equivalent to the corn-meal. In four cases out of eight the fertilizers were followed by a heavier crop than was the stable-manure. Many of the differences, however, are comparatively small.

In the wheat experiments the corn-meal manure proved superior to the cottonseed manure in every case as regards grain, and in three out of four cases as regards total yield. The fertilizers equivalent to the cottonseed-meal proved superior to those equivalent to the corn-meal in three cases out of four as regards grain, and in every case as regards total yield. The fertilizers surpassed the corresponding stable-manure in seven cases out of eight as regards total yield, while as regards grain the proportion is four to four.

Some of these results are quite different from those which we should have expected. Cottonseed-meal of good quality contains more than two and a quarter times as much nitrogen, four and a half times as much phosphoric acid, and four times as much potash, as corn-meal, and consequently the manure made from the former in these experiments must have been much the richer. The greater growth of the mangolds on the cottonseed sections accords with this fact, while the still greater effect of the commercial fertilizers corresponds with their greater solubility and consequent prompter action. With the barley and wheat, these results are far less marked. With the barley, they are mostly the same in kind. With the wheat, cottonseed-meal was excelled by corn-meal as a manure-producer, while otherwise the results were in the main the same as with the other crops.

A more careful examination, however, shows that the differences, both as to barley and wheat, are too small to be of very much significance. The greatest difference of yield of grain between the corn-meal and cottonseed sections was, in the case of barley, two hundred and thirty pounds per acre, equal to about five bushels, and, in the case of wheat, a hundred and sixty-eight pounds per acre, equal to less than three bushels. The differences in the total yield (grain and straw) are correspondingly small. It is certainly questionable, whether these differences are not less than the errors of experiment; and the only safe conclusion which we can draw is, that the yield was not greatly different in the two cases.

The commercial fertilizers showed greater differences; the richer manuring, containing the equivalent of the cottonseed-meal, generally proving decidedly superior, particularly as regards the total yield, the grain being not so much affected.

As compared with the stable-manures, the fertilizers show but a slightly larger yield of wheat. The barley, it must be remembered, received no manure or fertilizers directly, except a light top-dressing of nitrate of soda on section 3, but only the droppings of the sheep fed on the mangolds of the preceding year.

It is not the purpose of this article to theorize as to the reasons of the results obtained in these experiments, and such theorizing would be premature at present. One thing is shown very plainly by them, however; and that is, that, in all discussion of methods and systems of fertilizing the soil, two aspects of the question must be clearly distinguished. We may regard manures either as direct sources of food to the plant, or as means of enriching the soil, and accordingly distinguish between the immediate returns which they yield, and their value as an investment. In these experiments there can be no doubt that the cottonseed sections received more plant-food than the corn-meal sections in every case, and we have no reason to suppose that this plant-food would not all become available at some time; but the immediate returns were not always greater. In the comparatively short time during which the experiments have been in progress, it has been the immediate value of the manures and fertilizers used which has manifested itself.

Whether, after a number of years, the richer manuring will not show better results on the grain-plots, is a question which, *a priori*, would receive an affirmative answer; and the testimony of experiment on this point will be awaited with interest.

H. P. ARMSBY.

THE AMERICAN FISH-CULTURAL ASSOCIATION.

THE annual meeting of this association was held in the lecture-room of the National museum at Washington, on May 13, 14, and 15. President Benkard made an address of welcome, and briefly reviewed the work of the association for the past year.

Many papers were read, and the attendance was good throughout. Mr. F. Mather gave an account of the hatching-work at Cold Spring Harbor, stating that the eggs of the tom-cod had been successfully hatched there this spring.

Prof. H. J. Rice related his experiments with various substances used to destroy the Saprolegnia, the fungus which attacks fishes in aquaria. The most successful results were obtained by the use of a bath of common salt. Fishes which were badly infested with the fungus, after immersion in a moderately diluted solution of salt and water for a minute or so, after a while had the adherent film of fungus loosened in large flakes. This method, if applied in time, would prove effectual, if one were afterwards careful not to introduce into the aquarium organic material which would decompose, and afford a nidus for the nourishment and multiplication of this pest from its spores.

Mr. L. Stone read a paper on the artificial propagation of salmon in the Columbia-River basin, taking the ground that it was probably now too late to begin propagating these fishes in some of the most depleted branches of the Columbia.

Mr. C. G. Atkins gave some important data respecting the rate of growth, and facts regarding the habits of land-locked salmon. In reply to questions by Mr. G. B. Goode, the speaker thought that the land-locked salmon did not hybridize with the common salmon under natural conditions; nor did he think that there was evidence at present to prove that the

land-locked salmon had descended from the sea-salmon, though the latter was probably the ancestor of the former.

Dr. W. M. Hudson, of the Connecticut shell-fisheries commission, gave an interesting account of the great work in progress in extending the area of the oyster-beds in the waters of Connecticut by sowing shells, together with a small proportion of live oysters, over the bottom, in waters not before productive. The statistics presented by the author showed that this industry had developed within a very short period to amazing proportions in his state, mainly through the enlightened administration of the commissioners, and the enactment of good protective laws by the state legislature. The speaker also gave a synopsis of the laws regulating the ownership of the beds, which he said were working admirably, and concluded by saying that the worst enemies of the oyster in his state were the star-fishes and human poachers, being undecided in his own mind which of the two was the worse. Steps were being taken to have all the star-fishes which are dredged destroyed.

Lieut. Francis Winslow, U.S.N., read a long paper on the present condition and future prospects of the oyster-industry, in which he showed that the beds of Virginia and Maryland were being depleted by excessive dredging, and commended reparative measures, such as were in successful operation in the waters of Connecticut. His paper was illustrated by a large and important series of charts, upon which were mapped almost all of the oyster-beds of the eastern coast of the United States, showing the depth of water in which the beds lie, and, as far as possible, their present condition.

Mr. G. Brown Goode presented a paper on the oyster-industry of the world, which is seated chiefly in the United States and France. Great Britain has still a few natural beds remaining, and a number of well-conducted establishments for oyster-culture. Canada, Holland, Italy, Germany, Belgium, Spain, Portugal, Denmark, Norway, and Russia have also oyster-industries, which are comparatively insignificant, and, in the case of the last two countries, hardly worthy of consideration in a statistical statement.

Recent and accurate statistics are lacking, except in two or three instances. A brief review by countries, in the order of their importance, was presented. The oyster-industry of the United States was shown to employ 52,805 persons, and to yield 22,195,370 bushels, worth $30,438,852; and that of France, in 1881, employed 29,431 persons, producing oysters valued at $3,464,565; the industry of Great Britain yielded a product valued at from two to four millions of pounds sterling; Holland was shown to have a considerable industry in the province of Zealand, and to have produced native and cultivated oysters to the value of $200,000; Germany has an industry on the Schleswig coast valued at about $40,000; while the products of other European countries mentioned was too insignificant to deserve a place in this brief abstract. An estimate of the total product of the world was presented as follows, the figures being given in the number of individual oysters produced: —

Countries.	No. of oysters.
United States [1]	5,550,000,000
Canada	22,000,000
Total for North America	5,572,000,000
France	680,400,000
Great Britain	1,600,000,000
Holland	21,800,000
Italy	20,000,000
Germany	4,000,000
Belgium	2,500,000
Spain	1,000,000
Portugal	800,000
Denmark	200,000
Russia	250,000
Norway	250,000
Total for Europe	2,331,200,000

The oyster-industry is rapidly passing from the hands of the fishermen into those of oyster-culturists. The oyster, being sedentary except for a few days in the earliest stages of its existence, is easily exterminated in any given locality; since, although it may not be possible for the fishermen to rake up from the bottom every individual, wholesale methods of capture soon result in covering up, or otherwise destroying, the oyster banks or reefs, as the communities of oysters are technically termed. The main difference between the oyster-industry of America and that of Europe lies in the fact, that in Europe the native beds have long since been practically destroyed, perhaps not more than six or seven per cent of the oysters of Europe passing from the native beds directly into the hands of the consumer. It is probable that sixty to seventy-five per cent are reared from the seed in artificial parks, the remainder having been laid down for a time to increase in size and flavor in shoal waters along the coasts. In the United States, on the other hand, from thirty to forty per cent are carried from the native beds directly to market. The oyster-fishery is everywhere carried on in the most reckless manner; and in all directions oyster-grounds are becoming deteriorated, and in some cases have been entirely destroyed. It remains to be seen whether the governments of the states will regulate the oyster-fishery before it is too late, or will permit the destruction of these vast reservoirs of food. At present the oyster is one of the cheapest articles of diet in the United States; while in England, as has been well said, an oyster is usually worth as much as, or more than, a new-laid egg. It can hardly be expected that the price of American oysters will always remain so low; but, taking into consideration the great wealth of the natural beds along the entire Atlantic coast, it seems certain that a moderate amount of protection will keep the price of seed-oysters far below European rates, and that the immense stretches of submerged land especially suited for oyster-planting may be utilized, and made to produce an abundant harvest at much less cost than that which accompanies the complicated system of culture in France and Holland.

Mr. J. A. Ryder thought that purely artificial

[1] On the basis of 250 oysters to the bushel.

methods, applied to the propagation of the oyster, were not as unpromising as some seemed to suppose. This much, at least, was certain, — that a simple method of confining the fry so as to prevent its escape from partially land-locked waters was practicable, and would doubtless be found to be a valuable aid in oyster-culture in the future.

Mr. George S. Page read a paper on the success with which certain lakes in Maine had been stocked with black bass from fish taken from New York.

A paper was then read by Col. M. McDonald on the natural causes influencing the movements of fishes; the author remarking, that in aquaculture, as in agriculture, a number of conditions necessarily concur in determining production. Many of the conditions are capable of being modified by man's agency. His influence in determining increased production, either on the land or in the water, is measured by the increase in average production, which he may effect by modifying favorably the natural conditions which are under his control.

The most important condition determining the fluctuations in the aggregate number of fish taken year by year is the temperature of the medium in which they live. In the case of the shad (Alosa sapidissima), the study of records of water-temperature would seem to indicate that it is ever moving, in its ordinary migrations, towards a temperature of 60°. Assuming this to be true, we should expect in an area like the Chesapeake, limited and bounded seaward by a wall of low temperature, always to find the shad in that portion of this area which approximated more nearly to 60°. To trace the shad in their migrations, it is only necessary to determine the shifting of this area of congenial temperature under the influence of the seasons. Our temperature records for 1881, 1882, and 1883, indicate, that, for the winter months, the area of maximum temperature is not in the rivers, nor in the bay, but on the ocean plateau outside, extending from the capes of the Chesapeake to the Delaware Breakwater. The presumption, therefore, is, that the schools of shad belonging both to the Chesapeake and the Delaware have their common winter quarters on this plateau. When, under the influence of the advancing seasons, the waters of the Chesapeake and the Delaware bays become warmer than those of this plateau, the migration into continental waters begins. The proportion of the run that will be directed to the Delaware or to the Chesapeake will be determined at this early period. If the water at the northern end of this area warms up more rapidly than at the southern, then an undue proportion of the shad will be thrown into the Delaware. On the other hand, cold waters coming down the Delaware may effect the contrary movement, and throw the schools almost entirely into the Chesapeake; thus leading to a partial or total failure of the shad-fisheries of the Delaware for the season.

When the schools of shad have entered the Chesapeake, their distribution to the rivers will be determined in the same way by temperature influences. If the season is backward, so as to keep down the temperature of the larger rivers which rise in the mountains, then the run of shad will be mainly into the shorter tributaries of the bay, which have their rise in the tide-water belt, and, of course, are warmer at this season than the main rivers. Again: warm rains at the beginning of the fishing-season, and the absence of snow in the mountains, will determine the main movement of the shad into the larger rivers of the basin; and if, when the schools enter the estuaries of these rivers, they encounter a temperature considerably higher than that in the bay itself, the movement up the river will be tumultuous, the schools of shad and herring all entering and ascending at once, producing a glut in the fisheries, such as we sometimes have recorded.

We see, therefore, in the light of these facts, that we may have a successful fishing-season on the Delaware, accompanied by a total or partial failure in the Chesapeake area, and *vice versa;* and, considering the Chesapeake area alone, we may have a very successful fishery in the aggregate, yet accompanied by partial or total failures in particular streams, under the influence of temperature conditions. If statistics of the shad-fisheries are to furnish a measure of increase or decrease, they must include the aggregate catch of the Chesapeake and Delaware River, and, indeed, of rivers much farther to the north. Statistics based upon a comparison of the catch in the same river, in different seasons, are of no value as serving to give a measure of the results of artificial propagation.

That the aggregate production of the shad-fisheries of the Atlantic coast is on the increase, is shown by the fact, that, in the face of an ever-increasing demand, prices have not only been held at what they were in 1879, but have been sensibly reduced.

Mr. J. A. Ryder made a communication upon some of the forces which limit or determine the survival of fish embryos, remarking that different species of fishes differed very widely in respect to the number of ova produced by a single female during one season. After a comparison of the habits of the different forms, and after some attention had been bestowed upon the contrivances intended for the protection of the eggs and young which are developed by the parent fishes of certain species, as well as the protective adaptations developed by different ova, the speaker had concluded that the number of survivals out of any given brood of eggs was dependent upon the amount of such natural protection afforded them; that such a protective influence likewise tended to diminish the number of ova produced by a species during a single season just in proportion as such natural protective agencies were most effectual. This view the speaker thought was strongly supported by what is known of such species as commit their eggs to the mercy of the environment, as in the case of cod, with its two to nine millions of eggs left to float and hatch on the surface of the ocean; in which case a very small percentage of germs ever reach adult age, whereas every one of the six to twenty-five eggs of a viviparous or nest-building species grows at least large enough to begin the struggle for existence with

the environment, under circumstances a hundredfold more favorable to their survival than the young of a totally unprotected form, or one only partially protected from immediate destruction by the buoyancy of its germs or ova.

The natural limitations of the supply and proper kinds of food were also alluded to, and some of the early imperfections of fish embryos pointed out, some having an imperforate oesophagus at the time of hatching, so that at this time they cannot take food. The relative strength of the embryos of different species at the time of leaving the egg was also shown to be dissimilar in the cases of those species which do not protect their broods; and it was suggested that such absence or presence of embryonic vigor might have an influence in diminishing or increasing the chances of survival.

The point, however, which the speaker wished especially to insist upon, was, that, other things being equal, it was probably true that the number of survivals out of a brood of eggs stood in nearly an inverse proportion to the number of germs actually produced, and that natural or adaptive protective agencies tended to diminish the fecundity of a species, just as a want of such protective endowments tended to increase fertility in order, apparently, to compensate for the wholesale destruction of such germs during their early and critical stages of development.

Dr. Theodore Gill, commenting upon Mr. Ryder's remarks, said that the facts just reported afforded a broad inductive basis for the doctrine, that, in proportion as the eggs of a species of fish were protected by the parents, just in that proportion were the chances of survival of the individual young increased, and the number of eggs correspondingly diminished. The speaker thought that it was not generally understood that many fishes were in the habit of caring more or less for their young, and that this ignorance was due to the fact that very few of the well-known fishes of Europe had such habits; and our popular writers, who draw so largely from European literature upon such subjects, failed to appreciate how frequently such was the case with our native forms. Citing the case of certain marine cat-fishes which hatch their young in the mouth, besides others which carry their ova upon processes on the abdomen, the speaker desired especially to call attention to the fact that about two-thirds of the sharks and rays, or elasmobranchs, were viviparous; the young undergoing their embryonic development within the body of the parent.

Mr. E. G. Blackford of New York read a paper entitled 'Is legislation necessary for the protection of the ocean-fisheries?' Judging from his own experience and observation for many years past as a dealer, he would hesitate regarding the expediency of legislative interference with the ocean-fisheries; which opinion he illustrated by statistics, and concluded by saying that probably the only fishery-products of which the supply had been perceptibly diminished by over-fishing, during the last fifteen years, were the striped bass, or rock-fish, and the lobster.

Mr. Joseph Willcox gave an account of his observations upon the sponge fauna and fisheries of the shallow waters of the west coast of Florida, north of Tampa Bay. About thirty species of fibrous, calcareous, and siliceous sponges were collected by him in this region; and he suggested, that, in view of the fact that fishing for the valuable fibrous or ceratose sponges of commerce was becoming less remunerative, steps ought to be taken to artificially propagate such forms as were of economical value.

Prof. W. O. Atwater of Middletown, Conn., gave a very interesting *résumé* of his investigations upon the subject of the chemical composition and nutritive value of American food-fishes and invertebrates. These investigations were directed to the determination of the percentages of proteids, carbohydrates, water, and refuse, contained in flesh-foods of different kinds: the results were carefully tabulated, and afford important data for the determination of the relative values of different fishes and mollusks as compared with other meats. Some of the results arrived at are quite remarkable: for example, a hundred pounds of oysters were found to contain very little more proteine than the same weight of milk, when the waste (that is, the shells) of the oysters was considered in the analysis. When the edible portion alone was analyzed, the nutrient matters contained in the oyster were found nearly in the same quantity as in codfish from which the head and entrails had been removed. The actual cost of the proteine consumed as food, it was shown, varied between very wide limits: for example, if consumed in the form of salmon early in the season, at one dollar per pound, the cost of proteine to the consumer was at the rate of five dollars and seventy-two cents per pound. If consumed in the form of the alewife, at three cents per pound, the actual cost of the proteine per pound was only nineteen cents. The nutritive value of different fishes was also found to vary considerably; that is to say, the percentage of proteine and carbohydrates is variable in quantity in different species. Thus, the percentage of available food-materials in the whole flounder is only five and three-tenths per cent, while in fat mackerel it is twenty-four and two-tenths per cent.

The presence of only a small percentage of carbohydrates in fish-food was noted, in which respect it contrasts strongly with fat pork and beef, which are rich in proteine and carbohydrates, and with farinaceous foods, which are poor in proteine; indicating, that, as an adjunct to these, fish-foods have a high value in all dietaries.

Mr. Richard Rathbun presented a paper on the decrease in the abundance of lobsters, briefly stating his conclusions regarding the supposed decrease in their number, based upon materials gathered from many sources in the interest of the tenth census, and still unpublished.

The lobster-fishery, as a separate and distinct industry, was first started about the beginning of the present century, on the coasts of Massachusetts and Connecticut, and only as late as 1840 on the coast of Maine, where it has since attained its greatest development. The vicinity of Provincetown, Cape Cod,

was at one time, about twenty-five to fifty years ago, the principal source of supply for the larger markets of the country, and especially for New-York City; and the trade between these two places was of great importance. The Cape-Cod grounds are now, however, so nearly depleted that the annual catch is of very slight value. Other important areas have shown indications of a similar decrease; and the market supplies have been increased from year to year only through a great extension seaward of the fishing-grounds, and the much greater number of traps used. A suggestive indication of the decrease in abundance of lobsters is furnished by the marked decrease in the average size of those now taken to supply the trade.

The fact was noted that the lobster is not a truly migratory species, but simply moves into slightly deeper water on the approach of cold weather, to return again to the same shallow areas as the spring advances. Continued over-fishing in any one region will therefore tend to reduce the stock of lobsters in that region, without the probability of its being rapidly replenished by migrations from a neighboring region; and the greater or less depletion of many areas may be explained in that way.

The solution of the problem as to how the fishery may be protected in the interests of the fishermen and the trade must be reserved for future investigations; but existing laws do not appear to give the desired benefits.

On Tuesday evening the association met in the hall of the National museum, to listen to an address by Hon. Theodore Lyman of Massachusetts, who reviewed the work of the U. S. fish-commission and of the state commissions in an able manner.

Hon. Theodore Lyman was elected president of the society for the ensuing year; and during the return trip from the river-excursion on the steamer Fish-hawk, the name of the association was, after considerable discussion by the members present, changed to the 'American fisheries society.' A conference of all of the state fish-commissioners present at the meeting, with the U. S. commissioner of fish and fisheries, Professor Baird, was held on the 15th.

MEETING OF MECHANICAL ENGINEERS AT PITTSBURGH.

THE meeting of the American society of mechanical engineers at Pittsburgh, May 20–24, was in many respects one of the most interesting that has been held. The attendance was as good as usual, say twenty-five per cent of the membership, and the quality of the papers above the average. The arrangements for the social comfort and enjoyment of the guests were not, however, so complete as at the last spring meeting. It was a mistake, that the announcement of a *conversazione* and social re-union was not carried out, and an opportunity given, early in the meeting, for the formation and renewal of acquaintances. The excursions so generously provided were of great interest; but we venture the assertion that the mass of the visitors gained but little accurate information. By providing for such an occasion an appropriate manual or guide, or possibly a larger reception committee, the advantage to the guests can easily be quadrupled. It might even be better, as was done at the last meeting, to devote the whole day to a well-planned visit to a single establishment.

The society met in joint session with the Engineers' society of western Pennsylvania, whose president, Mr. Miller, welcomed the visitors, and invited their president, Prof. John E. Sweet (formerly of Cornell university), to the chair. The evening of May 20 was devoted to the report of Messrs. Roberts, Phillips, Hunt, McDowell, and Jarboe, — a committee appointed, at the January meeting of the local society, to investigate the whole subject of natural gas. There are also a city, and an underwriters' committee on the same subject.

Though Pittsburgh is within reach of three or four prolific localities, and gas has been used for many years, it is but recently that any organized effort has been made to use it on a large scale. Already there are a hundred and fifty companies chartered in the state, representing over two million dollars; and gas is brought from eight to twenty-five miles for use in the city. Five-inch mains are being followed by eight-inch, new wells are being bored, and the time when Pittsburgh shall become a smokeless city may not be far distant. Though the gas is used under a pressure of a few ounces, the pressures at the wells run from fifty to a hundred and twenty-five pounds: this is due to the friction in the mains, five pounds being allowed for each mile. If the flow be shut off the pressure runs up much higher, and great difficulty has been experienced in making tight joints; cast-iron is too porous, and ordinary pipe-threads do not fit well enough. A number of new coupling-devices were exhibited, in some of which a lead packing was used. No allowance for expansion need be made, as the gas maintains an even temperature of about 45° F. When gas is allowed to burn freely at the mouth of a well, the cold produced by the expansion is such that ice has been projected through the flames.

The gas is used in all kinds of furnaces for making steam, iron, glass, etc.; and electric-light carbons, and the finest lampblack for printing-inks, are made from it: but it is used with suicidal wastefulness, which causes anxiety, as many wells give out in less than five years. The report looks to its economic and safe control. For household use it might otherwise be dangerous; and such use has commenced, though no practicable method of deodorizing it has been found. Being composed largely (ninety-six per cent) of marsh-gas, its value as a heating-agent is high, and its density is about half that of air. One pound (23.5 cubic feet) of gas has a theoretical evaporating-power of twenty-four pounds of water, twenty pounds having been actually evaporated. The best method of burning it is not generally known: experiments with injector-burners show that they do not suck in sufficient air for complete combustion, and the best results have been from numerous jets in contact with the whole heating-surface of the boiler. The value of the gas, as compared by evaporation tests with coal at $1.40