an even break between profit and loss has doubtless been the goal sought and one hitherto entirely beyond reach.

It is unlikely that more than a nominal excess of revenue over all the costs of operation is to be expected.

Two years ago this method of making sewage disposal economic by the aid of fish culture evidently had been stamped with the seal of official approval in Germany. A Hamburg commission had examined and reported favorably on the Strassburg installation, and had recommended tentative establishments in suburban sections in the region about Hamburg. In Strassburg itself it was learned that the plans and specifications for enlarging the system to the demands of the whole body of Strassburg sewage had been for some time completed, and had official approval, but the necessary appropriation of funds had not been made. It appeared that military influences alone had intervened to prevent this not inconsiderable public expenditure. In May, 1914, this seemed puzzling. Within less than three months war had broken out, and it may be inferred the Strassburg project is at least no further advanced.

The question arises how far these methods of sewage disposal are applicable in the United States. In some respects it is likely that greater difficulties will be encountered than in Germany. The public will regard fish raised from sewage with more suspicion than the Germans displayed toward them, and it will be less susceptible than the German public to efforts to counteract its prejudices in this respect. Yet conditions suitable for producing fish from sewage can undoubtedly be found at many places here. In localities with a severe winter climate there has been little or no experience with the method, and low winter temperature must reduce, modify or put an end to its efficiency. The Strassburg ponds are operated in a climate considerably milder than that of our northern cities.

THE ULTIMATE SOURCES OF MARINE FOOD

By Prof. Irving A. Field,
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The ocean as a source of food for human consumption always has been a subject of interest, but the attention given to developing the food resources of the sea has been almost nothing compared to that devoted to agriculture. Without exercising any intelligent control in the cultivation of marine food products we are now appropriating for use such food materials as happen to be produced within our reach just as primitive man in ages past depended on land plants and animals in an uncultivated and undomesticated state. At the present time we see the science of agriculture reaching a high stage of development. Most of our nation's land fit for growing crops has been appropriated for cultivation, scientific methods for increasing the yield have been developed, labor saving devices for reaping have been perfected and yet with it all our rate of food consumption is increasing more rapidly than the rate of production. The capacity of the soil to produce enough food for our rapidly increasing population is fast approaching its limit. Unless the chemists come to the rescue with inexpensive methods for rapidly combining the necessary chemical elements into palatable, digestible and nutritious compounds we shall have to devote our energies to the development of the natural food resources which lie in the waters covering nearly three-fourths of the earth's surface. A prominent authority once stated that four square feet of ocean was capable of supporting a human life. At first thought such a thing seems impossible, but a better understanding of the sea will show that his statement is not far from the truth. It is the purpose of this paper to point out the ultimate sources of marine food and the almost unlimited resources they provide for the production of human food.

A brief comparison of the conditions of life found on the land and in the ocean will help one to understand the wonderful opportunities which are offered for deriving food from the sea.

On the land there is one vast expanse of verdure. Plants of all sizes from the minute algae to the giant trees are abundant everywhere and they form the ultimate food basis for animal life. The animals for the most part are herbivorous. The Carnivora are comparatively few in number, which is a very important condition for if they should exceed the vegetable feeders in abundance it would soon mean extinction for both races.

In the sea, life conditions are very different. Vegetable life is as inconspicuous in the sea as it is conspicuous on the land. To be sure along the coast there is a fringe of sea weeds and floating in the middle of the ocean are great masses of algae such as the Sargasso sea; but taken as a whole the ocean is barren of visible vegetation. Under these conditions we find practically no animals that correspond to the terrestrial Herbivora. Most of the animals are carnivorous. A few fishes may browse on the sea weeds which fringe the shore or float in the water, but, on the whole, most marine animals are voracious beasts of prey. The larger species devour the smaller ones and these in turn feed upon those smaller than themselves. Furthermore animal life swarms in the sea in incredible multitudes. The naturalists of the Challenger expedition reported that the waters of the equatorial Pacific contained great banks of pelagic animals through which the vessel sailed. Chiercha wrote that the equatorial calms of the Atlantic are rich beyond all measure in animal life and that the water often looks and feels like coagulated jelly. The Challenger expedition reported having encountered banks of copepods a mile thick and on one occasion to have steamed for two days through a dense cloud formed of a single species, one found distributed from the Arctic regions to the equator. Of the fishes Professor Brooks says, "Herring swarm like locusts and a herring bank is almost a solid wall." Goode tells of a school of mackerel which was estimated to contain a million barrels and of another which was a windrow of fish half a mile wide and at least twenty miles long. In the bays and estuaries beds of sea mussels are found containing 6,000 to 8,000 bushels to the acre.

How this vast multitude of animals can be supported in a region apparently destitute of vegetation has been a problem of investigation since the microscope came into use and it is interesting to note that the first serious contribution on the subject was written Oct. 16, 1699, by the old pioneer, Anton van Leeuwenhoek, who ground lenses and made his own microscopes. After observing the minute organisms which he discovered in fresh water by means of his microscope he came to the following conclusion: "If it be then asked, to what end such exceedingly minute animalcules were created, no answer can readily be given which seems more agreeable to the truth than that, in like manner as we see constantly, that the bigger kinds of fish feed on the smaller; as, for example, that the cod fish preys on the haddock and other smaller kinds of fish; the haddock again on the whiting; these on still smaller fishes, and among the rest on shrimps; and shrimps on still more minute fishes; and that this gradually prevails among all the kinds of fish; so that, in a word, the smaller are created to be food for the larger. Again, if we consider the nature of our sea, abounding with fish, yet having nothing at the bottom of it save barren sand: stored with various shellfish, yet destitute of every green herb; and if we, moreover, lay it down for a truth, that no fish can be supported on water alone, there will not remain a doubt, that the smaller fishes are destined, by nature, to be the subsistence of the larger." It is evident from Leeuwenhoek's illustrations that his use of the expression "smaller fishes" refers to what we now recognize in general as plankton, which includes both animal and vegetable organisms.

Peck, in his splendid paper on The Sources of Marine Food, gives us an excellent example of the food relations described by Leeuwenhoek. Reporting on the stomach contents of the squeteague he says, "On the morning of July 23 there was taken a large specimen whose stomach contained an adult herring. In the stomach of the herring were found two young scup (besides many small crustacea), and in the stomach of one of these scup were found copepods, while in the alimentary tract of these last one could identify one or two of the diatoms and an infusorian test among the mass of triturated material which formed its food. This is an instance of the universal rule of this kind of food: The squeteague captures the butterfish or squid, which in turn have fed on young fish, which in their turn have fed upon the more minute crustacea, which finally utilize a microscopic food supply." These microscopic organisms constitute an unfailing, ultimate food supply and without it the larger animals of the ocean whose chief business is to devour each other, would soon exterminate themselves. It consists of single-celled plants and animals, chief among which are the diatoms and radiolarians. According to Peck these two groups alone may be regarded as the great primary food supply for the larger marine animals. The diatoms in particular may be said to constitute the pastures of the sea.

How these minute creatures can support such a large and extensive fauna may be readily understood when their habits are known. They grow under far more advantageous conditions than our land plants and consequently grow faster, almost infinitely faster. Land plants have a portion only of their bodies in the ground and can absorb the mineral elements necessary for their growth only as the rains dissolve them. Being crowded into limited space and subject to seasons of drought and cold their growth is constantly arrested.

On the other hand the microscopic marine plants are bathed in a uniform solution of mineral food, they have the full benefit of the sunlight and the temperature of the water is not subject to extreme changes. Under such conditions growth is so rapid that it passes beyond our powers of conception. Microscopic examination of water taken from almost any part of the sea shows that in reality it is a living broth. To give us a clear picture of the wonderful productivity of these unicellular organisms it requires the expression of the late Professor Brooks who says, "Their vegetative power is wonderful past all expression. Among land plants, corn, which yields seed a hundredfold in a single season, is the emblem of fertility, but it can be shown that a single marine plant, very much smaller than a grain of mustard seed, would fill the whole ocean solid in less than a week if all its descendents were to live. This stupendous fact is almost incredible, but it is capable of rigorous demonstration and it must be clearly grasped before we can understand the life of the ocean."

Until recently students of marine biology have looked upon diatoms as constituting the ultimate food basis of marine animals. Practical oyster growers in order to find out the best localities in which to plant their oyster beds have tried to determine the food value of the surrounding waters in quantity of diatoms per volume of water. In general it has been found that oysters and mussels thrive best where diatoms are most abundant. On the other hand investigations, made by Dr. H. F. Moore of the U. S. Bureau of Fisheries and others, show that the amount of diatoms consumed by shellfish is not sufficient to account for their increase in growth. The question then arises what is the source of the additional nourishment that they obtain? Some investigators say it is from the soluble organic matter in sea water which is constantly absorbed through the body surface, while others attribute it to the suspended organic particles which are taken in with the diatoms. The truth probably lies in the latter assumption as is shown by several very important researches recently conducted at the Danish Marine Biological Station.

Petersen, 1890, was the first to express the idea that the abundance of fish on the Danish coasts was due chiefly to Zostera which is better known to fishermen as "eel grass." Petersen and Jensen (1911) tried to show that, in all probability, the plants of the eel grass belt, and not the plankton organisms should be regarded as the main sources of the organic matter of the sea bottom in Danish waters. Their reasoning is based on the fact that the quantity of carbon in a series of bottom samples is directly proportional to the amount of Zostera vegetation and not to the quantity of plankton present.

This study was continued in greater detail and published by Jensen in 1914. He shows that the eel grass plays an important part in the production of organic matter in the sea. In all the Danish waters he found fragments of eel grass deposited in greater or less quantities, for the most part in very fine particles as detritus. In this detritus he found comparatively few diatom shells. Much of the detritus particles were too small to be identified by the microscope as of eel grass or plankton origin. By chemical means, however, Jensen was able to determine the source of the organic matter in the sea bottom. He found that the eel grass cells contain a considerable quantity of starch-like substances known to the chemists as pentosans, whereas those of diatoms are composed mainly of silica and those of Peridineans of fairly pure cellulose. By comparing analyses of various bottom samples of organic matter with those of eel grass and diatoms the following conclusions were reached: "(1) In the more sheltered waters the organic matter of the sea bottom is to a pre-eminent degree formed by eel grass. (2) In the more open waters, at least half of the organic matter is probably formed by eel grass. (3) In the deepest waters the organic matter is probably formed chiefly by the plankton organisms."

Calculations on the production of phytoplankton (minute floating plant life) and eel grass per square meter have been attempted, but what has been done so far approaches a mere approximation only. In regard to the phytoplankton, Hensen (1887) figured that one square meter of surface produces annually 15-18 grams of dry organic matter exclusive of the phytoplankton consumed by the surface fauna. The total production of phytoplankton he estimated to be 150 grams per square meter annually. Jensen by very careful calculations estimates that in the Danish waters about 100 grams of organic dry matter per square meter is produced each year by the phytoplankton. For eel grass the percentage of dry organic matter produced annually per square meter he found to be 1,920, 1,120 and 344 grams in good, moderate, and bad localities respectively. Eel grass beds cover about one-seventh of the area studied (between the Skaw and the Baltic) which means that the annual production of eel grass per square meter of the water as a whole is 120 grams of organic matter. Comparing the production of eel grass and plankton on a basis of Jensen's calculations we see that eel grass produces 120 grams of organic matter per square meter while the plankton produces 100 grams.

Now the question arises, how much of the organic matter from each source is deposited on the sea bottom? Undoubtedly much of the matter of the plankton dissolves following the death of the organisms due to the action of baceria. Admitting that a portion of the eel grass material is similiarly lost it is evident that the plankton organisms with their relatively far greater surface are in a much higher degree liable to destruction than the eel grass. Furthermore a large part of the plankton is devoured by the plankton fauna which would lead one to believe that but a limited portion of plankton production is deposited on the sea bottom. These calculations are supported by the results of chemical analyses of the organic matter in the sea bottom. Jensen has done this and states his conclusions as follows: "In the more sheltered waters the organic matter of the sea bottom is derived almost exclusively from the Zostera (eel grass); in the more open waters, it is possible that the plankton organisms may play a not altogether unimportant part as a source of the organic matter of the bottom."

The transformation of nitrogen during the decomposition of eel grass and its relation to the nitrogen content of the organic matter in the sea bottom was also investigated by Jensen. He found that the green eel grass is as rich in nitrogen as peas or beans, which contain about 3%. As the eel grass decomposes the percentage of nitrogen decreases until it is as low as 0.88%, then as decomposition continues it rises again up to 1.39%. Analyses of the organic matter in the sea bottom indicate that the average amount of nitrogen present is 4%. Thus it is evident that the organic substances of the sea bottom contain a greater proportion of nitrogen than the eel grass.

Why the organic matter in the sea bottom is so much richer in nitrogen than the eel grass from which it is formed chiefly is readily explained by Jensen. As has been shown the amount of nitrogen in the green eel grass is greater than that in the early stages of decomposition. Later the amount of nitrogen increases becoming much greater than in the green eel grass. The diminution in nitrogen during the first stages may be due to the fact that a portion of the nitrogenous protoplasm is dissolved in the sea water as the cells die. The increase in proportion of nitrogen in the final stages of decomposition may be due to two causes. (1) Either by the destruction of non-nitrogenous substances in the sea bottom to a greater extent than is the case with the nitrogenous matter, or (2) by the fixation of inorganic or free nitrogen by bacteria.

It has been established beyond all doubt that non-nitrogenous substances of the sea floor are to a very considerable extent destroyed by bacteria, at least one step in the process being the fermentation of the pentoses. Another is the formation of methane from the fermentation of cellulose. On the other hand it is probable that the nitrogenous substances are acted upon to a lesser degree due to the fact that they are comparatively easily transformed into humic compounds, which are less easily destroyed.

It is also possible that the excremental action of the fauna contributes to render the bottom richer in nitrogen. The nitrogenous portion of the bottom is indigestible while the non-nitrogenous matter contains considerable quantities of digestible pentosans. Hence when fed upon in the form of detritus by such organisms as mussels and oysters the non-nitrogenous matter would be removed and the nitrogenous portion returned to the bottom. This was well illustrated by comparing the composition of oyster excrements which consisted of almost pure detritus, with bottom samples taken at the same place where the oysters were found. The nitrogen of the bottom samples amounted to .187% while that of the excrements was .71%.

That nitrogenous matter of the bottom can also be increased by the fixation of inorganic nitrogen through the action of bacteria is likewise probable. The nitrogen may be taken from the ammonia or nitrates dissolved in the water or from the free nitrogen which is also present in solution. Bacteria such as *Azotobacter* and *Clostridium,* which perform this function, are of common occurrence on the bottom and a considerable amount of nitrogen fixation has been shown to take place where the vegetation is abundant.

In addition to the above sources of nitrogen it should be mentioned that the fauna itself, by dying and forming detritus, also serves to increase the amount of nitrogen in the sea floor.

A determination of the total quantity of detritus and plankton in sea water was also attempted. Ten liter samples of sea water from various localities were carefully filtered and the total quantity of detritus and plankton measured. It was first weighed and dried at 100° C. and then weighed again. Samples were also subjected to microscopic examination to determine the amounts of detritus and plankton organisms present.

The results were that nearly all the samples showed a greater proportion of detritus than of plankton. The weight of the dry matter in the residue varied between

9.6 and 72.3 milligrams per 10 liters of sea water. No relation could be shown to exist between the weather conditions and amount of detritus in the water.

The conclusion to be drawn from these results is that sea water is rich in the quantity of detritus it contains.

The next question which arises is, what value does this organic matter of the sea bottom possess as a source of nourishment for the benthos or bottom fauna?

Assuming that the organic matter of the sea bottom forms a source of nourishment for the majority of the fauna living in and near the bottom Jensen considered it advisable to investigate the question as to how far suitable nourishment for such fauna can be shown to exist among the substances of which the sea floor is composed.

Since eel grass contributes most of the organic matter of the bottom it was natural to examine quite closely the chemical composition of this weed. It was found to compare favorably with the composition of the common fodder grasses. Protein was found present to the amount of 7.5% and pentosan 8-9%. No fat determination was made.

When eel grass is treated with pancreatin from 23 to 26% of the nitrogen is digested. Since the eel grass contains 7.5% proteins, of which about ¼ is digestible by pancreatin the amount of digestible proteins contained may be put at 1.08%. Decomposed eel grass contains less nitrogen and is less digestible. For example black eel grass (dead) was found to contain 1.39% nitrogen of which but 6.6% was digestible. These figures should, however, in all probability mainly be taken as minimal.

Experiments on the digestible nitrogenous compounds in the sea bottom brought out the fact that there is only a very small amount of proteins in the bottom which are digestible with pancreatin. In fact the amount is so small as to be very nearly within the limits of possible error. The analyses for the top layer, however, give such positive results that it is justifiable to conclude that the upper-most layer of the bottom really does contain a certain amount of proteins digestible by pancreatin. In the upper layer from 44 to 68 milligrams of digestible proteins per 100 square centimeters are found, which means that the amount of digestible proteins per square meter is approximately 5 grams.

On the other hand digestible non-nitrogenous compounds in the sea bottom consist of a fairly considerable amount of material in the form of pentosans amounting to from 0.3 to 1.0%. This is an important fact for there is reason to suppose that the bottom fauna is able to digest pentosan. It has been well established that herbivorous animals utilize pentosan as a food and Biederman and Moritz (1898) showed that Gastropods were able to digest pentosan. It is probable, therefore, that bivalves also can digest pentosan and that the considerable amount of pentosan present in the sea bottom besides other possible substances (hemicellulose generally) plays an important part as non-nitrogenous nourishment for a great portion of the bottom fauna.

In support of Jensen's observations Blevgad, 1914, has made an interesting study of the food of the commonest and most widely distributed bottom-inhabiting animals in the various communities of the Danish waters. His report is based on the analysis of stomach contents. Three main sources of nourishment for the bottom fauna of the sea were determined. (1) *Plants*—fresh growing plants of the benthos formation, chiefly eel grass which in the Danish waters produces about 8,232,000 kilograms annually. In course of time, this decays and falls to pieces forming (2) *detritus*. This includes dead or dying organisms or portions of them whether vegetable or animal in origin as are found in suspension (or solution in the sea water) or deposited on the bottom. Most of this detritus is of eel gras origin. (3) *Animal* or carneous food or the third source includes all living animals found in the sea, together with their carrion, save where these are to be reckoned as forming part of the detritus as just defined.

The plankton, heretofore considered as of greatest significance, he does not list as an important source of food. Whereas previous observers have emphasized the great importance of plankton, Blevgad emphasizes the importance of detritus. He furthermore questions Pütter's (1908) theory to the effect that the carbon compounds present in solution in the sea water are of very extensive importance as food for certain animals of the bottom fauna. At least it must for the present be regarded as unproved. It is possible, however, that some organisms may live on dissolved organic matter and so for the sake of convenience Blevgad classifies dissolved organic matter under detritus.

The commonest animal forms in Danish waters are classified into three groups according to their mode of feeding. (1) *Herbivores* which include certain Gastropods, two Echinoderms and some Crustacea. (2) *Pure detritus eaters* which comprise all the Lamellibranchs, Holothurians, Sipunculidae, Cumacea, Diptera larvae and Ascidiae, two Gastropods, Balanoglossus, Amphioxus, Ostracods, Bryozoa, Porifera and Foraminifera. The great mass of material in the alimentary tracts of these animals is detritus and when analyzed chemically it corresponds to that on the ocean floor. Plankton organisms are only incidentally present. These observations led Blevgad to make the extreme statement, "The living phytoplankton is thus of no importance at all as a food for the bottom fauna." (3) *Purely carnivorous animals* including a few Polychaeta, some Gastropods, some Crustacea, some Echinoderms, Coelenterates, Nemerteans, Planarians and Pantopods constitute the last group. Quite a large number of animals are both carnivores and detritus feeders.

The investigations tend to show the extreme importance of detritus as a food for the fauna on the sea bottom. To use Blevgad's words, "Detritus forms the principal food of nearly all the invertebrate animals of the sea bottom, next in order of importance being plant food from fresh benthos plants. The value of the live phytoplankton in this connection is absolutely minimal, amounting in any case to nothing more than an indirect significance through the medium of the plankton copepods."

That detritus is formed so abundantly in the shallower waters of the ocean and constitutes such an important food supply for most of the bottom-inhabiting animals is of great significance in its bearing on the coming science of sea farming. If the investigators of the Danish Biological Station are right in their conclusions concerning the importance of detritus as a food for the benthos fauna then we shall have to revise our methods of determining the available oyster, mussel or clam food supply in the waters of a given locality. It also means that the available fields for the cultivation of oysters or other shellfish are far more fertile than we have ever dreamed in the past. The knowledge of the rôle played by detritus in its relation to the benthos fauna helps us to understand better the phenomenal growth which often takes place in many mollusks in the absence of an abundant supply of plankton. For example many mussel beds are known to yield on an average about 2,000 bushels annually and experiments have shown that one bushel of seed clams planted in a barren flat will yield ten bushels of marketable clams one year later. This serves to show what splendid opportunities for increased food production lie within our reach. Between the plankton organisms and detritus there is an inexhaustible ultimate food supply which can be quickly and readily converted into a form available for human consumption. A partial solution of the problem of the ever increasing high cost of living undoubtedly lies in appropriating this vast resource for greatly increasing our own food supply. Cultivating the ocean promises to yield the fisherman far greater returns, with less expense of time and energy, than the farmer is able to produce from the land. Each new discovery in marine biology is making it more clear that for the comfort and economy of the nation we ought to be doing more in the scientific development of our fisheries.

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PHYSIOLOGICAL CHARACTERS OF MARINE ANIMALS FROM DIFFERENT DEPTHS *

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I.—INTRODUCTION.

The sea is the largest single type of habitat and on account of its vastness we are accustomed to think of its life as comparatively uniform for slightly different depths, and of its conditions as essentially the same for closely connected parts and opposite sides of comparatively narrow channels. It was a matter of much surprise to the writer to find that marine fishes showed marked sensitiveness to slight differences in acidity and alkalinity, and that, as compared with the difference to which they respond, the differences in this respect between the two sides of the channel south of Brown's Island, Puget Sound (Friday Harbor, Wash.),† which is only about a fourth of a mile wide, are great. The water on the north side of the island is uniformly alkaline and suited to the development of the eggs of fishes and invertebrates which require an alkaline medium, while the water of the south side is acid much of the time and the eggs of various animals do not develop well. This difference is correlated with striking differences in vegetation and animal life which the casual observer would attribute to the difference in current and bottom, the south side being most strongly swept by the tide and rocky, while the north side is sandy and escapes the main force of the tide. In a paper by the writer and Mr. E. B. Powers, attention was called to the fact that slight contamination of the sea can have pronounced effects.

* Contribution from the Puget Sound Marine Station.

† Biol. Bull. XXVIII: 315-334; also reprinted in *Fishing Gazette*, March and April, 1916.

The Baltic towns of the Hanseatic League were dependent in part upon the herring industry and after a century of great growth and prosperity fell into decline at the middle of the fourteenth century. Their prosperity was the accompaniment of the presence of great shoals of herring off the Island of Rügen in the Baltic. Their decline was caused in part by the failure of the herring industry and the supposed migration of the herring to the North Sea which has since been the centre of the industry. Schouwen (on the Netherland coast of the North Sea) appears to have been frequented by the herring shoals in preference to Rügen. The rapid growth of the Netherland cities, their supremacy and final separation from the Hanseatic League followed. A little later the herring again changed their haunts choosing the coast of Norway where both Norsemen and Netherlanders caught them. The Beukelszoon method of curing herring having come into use, nearness to home was no longer a necessity. The Norse fisheries flourished until 1587 when an "apparation of a gigantic herring frightened the shoals away." Thus it appears that the development of the herring industry in each locality led to the apparent desertion of the locality by the fish, though the migrations assumed by historians may be doubted. Was this due to the contamination of the sea by the cities, or merely to over catch? Whichever may have been the case it is certain that contamination will not invite runs of the herring. The common assumption that the sea is so large that pollution can not have a significant rôle is rendered entirely untenable by the greatly increased sensitiveness of the marine fishes as compared with the fresh water ones.

These unexpected differences in the character of the water near the surface and the sensitiveness of animals tc it, are only excelled by the marked differences among animals of the same species from different depths.* Uniformity of physiological characters has been commonly assumed. It has been customary since the early writings

* For a full account of the experiment see Puget Sound Marine Station Publications, Vol. I.

of Sir Edward Forbes to divide the margins of the sea bottom into several belts, the uppermost of these is commonly known as the *shore belt* and reaches from the level of the usual high tide to the average of low tides which is about three feet above the mean low tide of the U. S. Navigation Charts. The reason for this lower limit not agreeing with the mean low tide lies in the fact that the usual low tide is considerably above mean low tide level so that animals living within about three feet from mean low tide are exposed out of water only for a few hours during a brief period once a month. A growth of Ulva which reaches up to this level covers the stones quite completely at such times so that the animals are not fully exposed.

Immediately below this is the Laminarian Belt which is characterized by broad leaved algae. The algae shelter animals from light and enemies. The lower limit of this belt is the lower limit of light for green algae. The Laminarian Belt extends from three feet above mean low tide to a depth of about sixty feet.

The belt below this is commonly known as the Coralline Belt because of the presence of Coralline Algae. For convenience it may be subdivided into the Coralline which reaches to 300 feet and the Subcoralline from 300 feet to about 600 feet. It is characterized by a very short daylight period and faint light at all times.

The advantages of the Puget Sound Marine Station locality for the study of physiological difference between animals from different depths lies in the fact that the abrupt shores make it possible to get animals from several different depths ranging from 0 feet to 540 feet (165 meters) within a few moments and submit them to experimental conditions within a short period.

II.—RESISTANCE TO HIGH TEMPERATURE.

The following selected results of comparison of the resistance of animals of the same species from different depths to fatal conditions will serve to illustrate the whole series of experiments.

TABLE I.

Showing the relative resistance of two Puget Sound commercial shrimps, the coonstripe (*Pandalus danae* Stimp.) and the deep coonstripe (*Pandalus stenolepis* Rath), from different depths to a temperature of 24° C. The animals were kept at this temperature in small dishes containing sea water surrounded by a large mass of water heated by an alcohol lamp.

Pandalus danae		Pandalus stenolepis	
Depth in Meters	Survival Time in Minutes	Depth in Meters	Survival Time in Minutes
4	34	....	......
14-20	27	....	......
40-60	21	40-110	11
60-100	13	100-140	8
100-156	12½	150-165	7

Marine animals, particularly fishes and crustacea, take on the color of the background present during development and those from considerable depth are pale in color and the shrimp have decidedly luminescent eyes. The relation of color to light and background has caused the shrimps from the different levels to be easily distinguished and also leads to the conclusion that they have lived at the level from which they were collected since an early juvenile condition, because it is only in the young that such changes can be brought about. The shrimps from the different levels were placed in the same dishes during the experiments so as to preclude the possibility of the different individuals, having been experimented upon under different conditions. The general results were confirmed by numerous tests at other temperatures.

It will be noted that the shrimps of each species from deeper water died in a shorter time. Likewise the shrimp which habitually lives at greatest depth dies much quicker than those from the lesser depth. Crabs show similar relations. The data suggest that those that live in the dark are more sensitive than those from the light, which accords with the results with crabs from different depths.

III.—RESISTANCE TO FRESH WATER.

Marine animals do not generally survive for any length of time in fresh water or in water without their normal salt content. Taking for example one of the shrimps noted in the preceding table we find that loss of equilibrium follows in a few minutes after the animals are immersed in the fresh water.

Table II.

Showing the Survival of Marine Shrimps from different depths in Fresh Water.

Pandalus danae		Crangon munita Dana	
Depth in Meters	Survival Time in Minutes	Depth in Meters	Survival Time in Minutes
4-6	25	....	......
12-20	23	15-20	54
30-50	13	35-75	24

Here again as in the case of temperature the shrimps from the shallower water survive longest. The same general results were obtained with mussels, barnacles, etc.

IV.—RESISTANCE TO ALKALINE AND ACID WATER.

The experiments with herring showed that the fishes are much influenced by the reaction of the water, i. e., whether it is acid or alkaline. Accordingly a series of experiments was run to determine the relative resistance of the animals from different depths to acidity and alkalinity.

Table III.

RESISTANCE TO ACID WATER.

(100 c. c. of tenth normal alkali required to neutralize one liter of sea water,—phenolphthalein indicator.)

Pandalus danae		Pandalus stenolepis	
Depth in M.	Time to loss of Equilibrium	Depth in M.	Time to loss of Equilibrium
4	10	50	13
20	23	40-60	14
100-150	81	170	18

Here the relative resistance of individuals from different depths is reversed; those from the deeper water lose their equilibrium later than those from the shallow water. Death follows after irregular intervals.

Table IV.

RESISTANCE TO ALKALINE WATER.

(41. c. c. of tenth normal acid to neutralize one liter,—methyl orange indicator.)

Pandalus danae		Pandalus stenolepis	
Depth in M.	Loss of equilibrium	Depth in M.	Loss of equilibrium
4	After 19 mins., 5 (all) on sides	10	After 67 mins., all dead
20	After 19 mins., 3 (of 5) on sides	180	After 92 mins., all alive

As in the case of the acid water the animals from deeper water are more resistant. There are some variations and irregularities, and while the experiments with acid and alkaline water were not extensive they indicate the reverse of the results with fresh water and high temperature.

V.—GENERAL DISCUSSION AND CONCLUSION.

The resistance to fresh water and to high temperature on the one hand and acid and alkaline water on the other being reversed, we conclude the physiological characters of the animals differ generally and that the differences are not purely adaptive adjustments. Fluctuations in temperature and salinity are greatest at the surface and thus animals at the surface might be expected to show greatest resistance to differences in these respects. On the other hand since fluctuations in degree of alkalinity are usually greatest in the region occupied by vegetation it would accordingly be expected that animals from the Laminarian Belt would be more resistant to alkaline conditions than those from deper water but such is not the case.

The experiments indicate that it is not safe to assume that individuals of a species have the same physiological constitution regardless of conditions or that the presence of a species coincident with a uniform condition of a given factor such as temperature does not indicate that temperature controls the distribution. The organism may be physiologically different.

In fresh water the presence of certain animals is often taken to indicate that conditions are suitable or detrimental to fishes, or that the water is or is not contaminated. Such conclusions must be made with due caution and variations in physiological characters of such index organisms must be fully investigated before their presence can be relied upon to indicate the conditions they are supposed to show.

THE INFLUENCE OF FASTING ON LOBSTERS*

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The most apparent effect exerted on living organisms by fasting is the loss of weight which they sustain. With the prolongation of the fast, which in the case of man has on many occasions exceeded a month and in the case of other animals even much longer periods, the diminution of the mass of the organism becomes so conspicuous as to point unmistakably to the serious organic changes wrought by the protracted abstinence from food. The emaciation of an individual is a positive indication that he is in a state of either chronic or acute starvation.

To the best of my knowledge of all animals, lobsters alone do not conform to the general rule. They offer no recognizable external signs of emaciation or loss of mass to warrant an observer in concluding that this or that lobster has been deprived of nourishment for any length of time. Indeed not only are the outward symptoms missing, which one so readily detects in a starving individual, but the weight of fasting lobsters changes so slightly that it can be found out only by very careful measurements.

I observed six lobsters in the course of a fast which lasted fifty-six days, during which time they were kept in thoroughly filtered sea water, and none looked different at the close of the ordeal from what they did at the beginning. They were weighed carefully every two weeks on a balance weighing accurately to one-hundredth of a gram, and the greatest loss observed was 1.89 per cent. of the initial weight in two weeks time, whereas the average loss for the eight weeks was only 2.89 per cent. It will be better appreciated how insignificant such a change is from a review of the actual weights, which

* For a complete statement of the data the reader is referred to the author's article in the Journal of Biological Chemistry, Vol. 24, pp. 137-146, 1916.

at the beginning of the experiment was 167.5 grams and at the end 162.7 grams, or a difference of about one-sixth of an ounce.

This very slight change in weight is, however, deceptive, and behind an apparently immutable surface, as an investigation of the changes in the makeup of the lobsters reveals, far-reaching transformations are effected. To anticipate, a study of the chemical composition of the fasting lobsters proves that the exceptional position occupied by these animals in not conforming to the general rule of emaciation, is only skin deep and that the loss of substance which they suffer is as profound and fully as extensive as that sustained by any other organism.

It is a matter of common knowledge that every organism is composed of three kinds of material, water, organic and mineral matter. With respect to quantity, water is by far the most important of these three constituents. A normal lobster (including the shell) contains 67.3 per cent. of water. The remaining 32.7 per cent., or one third, is made up of 21 per cent. organic material and 11.7 per cent. mineral matter. It may therefore be said that, roughly, seven-tenths of the lobster is water, two-tenths is organic stuff, and one-tenth is a mixture of salts.

After fasting fifty-six days the composition of the lobsters changes radically. They now contain 78.2 per cent. of water, 10.8 per cent. of organic and 10.6 per cent. of mineral matter. Roughly speaking therefore, eight-tenths of the lobster is water and the organic and mineral portions represent each a tenth of the entire organism. A comparison of these figures shows at a glance that the content of fasting lobsters is greatly impoverished as regards its organic moiety, which involves all the edible and really nutritious elements, i. e., the glycogen, fat and proteins.

The difference in the relative composition (percentage) of the two kinds of lobsters is not sufficient, however, to fully picture the transformation effected by the fast, or to explain why the weight remains almost unmodified.

To gain a clear insight into these matters, we must compare the quantities of the various materials actually present in the lobsters before and after fasting.

The average weight of my lobsters was 167.3 grams, of which 112.7 grams was water and 35.2 and 19.5 grams was organic and mineral matter respectively. It may be observed further that the 35.2 grams of organic material are made up as follows: 0.27 gram of glycogen, 1.6 grams of fat, 17.3 grams of protein and 8.6 grams of what is commonly designated as "extractive." The remaining 7.4 grams, or a little over one-fifth of the entire organic matter, is probably chitin, the chief constituent of the shell.

The same lobsters, at the end of the fast, weighed on an average 162.6 grams. Of this 127.8 grams was water, 17.5 grams organic and 17.3 grams mineral matter. It is thus quite evident that one-half of the total organic matter has been lost, having been used up by the lobster in maintaining its existence while no other nourishment was available. It is also interesting to note that the organic material of the starved lobster contained no glycogen, only 0.1 gram of fat, 7.8 grams of protein and 2.6 grams of "extractives." There is thus 7 grams left over which probably represents the chitin. This quantity is very nearly the same which we found in the lobsters before they were subjected to the fast and we must conclude therefore that the shell has not been affected by the fast.

But the most significant fact disclosed by this study is the actual increase in the quantity of water from 112.7 to 127.8 grams. This absorption of water will help to elucidate the circumstance that in spite of the loss sustained by the organic portion of the body, the total weight of the lobsters remains almost stationary. Bearing this in mind, we may attempt to compute what the loss was at the end of fifty-six days of fasting. The loss observed in the change of body weight was only 2.73 per cent. Let us suppose, however, that no imbibition of water had taken place. With the knowledge gained from the study of other fasting organisms we may assume that at this particular phase of starvation the quantity of water in the body would have diminished about a third. Starting with a quantity of 112.7 grams of water, this would have decreased to 75.1 grams at the end of fifty-six days of fasting, had there been no compensating absorption of water from the surrounding medium. The weight of the lobsters would therefore have been 109.8 grams, and the loss 34.4 per cent., instead of 2.73 per cent. The hard shell protecting the entire body of the lobster and forming a solid supporting structure, apparently prevents the cells of the soft tissues from shrinking as they ordinarily do under the influence of inanition* when the cell inclusions are being used up. This may explain the extraordinary extent of the imbibition of water by the tissues as their reserves are being gradually exhausted. The relative increase in the water content of the body which invariably occurs in inanition is unquestionably to reduce the concentration of the body juices. But the great absorption of water by the tissues of starving lobsters is the result primarily of mechanical factors, the tissues imbibing an excess of water in the manner of a sponge.

* Morgulis, S., Archiv für Entwicklungsmechnik d. Org. 32, p. 169, 1911.

THE NATURE OF THE SPINES IN CATFISHES

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Anyone who has handled catfishes, dead or alive, is probably painfully aware of the presence of heavy and sharp spines in the dorsal and pectoral fins. In the following paragraphs an attempt is made to explain briefly the morphologic nature of these spines; that is, how do they compare with the more flexible fin supports and with the spines of other fishes?

The fin is to be looked upon as an extension of the general integument of the body. In nature it is precisely as if the skin of the back of the hand were pinched and drawn away from the surface. The web of the fin thus constituted becomes useful as a balancer, propeller, or rudder by virtue of its flexibility and consequent freedom of movement and at the same time has the possibility of a certain amount of rigidity. All these characteristics are imparted to the fin by its inner supports called fin-rays, to which group of structures the fin-spines belong.

The nature of any type of fin-spine is better appreciated after a review of the more common and more primitive fin supports, namely, the soft rays. This kind of ray is most numerous in fishes and because of its soft or flexible state it receives its designation. Its rôle in the fin is that of a skeletal support to the fin-web only. The origin and homology of the soft rays have been traced by Goodrich[1], Harrison[2] and others, and may, therefore, be omitted here. Much more desirable is a knowledge of the simple structure of a soft ray. In this connection there are two features to be noted. First, rays of this type are always dichotomously branched. The base of the ray is heavy and solid, but soon divides into

1. Goodrich, E. S. Jour. Mic. Science, vol. 47, 1903.
2. Harrison, R. G. Arch. f. Mik. Anat, vol. 42, 1893.

two parts, each of which divides into two and so on to the periphery of the fin. Because of this branching the ray becomes fan-shaped, supporting a much greater extent of the web at its free edge than at its base, Fig. 1. Second, each division of the ray is transversely segmented, a state which makes for flexibility as well as indicating its morphologic nature.

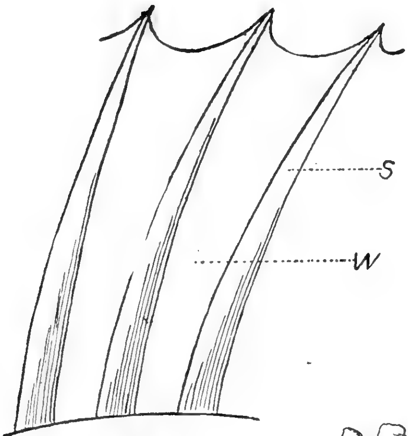
In what may, for convenience, be termed the "higher" or more modified bony fishes—strong and sharp spines may be present in all fins excepting the caudal. The Yellow Perch serves as a good example. The first dorsal of this species is supported entirely by spines. They are heavy at the base and with an even surface regularly taper to a sharp point at the margin of the fin-web, Fig. 2. They are without either transverse segments or branches. Spines of this type may be said to result from a suppression of branching and segmentation during development. Each spine, therefore, as an entity is an exact match for a soft ray. When the segmentation persists without the branching there results what has been termed a simple ray, Fig. 3. So far as definitive structures are concerned the simple ray occupies an intermediate position between soft rays and spines.

The presence of the catfishes among the groups commonly designated as soft-rayed fishes leads one to wonder at what appears to constitute an exception to the rule of the absence of fin-spines among these forms. There is no doubt about the rigidity, sharpness and efficiency of catfish-spines as organs of defence. They appeal to one as true functional spines whatever may be their nature in a structural way.

Observations upon the microscopic structure and development of catfish spines leads one to the conclusion that while they are strong and sharp spine-like structures in function their nature in a morphologic way is not such as to be considered widely different from that of soft rays. It has been noted above that the spines of the more highly modified fishes are regular with regard to surface. Quite the reverse of this state obtains in the spines of catfishes. While still covered by skin they may appear smooth enough, but after the soft tissues are removed the surface is found broken by deep and more or less longitudinal furrows with corresponding intermediate ridges, Fig. 4. These ridges are reminiscent of the ankylosis of dichotomous divisions of soft rays. The spine as a whole represents a single soft ray. Instead of a derivation through the suppression of branches and the early co-ossification of segments, the spines of catfishes ossify and become rigid after the formation of the dichotomous branches has taken place. This is clearly shown by a study of both the surface of the spine and microscopical preparations.

As a rule the anterior branch of the first soft ray in a fin is the shortest one, the succeding divisions becoming progressively longer according to the curvature of the edge of the fin-web. These relations are obvious in the elements of the spines of catfishes as shown in Fig. 4. The first ridge (fd.) on the anterior side of the spine represents the first division of the ray. It extends diagonally towards the anterior margin and comes to an end somewhat before the middle of the spine is reached. The second (sd.) division is similar in appearance and course, but does not end until the distal half of the spine is reached. The third (td.) is the longest of the spine elements and forms the point. The fourth (fd.) although not so pronounced as the other divisions is incorporated with the spine to about the middle of its extent at which level it fails to co-ossify with others and becomes an independent division in the fin-web near the margin of which it divides. The free portion of this division is in every respect like that of soft rays. In the proximal portion of the spine, particularly of very young specimens there are numerous openings extending into the cavity. These represent the last vestiges of the spaces between segments. As the fish matures new bony tissue is deposited in the longitudinal grooves which become less and less conspicuous with age.

From observations such as those mentioned above it appears that the spines of the common catfishes represent modifications of soft rays through ankylosis of the segments and dichotomous divisions rather than suppression of those parts as in the spiny-rayed forms. In other words, the catfish spine is a modification of a definitive soft ray rather than that of its embryonic rudiments. The presence of spines in catfishes becomes harmonious, therefore, with their rank among the soft-rayed groups.



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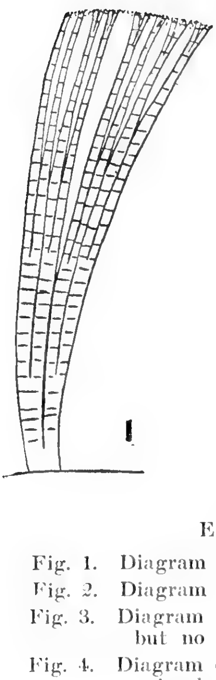

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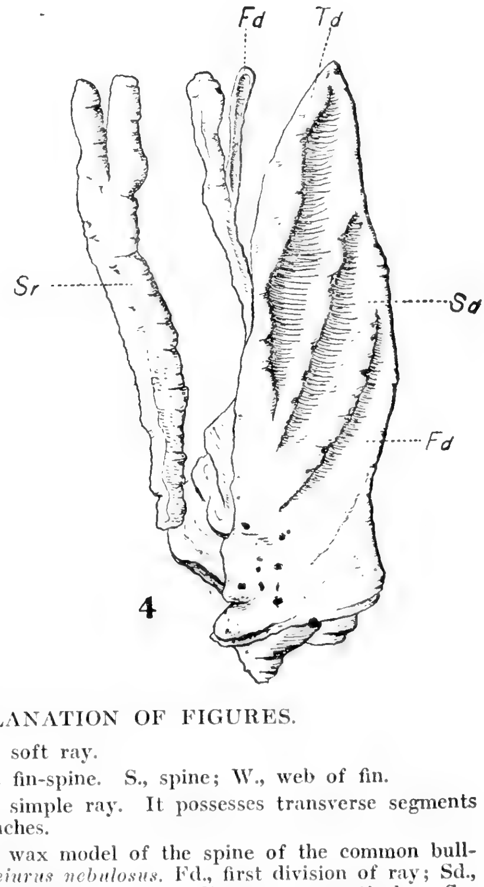

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EXPLANATION OF FIGURES.

Fig. 1. Diagram of a soft ray.

Fig. 2. Diagram of a fin-spine. S., spine; W., web of fin.

Fig. 3. Diagram of a simple ray. It possesses transverse segments but no branches.

Fig. 4. Diagram of a wax model of the spine of the common bullhead, *Ameiurus nebulosus*. Fd., first division of ray; Sd., Td., Fd., second to fourth divisions respectively. Sr., first soft ray of fin.

TRANSACTIONS

of the

American Fisheries Society

"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

VOLUME XLV, NUMBER 4

1915-1916

Edited by The Recording Secretary

SEPTEMBER, 1916

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NEW YORK, N. Y.

CONTENTS

213

CERTIFICATE OF INCORPORATION OF THE AMERICAN FISHERIES SOCIETY

We, the undersigned, persons of full age and citizenship of the United States, and a majority being citizens of the District of Columbia, pursuant to and in conformity with sections 599 to 603, inclusive, of the Code of Law for the District of Columbia, enacted March 3, 1901, as amended by the Acts approved January 31 and June 30, 1902, hereby associate ourselves together as a society or body corporate and certify in writing:

1. That the name of the Society is the AMERICAN FISHERIES SOCIETY.

2. That the term for which it is organized is nine hundred and ninety-nine years.

3. That its particular business and objects are to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish with power:

a. To acquire, hold and convey real estate and other property, and to establish general and special funds.

b. To hold meetings.

c. To publish and distribute documents.

d. To conduct lectures.

e. To conduct, endow, or assist investigation in any department of fishery and fish-culture science.

f. To acquire and maintain a library.

g. And, in general, to transact any business pertinent to a learned society.

4. That the affairs, funds and property of the corporation shall be in general charge of a council, consisting of the officers and the executive committee, the number of whose members for the first year shall be seventeen, all of whom shall be chosen from among the members of the Society.

Witness our hands and seals this 16th day of December, 1910.

Seymour Bower	(Seal)
Theodore Gill	(Seal)
William E. Meehan	(Seal)
Theodore S. Palmer	(Seal)
Bertrand H. Roberts	(Seal)
Hugh M. Smith	(Seal)
Richard Sylvester	(Seal)

Recorded April 15, 1911.

AMERICAN FISHERIES SOCIETY

Organized 1870

The first meeting of the Society occurred December 20, 1870. The organization then effected continued until February, 1872, when the second meeting was held. Since that time there has been a meeting each year, as shown below. The respective presidents were elected at the meeting, at the place, and for the period shown opposite their names, but they presided at the subsequent meeting.

PRESIDENTS, TERMS OF SERVICE, AND PLACES OF MEETING.

1.	William Clift	1870-1872	New York, N. Y.
2.	William Clift	1872-1873	Albany, N. Y.
3.	William Clift	1873-1874	New York, N. Y.
4.	Robert B. Roosevelt	1874-1875	New York, N. Y.
5.	Robert B. Roosevelt	1875-1876	New York, N. Y.
6.	Robert B. Roosevelt	1876-1877*	New York, N. Y.
7.	Robert B. Roosevelt	1877-1878	New York, N. Y.
8.	Robert B. Roosevelt	1878-1879	New York, N. Y.
9.	Robert B. Roosevelt	1879-1880	New York, N. Y.
10.	Robert B. Roosevelt	1880-1881	New York, N. Y.
11.	Robert B. Roosevelt	1881-1882	New York, N. Y.
12.	George Shepard Page	1882-1883	New York, N. Y.
13.	James Benkard	1883-1884	New York, N. Y.
14.	Theodore Lyman	1884-1885	Washington, D. C.
15.	Marshall McDonald	1885-1886	Washington, D. C.
16.	W. M. Hudson	1886-1887	Chicago, Ill.
17.	William L. May	1887-1888	Washington, D. C.
18.	John H. Bissell	1888-1889	Detroit, Mich.
19.	Eugene G. Blackford	1889-1890	Philadelphia, Pa.
20.	Eugene G. Blackford	1890-1891	Put-in Bay, Ohio
21.	James A. Henshall	1891-1892	Washington, D. C.
22.	Herschel Whitaker	1892-1893	New York, N. Y.
23.	Henry C. Ford	1893-1894	Chicago, Ill.
24.	William L. May	1894-1895	Philadelphia, Pa.
25.	L. D. Huntington	1895-1896	New York, N. Y.
26.	Herschel Whitaker	1896-1897	New York, N. Y.
27.	William L. May	1897-1898	Detroit, Mich.
28.	George F. Peabody	1898-1899	Omaha, Neb.
29.	John W. Titcomb	1899-1900	Niagara Falls, N. Y.
30.	F. B. Dickerson	1900-1901	Woods Hole, Mass.
31.	E. E. Bryant	1901-1902	Milwaukee, Wis.
32.	George M. Bowers	1902-1903	Put-in Bay, Ohio.
33.	Frank N. Clark	1903-1904	Woods Hole, Mass.
34.	Henry T. Root	1904-1905	Atlantic City, N. J.
35.	C. D. Joslyn	1905-1906	White Sulphur Spgs., W. Va.
36.	E. A. Birge	1906-1907	Grand Rapids, Mich.
37.	Hugh M. Smith	1907-1908	Erie, Pa.
38.	Tarleton H. Bean	1908-1909	Washington, D. C.
39.	Seymour Bower	1909-1910	Toledo, Ohio.
40.	William E. Meehan	1910-1911	New York, N. Y.
41.	S. F. Fullerton	1911-1912	St. Louis, Mo.
42.	Charles H. Townsend	1912-1913	Denver, Colo.
43.	Henry B. Ward	1913-1914	Boston, Mass.
44.	Daniel B. Fearing	1914-1915	Washington, D. C.
45.	Jacob Reighard	1914-1915	San Francisco, Calif.

*A special meeting was held at the Centennial Grounds, Philadelphia, Pa., October 6 and 7, 1876.

215

The American Fisheries Society

EDITORIAL

REPORT OF THE TREASURER.

As stated in a note at the foot of page 83 (Transactions, Vol. XLV, No. 2, March, 1916), of the proceedings of the San Francisco meeting, the report of the Treasurer for the year 1914-15 was missing. It has since been found and is herewith presented.—R. C. O.

To the American Fisheries Society:

I hereby submit my Annual Report as Treasurer from September 30, 1914, to September 1, 1915:

RECEIPTS.

1914			
	Sale of Reports	$ 50.50	
	Postage Deposit Refund	12.52	
	Life Membership Fees	50.00	
	Yearly Dues	675.10	
			$788.12

EXPENDITURES.

1914		
Sept.	30—Balance due Treasurer	$257.84
Oct.	3—Dr. H. M. Smith, postage, etc.	7.12
Oct.	7—Clark & Fritts, printing	16.75
Oct.	10—W. F. Roberts Co., printing	20.85
Oct.	18—C. J. Butler, P. M., stamped envelopes	10.68
Nov.	5—R. J. Holmes, stenographer	115.75
Dec.	6—W. F. Roberts Co., printing	14.00
Dec.	7—Clark & Fritts, printing	6.00

1915		
Feb. 12—Clark & Fritts, publishing	207.38	
March 2—Consolidated Engraving Co.	3.00	
April 26—Clark & Fritts, publishing	159.22	
July 26—C. J. Butler, P. M., stamped envelopes	21.36	
Aug. 10—Clark & Fritts, publishing	119.55	
Aug. 18—J. C. Hall Co., receipt books	6.75	
Aug. 20—Raymond C. Osburn, Secretary	71.62	
Aug. 20—Clerical work	3.00	
	$1,040.87	
Balance due Treasurer		$252.75
		$1,040.87

Respectfully submitted,

C. W. Willard, *Treasurer.*

Westerly, R. I., September 1, 1915.

DISTRIBUTION OF ANNUAL MEETINGS

The coming annual meeting in New Orleans calls to mind the fact that never before in the history of the Society has a meeting been held in the South. Washington, D. C., White Sulphur Springs, W. Va., and St. Louis, Mo., can scarcely be considered as being more than on the border line.

A glance at the geographical distribution of the annual meetings of the past forty-five years reveals the fact that twenty-nine of them have been held in the Middle Atlantic States, ten in the Middle Western States, six in Washington, D. C., three in New England (all in Mass.) and three in the west.

How are these irregularities to be accounted for? The first thirteen meetings after the organization of the Society were held in New York City, with one exception, Albany. This was probably because of the central position of New York with regard to the early membership. Since that time five meetings have been held in New York State, and only once in the last sixteen years. The six meetings held in Washington are not a disproportionate number when one considers the interest and activity of the members of the Bureau of Fisheries in the work of the Society. Aside from the above, only four States have had as many as three annual meetings, Massachusetts, Pennsylvania, Ohio and Michigan. Other States are as follows: Illinois, 2; Nebraska, Wisconsin, New Jersey, West Virginia, Missouri, Colorado and California, one each. Since 1900 there have been only two repetitions, indicating a desire on the part of the Society for a fair distribution of the meetings.

Undoubtedly a number of factors have entered into the choice of meeting places in recent years. The most important of these seems to be the distribution of members, most of whom are still in the New England, Middle Atlantic and North Middle States. Interest in fish culture has also been an important factor. For example, two of the Massachusetts meetings were held at Woods Hole and two of the Ohio meetings at Put-in-Bay. Great "convention cities," which have much to offer the visitor in the way of sight-seeing, have also influenced the distribution of the meetings, as witness New York, Washington, Boston, Philadelphia, Chicago and San Francisco.

Now, why have no meetings until the present one been held in the South? Two reasons which come to my mind at once seem sufficient to explain this apparent neglect. In the first place, the membership in the southern states has always been comparatively slight, possibly because, owing to smaller population and natural advantages, the necessity for artificial culture of fish has not been so pressing as in some other regions of our country, and therefore there has been less interest in this work and in the Society. If so, this is a condition that will bring its own cure in a few years,—the necessity is already keenly felt in some parts of the South, in fact. But of far greater weight is the fact that the meetings have always been held in the latter part of the summer, at the time when the fisheries men are as a rule more free to attend than at any other time, and then the southern states are supposed to be hot. The climate may be quite bearable, to be sure, as the writer can testify, but the northern man who has not summered in the South is firmly inclined to the belief that he would melt completely away if compelled to spend a few days in summer below Mason's and Dixon's Line.

New Orleans has broken the ice (a mere figure of speech, of course, as none ever occurs there outside of the refrigerator and the drinkables), and undoubtedly the meetings will be held in the South with increasing frequency in coming years, especially with the growth of membership in that section.—R. C. O.

LIFE OF INLAND WATERS

The science of limnology or hydrobiology, the study of the fresh waters and their inhabitants, has recently been enriched to the scientist and laid open to the beginning student and casual reader by the publication of a book bearing the above title, prepared by Prof. Jas. G. Needham and Mr. J. T. Lloyd of Cornell University, and issued by the Comstock Publishing Co. of Ithaca, N. Y. The long experience and fruitful work of the senior author are alone sufficient recommendation for the quality of the book, and it will be found an extremely instructive work, of value to all those interested in fisheries and the problems of the fresh waters.

While space will not permit a thorough digest of the four hundred and thirty-eight pages of well-selected and interesting reading matter, illustrated by two hundred and forty-four cuts, it may not be amiss to cite the topics discussed, which are in brief:

The nature of the aquatic environment,—properties and uses of water, water and land;

Types of aquatic environment,—lakes and ponds, streams, marshes, swamps and bogs;

Aquatic organisms,—plants, animals;

Adjustment to conditions of aquatic life,—individual adjustment, mutual adjustment;

Aquatic societies,—limnetic societies, littoral societies;

Inland water culture,—aboriginal water culture, water crops, water culture and civic improvement;

Bibliography,—more important papers dealing with life in the water;

Index.

While, as might be expected from the previous work of the authors, the emphasis is placed on ecology or the relation of aquatic organisms to their environment, there is also much valuable material on the general biology and life histories of aquatic forms, and the economic side is not neglected.

The reviewer does not hesitate to recommend the book as well worth the perusal of anyone interested in aquatic life.

R. C. O.

LIST OF MEMBERS, 1914--1915

Showing Year of Election to Membership

Honorary Members

The President of the United States, Woodrow Wilson.
The Governors of the several states.
Alabama, Charles Henderson.
Arizona, George W. P. Hunt.
Arkansas, George W. Hays.
California, Hiram W. Johnson.
Colorado, George A. Carlson.
Connecticut, Marcus A. Holcomb.
Delaware, Charles R. Miller.
Florida, Park M. Trammell.
Georgia, Nat. E. Harris.
Idaho, Moses Alexander.
Illinois, Edward F. Dunne.
Indiana, Samuel M. Ralston.
Iowa, George W. Clarke.
Kansas, Arthur Capper.
Kentucky, A. O. Stanley.
Louisiana, Luther E. Hall.
Maine, Oakley C. Curtis.
Maryland, Emerson C. Harrington.
Massachusetts, Samuel W. McCall.
Michigan, Woodbridge N. Ferris.
Minnesota, W. S. Hammond.
Mississippi, Theodore G. Bilbo.
Missouri, Elliot W. Major.
Montana, Samuel V. Stewart.
Nebraska, John H. Morehead.
Nevada, Emmet D. Boyle.
New Hampshire, Rolland H. Spaulding.
New Jersey, James F. Fielder.
New Mexico, William C. McDonald.
New York, Charles S. Whitman.
North Carolina, Locke Craig.
North Dakota, L. B. Hanna.
Ohio, Frank B. Willis.
Oklahoma, R. L. Williams.
Oregon, James Withycombe.
Pennsylvania, M. G. Brumbaugh.
Rhode Island, R. Livingston Beeckman.
South Carolina, Richard I. Manning.
South Dakota, Frank M. Byrne.
Tennessee, Thomas C. Rye.
Texas, James E. Ferguson.
Utah, William Spry.
Vermont, Charles W. Gates.
Virginia, H. C. Stuart.
Washington, Ernest Lister.
West Virginia, Henry D. Hatfield.
Wisconsin, E. L. Philipp.
Wyoming, John B. Kendrick.

'08 Antipa, Prof. Dr. Gregoire, Inspector-General of Fisheries, Bucharest, Roumania.
'06 Besana, Giuseppe, Lombardy Fisheries Society, Via Rugabello 19, Milan, Italy
'09 Blue Ridge Rod and Gun Club, Harper's Ferry, W. Va.
'93 Borodine, Nicolas, Petrograd, Russia.
'12 Calderwood, W. L., Inspector of Salmon Fisheries for Scotland, Edinburgh, Scotland.
'04 Denbigh, Lord, London, England.
'89 Fish Protective Association of Eastern Pennsylvania, 1020 Arch St., Philadelphia, Pa.
'04 Fryer, Sir Charles E., Former Supervising Inspector of Fisheries, Board of Agriculture and Fisheries, London, England.
'04 Hofer, Prof. Dr. Bruno, Biological Research Station for Fisheries, Munich Germany.
'04 Kishinouye, Dr. K., Imperial University, Tokyo, Japan.
'08 Kitahara, Dr. Tasaku, Imperial Fisheries Bureau, Tokyo, Japan.
'88 Lake St. Clair Shooting and Fishing Club, Detroit, Mich.
'04 Matsubara, Prof. S., Imperial Household Department, Tokyo, Japan.
'09 Nagel, Hon. Chas., St. Louis, Mo.
'95 New York Association for the Protection of Fish and Game, New York City.
'08 Nordqvist, Dr. Oscar Fritjof, Superintendent of Fisheries, Lund, Sweden.
'06 Perrier, Prof. Edmond, Director Museum of Natural History, Paris France.
'92 Southside Sportsmen's Club, Oakdale, L. I., N. Y.
'06 Steindachner, Prof. Dr. Franz, Royal Natural History, Museum, Vienna, Austria.
'92 Vinciguerra, Prof. Dr. Decio, Director Royal Fish Cultural Station, Rome, Italy.
'06 Von Grimm, Dr. Oscar, Inspector-General of Fisheries, Petrograd, Russia.
'08 Von Kadich, Dr. Henrich, Department of Forestry and Domain, Vienna, Austria.
'06 Von Pirko, Franz, Austrian Fishery Society, Vienna, Austria.

Corresponding Members

'84 Apostolides, Prof. Nicoly Chr., Athens, Greece.
'87 Armistead, J. J., Dumfries, Scotland.
'04 Ayson, Charles L., Hakataemen, Oamaru, New Zealand.
'04 Ayson, L. F., Commissioner of Fisheries, Wellington, New Zealand.
'09 Flegel, Chas., Canea, Crete.
'08 Higginson, Eduardo, Consul for Peru, New York City.
'97 Jaffe, S., Sandfort, Lustringen, Germany.
'84 Landmark, A., Inspector of Norwegian Fresh-Water Fisheries, Christiania, Norway.
'84 Marston, R. B., Editor of the Fishing Gazette, London, England.
'09 Mohsin, S. M., Bengal Fisheries Department, Calcutta, India.
'89 Olsen, Dr. O. T., Grimsby, England.
'08 Poiteau, Charlney, Lommel, Belgium.
'84 Raveret-Wattel, C., Director of Aquicultural Station at Nid-de-Verdier, 20 Rue des Acacias, Paris.
'09 Riedel, C., Bergstedt, Germany.
'84 Sars, Prof. G. O., Christiania, Norway.
'84 Solsky, Baron N. de, Director of the Imperial Agricultural Museum, Petrograd, Russia.
'10 Stead, David G., Fisheries Department, Sydney, New South Wales, Australia.

Patrons

'14 Alaska Packers' Association, San Francisco, Calif.
'15 Allen, Henry F. (Agent, Crown Mills), 210 California St., San Francisco, Cal.
'15 American Biscuit Co., 815 Battery St., San Francisco, Cal.
'15 American Can Co., Mills Building, San Francisco, Cal.
'15 Armour & Co., Battery and Union Sts., San Francisco, Cal.
'15 Armsby, J. K., Company, San Francisco, Cal.
'15 Atlas Gas Engine Co., Inc., Foot of 22d Avenue, Oakland, Cal.
'15 Balfour, Guthrie & Co., 350 California St., San Francisco, Cal.
'15 Bank of California, N. A., California and Sansome Sts., San Francisco, Cal.
'15 Bloedel-Donovan Lumber Mills, Bellingham, Wash.
'15 Bond and Goodwin, 454 California St., San Francisco, Cal.
'15 Burpee and Letson, Ltd., South Bellingham, Wash.
'15 California Barrel Co., 22d and Illinois Sts., San Francisco, Cal.
'15 California Door Co., 43 Main St., San Francisco, Cal.
'15 California Stevedore and Ballast Co., Inc., 210 California St., San Francisco, Cal.
'15 California Wire Cloth Company, San Francisco, Cal.
'15 Caswell, Geo. W., Co., Inc., 530-4 Folsom St., San Francisco, Cal.
'15 Clinch, C. G., & Co., Inc., 144 Davis St., San Francisco, Cal.
'15 Coffin-Redington Co., 35-45 Second St., San Francisco, Cal.
'15 Columbia River Packers' Association, Astoria, Ore.
'15 Crane Co. (C. W. Weld, Mgr.), 301 Brannan St., San Francisco, Cal.
'15 Dodge, Sweeney & Co., 36-48 Spear St., San Francisco, Cal.
'15 First National Bank of Bellingham, Bellingham, Wash.
'15 Fuller, W. P., & Co., 301 Mission St., San Francisco, Cal.
'15 Grays Harbor Commercial Co., Foot of 3d St., San Francisco, Cal.
'15 Hendry, C. J., Co., 46 Clay St., San Francisco, Cal.
'15 Jones-Thierbach Co., The, Battery and Merchants Sts., San San Francisco, Cal.
'15 Knapp, The Fred H., Co., Arcade-Maryland Casualty Building, Baltimore, Md.
'15 Linen Thread Co., The (W. A. Barbour, Mgr.), 443 Mission St., San Francisco, Cal.
'15 Mattlage, Chas. F., Company, 335 Greenwich St., New York City.
'15 Nauman, C., & Co., 501-3 Sansome St., San Francisco, Cal.
'15 Oliver Salt Co., Mt. Eden, Cal.
'15 Morrison Mill Co., Inc., Bellingham, Wash.
'15 Morse Hardware Co., Inc., 1025 Elk St., Bellingham, Wash.
'15 Pacific Hardware and Steel Co., 7th and Townsend Sts., San Francisco, Cal.
'15 Pacific States Electric Co., 575 Mission St., San Francisco, Cal.
'15 Phillips Sheet and Tin Plate Co., Weirton, W. Va.
'15 Pope and Talbot, Foot of 3d St., San Francisco, Cal.
'15 Puget Sound Navigation Co., Seattle, Wash.
'15 Ray, W. S., Mfg. Co., Inc., 216 Market St., San Francisco, Cal.
'15 Schmidt Lithograph Co., 2d and Bryant Sts., San Francisco, Cal.
'15 Schwabacher-Frey Stationery Co., 609-11 Market St., San Francisco, Cal.
'15 Ship Owners and Merchants' Tug Boat Co., Foot of Green St., San Francisco, Cal.
'15 Sherwin-Williams Co., The, 454 Second St., San Francisco, Cal.
'15 Smith Cannery Machines Co., 2423 South First Avenue, Seattle, Wash.
'15 Standard Gas Engine Co., 1 California St., San Francisco, Cal.

'15 Standard Oil Co. of California, Standard Oil Building, San Francisco, Cal.
'15 United Engineering Works, 232 Spear St., San Francisco, Cal.
'15 U. S. Rubber Co. of California (W. D. Rigdon, Mgr.), 50-60 Fremont St., San Francisco, Cal.
'15 U. S. Steel Products Co., Rialto Building, San Francisco, Cal.
'15 Wells Fargo National Bank of San Francisco, Montgomery and Market Sts., San Francisco, Cal.
'15 Western Fuel Co., 430 California St., San Francisco, Cal.
'15 Western Meat Co., 6th and Townsend Sts., San Francisco, Cal.
'15 White Bros., Hardwood Lumber, 5th and Brannan Sts., San Francisco, Cal.

Active Members*

LIFE MEMBERS INDICATED BY ASTERISK (*).

'16 Adams, Prof. Chas. C., State College of Forestry, Syracuse, N. Y.
'13 Adams, Wm. C., Commissioner of Fisheries and Game, Boston, Mass.
'10 Aitchison, W. W., 5 Wabash Ave., Chicago, Ill.
'98 Alexander, George L., Grayling, Mich.
'13 Alexander, M. L., President, Louisiana Conservation Commission, New Orleans, La.
'06 Alford, Jabe, President State Board of Fish Commissioners, 29 W. Dayton St., Madison, Wis.
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'02 Paxton, Thomas B., Board of State Fish and Game Commissioners, Cincinnati, Ohio.
'11 Pell, Geo. W., 520 16th St., Denver, Colo.
'05 Peoples, Hiram, New Providence, Pa.
'10 Perce, H. Wheeler, 1145 Webster Bldg., Chicago, Ill.
'10 Pew, John J., Gloucester, Mass.
'09 Pfleuger, J. E., Akron, Ohio.
'13 Poole, Gardner, 126 Atlantic Ave., Boston, Mass.
'11 Pohoqualine Fish Association, 233 Dock St., Philadelphia, Pa.
'09 Pomeroy, Geo. E., Toledo, Ohio.
'04 Pope, T. E. B., Milwaukee Public Museum, Milwaukee, Wis.
'06 Porter, Richard, Board of State Fish Commissioners, Paris, Mo.
'09 Postal, Fred., State Board of Fish Commissioners, Detroit, Mich.
'08 Prince, Prof. E. E., Dominion Commissioner of Fisheries, Ottawa, Canada.
'16 Purdy, Dorman S., 115 Eddy St., Ithaca, N. Y.

'03 Race, E. E., U. S. Bureau of Fisheries, Green Lake, Me.
'10 Radcliffe, Lewis, U. S. Bureau of Fisheries. Washington, D. C.
'84 Rathbun, Dr. Richard, Assistant Secretary Smithsonian Institution, Washington, D. C.
'93 Ravenel, W. de C., U. S. National Museum, Washington, D. C.
'13 Raye, W. H., Sealshipt Oyster Co., Boston, Mass.
'13 Redwood Library, Newport, R. I.
'09 Reed, Dr. H. D., Cornell University, Ithaca, N. Y.
'13 Reidel, F. K., Pleasant Mount, Pa.
'93 Reighard, Prof. Jacob E., University of Michigan, Ann Arbor, Mich.
'13 Reynolds, Jas. A., U. S. Bureau of Fisheries, Woods Hole, Mass.
'16 Reynolds, John J., 1610 L. C. Smith Bldg., Seattle, Wash.
'13 Rhines, Wallace D., Foreman, State Fish Hatchery, Linlithgo, N. Y.
'15 Rich, E. A., Co., 4 Boston Fish Pier, Boston, Mass.
'98 Richards, G. H., Sears Building, Boston, Mass.
'15 Richardson, Robert E., State Biological Laboratory, Havana, Ill.
'10 Rider, H. A., State Fish and Game Commissioner, St. Paul, Minn.
'13 Roach, Edwin R., 518 Hamilton Bldg., Akron, Ohio.
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'10 Roberts, B. H., 1413 New York Ave., Washington, D. C.
'10 Rogers, James B., U. S. Bureau of Fisheries, Boothbay Harbor, Me.
'98 Rodgers, J. M., Plaza Hotel, Chicago, Ill.
'98 Rosenberg, Albert, Kalamazoo, Mich.
'10 Rowe, Henry C., Groton, Conn.
'16 Rowe, Wm. H., West Buxton, Me.
'16 Royce, James, DeBruce, Sullivan County, N. Y.

'11 Ruckman, Chas. W., U. S. Bureau of Fisheries, Homer, Minn.
'14 Russell, Geo. S., Bank of Commerce of N. A., Cleveland, O.
'13 Russell, J. R., U. S. Bureau of Fisheries, Birdsview, Wash.
'13 Ryan, Calvin D., U. S. Bureau of Fisheries, Concrete, Wash.

*'05 Safford, W. H., Missouri Fish Commission, St. Joseph, Mo.
'13 Santa Barbara Public Library, Santa Barbara, Calif.
'16 Saunders, Dr. Wade Hampton, Box 296, Roanoke, Va.
'15 Schmidt, Chris., Astoria, Wash.
'15 Schmidt, Max, 2d and Bryant Sts., San Francisco, Cal.
'15 Schofield, N. B., Sunnyvale, Cal.
'15 Schoonmaker, Byron C., De Bruce, N. Y.
'16 Schrader, Franz, Route 1, Prince Bay, N. Y.
'15 Seaborn, H. G., Tee Harbor Packing Co., Port Blakely, Wash.
'00 Seagle, George A., U. S. Bureau of Fisheries, Wytheville, Va.
'13 Seagrave, Arnold, Woonsocket, R. I.
'00 Sellers, M. G., 1518 Sansom St., Philadelphia, Pa.
'10 Shebley, Frank A., Superintendent Santa Cruz County Hatchery, Brookdale, Cal.
'15 Shebley, W. H., Sisson, Cal.
'13 Shellford, Victor E., Dept. Zool., University of Illinois, Urbana, Ill.
'11 Shira, Austin F., U. S. Bureau of Fisheries, Fairport, Iowa.
'08 Shiras, Geo., 3d, Stoneleigh Court, Washington, D. C.
'15 Siebe, J. F., 430 Battery, San Francisco, Cal.
'13 Singleton, J. Ernest, Woonsocket, R. I.
'01 Singleton, James H., Woonsocket, R. I.
*'03 Slade, George P., 309 Broadway, P. O. Box 283, New York City.
'13 Smith, Herbert C., White Cloud, Mich.
'91 Smith, Dr. Hugh M., U. S. Commissioner of Fisheries, Washington, D. C.
'99 Smith, Lewis H., Algona, Iowa.
'05 Snyder, J. P., U. S. Bureau of Fisheries, Cape Vincent, N. Y.
'08 Speaks, John C., Chief Warden Fish and Game Commission, Columbus, Ohio.
'87 Spensley, Calvert, Mineral Point, Wis.
'10 Stack, F. George, "Kamp Kill Kare," Raquette Lake, N. Y.
'13 Stapleton, J. J., Green Lake, Me.
'04 Stapleton, M. F., U. S. Bureau of Fisheries, Manchester, Iowa.
'15 Starr, C. D., Lewis Bldg., Portland, Ore.
'00 Starr, W. J., State Board of Fish Commissioners, Eau Claire, Wis.
'03 Steele, G. F., Room 604, 18 E. 41st St., New York City.
'11 Sterett, W. G., State Game, Fish and Oyster Commission, Port Lavaca, Texas.
'03 Stevens, Arthur F., 227 West Grand St., Elizabeth, N. J.
'12 Stivers, D. Gay, Butte Anglers' Association, Butte, Mont.
'14 Stone, Dr. Willard J., 3 Harold Arms, Toledo, Ohio.
'04 Story, John A., U. S. Bureau of Fisheries, Green Lake, Me.
'15 Stringham, Emerson, U. S. Bureau of Fisheries, Hamilton, Ill.
'14 Struven, Chas. M., 114 S. Frederick St., Baltimore, Md.
'14 Stryker, Thos. H., Rome, N. Y.
'13 Sullivan, Walter E., Tuft's School of Medicine, Boston, Mass.
'04 Surbur, Thaddeus, U. S. Bureau of Fisheries, Homer, Minn.
'15 Sutro, Adolph Newton, 1155 Pine St., San Francisco, Cal.
'10 Sword, C. B., New Westminster, British Columbia, Canada.

'04 Talbot, Henry, Interstate Commerce Commission, Washington, D. C.

'13 THAW, AUGUST B., 1421 Shelby St., Indianapolis, Ind.
'99 THAYER, W. W., U. S. Bureau of Fisheries, Northville, Mich.
'06 THOMAS, W. H., U. S. Bureau of Fisheries, Fairport, Iowa.
'13 THOMAS, ADRIAN, 2012 Hanover Ave., Richmond, Va.
'00 THOMPSON, W. P., 123 N. Fifth St., Philadelphia, Pa.
'00 THOMPSON, W. T., U. S. Bureau of Fisheries, Bozeman, Mont.
'08 THOMSON, G. H., Estes Park, Colo.
'15 THORNE, ANDREW, 745 Mills Bldg., San Francisco, Cal.
'13 TICHENOR, A. K., Secretary Alaska Packers' Assn., San Francisco, Calif.
'14 TILLMAN, ROBERT T., Beacon Paper Co., St. Louis, Mo.
*'13 TIMSON, WM., Vice-President, Alaska Packers' Assn., San Francisco, Calif.
'92 TITCOMB, JOHN W., Commissioner of Fisheries and Game, Lyndonville, Vt.
'11 TONGUE, LEONARD M., 718 Equitable Bldg., Baltimore, Md.
'14 TORREY, PROF. HARRY BEAL, Reed College, Portland, Ore.
*'01 and '12 TOWNSEND, DR. CHARLES H., Director New York Aquarium, New York, N. Y.
'13 TREXLER, COL. HARRY C., Allentown, Pa.
'13 TRIGGS, CHAS. W., 218 N. Canal St., Chicago, Ill.
'15 TROYER, M., Astoria Iron Works, Seattle, Wash.
'16 TRULL, HARRY S., 317 E. 196th St., Fordham, N. Y.
'99 TUBBS, FRANK A., U. S. Bureau of Fisheries, Mammoth Spring, Ark.
'98 TULIAN, EUGENE A., Box 1267, New Orleans, La.
'13 TURNER, CHAS. C., Judge Kentucky Court of Appeals, Frankfort, Ky.
'13 TYSON, JAS. W., Connecticut Fish and Game Commission, Hartford, Conn.

*'11 VALLETTE, LUCIANO H., Chief of Section of Fish Culture, 827 Rivadavia, Buenos Aires, Argentina.
'09 VAN ATTA, CLYDE H., U. S. Bureau of Fisheries, Leadville, Colo.
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'10 VAN SICKLEN, F. W., 36 Spear St., San Francisco, Cal.
'13 VARDEN, GEO. S., Paris, Ky.
'10 VILES, BLAINE S., Inland Fish and Game Commissioner, Augusta, Me.
'14 VOGEL, J. C., 2203 Pearl St., Philadelphia, Pa.
'00 VOGELSANG, ALEXANDER T., 20 Montgomery St., San Francisco, Cal.
'12 VOGT, JAMES H., Nevada Fish Commission, Carson City, Nev.
'09 VON LENGERKE, J., 200 Fifth Ave., New York City.

'06 WADDELL, JOHN, Grand Rapids, Mich.
'15 WAKEFIELD, L. E., 1310 Smith Bldg., Seattle, Wash.
'96 WALKER, BRYANT, Detroit, Mich.
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'96 WALTERS, C. H., Cold Spring Harbor, N. Y.
'98 WARD, PROF. H. B., University of Illinois, Urbana, Ill.
'12 WARD, J. QUINCY, Executive Agent, Kentucky Game and Fish Commission, Frankfort, Ky.
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'15 WEIS, CAPT. JAS. E., St. Joseph, Mo.

'15 Weise, Engleberg, Seattle, Wash.
'13 Welsh, Wm. W., Scientific Assistant U. S. Bureau of Fisheries, Washington, D. C.
'15 Welsch, R., Bellingham, Wash.
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'01 Wentworth, E. E., U. S. Bureau of Fiseries, Duckabush, Wash.
'13 Westerfeld, Carl, 854 Mills Bldg., San Francisco, Cal.
'13 Westermann, J. H., Harrietta, Mich.
'01 Wheeler, Charles Stetson, Union Trust Building, San Francisco, Cal.
'15 Wheeler, Fred. M., 546 Fulton St., Chicago, Ill.
'04 Whitaker, Andrew R., State Fishery Commission, Phoenixville, Pa.
'96 White, R. Tyson, 320 Bridge Street, Brooklyn, N. Y.
'10 Whitman, Edward C., Canso, Nova Scotia, Canada.
'15 Whitman, Ward and Lee Co., 9 Boston Fish Pier, Boston, Mass.
'15 Whiteside, R. B., 204 Sellwood Bldg., Duluth, Minn.
'99 Willard, Charles W., President Inland Fisheries Commission, Westerly, R. I.
'01 Wilson, C. H., Glen Falls, N. Y.
'11 Wilson, J. S. P. H., Chairman, Board of Inland Game and Fish Commissioners, Auburn, Me.
'10 Winchester, Grant E., Forest, Fish and Game Commission, Bemus Point, N. Y.
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'13 Winter, J. H., Alaska Packers' Assn., San Francisco, Calif.
'99 Wires, S. P., U. S. Bureau of Fisheries, Duluth, Minn.
*'13 Wisner, J. Nelson, Director, Institute de Pesca del Uruguay, Punta del Esto, Uruguay.
*'05 Wolters, Chas A., Oxford and Marvine Streets, Philadelphia, Pa.
'97 Wood, C. C., Plymouth, Mass.
'13 Woods, John P., President, Missouri State Fish Commission, 1st and Wright Sts., St. Louis, Mo.
'14 Work, Gerald, Perkins Hill, Akron, Ohio.
'84 Worth, S. G., U. S. Bureau of Fisheries, 616 West 38th St., Norfolk, Va.
'15 Wyman, Willis L., Park Rapids, Minn.

'09 Yerington, Edward B., Board of Fish Commissioners, Carson City, Nev.

'99 Zalsman, P. G., Grayling, Mich.

RECAPITULATION

Honorary	73
Corresponding	17
Patrons	54
Active	547
Total	691

CONSTITUTION

(As amended to date)

ARTICLE I

NAME AND OBJECT

The name of this Society shall be American Fisheries Society. Its object shall be to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; the uniting and encouraging of all interests of fish culture and the fisheries, and the treatment of all questions regarding fish, of a scientific and economic character.

ARTICLE II

MEMBERSHIP

Active Members.—Any person may, upon a two-thirds vote and the payment of two dollars, become a member of this Society. In case members do not pay their fees, which shall be two dollars per year after first year, and are delinquent for two years, they shall be notified by the treasurer, and if the amount due is not paid within a month thereafter, they shall be, without further notice, dropped from the roll of membership.

Any library, sporting or fishing club, society, firm or corporation may, upon two-thirds vote and the payment of the regular annual fee, become a member of this Society and entitled to all its publications.

Life Members.—Any person shall, upon a two-thirds vote and the payment of twenty-five dollars, become a life member of this Society, and shall thereafter be exempt from all annual dues.

Patrons.—Any person, society, club, firm or corporation, on approval by the Executive Committee and on payment of $50.00, may become a Patron of this Society with all the privileges of a life member, and then shall be listed as such in all published lists of the Society. The money thus received shall become a part of the permanent funds of the Society and the interest alone be used as the Society shall designate.

Honorary and Corresponding Members.—Any person can be made an honorary or a corresponding member upon a two-thirds vote of the members present at any regular meeting.

The President (by name) of the United States and the Governors (by name) of the several states shall be honorary members of the Society.

Election of Members Between Annual Meetings.—The President, Recording Secretary and Treasurer of the Society are hereby authorized, during the time intervening between annual meetings, to act on all individual applications for membership in the Society, a majority vote of the Committee to elect or reject such applications as may be duly made.

ARTICLE III

SECTIONS

On presentation of a formal written petition signed by one hundred or more members, the Executive Committee of the American Fisheries Society may approve the formation in any region of a Section of the American Fisheries Society to be known as the —— Section.

Such a Section may organize by electing its own officers, and by adopting such rules as are not in conflict with the Constitution and By-Laws of the American Fisheries Society.

It may hold meetings and otherwise advance the general interests of the Society, except that the time and place of its annual meeting must receive the approval of the Executive Committee of the American Fisheries Society, and that without specific vote of the American Fisheries Society, the Section shall not commit itself to any expression of public policy on fishing matters.

It may further incur indebtedness to an amount necessary for the conduct of its work not to exceed one-half of the sum received in annual dues from members of said section.

Such bills duly approved by the Chairman and Recorder of the Section shall be paid on presentation to the Treasurer of the American Fisheries Society.

ARTICLE IV

OFFICERS

The officers of this Society shall be a president and a vice-president, who shall be ineligible for election to the same office until a year after the expiration of their term; a corresponding secretary, a recording secretary, an assistant recording secretary, a treasurer, and an executive committee of seven, which, with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session —four to constitute a quorum.

In addition to the officers above named there shall be elected annually five vice-presidents who shall be in charge of the following five divisions or sections:

1. Fish culture.
2. Commercial fishing.
3. Aquatic biology and physics.
4. Angling.
5. Protection and legislation.

Vice-Presidents of sections are expected to present reports at each annual meeting.

ARTICLE V

MEETINGS

The regular meeting of the Society shall be held once a year, the time and place being decided upon at the previous meeting, or, in default of such action, by the executive committee.

ARTICLE VI

ORDER OF BUSINESS

1. Call to order by president.
2. Roll call of members.
3. Applications for membership.
4. Reports of officers.
    a. President.
    b. Secretary.
    c. Treasurer.
    d. Vice-Presidents of Divisions.
    e. Standing Committees.
5. Committees appointed by the president.
    a. Commitee of five on nomination of officers for ensuing year.
    b. Committee of three on time and place of next meeting.
    c. Auditing committee of three.
    d. Committee of three on programme.
    e. Committee of three on publication.
    f. Committee of three on publicity.
6. Reading of papers and discussion of same.
    (Note—In the reading of papers preference shall be given to the members present.)
7. Miscellaneous business.
8. Adjournment.

ARTICLE VII

CHANGING THE CONSTITUTION

The constitution of the Society may be amended, altered or repealed by a two-thirds vote of the members present at any regular meeting, provided at least fifteen members are present at said regular meeting.