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REPORT

OF THE

STATE COMMISSIONERS OF FISHERIES,

FOR

THE YEARS 1881 AND 1882.

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STATE COMMISSIONERS OF FISHERIES,

FOR THE YEARS 1881 AND 1882.

OFFICE STATE COMMISSIONERS OF FISHERIES,
February 23, 1883.

SIR: The State Commissioners of Fisheries have the honor to submit the following report of their operations during the years 1881 and 1882:

Fish-ways.

You are respectfully referred to our report for 1879 and 1880, which fully explains what was done in reference to fish-ways in the Columbia dam under the law of 1879. It will appear that the Commissioners used their best judgment in the construction of a fish-way in the said dam; but found, on trial, that there were difficulties in the way which they could not conquer without a greater command of means than the law allowed them, and they are thus prevented from carrying their experiments further in the Columbia dam, the place where the first fish-way must be built, as it is the first dam occurring above the mouth of the river. The difficulty with this fish-way will be easily understood. The dam is founded on smooth rock, and the principle of the fish-way is a simple opening in the work as nearly like a break as can be, except that the sides are smooth and regular.

Had the opening extended down to the smooth rock there is no doubt but what the fish-way would have been a success; but the company owning the dam were required by law to be consulted in the structure of the fish-way, and they said they could not afford to lose so much water as would pass through an aperture in it, extending down to the bottom of the river, which would have been forty (40) feet wide and ten (10) feet deep, the dam being higher at this point, crossing a channel in the bottom of the stream,

than it averages anywhere along its face. A transverse platform or sub-dam was therefore inserted, shoaling the opening to five (5) feet, and this circumstance is the chief, probably the only, cause of failure in the object of the structure.

The platform was built entirely of stone and timber, and the rocky floor in front of it paved with weighty stone; but the vast volumes of water, frequently rising ten or twelve feet above the platform and paving, proved irresistible, and the paving first and finally the platform was disturbed and shaken to an extent that produced a roughness in the current, passing through which most probably baffled and caused the fish to avoid the aperture. Whilst in their endeavor to ascend it they were caught by the piratical fishers, who night and day kept up a constant depredation upon the State work.

Wardens were appointed, arrests were made, imprisonment was visited upon the depredators; but the number of shad that passed through to the upper waters, although still exceeding such numbers passing through any other fish-way in the country or perhaps in the world, was not as great as had been hoped for.

The hands of the Commissioners were tied; they were not allowed to expend more than a certain sum upon the Columbia fish-way, say $15,000, whilst the bare completion of the work very nearly reached that figure; indeed, the ordinary repairs due to the first season's use well-nigh covered it. Money was appropriated but could not be used except upon the success of the Columbia fish-way, and then not upon the Columbia dam but upon dams further up the stream.

The Columbia fish-way, then, has simply been protected from the usual annual freshets. Nor can it be a success until some radical change is effected in it. The platform, shoaling to five feet, could be made permanent by riveting it to the rocks and otherwise solidifying it, so that it should not be carried away or disturbed by high freshets, for confidence is not lost in this style of fish-way, by any means; but this cannot be done without money, and there is no money available for the purpose. Experience has shown that it is a difficult matter to build a fish-way, and although this promises well, it may again fail even with its apparent faults remedied. There is a plan, however, that might possibly answer, and that is to let by contract the construction of a fish-way, to be paid for upon its success, ascertained by trial; and further, should it prove a failure, the party to place the dam in the condition in which it was before the work was commenced.

Otherwise, if the amount already appropriated for fish-ways, and unexpended, be intrusted to the hands of your Commissioners they still believe that the fish-way now in the Columbia dam could be altered so as to answer the purpose. It would be easy to modify the law in such a manner as to satisfy these conditions.

Our report for 1879 and 1880 treats upon this subject, and to this we respectfully refer you We shall have to allude to that document frequently in the progress of this report, and perhaps draw upon it largely in the form of extracts.

At page 3, for instance, we call your attention to the following:

"*Statement of the Number of Fisheries in Full Operation Below the Columbia Dam in the Season of 1880:*

1. From Columbia to Turkey Hill, first five miles, ...	48
2. From Turkey Hill to Maryland State Line, twenty miles, 100 scoop net operations in same distance, ...	100
3. From State Line to Havre-de-Grace, nineteen miles, . . .	100
4. From Port Deposit to Chesapeake Bay, 250 gill-net boats, employing 500 nets from 150 to 400 yards long, each, (from five to ten miles), ...	250
The catch of shad from Columbia Dam to Turkey Hill, within first five miles, in 1879, numbered, ...	32,000
The catch for the same locality in 1880, reached, ...	45,000

The above facts were ascertained on the ground by a special and reliable messenger."*

The seasons of 1881 and 1882 were, perhaps, not as successful fishing years as their two predecessors, but the bare figures exhibited here are enough to convince any one that if fair play is to be conceded to the riparian inhabitants of the upper Susquehanna, very considerable modifications must be made in the laws in these cases made and provided.

Even if there were no dam at Columbia, the laws should be so framed as to show fair play to the people of the upper river, as they can never have justice until protected by law.

As to fish-ways, we believe we can say, that of those calculated to admit shad, ours has been as successful as any one as yet constructed in the United States. That it can be made a perfect success, we are scarcely as yet prepared to say; but if we keep on trying it is entirely possible that we may reach a degree of perfection quite desirable at the present time. Next in the category come

Kiddles or Fish-baskets.

These, as we have before shown, are forbidden in *Magna Charta*. They were put down with the strong hand by the people in the time of King John, and we believe have never since been allowed in any part of the British Islands. The law in respect to them must be strengthened; they must be declared nuisances, and destroyed wherever seen.

It is due to the Pennsylvanian riparians of the Susquehanna that they should be abolished in Maryland, for there is no greater enemy of anadromous fishes than just these vile death-traps. What they cannot take

*This statement of facts carries with it its own commentary. Unless reasonable close times are provided for, the up-stream inhabitants are simply deprived of their fishing rights. There must be reciprocal concurrent legislation between Maryland and Pennsylvania.

or use for their owners they destroy, so that others cannot use them, and millions upon millions of small fish are caught in them annually, only to be shoveled out into the current—putrid and useless for any conceivable purpose—manure, perhaps, only excepted. It is safe to say that we should have had in our Susquehanna both California and Buckport Salmon, had the stream been free from these villainous contrivances. Fishing associations have recently been springing up all through the country, and laboring to bring back to our streams their wonted supplies of wholesome and cheap food. Let these direct their attention to the fishery laws, so that fair play may once more be exhibited. Suggestions from these bodies to our Legislatures, may bring about changes in the law which will prove more salutary.

We again respectfully refer you to our report for the years 1879 and 1880, as great care was given to its compilation and arrangement, and as the edition published is exhausted, and as there is still a growing demand for it, we copy some of its articles here for the use of such persons as have not had an opportunity of perusing it. The paragraph on THE FISHING STREAMS OF PENNSYLVANIA, we deem entirely worthy of reproduction in this report, as also several articles following it.

The Fishing Streams of Pennsylvania.

In the appendix to this report will be found a circular addressed chiefly to members of the last Legislature on the subject of the fishing streams of the State. The circular is given, and the replies are tabulated, showing, or at least suggesting, what can be done if the propagation movement be taken up by the people themselves. As far as this movement has gone, it has amply repaid the State for the outlay made, the payment being in the form of valuable food fishes, at so much per pound, taking the place of other food which must necessarily have cost in money in exact proportion to its value as nourishment for the people.

In the same appendix will also be found the distributions made from the eastern and western hatching-houses during the past season, and since our last report. It will be seen that the work goes on faithfully, and that our game and food fishing resources are being added to day by day. These establishments are described as follows:

The Western State Hatching-House.

Through the liberality of the Legislature, in addition to the eastern hatchery, a second one was established west of the Allegheny mountains in 1876. After careful investigation of all leading springs west of the mountains, the present site near Corry, Erie county, was selected as affording the best facilities for fish culture. The place consists of nine acres and a half of land at the terminus of Smith street, leading from Corry, having thereon erected a good and complete dwelling-house, and one of the best modern hatching establishments, consisting of twelve to fifteen springs, furnishing abundance of water to run two such houses. These are so connected together by subterranean pipes and surface conduits as to form any number, almost, of ponds. With these facilities for fish culture, the amount of fry that can be turned out, at comparatively small expense, is surprising. Our establishments compare favorably with the best of those of any State in the Union.

We proceed to treat of some of the food fishes which have been, and may be, introduced into the waters of Pennsylvania:

Sea Salmon. (*Salmo Salar.*)

We refer to our former reports for what has been done in relation to this fish, one of the most valuable of all the food fishes. It will be seen that we have made strenuous endeavors to introduce them into our waters, but, as yet, without the success we had hoped for.

Both in the Delaware and in the Susquehanna adult fish of the Buckport (Maine) variety have been caught, evidently produced from fry deposited by us in both of these streams.

Either the numbers deposited must necessarily always be too small to escape the many vicissitudes they cannot but encounter, or the waters do not suit them, or they are destroyed by the kiddles and fish-baskets which impede all planting on the Susquehanna.

It is true that the Delaware is not so obstructed by these contrivances; yet on the Delaware larger numbers, due to the plant, have been taken, and if a constant supply of schools of these fish were planted on the Delaware, it may be that that stream may become a new *habitat* for the *Salmo Salar*; but up to this time we have not been so successful as could be wished. As to the Susquehanna, we never shall succeed with any new anadromous fish in that stream until the fish-baskets shall have been abolished, and some reciprocal close time arrangements be entered into by Pennsylvania with Maryland. This can only be done by concurrent laws, and the attention of the respective Legislatures should be drawn to the subject.

California Salmon. (*Salmo Quinnat.*)

Similar remarks may be applied to this fish as are used in reference to the Buckport variety. We have deposited at various times considerable numbers both in the Delaware and the Susquehanna; but as yet we have not been rewarded by the success we had hoped for. As for the Susquehanna, so much is it obstructed by fish-baskets that it is questionable whether any appreciable number of them have ever been able to go down to the sea. The New York Commissioners have not been more successful than we have been, and they discourage any further importation of this fish across the continent from the Pacific—at least until they can be better protected than they have been up to this time.

Land-locked Salmon. (*Salmo Salar Sebago.*)

Our experience in the introduction of this valuable fish is of a limited character. Experiments rather tend to demonstrate that this variety of

the salmon family can endure warmer waters than any other, as our list of distribution will exhibit. We placed several thousand in Harvey's lake, in Luzerne county, and Mr. H. S. Rutter reports their adapation and doing well, his observation, however, being confined to the stream that feeds the pond, not being able to watch their growth in the main lake, the expanse of water being so great that the utmost care would have to be observed to discover them, until they shall have become sufficiently numerous to be caught. The plant, however, may safely be considered as certain to be fruitful. We have in our State a limited though not inconsiderable number of places suitable to this fish, more particularly found in the north and north-eastern portion. We mean mountain lakes, such as Harvey's lake, the lakes near Minnequa, Conneaut, and the numerous lakes of the kind which are scattered over Wayne county. The fish may also possibly thrive in the upper branches of our streams. In these sequestered regions improvements can be made and individuals and clubs will soon establish summer resorts, where, with the rod, line, and gun they can while away the warm summer season. With the large distribution of brook trout going on in the mountain tributaries, these, with the beautiful lakes, will teem with the finny tribes; the groves and the woods furnish abundance of game, and these hitherto forsaken localities will be peopled during the summer with the denizens—rich and poor alike enjoying cheap transportation and recruiting health which hard work of the rest of the year has impaired. The whole salmon family attract true sportsmen's attention; voyages of thousands of miles are made in the old country for the purpose of finding them in abundance, ready to leap at the fly. The little school we placed in Harvey's lake, we hope is the beginning of a plentiful supply of this valuable fish.

We have every reason to believe that the deposit in Harvey's lake will prove a success, in which case the land-locked salmon will be introduced into all the lakes capable of supporting them, and into which the people will take the trouble of transplanting them, in the northern part of the State, which lakes are, as is well known, very numerous.

The Common Eel. (*Anguilla Acutirostris.*)

Less attention has been paid to this slippery customer than, perhaps, to any other inland fish inhabiting the waters of the State. Yet our pigeon-holes are filled with letters of inquiry as to why he is not protected as other fish. What are his habits? Parentage? Where does he belong? How propagated, &c. Packard says: "The common eel occurs on both sides of the Atlantic, on the North American coast, as far south as Cape Hatteras, and in inland rivers and lakes. The sexes do not differ externally and internally, only as regards the form of the reproductive glands. The ovaries form the ribbon-like masses extending from the liver to just beyond the vent, and attached by one edge to the walls of the body, with the free edge hanging downwards. When in spawn, the ovary is very thick, white, and the eggs can be seen with the naked eye, being nearly one half millimeter in diameter. When ripe they break through the wall of the gland, and drop into belly-cavity, there being no oviduct, and pass out of the genital opening situated directly behind the vent. The male glands occupy the same position as the ovaries of the female, but are smaller, narrower, and distinctly tabulated. Out of about six hundred specimens of eels, only four males have yet been found in this country. These had testes like those described by Syrske in the Italian eel, (*A. Vulgaris*,) while Packard detected the mother cells, and Mr. Kingsly observed moving, active spermatozoa. It is probable that the eel descends rivers in October and November, spawning in the autumn and early winter at the mouth of rivers, and in harbors and estuaries in shallow water. By the end of spring the young eels are two or three inches long, and then ascend rivers and streams. They grow about an inch a month, and the females do not spawn at least before the second year, *i. e.*, when about twenty inches long. Mr. Mather estimates that the ovary of an eel weighing six pounds when in spawn contains upwards of 9,000,000 eggs."

In addition to the above high authority, we append the article included in our last report, being unable to present anything later upon this interesting fish.

To the inland fisherman these are questions of interest and significance, as the eel is, undoubtedly, a great favorite with the people, and deserving of more than a passing notice.

Eels are natives both of fresh and salt water, those living in fresh water, the *Anguilla Acutirostris*, being found in many parts of the United States, their snake-like form diminishing their attractiveness as an article of food, and contributing much to the sport of taking and securing them even after being "well in hand," as the anglers have it.

They flourish in bogs, marshes, and in peat bottoms, spawn in the sea, and ascend the rivers in the spring by millions. The fishermen of the inland streams catch large numbers of them on their annual return to the salt water, by means of set fish-baskets, called also eel-weirs, so extremely destructive of other fish, especially young shad. They usually return between October and December, inclusive, but it is thought not until they have passed several years in the fresh water. For the catch in the fall "run down" scarcely ever includes small eels, although in the spring millions are found not thicker, and some much less, than pipe-stems.

Unlike the shad or salmon, which leave the salt for the fresh water for the purpose of spawning, they reverse the movement, and seek the sea at the spawning period.

In Europe, they are highly esteemed, considered, indeed, a luxury, and preferred by many to the angler's pride—the trout.

This is especially so in Italy and Germany, where their cultivation is made a source of considerable revenue and profit. They are not what some fastidious persons consider them, simply mud scavengers, ugly and repulsive cannibals, but fully meets the wants of the masses as a food fish, pos-

sessing a solidity of flesh and a delicacy of flavor surpassed by few varieties.

Being a bottom fish, the peculiar order and strong taste noticed by some are attributed to that fact, but if any "anti" eeler will take the trouble to extract the back-bone before cooking, he will find that it makes a wonderful difference, as the marrow of the spine is, without doubt, the true cause of these objectionable savors, and when it is withdrawn, the eel becomes a delicacy fit for any palate.

They are excellent feeders, taking fish, flesh, or refuse. They have been called "hogs of the ocean," and like their brethren of similar reputation on the land, are useful to man in proportion to their ill repute. Their habits have not been studied with the care bestowed on those of other fish, but their importance as an article of food is at last receiving that degree of attention which it justly demands.

Anatomically considered, they are peculiarly well adapted for migratory purposes, ascending dams with little difficulty, and when the water course is absolutely obstructed, they will pass over the dry land for quite considerable distances, living out of water remarkably well. "Their gills or breathing organs are covered by a most delicate cushion, which acts as a valve, and forms a reservoir, enabling them to take in a portion of water, and thus keep the gills moist during the period in which they are on dry land, preventing the gills from adhering together and stifling them." Another peculiarity is that an eel has a heart in its tail, a caudal heart, which, when he is dying, but not before, exhibits a pulsation of about ninety-five beats to the minute, and which can be distinctly seen by the aid of the microscope.

The flesh of the eel is salted, smoked, and pickled, and forms quite an article of trade, and must, some time in the future, supply a large amount of cheap food for the masses.

In the United States, there being such a large area of marshy ground, now worse than useless, along the eastern coast, were this cultivated for production of eels, it might be made extremely profitable.

The question of his propagation is not a new one, having perplexed the minds of zoologists from the days of Aristotle (the greatest naturalist of antiquity) down to the present time. Some held that the female reproduced her species without the aid of the male, while others maintained that a certain deposit of a fatty formation, found in the female along side of the ovaries, were the male organs, constituting the eel a hermaphrodite. A few, however, have alleged that there are male and female eels, having each their natural organs of reproduction and fecundation, which view is about being adopted as conclusively settled. Doctor Syrske's laborious researches and investigations, with powerful microscopes, published in the United States reports, we think satisfactorily show the latter view to be well taken, and successfully prove the actual existence and presence of the spermatic organs in a male eel. That the ovaries exist in the female has

been an accepted fact for centuries, although it took two thousand years to find it out, and, as stated by Doctor Syrske, "the spermatic organs being so much more smaller, it was much more difficult to discover them." The spermatic organs, two in number, are ribbon-shaped, with leaflets on their outer face, with transverse folds extending on each side of the alimentary tube. The spermatic organs in the male are not ribbon-shaped like the ovaries, but are two longitudinal rows, each with lobules, and found in eels of certain advanced sizes, these organs being distinguished from the ovaries by their lobular form, shining, glassy appearance, smoothness, without leaflets, and much greater density of tissue. He also states, as the result of his latest investigations of the two hundred and fifty-eight eels examined, that the females and males were about in even proportion.

It will be seen, therefore, that, practically, the vexed question may be considered as settled, and ordinary fisherman will no longer wonder why *they* could never discover any spawn. There is still, however, some uncertainty as to the *locale* in which the spawning of the eel takes place, and as to others of its habits. Mr. R. B. Roosevelt, president of the American Fish Culturists' Association, excellent authority, takes the ground, after a series of careful experiments, that eel spawn in fresh water in the spring. However this may be, we are inclined to believe the carefully prepared microscopic investigation of Doctor Syrske, alluded to, as settling the question as to their organs of reproduction. Perhaps, after all, the absolute truth on these subjects is not yet arrived at, nor need we wonder, seeing that mystery having hung about the habits of this extremely interesting fish, as we have remarked, for more than two thousand years, it would not be in the least surprising if that mystery were to continue for half a century or so longer; though it is to be hoped that the keen inquirers of the period will not continue to be baffled like their predecessors, but will unravel the difficult question, as other questions of the kind are solved, by the special perspicacity of the present age of investigation.

Some of the western States are introducing the eel where he is not to the manner born, and demanding culture and protection for him, considering him intrinsically valuable as a food fish, and that no system of fish culture can be complete without him.

The most useful method of taking the eel, however, has heretofore been the fish-basket or eel-weir. There must be some other means applied, for while that predaceous invention may suit very well for the special purpose, its utterly destructive effects on other tribes are such as to require its banishment from all civilized waters.

White Fish. (*Coregonus Albus.*)

In our previous reports we detailed at length the object and result of our official visit to Lake Erie to look after the fishing interests generally; but more particularly in regard to our duty in relation to the propagation and introduction of this valuable fresh water fish along the skirts of Lake Erie and inland bay, which claims attention. The visit had the desired

effect of producing an additional interest in the protection of all kinds of fish. The piratical pond nets were made things of the past, and new fields were opened for the angler where depletion hitherto prevailed. The Game and Fish Association of Erie, by their vigilance, have produced the most beneficial results, and, if persisted in, will restore what must certainly be a source of pride and gratification to the inhabitants of that city as well as a fruitful source of revenue. We have only about forty-five miles skirting the lake, and to give some faint idea of the magnitude of the lake fisheries, especially in regard to the more valuable migratory white-fish and herring, to say nothing about the trout, pickerel, bass, catfish, &c. The Ohio commissioners' report contains the number of tons caught for the Toledo market alone in one year:

Whole number caught,	3,000 tons.
Salted,	30,000 half barrels.
Frozen,	85 tons.
Shipped fresh,	915 tons.

We saw at the wharves of Erie responsible parties handling white-fish, herring, &c., by the thousand tons, observing ordinary fishermen bringing in in their small boats, as high as three hundred pounds at a time of white-fish, which, with the railway facilities of our State, brings these delicious and excellent fish within fifteen hours of the Delaware. The necessary legislation was conceded, and will doubtless be further granted, sufficient to protect their entire interests, involving, as it does, great commercial value and importance. Notwithstanding its importance, we have not deemed it advisable to handle or propagate this fish at our hatching-houses on account of our limited lake surface; but its importance may in the future require a contributive share on our part to keep up the supply which is now so generously awarded by Ohio, Michigan, and other western border lake States, and this spring we hatched and distributed two millions of fry at Erie from our western hatching-house at Corry.

ERIE, PA., *January 11, 1882.*

Col. JAMES WORRALL, *Harrisburg, Pa.:*

DEAR SIR: I have made an effort to get some statistics in relation to the catch of white fish at Erie, which would be of use to the Fish Commissioners, but found I could not get exact data, because some of the smaller dealers do not keep any books. The data which I send you are made up of the actual catch of the three largest houses in Erie, and estimating the catch of the smaller houses by taking the number of boats they had, and giving to each boat an average catch. We had caught and brought into Erie 800,000 pounds of whitefish, or 400 tons, which were caught as follows, viz:

	Pounds.
March,	30,000
April,	42,000
May,	50,000
June,	10,000
July,	60,000

	Pounds.
July,	60,000
August,	80,000
September,	200,000
October,	300,000
November,	28,000
	800,000 lbs.=400 tons.

Number of men employed,	125 to 150
Number of sail boats,	28
Number of steam boats,	6

Handled 250,000 pounds of Lake Superior and Lake Huron white fish, trout, and pickerel.

Average price paid to fishermen for fish, $5 00 per 100.

Average price fish sold at, $6 50 per 100.

The above is rather crude, but it is the best I can do this year, but hereafter I shall endeavor to get the dealers to keep a daily record. The catch is larger this year than in any previous year; but I do not attribute it to any increase in the fish, but to the fact that they now fish with steam boats, and tow the sail boats, and go consequently further out in the lake in deeper water. One of the steam boats caught in one day six tons. The largest catches were made about ten miles S. S. E. of Long Point, which is the deepest water in Lake Erie.

Trusting the above may be of some use to you, I am, sir,

Yours respectfully,

CLARK OLDS.

The very important extent to which it will be perceived the business of white fish alone is carried, suggests the idea of establishing a hatching-house at Erie. Facilities for such an establishment are easily attainable there, and there can be no doubt but what, with the aid of a hatching-house, the white fish business alone might be quadrupled. Other varieties, at present attracting but little notice, might soon be added to the hatching establishment, and thus one of the products of the great lakes be garnered for the benefit of Pennsylvania, although her frontage on these waters is comparatively small. We will carefully estimate the cost of a hatching establishment at Erie, and if thought advisable, the enterprise might be embraced with the fisheries legislation, which may be called for at the present session.

It is questionable whether, in any line of business, there is an enterprise offering itself which promises such valuable returns as a hatching-house at Erie. Its cost would be absolutely insignificant when compared with the great value of its certain returns.

Grass Bass. (*Promoxis Annularis.*)

We have heretofore alluded to the efforts made in introducing this valuable pan fish east of the mountains in the Juniata, Susquehanna, and tributaries. The commissioners succeeded through the kindness of Messrs. Klippart and Fisher, of Ohio, (Professor Klippart since dying—entailing

a great loss not only to the State he so honorably served, but to science and ichthyology, an intelligent and enthusiastic advocate.) We obtained adult fish at Licking reservoir, Ohio, and planted, since 1877, almost two thousand two hundred in our inland waters.

Those introduced into the reservoir at the head-waters of the Juniata, near Hollidaysburg, have increased, and quite a number have been caught by the anglers, and we have no doubt of their successful introduction elsewhere planted. Professor Kertland, recently deceased, thus complimented the grass bass on Lake Erie:

"The grass bass has not hitherto been deemed worthy of consideration by fish culturists, yet, from a long and intimate acquaintance with its merits, I hesitate not to pronounce it the *fish for the million*. It is a native of our western rivers and lakes, where it usually resorts to deep and sluggish waters, yet, in several instances, where it has found its way into cold and rapid streams, and even small sized brooks—by means of the construction of canals, or by the hand of man—it has adapted itself to the change, and in two or three years' time stocked to overflowing the new localities. As a pan fish for the table, it is surpassed by few other fresh water species. For endurance and rapidity of increase, it is unequaled. Its weight will vary with age, the quality of water, and the feeding ground, and averages from a half to two pounds. The grass bass is perfectly adapted to stocking ponds. It will thrive, without care, in very small ponds of sufficient depth. It will in no wise interfere with the cultivation of any number of new species, large or small, in the same waters, living harmoniously with all others, and, while its structure and disposition restrain it from attacking any other but small fry, its formidable armature of spinnis rays in the dorsal and abdominal fins will guard it from the attacks of even voracious pike."

Rock Bass or Goggle Eye. (*Ambloplites Rupestris.*)

In obtaining specimens of the grass bass we found associated with it the rock bass, and planted, perhaps, two hundred adult fish at different points. It is fully as desirable a pan fish, but we failed to get our orders filled on account of the lateness of the season, &c. Doctor Sterling says of this variety: "I would advise the introduction of rock bass, although they are particularly predaceous, exceedingly gamey, and very superior for the table. Its special recommendation is, that it is a fish for the juvenile angler. It does best where there is not much current, the flavor of those in shallow ponds not being so good as those of the lake, except in winter time. It is particularly well adapted to artificial ponds, being a voracious feeder and very hardy." We will add that in our opinion, after a trial with the grass bass, we found their flesh firmer and more flaky, resembling the black bass.

Copper-Nosed Bream, Blue Sunfish. (*Lepornis Incisor.*)

This admirable little fish, as well as the grass bass and rock bass, received special attention, and, in 1878, we procured two cans for distribution from Licking reservoir, Ohio, at the suggestion of Messrs. Klippart and Fisher,

after trial as a pan fish, after fully testing its qualities, and found that it did not suffer by comparison with either of the others. We have seen a few caught out of the reservoir near Hollidaysburg, and have no doubt, to a limited extent, they will increase. They certainly rank high for sport to the angler, and will please the palate of the most fastidious.

The Shad. (*Alosa Sapidissima,*) **Storer.**

We need not enlarge upon the character and importance of this magnificent fish. To improve the catch of shad in the Susquehanna, Maryland and Pennsylvania must coöperate or there will be continued failure. We succeeded in getting a law passed in Pennsylvania in 1881, making a "close time" from Saturday sunset to sunrise Monday. Let this even be observed, and we shall have comparative success in the Susquehanna above the Maryland line; but unless the people take an interest there can be no success. Fishermen do not stop to consider what they lose by depleting the number of adult fish which are seeking their spawning grounds. A very few shad are capable of producing millions of fry, and the same number taken, without discrimination, produce a loss in the yearly catch amounting to similar incalculable numbers. Shad can be increased in the Susquehanna by improved fish-ways in the dams, and by prosecuting those who infringe upon the close times. The first we have not yet attained; but that they can be attained admits of no reasonable doubt. The fish-ways must, however, be protected, or be they absolute perfection in structure, they will fail of their object. Ingenious persons are now turning their attention to the improvement of locks and sluices, and these can be modified so as to form most effective fish-ways. But careful vigilance and protection are essentially necessary, and these are the duties of the people riparian to the Susquehanna. Without the performance of these duties there can be no improvement; but, in fact, continued deterioration of the inland fisheries.

Black Bass. (*Micropterus Salmoides.*)

This is one of the most prolific and valuable of our fresh water fish. Their natural increase is so great, and their growth so rapid, that it never has been an object of interest to the fish culturist to attempt their artificial propagation. When the spawning season draws near, they select, guided by natural instinct, with great care, for the purpose of propagation, certain portions of the river having a pebbly or gravel bottom. From these they carefully remove all sediment, weeds, and sticks. This work completed leaves a clear, bright place in the bottom of the river, circular in form, and having a diameter of about two and a half or three feet. When the parent fish are ready to spawn, the female goes upon this prepared bed and deposits her spawn in a glutinous band or ribbon, running in various directions across the bed; she is followed by the male, who impregnates the eggs by the expression of his milt. They stand guard over their young with Spartan fidelity, alternately relieving each other, watching all intruders with a jealous eye. After the little fish are hatched, they still afford them

protection and teach them how to forage and obtain food suitable to their taste and condition. Their fertility is wonderful—a large pair of bass will deposit from twenty to thirty thousand eggs. It is thought they are capable of reproduction at two years old, being at that age about eight or nine inches long. They begin spawning in April and generally get through the latter part of June. They frequently obtain the growth of five or six pounds.

The following description of the fish is given by Thaddeus Norris in his book, the "American Angler:"

"Head and body, dusky olive above, sometimes with a yellowish tint, lighter on the sides; belly, white; opercles, light green or greenish yellow; first dorsal fin, nine spines and eighteen soft rays; pectorals, fifteen; ventrals, one spine, five rays; anal, three spines and twelve rays; caudal, nineteen; body, elongated, oval, straight on the belly; eye, large; mouth, very large, lower jaw longer. The vorner has brush-like teeth in front, teeth on the palatines, and pharyngeal bones; tongue smooth, without teeth in front." We have met with most wonderful success in their introduction, the Susquehanna, Juniata, and their tributaries literally swarming with these valuable fish, affording fishing, perhaps, to the extent of twelve to fifteen hundred miles on either side of the streams. We are also introducing as rapidly as we can into the streams adapted to them, in the western part of the State, to those where they originally prevailed, and others which never contained them. There seem to be as yet abundant food in the way of minnows, suckers, mullets, &c., notwithstanding predictions were that a few years would exhaust and require a fresh supply, as well as perhaps new varieties. We have lately been informed that the oil pipes passing along our western waters leak and pollute the streams, thus destroying the newly introduced tribes. If economy of oil does not suggest a remedy for this, some other remedy will have to be sought for. The pipes should surely be laid tight enough so as not to pollute a stream like the West Branch of the Susquehanna.

Salmon Trout. (*Salmo Confinus.*)

We have tried salmon trout, as mentioned in our last report, page 20. It seems that they cannot be made to increase and multiply in inconsiderable waters. Accustomed as they are to the almost unfathomed depths of our great lakes, they seem not to flourish in the lesser accumulations of water.

They have been crossed, however, with the brook trout by some of our superintendents of hatcheries—amongst the rest, by Seth Green, who speaks as follows on the subject:

Valuable Additions to Food Fishes.

To the Editor of the Sun:

SIR: At the New York State fish hatchery we have a pond containing sixty hybrid trout. The cross is male salmon trout with female brook trout. They are now three years old, and average one half pound. The largest will weigh three quarters of a pound. They resemble both parents, but are a little inclined toward salmon trout the most. On November 1 they began spawning for the first time, and continued until November 12. We succeeded in obtaining nineteen thousand four hundred spawn. A remarkable fact concerning the spawn is that they are fully two sizes smaller than brook trout spawn. It might be well to state that salmon trout spawn are twice as large as brook trout spawn. The eggs are perfect in shape, and a good percentage are impregnated. The formation of the fish in the egg can be seen plainly.

They began to spawn just after the salmon trout in our pounds had stopped, and before the brook trout had fairly commenced.

It is my opinion that they will make a fish well adapted to either lakes or streams. They are a well-formed and handsome fish, and the prospects are that they will be a valuable addition to our better class of food fishes.

We also crossed a few hundred hybrid eggs with male brook trout. A good percentage are impregnated.

All of the fish at the hatchery are looking very fine. We shall take a large supply of brook trout spawn; also California mountain trout spawn. The breeders of this variety are in splendid condition. We shall be able to furnish all parties in this State, desirous of obtaining them for public waters, with a good supply.

SETH GREEN.

ROCHESTER, *December 3, 1880.*

However, he says his experience with salmon trout as originals is "that they will live only in clear, cold, deep lakes, needing the purest water of any fish in the country." We hope to be able to furnish fish of a more promising character, better adapted to our waters, with certainly more favorable results; and in view of these facts have none for distribution at present. If the hybrids are a success, we may introduce some of them in due time. The New York commissioners have crossed the following varieties:

Female.	*Male.*
Salmon trout, with	Whitefish.
Salmon trout, with	Brook trout.
Brook trout, with	Fresh water herring.
Brook trout, with	California salmon.
Brook trout, with	California mountain trout.
Shad, with	Striped bass.
Shad, with	Herring.

In this connection we introduce another letter from Seth Green, recently indited, who seems to be indefatigable in his explorations of the mysteries of piscine propagation:

A New Experiment by Seth Green.

ROCHESTER, *January 21, 1881.*

Editor Afield and Afloat:

On the 31st day of December, 1880, the idea occurred to me to try the experiment of impregnating eggs of fish by injecting the milt of the male into the vent of the female by means of a syringe. January 3, 1881, I tried the experiment with brook trout, in the following way: I first selected ripe females and then took the milt from the male into a vessel, and also drew it directly from the male into a small glass syringe and injected it as quickly as possible into the female, and then placed her in a tub of water. I have tried this experiment on fifteen female brook trout, and let the milt and spawn remain in them from one minute to forty-eight hours before taking them. They are now eighteen days old and looking well. The experiment is a new one, and I shall look forward to the result with interest.

SETH GREEN.

Grayling. (*Thymallus Signifer.*)

There was great hopes of this fish at one time; but it seems they cannot be artificially propagated, nor are they, like the black bass, a fish that can take care of itself amongst all comers.

Transplantation of some adults from their native streams to waters of similar characteristics may probably succeed yet; but we fear that the tender, delicate Grayling must be left to itself and to the streams in which it has been planted by nature. Several pages of Sir Humphrey Davy's charming angler's book, *Salmonia*, are given to the Grayling, which fully indorse our idea of the fish. So many specialties of climate and water seem to be indispensable to success with them that there would seem to be few streams to be found anywhere in which transplantation of them would ensure success, although no doubt streams may be found in Pennsylvania in which they might thrive if carefully watched.

California Mountain Trout. (*Salmo Iridea.*)

McCLOUD RIVER TROUT, &c.

Perhaps no newly-discovered fish has awakened so much genuine interest as the California brook trout, not in the sense of never having been known exactly, but in its adaptability to the fresh water streams of the eastern States. It promises far better and more lasting results than the meteoric grayling. The McCloud river, in California, where they are found in great abundance, possesses a temperature analagous to our own Susquehanna, Juniata, and their tributaries. Its general average is about seventy degrees; but in some localities rises as high as eighty degrees. Not having any experience with this fish, we must turn again, as we do often with pleasure, and always with profit, to Seth Green's experience with this new-comer. Last spring we obtained about twenty thousand eggs by express from McCloud river in all, part received through Professor Spencer F. Baird, of the United States commission and part from private sources, but were unfortunate in their not being properly packed or impregnated, and lost all but about one thousand, which are promising well, and bid fair to eclipse our brook trout in rapidity of growth as well as ease in handling them. Mr. Green says: "California mountain trout are, also, more vigorous in every way than the eastern trout; they are not so handsome, having no carmine specks, and much duller colors on their sides and bellies; but they are hardy, lived well in confinement, and grew rapidly. They take a fly readily and furnish excellent sport to the fisherman, so strong and gamey that they break the brook trout anglers' tackle to pieces, while their flesh, which, like that of our trout, is sometimes white and sometimes red, is not to be surpassed as food. So strong are they that they are difficult to manipulate in extracting the spawn from them. They are hard to hold and will only give down their milt or spawn when they are ready. The person handling them must wait for his opportunity. The only California trout which were ever acclimated in the eastern States up to 1878 were hatched and grown in the New York establishment. They commenced spawning March 14, 1878, three years after they were imported in the egg. They yielded more eggs than the eastern trout in proportion to their size, and the eggs were slightly larger. They continued spawning until May 25, and began to hatch in forty-five days." The above extract is taken from a recent publication, "Fish Hatching and Fish Catching," by Green and Roosevelt, and we would add, in this connection, as a general answer to many inquiries on artificial fish breeding, that we do not know of a more valuable contribution on the subject, embracing everything of importance, described in a masterly manner, but in the most plain and intelligible style, commending itself as a valuable and exhaustive contribution to the ichthyological branch of natural history.

Mr. Green further states, substantially, in a recent contribution on the same subject to the "Afield and Afloat," that the mountain trout will live in many streams our brook trout will not live in. They have at the New York State hatchery 16,000 two-year olds and 34,000 yearlings, the product from 500 spawn obtained in 1875. A brook trout, at three years old, will weigh about one half pound, and a California mountain trout will weigh one pound. For sporting purposes, superior to the brook trout, much stronger and full of pluck. They are excellent table fish, fully up to the brook trout, feeding on the same food, and, from actual test, they are just the fish for the headwaters of the Hudson, Delaware, and Susquehanna. The plants he made in the Genesee river, in 1878, justify the belief that but a small proportion of them perish. They spawn in March and April, depending somewhat on the changes of climate and temperature. He thinks, when acclimated, they will commence spawning in the fall as our brook trout do.* A female California mountain trout produces, at five years

*The different spawning period may cause confusion with other varieties; but acclimation will, most likely, correct this. There is high authority for this prediction.—See Sir H. Davy in "*Salmonia.*"

old, about 1,500 eggs, and at this age some of them weigh as high as three and a half pounds. They are difficult to strip without injury, as they are so strong—being impossible almost for one man to hold them. To overcome this, we operate with them as with shad and other large fish—have one man hold the head while another does the stripping. When the spawning season arrives, the males are ferocious, and join in battles of the most furious character—sometimes inflicting such injuries as to produce death. When lacerated and torn in the flesh, if they are subjected to a strong salt bath daily for some time, it will effect a cure. Their spawn is between that of the brook trout and salmon trout, and hatch in about fifty days. The young are vigorous from the start, and but little trouble, with proper and regular feeding, to raise them" &c. We fully expect to meet all demands as soon as possible, and will endeavor to obtain such a number of stock fish as will fully demonstrate their utility in Pennsylvania waters.

The California trout is, in its structure, pretty much the counterpart of our brook trout. It has not the carmine spots which distinguish the latter, but has the same dorsal markings, a slightly more forked tail, and the same color and texture of flesh. The general external color is a silvery green or olive, mottled with irregular spots of a black or darkish color. Along the lateral line is, as has been already stated, a marking of red of varying distinctness, according to habit and habitat.

The fish is one of remarkable vigor and hardiness. It will thrive in water which to salmon and brook trout would be certain death. It will bear rough handling with comparative impunity, and bruises on its skin which, in other fish, would be followed by fungus and death, make apparently no harmful impression. It is an active fish, and though it will thrive in either lake or river, loves best a swift running stream, and the most thoroughly aired water. It is a voracious feeder, but its tastes are as delicate as others of the trout family. It loves best to take its food alive, and cannot resist the temptation of a struggling grasshopper or miller, no matter how full its maw may be already. No fish known is so certain as this to be attracted by the artificial fly. It does not matter much what the form or color may be, so that a motion is given to resemble life. In its greed for insect food it takes no account of seasons, and will rise as readily in January to a red fly when it is hardly possible for a natural fly to exist, as in July when the surface of the water swarms with insect life. It grows with nearly double the rapidity of the brook trout in the same water, and is, of all fish whose habitat is exclusively in fresh water, the most suitable for the large streams of the State of New York, like the upper Hudson, the Genesee, Mohawk, the East and West Canada creeks, the Moose, Black, and Beaver rivers, and all other streams which over-much fishing, dams, saw-mills, and other destructive agencies of human contriving, have spoiled for good trout fishing. Whether it can endure the poison of tanneries has not been yet tested. If it should be found to stand this last, desperate test, to which all others of the trout family have succumbed, it will deserve to take rank with the immortals.

The only unfavorable criticism which has been made on this fish is that they are not good keepers; that they rapidly soften after killing, and do not bear transportation well. This may be a disadvantage or an advantage, according to the standpoint from which it is considered. The residents in the neighborhood of trout streams do not care to have all the stock shipped to market; they want some for their own use; and if California trout will not bear transportation, there will be all the more to eat at home. No fish anywhere, or at any time, is as good as when fresh caught. The complaint of softness, we think, does not apply to all California trout, but to such as are caught out of season or in very mild waters. The quality of all trout is very much affected by the character of the water in which they live, and by what they feed on. Speckled trout caught within a few weeks of spawning time, and after spawning, till they recover vigor, will be slimy and soft, and tend quickly to putrifaction; and those that live in shallow water with muddy bottom, and feed on leeches and lizards, are never good keepers. Every one who has done much trout fishing will have observed that fish caught in a running stream, especially if the stream be one much subject to the influence of rainfalls, soften much more quickly than those taken in lakes. Even on a good spring stream the angler will sometimes observe the ribs of the first trout protruding before the last has been put in his basket. On the other hand, the whole day's fishing on the lake will be firm and hard. California trout, in this respect, will not differ materially from any other trout.

Brook Trout. (*Salmo Fontinalis.*)

At the commencement of our piscatorial labors, in casting around for the most prolific and valuable varieties of fish for introduction, it was not deemed advisable or politic to pay special attention to the acknowledged "pride of the angler." This conclusion was arrived at more on account of their not being considered a very fruitful fish, yielding, as compared to other varieties, fewer spawn, and more difficulty attending their handling and propagation artificially. We, therefore, confined our attention to more fertile varieties. We, however, indicated that additional facilities might afford in the future such appliances as would encourage an effort to restock our already fast depleting streams of this most valuable table fish and true sportsmen's friend. As public sentiment became better informed on fish culture, and the generosity of the people, through the Legislature, afforded the commission ample means and accommodation, to undertake the cultivation and dissemination of trout, our labors in this direction have been rewarded with wonderful results. Since it was made known we had them for public distribution, the orders from all directions have far exceeded the supply. In order to meet the demand, we have and are increasing our facilities every season for increasing the taking of spawn, and expect to distribute quite three quarters of a million this season. Our success in this direction would be greater if we had proper legislation protecting the newly introduced fry into depleted streams, and we hope for some at the

present session, which, if secured, will insure success and a complete restocking of the numerous trout streams of the State. The most flattering reports are received from all quarters, and we feel certain of the undertaking being a great success. Legislation simply preventing the catch of trout smaller than four inches, and having a close time of three years in streams stocked—permitting fishing the third year—would most certainly restock all our depleted streams. Our cultivation and distribution of trout have awakened a deep personal interest and investigation into the subject which has resulted in suggesting to private individuals the propriety of utilizing their springs and waters adapted to this variety. Inquiries all over the State as to the methods of cultivation, construction of ponds, kinds of food, manner of propagation, &c., are made, which really require short essays upon artificial fish culture, and involve much time and labor to answer at all satisfactorily. We thought, in view of this, to refer such parties to the most recent and reliable publications in regard to this variety, as well as all others, and take pleasure in commending Green and Roosevelt on fish hatching and fish catching; price, $1 50; to be had at George H. Myers', 76 Chambers street, New York. In view, however, of our report obtaining somewhat of a general circulation in our own State, so numerously dotted with trout streams and springs, we have thought it advisable to briefly generalize on the culture of this variety. The diagram exhibiting the grounds of the Corry hatchery affords good illustrations of location, shape, and arrangement of ponds, runs for spawning, distribution of water, &c.

Abundance of pure cold spring water is necessary. The water should (unless there be a large volume of it) have a fall of four to eight feet, so located as not to receive surface water. The temperature in summer should not rise higher than sixty-five degrees. The water should be taken from the fountain head—the quantity needed depending entirely on magnitude of operations. The diagram affords an illustration of how every gill of water can be utilized, if necessary, from pond to pond, as well as controlling the fountain head for supply direct to hatchery. The ponds should be pear shaped, with runs from one to the other, covered with pebbles, where the spawners can go for natural or artificial impregnation, as well as to get rid of parasites. They should be about six to eight inches deep, the ponds varying from two and a half to five feet in depth. There should be wire screens between the ponds, painted with coal tar and asphaltum mixed, rendering them impervious to water and durable. The screens where the small fry are kept should be twelve threads to the inch; older fish, five or six threads to the inch. The temperature of the water should be as uniform as possible, running from forty-five to sixty-five degrees. The character of the troughs will be found in description of hatchery. The water should be run through filtering cloths from the distributing trough, regulated by faucets. The troughs covered with small gravel, size of peas; a trough should be six inches deep, fifteen wide, and about ten long, having strips at intervals, making nest in bottom; this size would require about a

five eighth inch hole to supply with water, with slight head sufficient to make rippling over the cross pieces. The gravel should be well washed and kept clean, filled in about an inch deep, coming within a quarter to half inch of top of cross piece. When the eggs are placed in the troughs, a feather will suffice to spread them gently. Several devices are used for running dead eggs, which should be attended to daily. We use a wire bent in eye shape, on the end of elastic wood (hickory) cut like the letter U, about six to eight inches long. Eggs can be examined by placing them in a small phial of water, placing them between you and the light horizontally, and placing the microscope on them. A small net can be constructed to remove the fry by fine netting placed over wire, the shape of a D, with handle attached on the center of curve. The time required to hatch out eggs depends very much on the temperature of the water. Seth Green says, "fifty degrees will hatch out in fifty days, and each degree colder takes five days longer." Our experience is, a temperature of from forty-five to forty-seven degrees, taking about seventy-two days to produce the best fish. The temperature of water can be modified by pooling, if required. About the twentieth day a young fish can be observed in the egg. In due time the trout forces himself, tail foremost, through the shell, (if, unfortunately, he presents himself head foremost, death is his portion.) He presents a "wide-awake" appearance, consisting of enormous eyes, small body, and a knap-sack appendage, which is called the umbilical sac, containing his food, which is absorbed in from thirty to forty days, after which time he goes it on his own hook. From this time till they attain five or six months old, many die, and it is, therefore, the most critical period in their lives. They should be thinned out, and after being fed a month or two, placed in ponds, thriving better. Their troughs should be cleaned daily, and food just enough to satisfy, and not deposit to foul the bottom and decay. The best food is liver, chopped fine as possible, or mashed through a very fine wire screen, without gristle. It is said half a pint will feed a hundred thousand when they first begin to feed. The young fish should be fed six or eight times a day till four months old, when twice will do. When they grow older beef lights can be used, or pluck, as it is called by the butchers, which is cheaper than heart or liver. Whenever you see them play cannibal increase the feed, and it will have a tendency to save life, though not entirely prevent it. Space will not permit more extended detail, and reference must be had to the various publications on the subject, such as indicated, or to Livingston Stone, Fred. Mather, and other distinguished writers on the subject.

Carp. (*Cyprinus Carpio.*)

We feel assured that we can do nothing better in attending to this extremely valuable addition to the food fishes of this country than to reprint Mr. Hessel's exhaustive paper on the subject, which first appeared in the reports of the United States Commissioner, and was afterwards placed at large in the always valuable reports of the Commissioners of Massachusetts.

THE CARP AND ITS CULTURE IN RIVERS AND LAKES, AND ITS INTRODUCTION IN AMERICA.

By RUDOLPH HESSEL.

[Extracted from the report of the U. S. Commissioner, Part IV., 1875-1876, pp. 865-900.]

A.—INTRODUCTION.

The present article is intended to give a brief description of the well-known carp of Europe, its nature, way of living, its ratio of natural and artificial increase in open waters, rivers, and lakes, the most approved methods of its culture, and the proper construction of ponds and breeding establishments. An additional object in view is to draw attention to the introduction into the United States of this valuable fish as specially adapted to its needs.

B.—THE RACES OF CARP: THEIR HISTORY AND HABITS.

1. The Species and Varieties.

The carp, *Cyprinus carpio*, of the family *Cyprinidæ*, has a toothless mouth, thick lips, and four barbels on the upper jaw. In place of the usual teeth of the mouth, there are a number of stout teeth on the pharyngeal bones, which are arranged in three rows. It has one single dorsal, which is longer than the anal. Both of these fins have at their origin, on the anterior edge, a strong ray, which is serrated in a downward direction. The caudal is of semi-circular shape, and the natatory bladder is divided into two sections, with connecting air passage. The scales have an entire edge, and the body is compressed on the sides. The general color of the back and sides is a dark olive-brown, the abdomen often of a whitish-yellow or orange tint. The color depends, as with all fishes, partly upon the age and season, partly upon the water, the soil, and also upon the food of the fish.

Be it remarked that the carp, which has occasionally been compared to the buffalo-fish, has no resemblance to it, with the exception of the similarity of their coat of scales; neither does the flesh of the buffalo-fish ever come up to the excellence of that of the carp.

The carp was, in all probability, originally introduced into Europe from Central Asia, many centuries ago, and is now common in most of the large rivers. In some parts of Europe, principally in Bohemia, Austria, Southern, Central, and Northern Germany, it has become domesticated.

The carp is alleged to have been imported into England in the year 1504. In Austria, which possesses the most extensive carp-fisheries in Europe, the culture of the carp can be traced as far back as the year 1227.

The Emperor Charles IV of Germany, by granting sundry privileges, favored the establishment of ponds in his dominions, and the monks were especially assiduous in the culture of fish in ponds. As early as the first half of the fourteenth century, Bohemia had its first large carp-pond, and the culture of this fish progressed in that country, as also in Poland and that district which now comprises German Austria; also in Upper Lusatia, Saxony, Silesia, and Bavaria. A celebrated establishment for carp-culture, with large, extensive ponds, was located, as early as the fourteenth century, near the town of Wittingau, in Bohemia, Austria. The first beginning of it may be traced back to the year 1367. At that time the lords of Rosenberg called into existence and maintained for centuries, these establishments on a scale so extensive that to this day, they are the admiration of the visitor, the main parts having survived, while the race of the Rosenbergs has long been extinct.

The manor of Wittingau suffered greatly from the calamities of the Thirty Years' War, and with it, in consequence, its fish-culture. The latter only recovered the effects of it after passing, together with the large estate of a rich monastery of the same name, in the year 1670, into possession of the Princes of Schwarzenberg, their present owners. The extent which carp-culture has reached on these princely domains will be seen from the circumstance, that their artificial ponds comprise an area of no less than twenty thousand acres. The proceeds amount to about five hundred thousand ponds of carp per annum. The ponds of the Princes of Schwarzenberg are probably the most extensive of the kind on the globe. They are usually situated in some undulating lowland country, where small valleys have been closed in by gigantic dams for the purpose of forming reservoirs. Similar establishments, though not equally extensive, are found in the provinces of Silesia and Brandenburg; as, for instance, near Breslau and Cottbus, in Peitz and Pleitz, which I visited last year. In Hesse-Cassel, Hanover, Oldenburg, Mecklenburg, and Holstein, there are also many hundreds of ponds, none of them covering more than a few acres, but almost every large farm possessing at least one of them.

It will be easily understood that after such an exclusive culture in ponds, continued through centuries, as also an existence in open water, where the *Cyprinidæ* were left more to themselves, a number of varieties or rather genuine species, *Cyprinus Carpio*, showing striking differences from the races, were developed; these races, though derived directly from the original type, just as with our domestic animals. They are divided into three chief groups:—

1. *Cyprinus Carpio Communis*, the scale carp; with regular concentrically arranged scales, being, in fact, the original species improved.

2. *Cyprinus Carpio specularis*, the mirror carp; thus named on account of the extraordinarily large scales which run along the sides of the body in three or four rows, the rest of the body being bare.

3. *Cyprinus Carpio coriaceus, sive nudus*, the leather carp; which has

on the back, either only a few scales or none at all, and possesses a thick, soft skin, which feels velvety to the touch.

The two last-named, are distinguished from the original form by a somewhat shorter and stouter, but more fleshy, body. It is rather difficult to decide which of these three species, is the most suitable for culture. There are some districts, where only scale carp are bred, and mirror carp are not valued, as there is no demand for any but the former in the market; as, for instance, in Bohemia, in the above-mentioned domain of Wittingau. Again, in other districts, as in parts of Bavaria and Saxony, &c., for the same reason, mirror carp or leather carp only are bred. There is, in fact, no sufficient reason for making any distinction among these three varieties; for, if they are genuine types of their respective species, they are indeed excellent and desirable fish.

The assertion which has been made at times that the scale carp is better adapted for transportation, than either the mirror or leather carp, by reason of its coat of scales, which would protect it more efficiently from the accidents incidental to transfer, as also against inimical or hurtful attacks in the ponds (the mirror carp having very few, and the leather carp no scales,) is not correct. In transportation, scales are not only inefficient for protection, but they frequently cause the death of the fish, especially in transporting the so-called breeding-fish; for, if a scale be torn off in part only, ulceration will ensue, and the fish, of course, will die. Again, should any scale be lost, the bare spot will very soon begin to fester or develop a confervaceous growth, and the consequences will be the same. On the contrary, the leather carp, which, oddly enough, like the frog, is destitute of covering, will bear a great deal more in usage and injury, whether young or old, than the scale carp. The smooth, slippery skin of the leather carp suffers much less from friction during transportation than the scale carp; and any slight wound will heal up much more easily, as the epithelium will cover it immediately, and the formation of a new skin can progress under its protection. I have often had the opportunity of seeing such scars upon the skin of the mirror carp, and even more so on that of the leather carp. They are the effects of an injury from the sharp edges of the heron's bill, the bite of a pike, or some other hurt, and I never saw anything of the kind on a scale carp; for, if one of these be wounded, it almost invariably dies.

The carp will sometimes cross with some related species of the *Cyprinidæ*,—for instance, *Carassius vulgaris*; and, in consequence, hybrids have been engendered, which sometimes resemble the genuine carp so much that it is often very difficult for the student, as well as for the professed culturist and experienced fisherman, to immediately recognize them. Such fishes are valueless as food, on account of their bad and very bony flesh. One of the hybrids mentioned is the *Carpio kollarii*,—*Cyprinus striatus*, which was formerly regarded as a separate species. It is a cross between the carp and *Carassius vulgaris* (crucian carp,) a very poor and bony fish,

which, in Germany, is sometimes called "poor man's carp." Some varieties exist of this common fish. The latter has even been dignified by a specific name of its own, *Carassius gibelio.*

The spawning seasons of the crucian and the true carp coincide, and, where kept together, hybrid races may readily be formed; that period including the time from the month of May until August.

In order to determine this question, I myself managed to bring about such crosses by placing (1) female common carp with male crucian carp, and (2) female crucian carp with male common carp, in small tanks constructed with this end in view; (3) I also put together female *Carpio kollarii* with male common carp,—this for the sole purpose of testing the capability of propagation of the *Carpio kollarii*, which had been doubted. In the two former cases I obtained forms analogous to the *Carpio kollarii*, sometimes approaching in appearance the true carp, at others the crucian carp. In the third case, however, having placed ripe *Carpio kollarii*, together with *Cyprinus Carpio*, I obtained a product with difficulty to be distinguished from the genuine carp. I took the trouble to feed them for three years, in order to try their fitness for the table; but their flesh was exceedingly poor and very bony, and could not be compared by any means to that of the common carp.

Considering, then, the whole extensive tract of country devoted to fish-culture in central Europe, where crucian carp are to be found from Italy to Sweden and Norway, from France to the boundaries of eastern Siberia; considering the many who cultivate on a small scale, and the owners of badly-stocked ponds, with their different doubtful productions,—how often do we find in the markets or ponds, very nice crosses which have been propagated through from three to ten generations, and which are sold for carp! There are many small sheets of water in Germany, France, Austria, Italy, Holland, and Belgium, and probably also in England, the proprietors of which imagine, in good faith, that they have stocked their ponds with good, genuine carp, which, in reality, through careless selection or ignorance, are hybrids which may even have been cultivated for two or three generations. In some ponds in Switzerland, near the lake of Constance, some crosses of *Abramis brama*, were found as late as twenty years ago.

2. The Habits and Mode of Reproduction.

The carp is partial to stagnant waters, or such as have a not too swift current, with a loamy, muddy bottom, and deep places covered with vegetation. It inhabits now most of the larger and smaller rivers of Europe, particularly the Elbe, Weser, Rhine, Danube, Po, Rhone, Garonne, Loire, then the Bavarian and Swiss lakes, the lake of Constance, &c.; even salt water seems to agree with it very well. I have taken it in the Black Sea, where its weight often amounts to from fifteen to twenty pounds. It is also found in the Caspian Sea in great numbers, and is known there by the name of *Sassan*.

It is an advantage that the carp is able to live in water where other fishes could not possibly exist; for instance, in the pools of bog-meadows or sloughs. However, it is not by any means to be inferred from this that the best locality for carp-ponds of a superior kind could be in such situations. The presence of too much humic acid is unfavorable to the well-being of the carp, as we shall see presently in the chapter upon the establishing of fish-ponds.

The carp lives upon vegetable food as well as upon worms and larvæ of aquatic insects, which it turns up from the mud with the head. It is very easily satisfied, and will not refuse the offal of the kitchen, slaughter-houses, and breweries, or even the excrement of cattle and pigs. I propose to enter further upon the subject of feeding it when I speak of its culture in ponds.

In the moderate zone—that is to say, in central Europe—the carp will, at the beginning of the cold season, seek deeper water to pass that period in a kind of sleep. This will sometimes occur as early as the beginning of November, if the winter should set in early; and it is to be remarked that they will retire at an earlier period in ponds than in rivers. They do so always in groups of from fifty to a hundred and more. They make a cavity in the muddy ground, called a "kettle;" in this they pass the time until spring, huddled together in concentric circles, with their heads together, the posterior part of the body raised and held immovably, scarcely lifting the gills for the process of breathing, and without taking a particle of food. They do not take any food from the beginning of October, and continue to abstain from it in some countries until the end of March, and in colder districts even somewhat later. It will not answer, however, to depend on this habit when transporting them for propagation in the spring or winter time, more especially young carp one or two years old. The fish will arrive in a worn and hungry condition, and must be kept in a tank constructed on purpose for observation, where it has no chance to bury itself in the mud; here it will sometimes take a little food. At such times I generally make use of boiled barley, or rye flour converted into a kind of tough paste by the addition of hot water, and with this I mix a little loam and rye-bread; but I continue the feeding only until I can judge from the looks of the fish that they have recovered. This method I followed with the carp which I imported from Europe for the purpose of breeding in the winter of 1876–77. It is a most striking fact that the carp, though it does not take any food during this winter sleep in its natural retreat, does not diminish in weight, while, in the so-called "winter chambers," it does so to a remarkable degree. These "winter chambers" are large tanks, a thousand to five thousand square feet in size, or less; they are sometimes walled in with masonry; sometimes they are constructed of wood. Fishes intended for sale are kept in them for a few weeks or months during the winter.

The carp does not grow in the winter. Warmth alone seems to exercise a favorable influence upon it, and to promote growth. It only grows in the months of May, June, July, and August, and does not appear to continue doing so in September. The slight increase in weight which takes place during the latter month seems to grow out of an accumulation of fat which is being deposited around the entrails. In ponds which contain plenty of food and healthy water, in an ordinary year, the growth and increase of weight in the year will be represented in figures as follows:

	Per cent. of original weight.	Per cent. of growth.
May,	10–15	13
June,	33	31
July,	36	34
August,	20	18
September,	6	4
Total,	110	100

If the weather in the month of May be mild and warm from the beginning, a better growth may be expected, amounting, as in June, to about thirty per centum. This month (May) is decidedly of great importance for the growth of the fish during the current year; for, in proportion as the fish has grown in the short space of one month, it will take more food in the following ones as the increase of its growth and consequent wants will demand. Culturists, therefore, consider the month of May as being the most important of the whole period of the carp's growth. The above-given calculations, of course, are limited to ponds in which no artificial feeding is resorted to, but in which there is sufficient food by reason of the good quality of the water and soil which produces it.

In small ponds, situated in parks or gardens, which possess favorable soil and river-water, the increase of weight will be even a little greater, if feeding is had recourse to, for such small ponds (covering only half an acre) cannot produce sufficient food themselves. On the whole, feeding is a makeshift, as will be seen presently, and which in very large ponds of more than from twenty to a thousand acres should not be made use of.

The above calculations are only admissible for central Europe, from the Adriatic to the Baltic and the North Sea. In countries further north, as in Sweden, the growth of the carp is less; as, on the contrary, in more southern countries than central Europe—for instance, in Illyria, Dalmatia, southern Italy, southern Spain, and partly, also, southern France—the result is more favorable still. There a milder and warmer climate, an early spring, a very warm summer and autumn, and a late winter, which, in addition, is mild and short, combine to exercise a favorable influence upon the thriving condition of the fishes.

In these warm climates the fish becomes lively at a much earlier season,

if it does at all pass the winter in that lethargic state, without taking any food, than it does in the countries of the northern parts of central Europe.

The pond carp of central Europe generally leaves its winter retreat when the rays of the spring sun have warmed the water thoroughly, while at the same time it begins to seek for food at a somewhat earlier period in rivers and lakes. At the beginning of the month of March the eggs have developed themselves considerably in the body of the fish, and it only needs a few weeks of warm weather to bring about the spawning season. This commences in the middle of May in such lakes and ponds of central and northern France, and southern Germany, and Austria, as have a warm situation and are sheltered from the cold winds. It continues in some localities throughout June and July, and sometimes, in more elevated situations, until August; as, for instance, in Franconia and Upper Bavaria. The spawn of so late a season, however, is scarcely fit for breeding purposes, as the fish cannot grow much more during the short space of warm weather. It remains very small, and suffers greatly from the ensuing winter weather, and is easily dwarfed at that time. The spawning of the individual fish does not take place all at once. Days and weeks may pass before it will have left the last egg to the care of nature. At times, upon the setting-in of rainy, cool weather during this period, it will be interrupted, but re-assumed as soon as the temperature grows warmer again. Culturists altogether dislike cold weather at this time, as not only the eggs, but the young fry also, suffer much from it. Wet, cold summers are no more profitable to the culturist of carp than to the agriculturist. In the southern part of Europe the spawning season commences at an earlier date than in Central Europe. In Sicily, in the neighborhood of Palermo, where there are some private ponds, the carp begins to spawn at the commencement of the month of April. This is said to be the case also in the French province of Constantine, Algeria, Africa.

The abundance of eggs in the carp is very great, and it is this circumstance which will explain its extraordinary increase in the natural waters. A fish weighing from four to five pounds contains, on an average, four hundred thousand to five hundred thousand eggs. Other statements figure still higher. I not only made calculations myself formerly, repeating them in 1876 on a female mirror carp, which I obtained from the environs of Gunzenhausen, Bavaria, and which, curiously enough, at the end of November, was entirely ripe, but I also obtained statements from culturists on whom I could depend. The calculation I made in the following manner: After freeing the eggs from all the fat and the enclosing membrane, and after having washed them in alcohol, I counted off exactly a thousand of them; these I weighed, and according to the result I deduced the number of the whole. In the somewhat longer-bodied scale carp I generally found comparatively more eggs than in a mirror or leather carp, though all were of equal age and weight.

During the spawning season an appreciable change takes place in the

male, protuberances like warts appearing on the skin of the head and back, and disappearing upon the expiration of that period. This is a peculiarity with most of the cyprinoids. Some time before the spawning season sets in the falling out of the pharyngeal teeth takes place—these grow anew every year.

Some days before spawning the fish show an increased vivacity; they rise more often from the depths below to the surface. Two or three or more of the male fish keep near the female; the latter swims more swiftly on a warm summer morning, keeping mostly close to the surface, followed by the males. This is called "*streichen*,"—running-spawning—and is more frequent in warm than in windy and rainy weather. The female prefers spots which are overgrown with grasses and other kinds of aquatic plants, such as *Utricularia*, *Nymphœa*, and *Alisma*. The male fishes follow close to the very water's edge, as far as the diminished depth will allow them. They lose all their timidity and precaution, so that they may be taken quite easily. They lash the water in a lively way, twisting the posterior portion of the body energetically, and shooting through the water near its surface with short, tremulous movements of the fins. They do so in groups of two or three males to one female fish, and forming an almost compact mass. This is the moment when the female drops the eggs, which immediately are impregnated by the milter. As this process is repeated several times, the female drops probably only from four hundred to five hundred eggs at a time, in order to gain resting time, so that it will require days and weeks before it has given up the last egg.

The eggs of the carp are adhesive, not detached, like those of the *Salmonidæ*—these latter lying loosely on the ground, while the former adhere in lumps to the object upon which they have fallen. As soon as the egg has left the body of the fish it swells up a little, the mucus which surrounds it serving as a means to fasten itself upon some aquatic plant, stone, or brushwood. Those eggs which have no such object to cling to are lost. I found numerous eggs on the reverse sides of the leaves of the *Nymphœacea* and their stems, the *Phellandrium*, and *Utricularia;* but the greater number of them I discovered on the *Festuca fluitans*, which, among fishermen, is known generally by the name of "water-grass." Its narrow, long, strap-shaped, thin leaves spread softly over the water's surface, as also its numerous branches in the water afford to the fish the sought-for opportunity to deposit its eggs upon its tender leaves. The seeds of this grass are an excellent food for the carp. This may be regarded as a useful indication to be acted upon in the construction of ponds.

The eggs will develop themselves quickly, if assisted by warm weather. As early as the fifth or sixth day the first traces of dusky spots, the eyes, will be visible, and toward the twelfth, or at the latest the sixteenth, day the little embryo fish will break through its envelope. This rapid development takes place only in shallow, thoroughly warmed ponds, or in such as were expressly constructed for hatching, and called breeding-ponds. If

these ponds are deep, and consequently their water is colder, the hatching process may require as many as twenty days. In from three to five days the young fish has absorbed the yolks, and seeks its food. If the breeding-pond be productive enough to furnish the necessary food for so many young fishes, these will grow very rapidly. I shall return to this subject hereafter.

I remarked above that the carp prefers stagnant or slowly running water with a muddy bottom, and that it lives upon vegetable as well as animal food, aquatic plants, seeds, worms, and larvæ of water insects—it is, therefore, no fish of prey. It does not attack other fishes, and has no teeth in its mouth, but only in the throat, and is, on account of its harmlessness, an excellent fish for the culturist, as well as for stocking large lakes and rivers in general.

3. The Growth and Size.

Its growth differs according as the fish inhabits cold or warm water, a river, lake, or pond, finding plentiful food therein, or being fed. An additional factor is the quality of the soil, whether muddy or stony. In cold water, or such as has a stony ground, the carp will not progress favorably. For this reason the statements concerning its normal size, attained to in a certain given time, differ widely, Very naturally it will exercise an extremely great influence upon the thriving of the fishes, whether the pond contains a great number or only a few of them; whether it is overstocked, as culturists term it; or whether there are only a proportionate number of fishes in it, according to its capability of producing food. Other considerations remain to be mentioned; namely, is the pond provided with supplies from brooks falling into it, or are the fishes to be fed? The latter course is almost indispensable in the culture of trout. The expenses incurred in this case diminish the income of the culturist: if not resorted to, the result will be the same, as the value of the fish will be smaller. This feeding is needless with the carp, if it be cultivated judiciously in suitable ponds; and for this reason alone the culture of the carp is preferable to that of the trout.

In rivers and lakes it grows larger, although the same fish, for the reason, probably, that in larger space, which at the same time yields more sheltered retreats, it escapes from the pursuit of man more easily than in regular artificial ponds, and finds more plentiful supplies of food. The question of the species, or, I would rather say, the race, is of great moment, particularly in respect to carp-culture in ponds.

A favorable result may be expected from the culture of this fish wherever the necessary water is to be found, be it in the North or South, and that, too, as well as in ponds in open lakes and rivers.

The normal weight which a carp may attain to in three years, whether it be scale carp, mirror carp, or leather carp, is an average of from three to three and one fourth pounds; that is, a fish which has lived two summers—consequently is eighteen months old—will weigh two and three

fourths to three and one fourth pounds the year following. The growth may turn out to be even more favorable in a warm year, or if only a few fishes have been placed in a pond, as we shall see further on in the chapter treating of pond-culture and the operations of the culturist.

Carps may reach a very advanced age, as specimens are to be found in Austria over one hundred and forty years old.

The increase in length only continues up to a certain age; but its circumference will increase up to its thirty-fifth year.

I have seen some common carp in the southern parts of Europe—in the lowlands of Hungary, Servia, Croatia, Wallachia, as also in Moldavia and the Buckowina—which weighed from thirty to forty pounds and more, measuring nearly three and one half feet in length by two and three fourths feet in circumference.

Old men, whose credibility and truthfulness could not be doubted, assured me, and gave the most detailed accounts, of the capture of this species of fish in former years, giants, which weighed from fifty to sixty pounds, and which they had seen themselves. During the Crimean war in 1853, a French engineer officer, stationed at Widdin, on the Danube, in Turkey, killed a carp by a bullet-shot some distance below the city; this fish weighed sixty-seven pounds. I had some of its scales in my possession, of which each had a diameter of two and one-half inches. Their structure indicated to a certainty that the age of this fish could be no more than twenty-four years at the most. It is a well-known fact that two large carps, weighing from forty-two to fifty-five pounds, were taken several years ago on one of the Grand Duke of Oldenburg's domains in Northern Germany. They had been kept in some particularly favorable water, productive of plentiful food, and had been used as breeding-fishes. These two specimens might, from their size, be calculated to be comparatively very aged fishes: it was proved that they were only fifteen years old. If we may credit the chronicles kept centuries ago by old families, and especially by the monks, who had taken possession of all the best localities along the banks of the beautiful blue Danube, then still greater giants had been caught, and that in the waters of the Danube itself. A chronicle of the monastery of Mölk, in Austria, refers to a carp weighing seventy-eight pounds, which had been captured on Ascension Day in 1520. Another record speaks of a carp which had been taken in the third decennium of the present century in the lake of Zug, in Switzerland, and which weighed ninety pounds. These giants are certainly only wonderful exceptions, and have become celebrated through the scarcity of such occurrences; but still these facts are encouraging illustrations that it is possible for such large specimens to grow up in favorable water. All the countries where these large fishes have been found, and which are situated between the Black, the North, and the Baltic Seas, are pretty nearly such as have a late spring and a long, cold winter. Near Widdin the Danube has been frozen repeatedly. There the carp passes from five to seven months in its

winter sleep, during which it does not grow. If this fish thrives so well in the countries which have such a very cold winter (on an average they have the same winter temperature as Boston, Chicago, Milwaukee, Pittsburgh, Philadelphia, New York, Baltimore, and St. Louis), where the rivers have not enough food for these fishes by far, their level being regulated by dams, which are a subject of constant complaint to the fishermen, how much more would they thrive in the waters of this country with their great riches of food! But, if we take into account the rivers of the mild south and south-west of the United States what success may not be expected for this fish in those regions?

If the carp finds food in superfluity, it will grow much more rapidly than the above statement indicates. This gives an increase of from three to three and one fourth pounds in one year and six months; but this is only the normal one, the food consumed being of an average amount. If the fish obtain food very plentifully, it will grow more rapidly. In this case, again, it is to be considered that the waters of the milder climates of this country possess this advantage, scarcely to be judged of or estimated at its proper value as yet, that the fish may be able, during three quarters of the year or even the whole year round, to take food, and will omit the lethargic winter sleep conditioned by the cold winter. There is scarcely a comparison to be made so far as the carp are concerned between the rivers of this country, so richly supplied with food, which it will not be compelled to seek for it under a constant strife for existence, and those of the much poorer waters of the Rhine, Elbe, Rhone, &c. In the waters of its native country, in Central Europe, after its first wakening from the long winter's sleep, it seeks most diligently after the contents of the seeds of the *Nuphar luteum* and *Nymphœa alba*, the yellow and white water-lily, the *Phellandrium aquaticum*, *Festuca fluitans*, &c. The waters of the United States abound in all these plants and numerous others, the seeds of which will serve the fish as food; for instance, the wild rice (*Zizania aquatica* and *Z. fluitans*), the well-known Tuscarora rice or "water-oats" with its great riches of seeds, and many others, which will yield food profusely, and which European waters do not possess, thus giving a great advantage to the American carp-culturist. And then there is the culture of fish in ponds. There are culturists in Central Europe who, wishing to see the fish growing more rapidly, take the trouble to feed them with soaked barley, which they occasionally throw out in different places; and, by doing so, they have had a very full success, the fish growing larger, that is, more quickly, when not thus fed. By introducing the above-named wild or natural water-plants in carp-ponds, they will be perpetuated; and the grains which have fallen to the bottom of the water will form an ample article of food for the first spring days, if we do not prefer to give them the almost worthless offal of the slaughter-houses. I do not advocate the so-called artificial feeding of this fish where the ponds themselves yield food in ample abundance, a consummation toward which the Tuscarora rice will largely contribute.

FIG. 1. *Gronaas nigrilabris*, Cope; a blind Silurid; *Op.*, operculum; *Pop.*, preopercULUM; *Iop.*, interopercULUM; *D.*, dorsal fin; *Ad.*, adipose dorsal fin; *C.*, caudal, *A.*, anal fin; *P.*, pectoral, and *V.*, ventral fins; *Ll.*, lateral lines.

Let us once more consider the fact of its extraordinary increase of weight of about a hundred and ten per centum in the exceedingly short space of four months; for during the cold winter time, when ice thickly covers rivers and lakes, nature banishes it into its temporary tomb, which it choses and digs for itself, to hold its winter sleep in. This fish needs from fifteen to eighteen months of growth, to gain, according to a low estimation, the weight of three pounds without being fed. But much more satisfactory results are frequently arrived at when favorable circumstances combine, and when it will reach a greater weight. There are some culturists who obtain in the space of time fishes of four pounds' weight; of course they possess warmly situated ponds, which thaw very early in spring, and perhaps they assist nature in some degree by feeding the fishes. I have done so myself in two successive years, which were exceptionally warm, when I fed the fishes with the almost worthless malt refuse, or "grains." They increased visibly, and attained to the above mentioned weight in the same space of time.

This fifteen to eighteen months of the actual time of growth transpires during a period of three years and six months, as intervening months of winter sleep are to be included, during which the growth is interrupted.

I will not recur to what this fish promises to become in the milder regions of the south, where neither ice-bound water nor cold temperatures force upon it the lethargy of the winter sleep; where it will have the longer space of from eight to ten months, or maybe the whole year, including the mild winter, for the most vigorous and rapid development.—not, as in Europe, the sparingly allotted four or five months.

It is not to be doubted that the carp will arrive at the weight of from two and three fourths to four pounds in one year in those warm climates, when in colder regions it requires two years and six months. I do not think that I am mistaken in this: I am ready to stand by this assertion, which the future will surely verify.

I believe I have said all that is most desirable for the culturist to know concerning the carp and its natural history; and I will now treat briefly of its culture in ponds, rivers, and lakes, as also the construction of ponds.

C.—THE CULTURE OF CARP AND CONSTRUCTION OF PONDS.

1. Its Adaptibility to Artificial Culture.

The conclusion from what has been said will be, that the carp is excellently qualified for culture in inclosed waters, as artificial ponds, and also for the stocking of open waters, such as rivers and lakes, for what is called "free fishing."

It is in the power of the culturist to produce, by means of artificial impregnations and hatching, as also by the natural increase of this fish, with its abundance of eggs, any amount of fry, as well for fresh water as most probably also for salt water, as the fact of its occuring in the salt

water of the Black, and very frequently in that of the Adriatic Sea, will demonstrate.

There is no other fish which will, with proper management, be as advantageous as the carp. Its frugality in regard to its food, its easy adaptability to all waters, in rivers, in lakes and ponds, and even salt-water estuaries, its regular, rapid growth, and its value as a food-fish, are its best recommendations.

2. The Localities best adapted to a Carp-pond.

I will try to describe, in the first place, the manner in which carp-culture in ponds is conducted in Central Europe, and subsequently explain more fully its introduction in open waters.

If intending to establish carp-ponds, it will be necessary to ascertain the following points before the execution of the plan:

1. Is there a sufficient quantity of water at hand for all purposes, for the summer as well as winter?

2. Is the ground, soil, and water favorable for culture?

3. It is important to examine the land minutely, in order to find what are the components of the soil, for not every kind of soil is suitable for carp-culture.

4. It ought to be decided from the commencement how large the establishment is intended to be, whether only for private use and pleasure, or whether wholesale production of the fish as an article of trade is contemplated.

If points 1 and 2 have been satisfactorily settled, then the ground must be examined, particularly whether it is so constituted as not to allow the collected water to penetrate, and whether the ground is sandy or loamy. Above all, it must not be neglected to measure the depth of the stratum which holds the water, and to be fully assured that it is sufficiently impermeable to withstand the pressure of the water and to hinder its oozing through, so as to prevent the consequent drying-up of the pond.

A rocky, gravely ground is not appropriate for carp culture. Sandy ground, without a considerable mixture of loam, clay, and humus, is of small use. I speak here of large ponds of considerable extent. Small ponds with a sandy bottom may be improved by supplying them with loam, as it is frequently done in agriculture.

Loam is a mixture of a small per centum of sand and a larger quantity of clay, and is suitable for ponds. If such ground contains some marl, or, better, some little elements of humus,* it is of the greatest advantage for fish-culture. These constituents of humus, if dissolved, give the water a yellow, muddy color; and this water supports by its ingredients a profuse number of microscopic beings, which again form the support of a larger class of creatures, and represent therefore the productiveness of food

* By *humus*, is meant such soil as the components of a swamp become after many years of change from its vegetable character.

of the pond, on which, in its turn, the carp depends for its subsistence. Too much humus or dissolved peat is injurious. Water which runs through bog-meadows or oak-woods is not of much use, because it contains too much humic acid and tannin: these impart a moldy taste to the fish. A too considerable amount of gypsiferous earth, carbonate of lime, or sulphate of lime, is injurious also. Should any mineral springs fall into a pond, they must be turned off. The most favorable water will always be that which comes from rivers and brooks. Ponds might be constructed which would fill themselves with rain-water during the winter or at any other time; but such water takes a moldy taste easily, which it will communicate to the fishes, as does the water from bogs also.

In Europe experience has shown that water coming from fertile fields and meadows, carrying with it particles of offal from villages, is best adapted for carp-culture.

Spring-water direct from the ground is not favorable, and ought to be conducted for at least a few hundred yards through wide, shallow ditches in order to receive more nourishing components from the air as well as the earth, and above all to be warmed to some extent by the sun and warm air.

A tract of land, such as above described, merits the preference as a site for a pond, if, in other particulars, the ground is favorable and has not too great a fall. If this were the case, very high and strong dams would be required for the collection of water. Such dams cost large sums if constructed of good water-proof material.

A low undulating country, with only slight elevations or hills, where the small valleys are easily closed up by dams for the purpose of forming reservoirs, is favorable, the construction of these dams involving comparatively trifling expense.

3. The Construction of the Ponds.

Ponds must not be too deep, as the water will be colder and will harbor fewer insects, larvæ, and worms, which form part of the carp's food: besides, this fish does not grow quickly in cold water. A depth of three feet in the centre of the pond is sufficient; toward the outlet-sluice it may be from six to eight feet deep, but only for an area of from two hundred to one thousand square feet. In the depths of this "collector" the fishes seek their resting-place for the winter, and also in summer, when the water is too warm near the edge. The outer part of the pond should not be deeper than one foot for the distance of about seventy or a hundred feet, so that the water may be warmed more thoroughly by the sun.

Toward the center of the pond, and in accordance with its size, a cavity of from twenty to fifty feet in length, and two feet deeper than the rest of the ground, should be dug. This will serve the fishes for a resting-place in summer and winter. This cavity is sometimes called a "kettle," though the appellation varies in different localities.

From the entrance of the pond to the other end, where the "collector" and the outlet-sluice are situated, two or three ditches of two feet in depth

and four feet in length must be made, which cut the deeper "kettles" transversely as far as the collector. These ditches are intended to carry all the fishes into the collector when the pond is being drained. The collector is nothing but a place of from twenty to forty feet in length and breadth near the outlet-sluice, one foot deeper than the remaining bottom of the pond. In ponds of superior construction it has generally a wood flooring, and must be cleaned of the mud every year, so that the fishes may not become too much soiled by the mud.

In speaking of the erection of a breeding establishment for carp, I have in view a water-extent of at least thirty-five to seventy acres' area, which in central Europe would be considered an establishment of about one third magnitude.

The inflow of water into the pond should never be allowed to be direct; as, for instance, a brook falling into it. This often causes the water to rise at an inopportune time, carrying into the pond other fishes, especially the rapacious pike. The carp also has the disposition to swim toward the inflowing water, by which means it is drawn away from its proper feeding-places. The water should be conducted into the pond sideways from the stream; and, if it should be a small brook only, it may be turned off entirely, and carried alongside the pond, from which point the latter can be easily supplied with water.

The inlet-sluices from the stream must, of course, be of a strong and practical construction, so that an overflow is impossible; and they ought to be provided with gratings to prevent other fishes from intruding.

It is an indispensable condition for the culture in ponds, according to established rules, that they be so constructed as to allow of being thoroughly drained, so that the fishes may be taken out without any difficulty. The bottom of ponds should be of such a description as to permit their being dried up for agricultural purposes if necessary.

In Europe ponds of from ten to two thousand acres' extent are frequently to be found, which, after having been used for fish culture for a time, are dried up; and sometimes grass, oats, wheat, &c., are planted on the ground. This improves the soil exceedingly for fish-culture. I mention this simply in order to show that the soil gains by this manipulation, not only for fish-culture, but also for agriculture. If the soil at the bottom of ponds has been freed from the humic acid by vegetation, after being plowed and exposed to the air thoroughly, fishes will thrive incredibly well in them. This I intend as a suggestion particularly for farmers who would wish to establish a small pond of, perhaps, five or six acres' size, to show that the soil of their land would not lose, but rather gain, by doing so. Agriculture and carp-culture go hand-in-hand in some central European countries, and form a kind of complement to one another. To-day a piece of ground may be a field or fertile meadow; next year it will be found to be a productive pond, to serve again one or two years later its first purpose.

If the size of the principal and supplementary ponds has been decided on, the height, depth, and width must be measured, and the levels of the ground and dams, if such are needed, should be carefully taken. The leveling of the bottom is required to assist in the determination of the depth of the ditches, "kettles," collector, and outlet to be dug in it.

In the erection of the required dam it is most important that it be constructed of the very best material, so as to make it secure against the destructive influence of the water. It ought to be three times as wide at its base as it is high, and at the top the width should be the same as the height. The interior, or water-side, should be less inclined than the exterior one.

Before the foundation of the dam is laid, the ground where it is to stand must be dug out to a depth of two, and a width of from four to five, feet throughout the whole length of it. If the ground does not consist of loam, it must be filled up with it about one foot deep, and this must be tamped down hard. A second layer follows, and is disposed of in the same manner. This is repeated, the clay being moistened every time if required, and then beaten down solidly. This lower stratum is but the foundation of the dam, which is formed from the earth dug out of the pond or its vicinity. This is continued until the dam is completed. Care must be taken, however, that the construction and tamping-down of this lower stratum be done in layers, and that nothing but good clay be used. In this manner the material of the foundation will become a very tenacious mass, which will not allow any water to penetrate. The completion of this laborious task will be a source of ultimate satisfaction, as many disadvantages, which might arise after the filling of the pond, will be done away with through its agency. The dam should not be made entirely of clay; for in midsummer, during the great heat, it would dry out too much on that side most exposed to the sun, and consequently it would become full of fissures, through which the water would escape, and this might become disastrous for the establishment.

On account of the required outlet-sluices, &c., the fact must be kept in view, that such newly constructed dams will sink ten per cent. after a lapse of time of little more than a year, with the exception of that portion which has been solidly made. The dam should be sodded. For the draining of the pond, at the "fishing-out" season, it should have an outlet at the lower end, if no other advantageous arrangements can be made for the purpose. The use of wood-work for the channel should be avoided, its durability not being sufficient. The most desirable construction would be that the outlet-channel consist either of masonry-work or water-pipes, which may be made either of clay or iron. This channel or pipe must be so made that it can be closed tightly or opened again readily if needed, and must be provided with two or threefold gratings to prevent the escape of the fishes upon the opening of the sluice. At the same time there should be an outlet-channel, several feet in breadth, at the side of the

pond, to allow the water to run off. This must also be secured by grating, but should be kept open always, so that, in case of continued rainy weather or sudden and violent showers of rain or thunder-storms, no overflowing of the banks or dams may be possible through the unexpected rising of the water in the pond. Large fish-ponds of several hundred acres' extent (some have a surface of twelve hundred, fifteen hundred, or two thousand acres) have generally, and according to their size, two or three outlets I have described, and which pass underneath the dam. The outflow from these is usually regulated by adjustment of the flood-gates from the top of the dam.

The so-called "Mönche" (monks) are wooden boxes, which stand in the pond at a distance of a few feet from the dam. They are perforated like a sieve, or are provided with small adjustable boards, and wooden pipes run from them through the dam. In Bohemia they are called "carp-houses." They are, however, rarely used in large establishments at present, only such culturists making use of them who have but small breeding-ponds at their command and carry on culture on a small scale. These locks suffer too much from the water, air, and sun, as also from the pressure of the ice in winter, so that they require considerable repairs at an early date after their first coming into use; but they serve their purpose fully in small ponds, especially in smaller ponds, which are intended for pleasure or experiment.

There are so many different ways of constructing these subterranean sewers, that I may as well pass them over; they belong more particularly to the department of hydraulics. It is the province of the culturist to find for himself that which will be the best and most practical method in the construction of outlets.

If it be desired to make use of natural ponds, of which there are numbers in every State of the Union, it is necessary to ascertain whether they can be put into the proper condition for regular culture. This can only be done if the influx of water can be regulated and the entire drainage of the pond made possible. An intrenchment will be required with such ponds in order to make them dry. Trunks of trees should be taken out of them; and where they are too deep they should be filled up, or, if this cannot be done, they should be brought into connection with the above-described sewers on the bottom of the pond. If this is not done, too many fishes will remain embedded in the mud when the pond is being drained, and this lessens the profits to a great extent.

Should any brooks fall into such ponds, as is often the case with large ones, they must be kept under strict observation on account of possible overflows which might occur. If it be practicable, the brook had best be turned off and conducted alongside the pond, when the latter can be supplied with water if required.

Such brooks, coming from a neighboring hilly territory or from mountains, will frequently occasion an overflow if either a thunder-shower or

sudden thawing of snow and ice should set in. In the latter case the ground might be too hard with the frost to allow the water to run off readily.

If the overflow should even be inconsiderable, it would still exercise an injurious influence upon the fishes, as the influx of so much water, which in all probability would contain unfavorable substances, would be apt to drive them from their winter retreat.

In summer, sudden, violent rain-showers may cause an overflow within a few minutes, which will carry off the fishes, and eventually may destroy all the ponds. To secure against this, the construction of reserve-sluices, such as are contrived in artificial ponds, and a wide reserve ditch alongside the pond, which is destined to cary off the threatening high water, are recommended. A small dam between the pond and brook, instead of the reserve-ditch, will sometimes answer.

Great caution is necessary in the selection of the site for a pond or the natural pond, which is to be converted into a carp-pond.

Overflows not only injure the ponds and fishes, but may result in a still worse disaster,—that of carrying away the fishes into strange waters and destroying the ponds.

The fundamental rule in carp culture is, that the water be of the same depth in summer and winter. If the supply of water is too plentiful, great quantities of mud are carried into the pond, embedding the grass which grows in it and on its banks; this, in consequence, will rot and poison the water. The carp immediately desert such water on account of its offensive odor, and retire from their proper feeding-places to depths deficient in production of food.

The mud, which is being constantly reproduced, consists of the remainders of plants. From these, different gaseous compounds develop themselves in midsummer, and the fishes become sickly in consequence. In this case, especially if they rise to the surface seeking for air, more water must be supplied through the inlet-sluice, when they will recover by degrees. A casualty of this description may occur in very large ponds, though no overflow may have taken place.

Pernicious gases develop themselves from the mud even in winter; but they rarely have any bad effects, being injurious only if the water is covered by ice, when the fishes die from suffocation. For this reason large apertures are cut into the ice for the supply of fresh air.

4. Stocking the Ponds and Care of the Fishes.

To carry on carp-culture in a regular and judicious manner, several ponds are required, according to the various purposes they are destined for.

1. The hatching-pond.
2. The breeding-pond.
3. The culture or regular carp pond.

The hatching-pond serves more particularly for natural impregnation

and hatching, or rather for natural propagation generally, by placing a number of male and female fishes into the pond. Here the females drop the eggs, during the spawning season, upon aquatic plants, where they are impregnated by the male.

In stocking ponds, three females are calculated to two males, sometimes twice that number, per acre. The females bear a great number of eggs, as has been remarked before; but the smaller number only are impregnated; neither do all these come to life.

The most liberal estimate will not exceed the number of from eight hundred to one thousand young fishes to one spawner: the aggregate per acre amounting to from four thousand to five thousand.

It is scarcely possible to say what is the most desirable number of milters and spawners for stocking ponds, as the views on this subject differ widely in Europe. I believe, however, the above to be correct, and it is accepted as such by all extensive establishments.

The above-mentioned result will be much more favorable if the old rule, now unfortunately almost forgotten, is observed,—to feed the carp which are in the spawning-pond, shortly before and during the season of spawning, so as to prevent their searching for food, which generally leads them to eat their own eggs. After the fish have laid their eggs, they must simply be removed from the ponds, which prevents their eating the eggs. This useful rule, formerly much practiced in Europe, has unfortunately fallen into disuse: in fact, it has almost been forgotten, probably because carp naturally increase very fast.* By removing the spawners, three times as many young fish are kept alive than by leaving them in the spawning-ponds. On no account should too great a quantity of young fish be placed in a pond. The above-mentioned number of four thousand to five thousand young fish to the acre requires water which is very rich in natural food. If there are too many young fish in the spawning-pond, they grow very slowly, as the pond cannot produce the necessary quantity of

* In Germany this rule is only observed by some small pisciculturists; in France, on some of the former lordly manors,—in the department of the "Seine inferieure" and in the department of the "Rhône,"—where they likewise had the custom to plant aquatic plants (*Ultricularia*, *Phellandrium*, c.) in loosely plaited baskets, which, when covered with the impregnated egg, were transferred to other ponds. Duhamel also practiced this in his time. This practice has doubtless led Dr. Lamy of Rouen to his artificial spawning-places made of reeds. By an order of the Abbot of the Benedictine Convent of Kremsmünster, in Upper Austria, (founded in 777,) of the year 1529 the fishers of the convent domain were reminded that spawning-carps must be of a certain age and size, and must consequently be weighed. After spawning, they had to be removed from the pond. This convent is still in existence, and is the wealthiest convent of the Austrian monarchy, owning upwards of one hundred and fifty large villages, and possessing a large and valuable library and observatory and scientific collections. But the order of the good old abbot is no longer observed. Similar orders were, in former centuries, also given by other convents in Austria, as Lambach, in Upper Austria, Wellehrad, in Moravia, and others. The fishermen's guilds, of Nuremberg and Bamberg had, about the year 1600, similar rules, which were placarded in their guild-halls, and which were strictly observed. At present such rules are not known in either place.

FIG. 5. *Scaphirhynchops, platyrhynchus*—Raf. Much reduced.

FIG. 4. *Polyodon folium*—Lac. Much reduced. From a specimen from Western Pennsylvania.

FIG. 6 *a*. *Accipenser sturio*—Linn. From Massachusetts; much reduced. From Storer.

FIG. 6 *b*. *Amiurus natalis var. cuprens*. One half natural size.

food. Such fish are scarcely one to two inches long when they are one to two years old; only the head grows a little, whilst the rest of the body remain, small. As soon as young fish feel the want of food for any length of time, the gristle and bone of the skeleton harden, thus bringing its development to a close, not allowing nature fair play, and the fish remains a cripple for the rest of its life, even if it is placed in ponds affording unlimited supply of food. It is therefore better either to place fewer young fish in the ponds or to make the ponds larger; it will be found to pay. The young fish will grow rapidly; their development will be healthy, and even during the first year they will reach the length of five to six inches. Strong and healthy fish can thus be placed in the growing-ponds, and here, too, they will grow rapidly. If there are too many young fish for the water-area, it is better to place them in some lake, brook, or river. On no account should they be kept in the pond. Beginners in carp-culture usually consider it quite a sacrifice to let so many young fish loose in the open river or lake: they keep them, and later they will bitterly regret their parsimony, or rather their imprudence, by having weak or not fully developed fish.

The hatching-pond should not be as large as the breeding-pond; its depth not to exceed one or one and a half feet. The outer portion, or, as it is termed, the low-water margin, should generally be from two to five inches in depth, and from thirty to forty feet in width. Provision should be made that *Festuca fluitans* grows there plentifully; for the fishes give the preference to this plant for the deposition of eggs, as I before observed. But the bottom of these hatching-ponds must be of similar construction to that of the larger ones; that is, they must be provided with the above-described cavities, or kettles, collectors, and collector-ditches. The "collectors" must be cleaned from the mud every spring: they need not be as deep in these ponds as they are in such as are intended for the reception of larger fishes; a depth of from four to five inches only being required for fishes of minor size. The hatching-ponds have outlets and reserve sluices in the dam, at the lower end or on the sides, to guard against overflows. These ponds must be secured against the intrusion of pike, eels, bass, cat-fish, tritons, water-snakes, turtles and water-lizards, rats and water-fowls, or any voracious animals, and, in the South, the alligator. A fine grating will prevent the entrance of the former: against the latter various traps are in use, and other means might be devised. It is of the highest importance that new ponds be assiduously kept clear of the animals mentioned, and of many others not named here.

In small establishments, embracing only a few acres, it will be found advantageous, in spite of the somewhat greater expense, if the ponds (both natural and artificial), either all or singly, are surrounded by a very close board fence, three to four feet high, and going four to six inches into the ground. Such a fence will afford no protection against aquatic birds, water-snakes, and muskrats: but it will exclude the snapping-turtle, the

most dangerous and voracious enemy of fish, which is more to be feared than either cranes or otters. This detestable animal has been known to clean a pond of fish, and then, led by its sense of smell, to follow the fish going even up hill and against the stream. At night it seizes the fish, which, not suspecting any danger, rest at the bottom, with its sharp fangs, resembling shears, and kills them. It is a peculiarity of carp to keep at the bottom during the night, and likewise during cold and gloomy weather; and the snapping-turtle would therefore have many an opportunity of destroying them. Large iron fish-hooks, with a piece of meat fastened to them as bait, will do good service, if distributed in suitable places on the banks. This should be done from spring to October. The pieces of meat should be of such a size that even large carps cannot bite them; they will then form a most attractive bait for the ugly monsters. These hooks should be fastened with a strong brass wire, as the snapping-turtle could easily bite through twine, and should be inspected every day.

In placing spawners in ponds, great caution must be practiced in their selection, so that only really healthy fishes may be introduced, and not such as are affected by fungous growths, the gelatinous polyp, or other disease. In Europe the polyp, in particular, has frequently destroyed the productiveness of ponds for many years.

The newly obtained young fry are left in the hatching-ponds during the winter, after which they are to be transferred to the larger ponds.

The catching of the young fishes must be done with great care, and the water must be drained off through the grated outlets very slowly, so that no fishes may remain in the mud; for, if a new hatching operation is contemplated in the pond, the newly hatched fishes will be retarded in their growth on account of the scarcity of food, this being consumed by any remaining larger ones. The young fishes must be handled carefully; for the slightest injury of the scales may cause disease and death.

The breeding-ponds have the same construction as the hatching-ponds; they have dams, reserve-sluices, outlet-channels, collectors, and ditches in the bottom. The only difference is in being deeper and larger than hatching-ponds. They have an average depth of one foot and nine inches, and the width of their shallow borders is from seventy to eighty feet. The "kettles" have a depth of four and one half feet from the surface: their borders are from six to eight inches deep. The growth of grass should also be advanced in these ponds. In small ones of about four or six acres, the "kettles" may have a length and width of sixty or seventy feet.

The stocking of the breeding-ponds takes place in spring, immediately after the emptying-out of the hatching-ponds: it lasts from the latter part of March until April.

From eight hundred to one thousand breeding-fishes may be calculated to an American acre, eight hundred being the average. To cover possible risks, one hundred more may be added, as in the most successful pond slight losses are to be expected.

In favorable ponds, where the carp is left to seek its food, it will have gained a weight of about one and one fourth pounds in the ensuing autumn. In small ponds, about one acre in size, where feeding is practiced, they will weigh more.

In the southern countries of Europe, in favorably situated ponds, they will sometimes reach a weight of two pounds in the same space of time.

This I found to be the case in southern France. However, these favorable results are only attributable to the mildness of the climate, and I doubt not that proportionably better results may be arrived at in the south of this country.

In ponds of small capacity, in which nourishing food is produced in small quantities, the results of breeding are not very encouraging.

An advantage will be gained in northern, colder countries, by leaving the young fishes two summers in the breeding-ponds; that is, they are transferred to a second, larger one, and only from this they pass into the culture or real carp ponds. This will answer especially well if the bottom of the pond is poor, or if feeding has not the desired effect.

This method is followed by many competent culturists in Germany and Austria, who, in the possession of extensive lands and excellent numerous ponds, find it to their advantage, as it enables them to place larger breeding fishes in the carp-ponds; and, though this is done a whole year later, the loss of time is compensated for by the large size of the fishes produced in the carp-ponds.

In the spring of the third year those fishes which have been one year in the breeding-pond are transferred to the carp-ponds, the construction of which I have described before. Fishes having been kept in the breeding pond for one summer only, without being fed, will be found to weigh at the expiration of that time from one to one and one fourth pounds, while those which remained there two summers will show a proportionally greater increase of weight. In southern Hungary and Croatia the fishes kept in the breeding-ponds but one summer occasionally thrive more favorably. Differences in the ratio of weight are commonly owing, as I observed before, to climatic influence; and the greatest and most rapid increase will be found in localities where there is an early spring and where the months of September and October are warm, but particularly where the nights are still and mild during spring and autumn.

Breeding-ponds should have a certain number of fishes only placed in them when they are stocked, and that number should never be exceeded. For the culturist it is important to bear in mind, that, the younger the transferable breeding fishes are, the less expense they will have caused, and the sooner their money-value may be realized; all carps weighing two and one half pounds and more being for the market.

To stock a culture-pond of one acre, four hundred to five hundred carp of one pound in weight will be required; and in the following year, or rather in the autumn of the same year, when the fishes are taken out for

the market, they will weigh in a good pond two and three fourths to three pounds each, or about twelve hundred to two thousand pounds in the aggregate. In some localities only two hundred carp are taken to one acre of American square measure; in other places, more.

Pike* are frequently put into carp-ponds in Europe without reducing the number of the carp, one pike being added to twenty-five or thirty of the former. This is an old practice, which has been proved of great use by experience, assisting through the effects exercised in the improvement of culture; that is, the favorable progress of the fishes. The carp is a very indolent fish, which frequently remains for many hours in the same place at the most favorable period for feeding; namely, in summer. It is aware of the pike's voracity, and remains always cautiously at a distance from it. The introduction of the pike is practiced for two reasons: (1) That the carp may not constantly remain in the same feeding-place, but, frightened away by the pike, may visit others also; (2) it is done, and principally so, to prevent the more mature carp from spawning. Should the spawning occur, as is the case occasionally, the young fry will be devoured by the pike, which otherwise would have deprived the large carps of their food. The pike will also destroy those fishes and their spawn which had succeeded in getting into the ponds without the knowledge or through the inability of the culturist to prevent it. Great care is required in the introduction of the pike; specimens of minor sizes than that of the carp must be selected. The growth of the pike being much more rapid than that of the carp, (three hundred per cent. per annum,) the former should be younger by one year at least than the latter, so that it may not prove dangerous to the carp. If this precaution is taken in the introduction of the pike, it will be an actual boon to the carp-colonies; for it will not only exterminate by degrees all those parasitical fishes which intrude themselves into the ponds, but it will devour frogs, or the smaller kinds of its own species, as well as water-snakes and tritons.

Should the pike suffer from want of food, after having cleared the pond of all these animals, it must be supplied with it. Small spoiled fishes, or such as have been stunted in their growth, will answer the purpose. If this is neglected, the hungry pike will attack its companions, the carps; and, though it may not devour them, it will mortally wound them with its teeth.

I have so far given the principle traits of natural carp culture, and will speak more explicitly of the artificial impregnation and hatching of the carp's eggs in my next report. So far as I know, this latter method has been little, if at all, employed in Europe, although it offers much greater advantages for the production of vast quantities of spawn. My own experiments were rewarded by the best results. I intend continuing them this summer in Baltimore, and hope to communicate the results hereafter.

*Males are selected for this purpose.

I now proceed to give a few rules of general importance for the construction and management of carp-ponds.

The ponds should have as shallow a border as possible. Their depth should be in accordance with their size,—one foot in the culture or regular carp ponds where large fishes are kept; one half foot in breeding, and one fourth to one half foot in hatching, ponds. The borders should be of considerable width. It is desirable in any case that a great number of such shallows be contrived in ponds, as these are the principal feeding-places of the carp.

Another important condition to be considered is this—that the water in ponds must be of the same depth all the year round, any variation in this having an injurious influence upon the fishes.

Ponds of smaller circumference, of from ten to fifteen acres, are, according to results obtained, better suited for carp-culture than very large ones, a hundred to a thousand acres in extent. These are frequently found in central Europe upon tracts of land belonging to some princely domain. In the former the fish finds more security, the bottom of the pond being smoother; it also suffers less from the waves these, being high and rough in large ponds, becoming very detrimental to the spawn and breeding-fishes especially during storms, when they are cast ashore, and become the prey of water-fowls or perish in some other manner.

The diminution of water by evaporation must be made up for by a fresh supply; this, however, must not exceed the quantity actually needed for maintenance of the regular height of water. Small ponds of from one to fifty acres' area, which serve some commercial or industrial purpose, as mills, &c., and which are constantly varying the height of their water, cannot be considered as favorable for regular culture-ponds. Although the fishes may grow to a pretty good size in them, they must still be regarded as belonging to the category of waters for "free fishing," like lakes and rivers. In these neither the height of water, nor the hatching of the eggs, nor yet the increase of aquatic animals, can be regulated at will. Still, leaving these waters to lie waste on this account would be a pity; for, if stocked with carp, they will, in spite of all disadvantages, remunerate the proprietor, and the care which he bestows on them will be a source of much pleasure.

I beg to make some remarks, in conclusion, relative to the introduction of the carp, and its increase in open waters, in which it is solely left to the care of nature, and to which subject I alluded at the commencement.

We introduce into our waters migrating fishes, such as the salmon and shad, and find it profitable, for the reason that they consume but little food in the rivers, growing up in the sea and ascending into fresh water as large fishes. We also maintain in our lakes white-fish, bass, pike, &c. These are all fond of animal food and belong in part to the class of fishes of prey. The carp, on the contrary, lives upon vegetable food, insects, larvæ, and worms; but it never attacks other fishes or their spawn. It can be pro-

duced in masses, and then be transferred into the waters destined for its reception. This can be done either by artificial impregnation and hatching, or in the way of natural increase.

For each of these methods two ways of action are open; (1) the spawn can be transferred into open water as soon as it is free from the egg; or (2) the young fishes may be kept in ponds for a season until they have had time to grow—that is, for one summer. In the latter case, the rule, that fishes which are destined for open waters must not be artifically fed, is to be strictly adhered to. Carp which have been used to feeding in that manner will not be so apt to find the food for themselves which until then had been supplied to them. Tormented by hunger, they will lose the fear of their enemies, and the consequent cautiousness, falling an easy prey to them before many weeks will have elapsed.

If artificial feeding is not intended, the ponds for the reception of the small fishes must be proportionately larger, so that they may find food in sufficient quantities in a natural way. Both methods have their advantages. If the young fry is transferred into open water five or six days after hatching, there will be no necessity for the establishing of large ponds. A great number of eggs must, however, be hatched in this case; for the small fishes will be destroyed in vast numbers by their enemies.

The better method of the two is certainly this: To keep the young fishes in large ponds until the fall, when they will have reached the age of five or six months. During this time they will have had the opportunity to learn how to find their food by their own efforts, such ponds producing it profusely to satisfy all their wants, and thus they will be prepared for their stay in open waters. To carry through the latter method, a larger extent of water is required, nature itself having indicated precisely the conditions under which and the limits in which the natural and unimpaired growth of the young fishes may be expected.

They do not require as extensive a pond during the first months of their development and growth as those which have reached a more advanced age. For this reason it will be more advantageous to choose the middle way by retaining the young fishes in the ponds for about one or two months, and then to give them their liberty, instead of transferring them immediately after the hatching or keeping them for five or six months. By acting upon this suggestion, the incalculable advantage will be gained that the fishes profit by the rich food of the open waters during the season, and will have grown strong enough to fight more successfully for their existence. For this purpose establishments for artificial breeding, constructed with a regard to the demands of climate, are essentially needful in these open waters, so that the greatest possible number of eggs may be hatched.

In Europe the subject of stocking open waters with carp has been discussed, because there, in its native country, its excellent adaptation for this purpose has been recognized.

I observed above that this fish is found in great numbers in most of the

European rivers, particularly in the Rhine. Although this river has a very swift current, which at times forms rapids, here neither mud nor suitable ground is to be found which would qualify these localities for feeding-places for the rather indolent carp. Still, there are numbers of shallows and small creeks, the borders of which are richly overgrown with grass and *Festuca fluitans*, where the fishes find food plentiful and multiply.

The river carp is not as fleshy as the pond carp; this is accounted for by the great amount of bodily exercise which it is naturally compelled to take. In many places it is more highly appreciated than the pond carp, probably because the river-water does not impart to it the moldy taste which is sometimes found with the carp inhabiting ponds situated in marshy localities and morasses which have not a sufficient supply of fresh water.

The assertion in regard to the preference given to the river carp will be found to be correct, especially in regard to the rivers Rhine, Elbe, Weser, Vistula, Loire, Rhone, Garonne, and the Danube. The latter is celebrated in song as the beautiful, blue Danube; in reality its water has, during the greater part of the year, a grayish-white, muddy color, and a very swift current. It has, however, particularly in Austria, Hungary, and the lowlands in general which border upon it, numerous branches which creep along sluggishly, and also many small creeks with almost stagnant water.

A great number of fishes of prey inhabit this river; the pike, perch, the rapacious hucho, (*Salmo hucho*,) and, above all, the never-satisfied wels, (*Silurus glanis*,) which, in the lower Danube, reaches a weight of five hundred pounds. Its habits being similar to those of the carp, it lies on the mud banks or feeding-places of this fish, and becomes its most dangerous enemy and insatiable destroyer, and still the carp increases in the Danube. From the city of Ulm, where this river begins to be navigable after its escape from the Black Forest, a thousand miles downward to its mouth on the Black Sea, as also in this case, the carp is found. To this fact allusion has been made on a former occasion. The carp thrives best in those parts of the Danube where the water is least clear; at the influx of the muddy waters of its tributaries. At one time I was present at a draught of a seine, which took place close to the quay of the city of Pesth, in Hungary, and was arranged by Mr. Szihelsky Ferentz. At that point the river is constantly plowed by steamers, steam-tugs, canal, and ferry boats, and it would have seemed that there could not be many fishes there; yet three hundred fine carp, weighing from one to five pounds each, were taken in one draught of the net, within the distance of about one quarter of an English mile. The carp is partial to this locality, because it finds abundant food there in the offal from kitchens, slaughter-houses, breweries, and the sewers of both the cities of Ofen and Pesth. In the European lakes—for instance, in the lakes of Constance, Zürich, and Geneva—the carp comes sometimes from these into the ports to seek for food.

Comparing the water of the Danube with that of the Mississippi, I feel convinced that I may safely assert that the carp would thrive excellently in

the latter, although its water appears to be even more muddy and rapid than that of the Danube; and I believe this to be true of the Missouri and Ohio and many others of its tributaries. The Mississippi has near its borders many spots where the current is slow, and which are partially covered with vegetation. There are also numerous creeks, where the fishes would find food plentifully in the alluvial mud on the banks. What has been said of the Mississippi will be found to be the case with many other, or probably nearly all, American rivers. They will be found to be adapted for the introduction of the carp, so long as they are not mountain torrents which have to break their way through rocky and pebbly ground. The increase of this fish is of great importance from an economical point of view, especially so in regard to the south-western waters.

Under the present circumstances it is to be hoped that the endeavors which have been made for this purpose may before long be rewarded by success, and become a *fait accompli*, and that the difficulties which will have to be overcome may not prevent the achievement of it. The effort will and must meet with success at last.

5. Taking the Fish from the Ponds.

The emptying-out of ponds demands the greatest caution and attention. The water must be made to flow off very gradually through the several outlets, all of which are to be kept open at the same time. It requires frequently from ten to eighteen days to draw off the water. The fishes are driven carefully and slowly with boats into the principal ditches. They must not be chased on any account, or they will bury themselves in the mud. Occasionally many thousands will do so within a few moments, and will remain there, pressed together closely, and so perish through suffocation. This is recorded as having occurred from time to time, when, during the process of driving them into the ditches, the fishes were startled by some unknown cause, and they all sank into the mud instantaneously. Through the impossibility of extricating them speedily enough, many hundreds and even thousands perished, the owner sustaining heavy losses in consequence. To guard against such an emergency, preparations should be made for an immediate supply of water in similar cases, in order to save the fishes. If the fishing-out progresses in the regular manner, the fishes will, by degrees, draw off from the ditches into the collector. The collecting takes from five to six days in large ponds, containing frequently one hundred to four hundred tons of fishes. Care should be taken that crowding them together may be avoided. On the evening before the fishing-out, when the water of the pond has been diminished to the depth of half a foot, those fishes which have been collected are shut off from the pond by a large net; and in the early morning, at the dawn of day, they are caught. As so large a number of fishes cannot be disposed of at once, they are transferred to the so-called market-ponds, from which they are sold by degrees to fish-dealers. These market-ponds are quite small, capable of

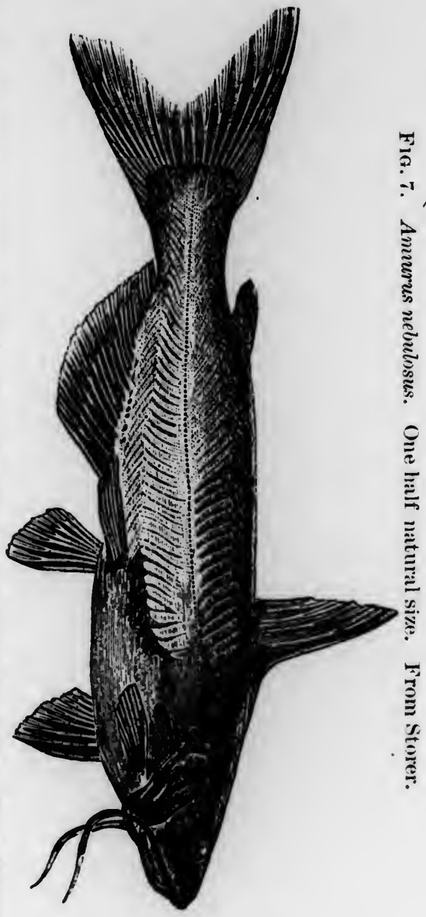


FIG. 8. *Ictalurus coeruleus*—Raf. From the Ohio; one fourth natural size. From Kleinpart.

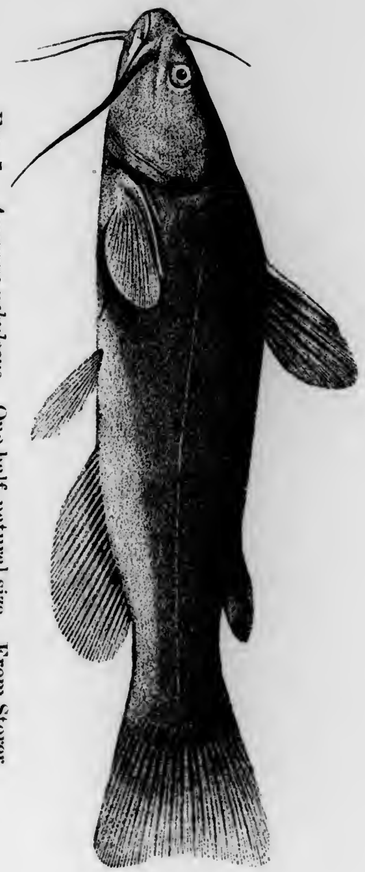


FIG. 7. *Amiurus nebulosus*. One half natural size. From Storer.

FIG. 9. *Catostomus teres*—Mitch. One third natural size. From Storer.

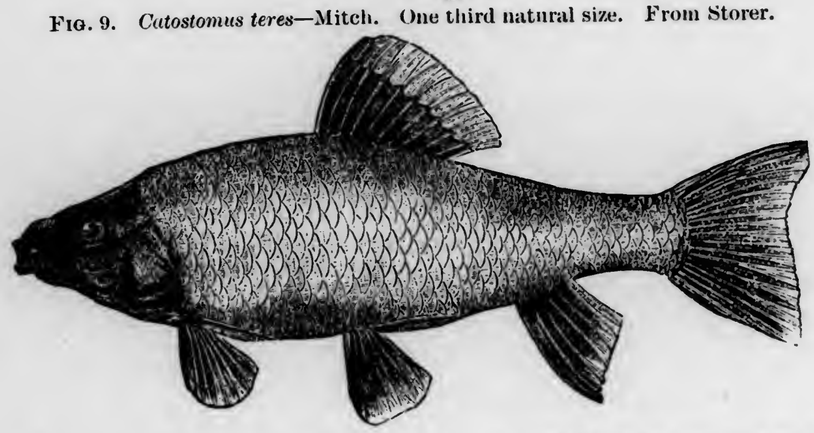


FIG 10. *Erimyzon succetta*—Lac. From the Ohio basin; one half natural size. From Klippart.

holding from two thousand to three thousand pounds of fish only, and are supplied with running water.

Those who never saw the fishing-out of a carp pond can scarcely imagine the beautiful sight of so many thousand fine fishes, fat and well-fed, raising their high, broad backs and thick, puffy lips above the water; their heads side by side; all being nearly of the same size, weighing from four to five pounds; their bodies closely pressing against each other, looking like an immense herd of sheep imprisoned in one large net upon a circumference of three thousand to four thousand feet. Closer and closer the circle is drawn around them, until its extent measures only about two acres, when they are caught by thousands, weighed in lots of one hundred pounds, and then they are placed into the market ponds. The pikes, which have reached an almost equal weight, are put into pike ponds. It requires often two or three days to weigh the fishes, ponds of one thousand or two thousand acres' area containing on an average two hundred tons of carp and twenty tons of pike, tench and other fish not included.

I assisted once at the fishing-out of one of these ponds, which took place in the neighborhood of the town of Guben-Pleitz, province of Brandenburg, Germany. The pond was the property of a competent culturist and valued friend, Mr. Thomas Berger of Georgenhof, near Cottbus-Peitz. The ponds in which this gentleman carries on carp-culture exceed the extent of six thousand Prussian acres. The pond which was fished-out at the time I speak of was but a small one, not more than two hundred acres in size; yet, to my surprise, I found that the greater number of the fishes were fine specimens of about three pounds' weight, though they were but in their second year, having weighed no more than one and one fourth pounds five short months before, (the fishing-out took place at the beginning of October,) and they had attained to this great weight in a comparatively very limited space of time. Several establishments of this kind are located in that district, and they commonly belong to some large princely domain, (crown property.) They are, like all large fisheries, admirably managed, and the results are most satisfactory.

6. Mixed Carp-Culture.

We have so far spoken of carp-culture, according to the different age of these fish, in special ponds, (hatching, breeding, and carp ponds,) termed "class-culture" in central Europe. We must now speak of another method pursued in so-called "mixed ponds," in which there are fish of all ages, from one year to eight to ten years.

Not much can be said regarding this method, as there are no hatching and breeding-ponds, but only one pond, which, however, must combine all the characteristics of the class-ponds. It must, therefore, have shallow places, overgrown with grass or aquatic plants, (*Festuca fluitans* and *Phellandrium*,) for the spawners and the young fish, and also places, eight to ten feet deep, for the larger fish. If such a pond is to yield some profit, it

must also be particularly rich in food. A natural pond may be used, or, if such a one is not found, it may be artificially constructed. It is indispensable, however, that such a pond should have the same depth of water all the year round; and it should be so arranged that even the last drop of water can be left off, as occasionally even the smallest fish, measuring only two to three inches in length, must be taken out. Such "mixed ponds" must likewise have "collectors" and "collector-ditches." It will also be found very useful to construct a sort of hatching place on some flat and sunny place near the bank; *i. e.*, a so-called cut in the bank, measuring forty to one hundred feet in length and thirty to fifty feet in breadth, and having a depth of five inches to one and one half feet. This cut should be thickly planted with the above-mentioned aquatic plants, and ought, so to speak, to be the only place in the pond where carp can ascend from the depth in order to deposit their eggs conveniently and engage in the spawning process.

As soon as this has taken place, the entrance to this cut is closed with a net, so the eggs cannot be eaten by the fish. This net may be removed when the young fish have come out of the eggs; but it is preferable to leave it in its place for some days, that the young fish may be able to feed for some time undisturbedly.

In Europe this method was generally adopted by beginners in carp-culture, commencing with a "mixed pond," and gradually proceeding to the small "hatching-pond," and finally to the "breeding-pond," as the great advantage of separate ponds for the different ages of fish over the "mixed-pond" system soon became evident.

In such a "mixed pond" no pike must be kept for regulating the stock, as may be done in a class-pond; for all the small fish would then soon be devoured. It must be made a strict rule, that, with the exception of the tench (*Cyprinus tinca*,) no other kind of fish, however harmless, is allowed in the pond. The tench is related to the carp; but it spawns four to five weeks later, so there can be no danger of cross-breeds.

Great care should be taken that no gold-fish (*Cyprinus carpio auratus*) or bream (*Brama*) get in the pond, for these fish would soon mix with the carp, and tend to degenerate the breed. Such fish should therefore be removed or killed at once. The gold-fish, especially the milter, swims in spawning-schools like the carp, and at the very same season. It thus spoils the eggs of the carp, as all eggs which it impregnates will produce spotted fish, having at least a silvery streak, one fourth to one half inch long and one eighth inch broad, between the caudal and the dorsal fin. Such bastards (the cross-breeds of gold-fish and *Carassius* also resemble them) do not grow larger than gold-fish, and have as many bones. They are unfit for table use, and entirely unsuited for ornament, as they are neither genuine carp nor gold-fish, and are disagreeable objects in the eyes of the scientist or connoisseur. If such fish are not removed immediately the consequence will be another cross-breed during the next spawning season,—for such a hybrid spawns, like the gold-fish, when it is a year old,—and the breed of carps would degenerate still more. It is best to kill such worthless cross-breeds at once, as they are apt to give great trouble.

I would embrace this opportunity to impress upon every carp-culturist who intends to make breeding experiments with any carp procured through the United States Fish Commission, the importance of having, if possible, only *one* of three above-mentioned kinds of carp, unless he can have every kind in a separate pond. Thus, the common carp (*Cyprinus carpio communis*) should never be placed in the same pond with the "mirror carp" or the "leather or naked carp" (*Cyprinus carpio alepidotus, coriaceus vel nudus*,) nor should the two last-mentioned varieties ever be in the same pond. Cross-breeds would invariably be produced, and in such a manner that one would have neither genuine common carps nor genuine mirror or leather carps, but a cross-breed of all the three varieties. Not even when quite young, and not yet capable of spawning, should these varieties be put together, because even if they are kept strictly separate during the spawning process, the young fish would never have the sharply-marked characteristics of their variety as regards form and color, but would approach nearer to the "mirror carp" and the "common carp." The carp has a striking tendency, when living with other varieties, to approach the primitive form of the common carp, and finally to be merged in it. These beautiful varieties should therefore be kept strictly separate. Lack of ponds or any other reason should never induce people to mix them.

If the breeding experiments are to be accompanied by good results, a pure variety should be selected, and the finest and best milters and spawners, showing strongly all the characteristics of their variety, should be procured, and the experiments will be crowned with success.

I must return to the so-called "mixed culture," by mentioning that it is not to be recommended. In central Europe it is never practiced by scientific pisciculturists, but only by small operators mostly in so-called "peasants' ponds." This method does never yield a certain and truly profitable result.

7. Feeding the Carp.

In conclusion, I will make some remarks on the feeding of the carp in close ponds. It is not every natural pond which is a good pond, having the essentials of a good soil at the bottom, and capable of producing sufficient food for the fish. If these conditions are wanting, the fish must be fed. This is, as a general rule, only necessary in ponds with sandy bottom without any clay. As I have said before, I am *not* in favor of feeding fish, as my stand-point is that of the rational culturist, sharing the opinion with most of the prominent pisciculturists of the Old World, that the carp should find its own food in the ponds.

If, however, the nature of the bottom demands artificial feeding, or if suitable food can be had at a remarkably cheap price, the feeding should be done with great caution. Never feed in one and the same place. Even

if the pond be very large, distribute the food in different places near the banks. If the food is always put in one place, or even if it is distributed over two places, the carp will stay in the neighborhood of these places, will become languid, and, instead of scouring the other parts of the pond in search of food, will remain at the bottom. It will even, if surrounded by the richest food, grow fat, but never have any firm flesh; nor will it ever grow much in length, as the somewhat phlegmatic fish does not get the exercise which favors its growth.

Never give them much food at one time, but by degrees, in small quantities,—never during the day, but either early in the morning, or in the evening. During the hot season only feed them late at night, because the carp, if it has eaten sufficiently in the morning, will remain at the bottom all day; while, during the higher temperature of the water, it is necessary for its health that it should swim round, and get a change of water. It is therefore useful to place in ponds containing large carps a limited number of pike, which, however, must be smaller than the carp. The carp fears the pike, and flies from it. If there are pike in the pond, the carp will get more exercise, and will seek natural feeding-places, whither on account of its innate sluggishness, it would never have gone.

Pond carp are accustomed to other food than the river carp. The former confine themselves to worms, larvæ, and plants; while those living in streams find all sorts of animal and vegetable refuse. These latter can also stand a greater amount of food, as the current naturally makes them take more exercise, thus increasing their appetite. It is different with the pond carp; if you give it too much food, it will not take any more than is necessary to satisfy its hunger. The remnants will remain at the bottom, and, if their quantity be considerable, they will spoil the water. If these remnants are chiefly animal refuse, as flesh or blood, fungi will grow on them, and will then produce, as with salmon and trout, diseases of the skin, the gills, and in the case of carp, sometimes internal diseases.

The writer once had the following experience: During his absence a number of large carp were fed on coagulated blood, which had begun to putrefy. The fish devoured it eagerly, got sick, and most of them died in a few days from an inflammation of the intestines. Spoilt food should never be given to fish. If slaughter-house or kitchen refuse can be had, give these, chopped up small about the size of peas. Never give so much that remnants remain for any length of time in the water and begin to putrefy. Let no one be induced, by the circumstance that the carp like to eat the dung of hogs, sheep, and cows, to feed them on any putrefying matter. There are instances on record that thereby epidemics, particularly diseases of the scales, have originated.

The carp likes, above everything else, vegetable matter, such as cabbage, lettuce, boiled potatoes, corn, turnips, pumpkins, melons, &c. The refuse of malt from breweries and distilleries is also very good food for carp; and, wherever such refuse can be had, it should be given to the fish.

The small pisciculturist, having a pond of perhaps one to two acres near his house, will often be able to feed his fish on refuse, as he will always have it fresh from the kitchen and stable.

In conclusion, I earnestly recommend the culture of the carp to all pisciculturists. If the value of the carp for table use has once been recognized, it will become a highly esteemed fish, especially in the neighborhood of large and populous cities, and its culture will yield a larger and more certain profit than the expensive trout.

8. Extent of Carp Culture in Europe.

In Europe many thousand acres of artificial waters are to be found. In these enormous quantities of carp are bred. Some of these ponds, or rather lakes, have an extent of about one thousand to two thousand acres. They are provided with gigantic dams, many of them sixty feet high. By these the waters are closed in into broad valleys, containing no other fishes than carps from four to five pounds in weight. If we consider the size of these lake-like ponds, surrounded by enormous dams which are overgrown with oak trees one hundred to three hundred years old, series of three and more of these lakes being not uncommon, then we can form some idea as to the remunerativeness of these establishments, particularly in Bohemia.

The standard establishment in regard to the most extensive business transactions is found in Austria. The Prince of Schwarzenberg, of whom I have spoken previously, possesses more than two hundred and fifty ponds of large size; the smallest having about ten acres, the largest two thousand acres water extent.

We find many villages where ponds of fifty to two hundred and more acres are maintained at the expense of the community.

From other sources we allude to the varieties of food attainable for carp as follows:

"*The Great Caladium Esculentium.*"—This plant grows in water twelve inches deep, has esculent roots filled with farinaceous and amylaceous deposits, expanding leaves, and large foliage, furnishing shelter.

"*Nymphœa Odorata.*"—Possessing deep fragrant foliage with crooked stems, affording shelter and lodgment for spawn, as well as seeds full of nutritious matter.

"*Nuphor Advena.*"—It also a valuable plant suitable for large ponds; more vigorous growth than others; affording food and shelter.

"*Melumbeum Luteum.*"—Of the water lily tribe; none more attractive. "The root contains a large percentage of mucilaginous and farinaceous matter, and is said to be one of the best known native vegetables for food." (Case's Botanical Index, page 77.)

"*Nasturtium Officinalis*" or cress, is one of the most attractive plants for carp.

"*Tizania Aquatica*" or water rice, is a plant yielding large quantity of seed, which fall when ripe and are eaten by the fish.

Structure of Ponds.

Many inquiries are made how to construct ponds for carp culture, and many, doubtless, after trial, will abandon the enterprise for want of success, when it may be attributed to ignorance in the essential feature of their surroundings. Many persons could and can succeed at *keeping carp*, when, perhaps, their grounds are ill-adapted to *carp culture*. The latter requires a number of ponds—while the former can be accommodated on almost every farm in one pond. The culture of carp requires, if properly done, a pond for the young fry, a pond for the growing carp, and a pond for the wintering carp. Ponds for fry and growing carp may be shallow and of almost any size in extent; not containing any or much iron or sulphur; from four feet in the center to nothing at the edge; with clayey rich bottom, and rich in succulents for nourishment, as heretofore indicated. The wintering pond should be at least six to nine feet in depth, and the deepest at the deepest point for hibernating purposes. The hatching pond should not be too large, as a small one is easier sheltered from high winds which cast the spawn ashore. They can be protected from overflows and rain storms, and most important of all, can be easier protected against the numerous enemies of the fry and spawn, *e. g.*, herons, ducks, frogs, crows, otter, muskrats, and the most dangerous of all, the *small diver*. The more exposed to the warm rays of the sun the better. The spawning taking place in May, continuing at intervals—the older fry making room for the younger by going into deeper water. Frog spawn should be drawn ashore. Two or three spawners, with an equal number of milters, will stock an acre. The ponds, if the water facilities are available, should connect by levels, constructed with such outlets as to control the depth of water and keep in such condition as to enable the large fish to be selected and separated as occasion required, it always being advisable to remove the fry from the hatching-ponds the following spring and not in the fall, as they do not winter well, especially if their *scales* are injured. The pond for culture or feeding the larger fish in should have a trough through the center to outlet, so that when ready for market, which would be the third year, when the water is drawn down they will descend to the lowest point, and can then be easily handled and caught by wading and using purse nets.

Wall-Eyed Pike. (*Stizostetheum Vitreum.*)

OR SUSQUEHANNA SALMON.

This fish is sometimes called Lucio-perca, adopted by Cuvier, indicating its affinity to both the pike and the perch, sometimes called the pike-perch. Along the Susquehanna and Juniata it is known by the inappropriate name of "salmon." This misnomer doubtless was given it on account of the peculiar color and flakiness of its meat. This fish is identical with the glass-eyed or wall-eyed pike of the northern lakes. How it came to our waters is not known, but it is not thought to be indigenous—transplanted, doubtless, from the northern lakes. It is known to the lake fisherman as *pickerel;*

split and salted and known in commerce as pickerel No. 1, and a very important factor in the lake fisheries. Next to the white fish and herring, it is most abundant, and the supply more regular than either of the others. It ranks next to the white fish in delicacy and desirable table qualities. Its time for spawning is in the spring. While fishing for shad during their spawning season they are frequently taken full of spawn. The fishermen regarding their own interests so little, although in such a condition as to yield a thousand fold, rarely return them to the river, but kill and keep them. This reckless and indiscriminate taking of these fish made them scarce in the Susquehanna, where forty years ago they were so abundant, up even to the headwaters of the Juniata. In the fall of the year, then, before the days of public improvements, they were caught and speared in such quantities by the people living along these waters that they were packed in barrels, salted, and in the spring carried to market by the arkmen, and exchanged for goods and groceries. Mr. Creveling secured some fourteen adult fish from the Susquehanna a year ago, and made an unsuccessful effort to propagate them artificially. After he had stripped the females with ease, much to his surprise the males were barren, and no milt could be expressed. This was an unaccountable occurrence in fish culture. We wrote Mr. Green about it, and he had never experienced such a condition of things in the same species of fish, invariably finding milt in the males when the females were ready to spawn. Since then we have not renewed our efforts. They are rapidly increasing, however, attributable to the increased protection afforded by legislation and enforcement of the laws protecting them during the spawning season; the black bass also preying upon shiners, &c., that live on the spawn of the Lucio-perca.

We have republished the article of our last report on Susquehanna salmon so called, to which we add, that there is a decidedly marked increase in this splendid variety since the Susquehanna has recently attracted attention, be the causes what they may—most probably those we have suggested. It is questionable whether any variety of fresh water fish would prove more valuable than this, should it become abundant in our great streams. The increase is noticeable in the Conewago district of the Susquehanna, between Middletown and Columbia, and decidedly marked on the North branch of the Susquehanna, almost, if not quite, as high up as the boundary of the State.

The fish does not seem to have been indigneous to this stream, but to have been transplanted many years ago from the New York lakes. We have heard the Priestly colony, near Northumberland, credited with its introduction—not the only benefit which that small body of intelligent Englishmen conferred upon the neighborhood in which they settled. They were exiled from home on account of religious opinions, leaning, we believe, toward a liberal Unitarianism, and were a sort of pilgrim fathers to the vicinity. If they are to be justly credited with the introduction of this valuable variety of fish into the most important of our streams, their exile

from England need not be regretted on this side of the water. We have made deposits of adults in the waters of the Lehigh for artificial hatching, seems to have failed with respect to them, and these last, if they increase in the Lehigh, will naturally gravitate toward the Delaware. So we may be able to present the counties with a second grand river full of them. The value of such a result would really be hard to estimate, and if they succeeded by transplantation in the Susquehanna, why may they not do so in the Delaware—a stream offering almost as many miles of fishing coast as its sister streams of the interior?

Pollution of Streams.

The deposition of deleterious liquids and substances of various natures in our streams from mining and manufacturing establishments of many kinds must also be regulated. It will not, of course, be expected that parties pursuing these avocations shall be unduly restricted in the pursuit of their business, but carelessness in the disposition of such deleterious matters may well be found to be a nuisance, causing more inconvenience and loss to the general public than what can be shown to be a gain to those who follow such avocations. This subject is agitating other neighborhoods in our own country, and has become a matter for serious consideration in the old countries.

It was deemed as not unworthy of a paragraph in Queen Victoria's speech from the throne last year, and is now under discussion in the Parliament of Great Britain. Not only are fishing waters liable to deterioration from this cause, but the streams that supply drinking water to large cities are also injured. The city of New York has had its attention involuntarily and forcibly drawn to this subject, finding the Croton water-shed so influenced more and more as the years roll on, and it will not be long until the city of Philadelphia will discover similar cause of complaint.

The subject commands the attention of the public, for the health of human populations is affected as well as that of the denizens of the deep, and if the interests of our race require an adjustment of the law on this subject, the finny tribe will benefit incidentally from the same cause. It may well be deemed of primary importance, and something remedial must be done.

Of course, it is desirable that no law should be passed bearing unevenly upon any class of citizens, or materially damage our manufacturing interests, but the principle has always been recognized that some small sacrifice must be made by the few for the benefit of the many. We particularly refer to the introduction of refuse matter from tanneries, oil refineries, dyeing establishments, lime-kilns, and oil exuding from imperfect pipe lines. The question will soon command attention in a sanitary point of view, and we hope that the necessity may not arise which will introduce legislation to prevent the pollution of the fresh water streams east of the Alleghenies.

It has been decided judicially in Vermont that it is illegal to throw sawdust into the streams.

FIG. 13 *a*. *Cyprinus carpio*, monstrous variety, the "Spiegelkarpf."

FIG. 12. *Cyprinus carpio*—L. From Austria; much reduced. From Heckel and Kner.

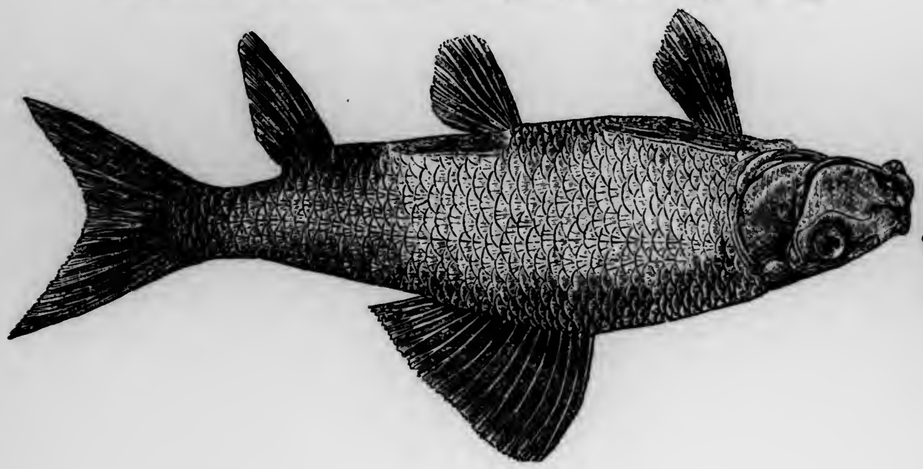


FIG. 11. *Myxostoma relatum*—Cope. Ohio basin; one third natural size.

Directions.

The following directions are substantially those of the New York report, which are applicable to our circumstances:

In delivering spawn from the hatching-houses the following rules must be strictly observed:

The young fry of any fish we hatch can be obtained at either of the hatching-houses on an order of any one of the commissioners. The eastern house is at Marietta, Lancaster county, Pennsylvania, John P. Creveling, superintendent; the western hatching-house is at Corry, Erie county, Seth Weeks, superintendent.

The means at the disposal of the Commissioners are too small to justify the delivery of all the fish that are hatched at the expense of the State; but the commissioners will do all they can. Where parties obtain orders, and accompany the fish, the State will furnish cans for transporting them, but which must be immediately returned by express, C. O. D., at the State's expense.

Persons desiring fish will please state the name of person to receive fish, location, kind of water, temperature, kind of fish—if any—already in the stream or lake, and the nearest telegraph and railway stations.

Salmon trout are a deep lake fish, and not suitable for shallow, warm streams.

Strawberry bass, also called grass bass, just introduced; none for distribution.

Black bass, during the months of September and October. Brook trout, from February 20 to March 20; these should be placed in small spring rivulets which supply the main stream.

No man should go to sleep while transporting fish, and leave them alone while in the cans, as it will be sure death to the fish.

Water in the cans containing the fish requires constant ærating with a plunger, which accompanies the cans, or the water must be renewed, as directed by the superintendent, on delivery, who will give full directions as to the management of the fish during transportation.

Carp can be obtained in limited numbers on application to Professor Spencer F. Baird, at Washington, D. C.

Six twelve-gallon cans filled with fish are all that one man can manage or take care of. Milk cans are of the kind used for the carriage of all kinds of fish. A twelve-gallon can will hold six thousand whitefish, or four thousand salmon trout, or five thousand brook trout, or from ten to twenty adult fish, as black bass, &c., according to the size.

All communications must be addressed to either of the commissioners or superintendents. Those from the eastern part of the State to A. Maginnis, Swift Water, Monroe county, or G. M. Miller, Wilkes-Barre; from the middle, to James Duffy, Marietta, Lancaster county, or John Hummel, Selinsgrove, Snyder county; and those from the west of the mountains, to Robert Dalzell, Pittsburgh, or Benjamin L. Hewit, Hollidaysburg, Blair county.

The communications should describe particularly the waters to be stocked, giving their names, locations, and size, and stating whether the ponds or streams have rocky or muddy bottoms, or have eel grass, flags, or pond lillies. The wall-eyed pike, rock bass, black bass, white fish, and salmon trout are suited to clear waters with rocky bottoms. Perch, carp, and strawberry bass will do better on muddy bottoms, with flags or pond lillies. State particularly what kind of fish already exist, so that kinds unsuited to each other may not be mixed.

Deposit all fish as near the head of the stream or lake as possible. Young fish, if practicable, should be deposited at night, where large fish do not feed so much, so that they may find hiding places before morning.

Brook trout put into mild, still water are thrown away. Black bass placed in a pond with mud or grass bottom will not thrive. They must have rock or gravel, where cray-fish, their favorite food abound. Oswego bass, in the water first stated, will increase, multiply, and make glad the heart of the fisherman.

Salmon trout will not remain in running streams, no matter how pure the water, and the lordly salmon himself is so particular about the temperature of the water he inhabits, that human investigation has hardly yet been able to tell just what it should be. We can judge best by leaving him to choose for himself.

Doubtless the failure to establish the California salmon in the waters of the Atlantic coast comes from this element of temperature. Certain it is that the trial has been faithfully made. Of the millions upon millions of the fry of this fish carefully procured, transported at much expense from its native waters, and hatched in nearly every fish cultural establishment in the Union, practically none survive to tell the tale of their fate. What becomes of them we do not know. If they live to get to the ocean they do not return to the parental stream at the annual spawning or any other time. They hatch readily and grow rapidly in the early stages; but none of over two years' growth are often seen anywhere. We have record of some found in a small stream where they had been planted four years before; but which, after the second year, had made no progress, but were true dwarfs, with big heads, meager bodies, and feeble action. There have been, also, a few instances where this fish, the result of planted fry, have been found of the weight of two pounds; but these have been in waters from which there was no convenient escape.

Of all fish that have come under the observation of the Commission, none have done as well, according to the cost, as the black bass—usually styled, in contradistinction to others of this general family, the "small-mouthed bass." This fish does its own hatching and attends to its own nursery duties. Of vigorous, yet clean appetite, he grows apace, and, where the location suits him, takes a lease for life, with a contingent interest for his posterity. A good black bass lake or stream will bear more fishing to the acre than any other fish water. The Oswego bass and the perch pike are

also cheaply procured, readily kept, and are profitable for both food and sport. The merits of the bull head we have sufficiently eulogized in another place.

If the commissioners had to choose from the whole fish calendar a variety with which the most could be done with the least cost, they would decide in favor of the bass. They are the manna and the quails of the wilderness. They came, as it were, as the special gifts of Providence; and if there were no other fish in the world we might be content with these.

The following table from the New York Report will convey some idea of the importance of the fish trade.

Sales of Fish in Fulton Market.

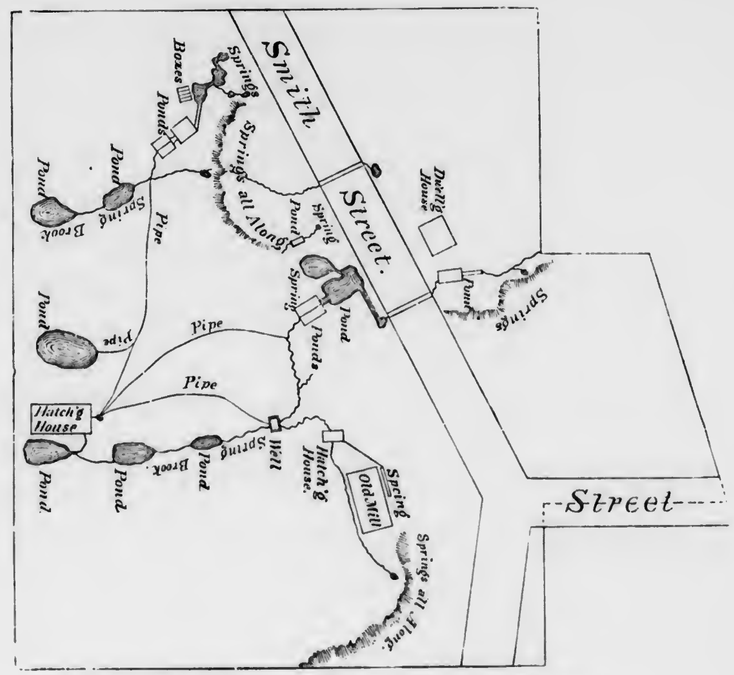
	March 1, 1878, to March 1, 1879.	March 1, 1879, to March 1, 1880.	Increase.	Decrease.
Flounders,	1,544,842	1,795,980	251,147	
Halibut,	3,327,790	3,549,121	221,331	
Codfish,	8,636,479	8,719,574	82,095	
Pollock,	222,908	315,879	92,971	
Haddock,	1,857,790	1,812,820	. . . .	43,970
Frostfish,	53,792	77,871	24,079	
Blackfish,	188,981	199,530	10,549	
Spanish Mackeral,	275,163	310,970	35,807	
Weakfish,	510,022	801,017	290,995	
Kingfish,	38,090	38,447	357	
Sheepshead,	82,474	67,325	. . .	15,149
Porgies,	2,198,780	2,388,863	190,083	
Sea Bass,	446,695	255,688	. . . . .	191,007
Striped Bass,	716,642	678,423	. . . . .	38,219
Bluefish,	3,843,983	3,570,543	. . . .	273,440
Smelts,	1,560,541	1,589,268	28,727	
Salmon,	436,623	394,220	. . .	42,403
Herring,	942,145	1,052,891	110,746	
Eels,	1,202,414	1,292,917	90,503	
Sturgeon,	70,633	68,858	. . . .	1,775
Black Bass,	79,850	85,011	5,161	
Pickerel,	508,131	744,566	136,435	
Yellow Pike,	173,367	129,251	. . . . .	44,116
Siscoes,	629,661	624,438	. . . . .	5,223
Whitefish,	741,943	693,085	. . . . .	48,857
Brook Trout,	6,522	8,139	1,617	
Salmon Trout,	84,262	96,160	11,898	
Catfish,	98,562	52,847	. . . . .	45,715
Small fresh water,	506,719	446,411	. . . . .	60,308
Green Turtle,	6,103	8,189	2,086	
Lobster,	1,625,655	1,737,224	111,569	
Salt water fish,	912,199	670,131	. .	242,068
	33,529,960	34,276,666		
INCREASE, 1879-80.			646,700	
	COUNT.	FISH.		
Mackerel,	2,317,763	3,827,324	1,509,561	
Shad,	661,594	953,439	291,845	GALS.
Scollops,	46,451	36,445	. . . . .	10,006

Sale of Fish in New York, 1880.

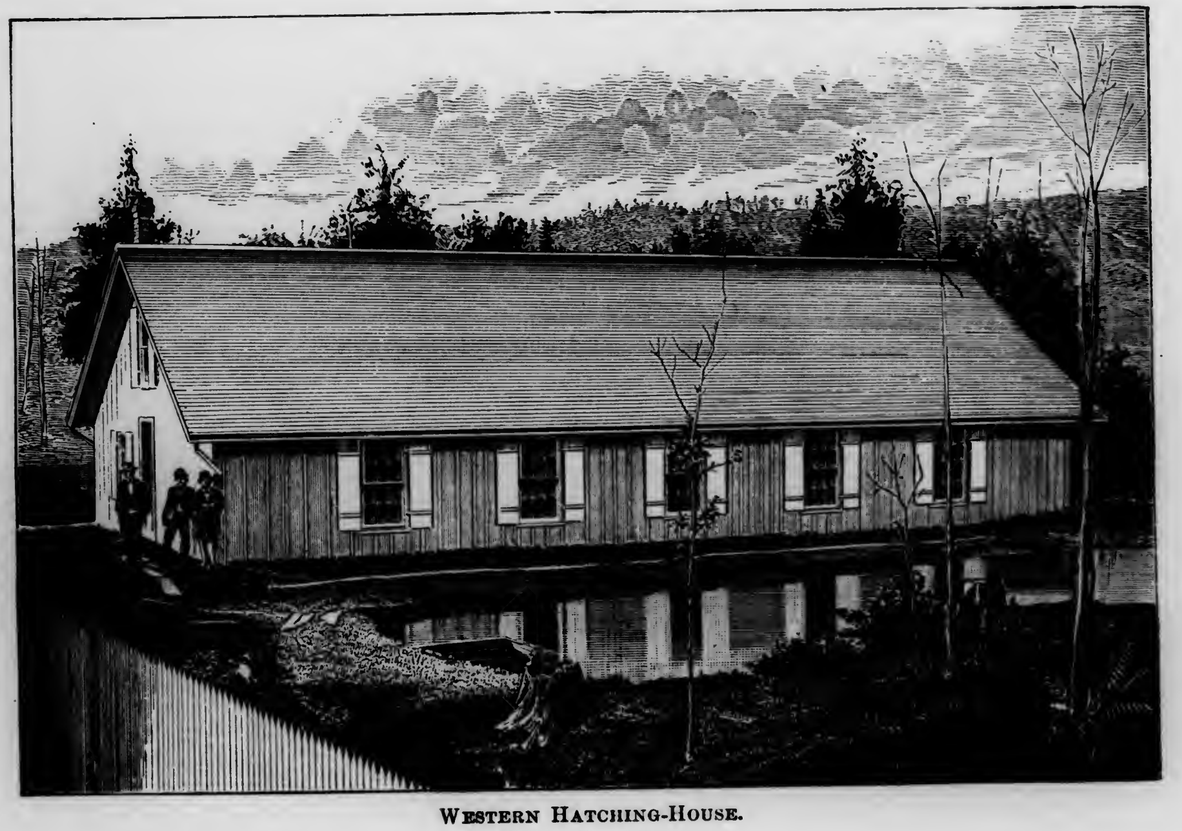
Total sales of Fish (fresh) in the City of New York, as compiled by E. G. Blackford for the United States Census Bureau, for the year 1880.

Flounders,	2,000,000 pounds.
Cod,	9,250,000 "
Haddock,	2,374,300 "
Black fish,	210,000 "
Spanish mackerel,	390,000 "
Kingfish,	42,000 "
Porgies,	2,500,000 "
Striped bass,	1,254,000 "
Smelts,	2,100,000 "
Shad,	1,333,000 counts.
Eels,	1,500,000 pounds.
Black bass,	92,000 "
Halibut,	3,650,000 "
Pollock,	700,000 "
Frostfish,	100,000 "
Mackerel,	5,000,000 counts.
Weakfish,	1,300,000 pounds.
Sheepshead,	72,000 "
Sea bass,	315,000 "
Bluefish,	5,000,000 "
Salmon,	432,600 "
Herring,	6,300,000 counts.
Sturgeon,	2,750,000 pounds.
Pickerel,	800,000 "
Yellow pike,	145,000 "
Whitefish,	725,000 "
Salmon trout,	115,000 "
Mixed small salt-water fish,	150,000 "
Mixed small fresh-water fish,	600,000 "
Terrapin,	6,750 counts.
Green turtle,	163,000 pounds.
Lobsters,	2,000,000 "
Scollops,	55,000 gallons.
Skate or ray fish,	7,000 pounds.
Bonito,	75,000 "
Buffalofish,	25,500 "
Garfish,	1,000 "
Crawfish,	75,000 counts.
Mullets,	30,000 pounds.
White and yellow perch,	315,000 "
Red snappins,	62,500 "

INTERIOR WESTERN HATCHING-HOUSE.



Plat of Property Western Hatching-House.



WESTERN HATCHING-HOUSE.

WESTERN HATCHING-HOUSE.

Suckers,	2,000	pounds.
Sisco,	700,000	"
Brook trout,	13,150	"
Catfish,	70,000	"
Waterfish,	150,000	"
Waterfish,	600,000	"

We renew our thanks to the officials of the Pennsylvania Central, Reading, Baltimore and Ohio, and other railroads of the State for facilities afforded us in the rapid transportation of fish, having always received thorough and prompt courtesies at their hands.

Hatching-Houses.

We mentioned both the hatching-houses in detail in our last report, and have every reason to be pleased with and proud of the Western establishment, of which we here repeat the description:

THE WESTERN STATE HATCHING-HOUSE.

Through the liberality of the Legislature, in addition to the eastern hatchery, a second one was established west of the Allegheny mountains in 1876. After careful investigation of all leading springs west of the mountains the present site near Corry, Erie county, was selected as affording the best facilities for fish culture. The place consists of nine acres and a half of land at the terminus of Smith street, leading from Corry, having thereon erected a good and complete dwelling-house, and one of the best modern hatching establishments, consisting of twelve to fifteen springs furnishing abundance of water to run two such houses. These are so connected together by subterranean pipes and surface conduits as to form any number, almost, of ponds. The hatching-house is sixty feet long by thirty in width, containing troughs as described in the eastern house, but better adapted to the purpose on account of the magnificent supply of water of the most uniform flow and temperature. With these facilities for fish culture the amount of fry that can be turned out, at comparatively small expense, is surprising. Our establishments compare favorably with the best of those of any State in the Union.

We proceed to treat of the different food fishes which have been and may be introduced into the waters of Pennsylvania, and which cannot prove but of interest to the people. This description of ours will be supplemented in the appendix by the fullest treatment of the icthyology of Pennsylvania it has yet received at the hands of any writer. It will be found to surpass any paper of the kind extant. It is from the pen of Prof. E. D. Cope, of Philadelphia, whose very name is a guarantee of its reliable character, as will be seen further on.

The Eastern hatching-house was complete in all its appointments, but the water supply for, now this is the third year, has very much fallen off in the winter and impaired its capacity for reproduction.

The Donegal springs had been for ages so well known in Lancaster county that the water supply was the last misfortune that could be feared with respect to them; but the decrease for this long period is but too manifest. It is true that for three successive seasons the whole region of south-east Pennsylvania has suffered from fall and winter drouths, but that misfortune has borne most heavily on Donegal. Many "old inhabitants" say that they never knew Donegal to suffer so before—at least, not in the last three score of years; but here came three winters in succession in which the depletion seemed almost a regular habit of this spring, and we, in considering the subject, have come to the conclusion that Donegal is no longer to be trusted. It is true that we have always had the Western hatching-house to send our suffering fry to as a relief from the drouth; but this was too much of a labor to incur season after season. So that it seems plain to us that a new Eastern hatching establishment should be chosen. That such can be found there is no doubt, and free from the difficulty which has occurred in the case of Donegal. Yet those who knew Donegal best might easily have been led into the same difficulty that we were, for the last three years have exhibited a different and abnormal regimen at Donegal from what had been known in a very long period.

It is fortunate that we believe we can dispose of Donegal at very near its original cost, which, in all probability, will purchase the usufructs of another spring or set of springs more certain in their flow than the Lancaster fountains—so that the process will be hardly more costly than the removal of our establishments from one point to another.

For this purpose, however, we must have an act of the Legislature, and we trust we shall be more fortunate in our selection than we were at Donegal.

In proof of how parties may be deceived in a matter of this kind, we have but to refer to the springs themselves, at almost any season, when some long-continued and severe drought has not been prevailing, when the most experienced judge on such matters might very easily be led to believe that the Donegal system of springs belonged to that copious and never-failing category of water sources always to be found in limestone countries—as much celebrated for their constant regularity of flow as for their amplitude.

> Though deep yet clear, though gentle yet not dull,
> Strong without rage, without o'erflowing full.

Of our western springs, near Corry, we cannot believe there is even the most remote danger; these are one of the perennial heads of the "Father of Waters"—the Mississippi itself. A view, interior and exterior of the western hatching-house is given with this article, as also a plot of the ground on which it stands, and which belongs to the State.

From an examination of our tables of distribution, &c., of fish and fry throughout the State, it will be perceived that if a very small proportion of these distributions became successful we should soon see very important

results growing out of them; that many of them *will* prove successful we think need not admit of a doubt. The casual accounts we get of the results of these distributions are highly gratifying—the increase in the supply of food fishes, if fully known, would be decidedly important, and the actual money value is in a marked degree encouraging. A carefully considered code of fishery laws ought to be placed on the statute book, and then enforced by the different local authorities. This, however, cannot be done unless sustained by public opinion and indeed by public prosecutions. People living riparian to our streams should watch them with unremitting vigilance, and piratical fishing should be suppressed by the strong hand of the law. It is by such courses, and only by such, that we can rehabilitate our grand series of water-courses, and make them *cornucopias* of cheap and abundant supply of food.

DISTRIBUTIONS.

The following memoranda from the superintendents show the distributions of fish and fry, which have taken place since our last report:

From Eastern Hatching-House, 1881.

LAND-LOCKED SALMON.

April 11.	R. C. Kembal, Canton, Bradford county, . .	2,000	
April 18.	Albert Lewis, Mauch Chunk, Carbon county,	2,000	
April 18.	C. W. Keiter, Kutztown, Berks county, . .	2,000	
			6,000

KENNEBEC SALMON.

These were presented by the United States Commission, and shipped from Druid Hill Park, Baltimore, Maryland.

April 26.	Juniata river, at Spruce Creek, Huntingdon county, ...	22,000	
April 28.	Lycoming creek, at Ralston, Lycoming county, ...	26,000	
April 30.	Juniata river, at Spruce creek, Huntingdon county, ...	28,000	
			76,000

SHAD.

These were presented by the United States Commission, and shipped from Havre-de-Grace, Maryland.

May 16.	Susquehanna river, at Sunbury, ...	1,000,000	
May 26.	Juniata river, at Mifflintown, ...	1,000,000	
May 31.	Juniata river, at Newport, ...	1,500,000	
			3,500,000

WALL-EYED PIKE, (ADULTS,) SUSQUEHANNA SALMON.

Nov.	5.	Lehigh river, at Easton, Northampton county,	30
Nov.	8.	Lehigh river, at Allentown, Lehigh county, .	28
			58

No method of artificially spawning these fish has yet been discovered, so they are transplanted after having reached maturity, as black bass are, and other varieties that cannot be "stripped." These Lehigh distributions, it is hoped, will naturally gravitate to the Delaware.

GERMAN CARP, COMMENCING IN DECEMBER, 1880.

Dec.	15.	D. & C. Moore, Altoona, Blair county, .	20
Dec.	15.	E. B. Isett, Spruce creek, Huntingdon county,	20
Dec.	16.	Rees J. Lloyd, Ebensburg, Cambria county,	20
Dec.	22.	E. A. Atherton, Glenburn, Lackawanna county, ...	20
Dec.	28.	John Williams, Loveville, Centre county, .	30
1881.			
Jan.	6.	Henry S. Cochran, Shamokin, Northumberland county, ...	20
Feb.	19.	William Johnson, Cherry Run, Union county,	16
March	2.	J. T. Smiley, Titusville, Crawford county, .	20
March	2.	John N. Muntz, Butler, Butler county, . .	20
March	25.	D. M. Stoler, Bedford, Bedford county, . .	10
March	28.	H. Peoples, Lancaster, Lancaster county, .	10
March	31.	E. D. Pearce, Chester, Delaware county, .	10
April	1.	G. Thomas, West Whiteland, Chester county,	10
April	1.	S. H. Hamm, Brinkertown, Clarion county,	10
April	2.	Joseph N. McClure, Sharon, Mercer county,	15
April	2.	J. P. Clutter, Lindley's Mills, Washington county, ...	15
April	2.	Samuel Blakeley, New Castle, Lawrence county, ...	15
April	2.	Marshall Kennedy, Pittsburgh, Allegheny county, ...	15
April	8.	A. M. Rhoads, Carlisle, Cumberland county,	8
April	8.	S. Buttermore, Connellsville, Westmoreland county, ...	8
April	8.	T. J. Higgens, Shenandoah, Schuylkill county,	8
April	8.	W. B. Erdman, Macungie, Lehigh county, .	8
April	8.	R. S. Robinson, Circleville, Westmoreland county, ...	8
April	8.	C. A. Seidle, Hamburg, Berks county, . .	8
April	11.	John Hiestand, Lancaster, Lancaster county,	13
April	15.	Senator Joseph Thomas, Quakertown, Bucks county, ...	10

FIG. 13 b. "*Spiegelkarpf.*"

FIG. 14. *Carassius auratus*—L. From the Schuylkill river; one half natural size.

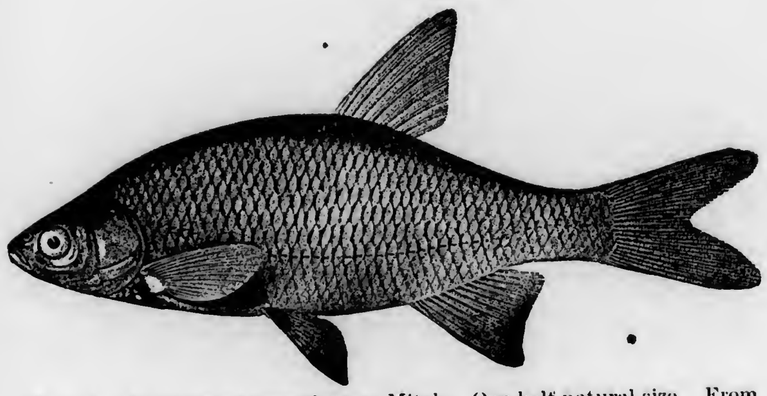


FIG. 15. *Notemigonus chrysoleucus*—Mitch. One half natural size. From Storer.

April	15.	W. D. Reitzel, Salunga, Lancaster county,	10
April	18.	C. B. Herr, Lancaster, Lancaster county,	6
April	22.	T. B. Klein, Palmyra, Lebanon county,	10
April	22.	Robert McCachran, Newville, Cumberland county,	10
April	22.	T. J. Vanderslice, Bloomsburg, Columbia county,	10
April	22.	H. Sholl, Bath, Northampton county,	10
April	19.	Edward Spence, Georgetown, Beaver county,	10
May	3.	Jacob Bertles, Quakertown, Bucks county,	30
May	6.	Albert W. Storm, East Berlin, Adams county,	10
May	6.	F. Martin, Kittanning, Armstrong county,	10
May	6.	Alexander Port, Huntingdon, Huntingdon county,	10
May	6.	W. C. Brown, Marchland, Indiana county,	10
May	6.	Senator G. H. Smith, Philadelphia county,	10
May	13.	R. L. White, Roulette, Potter county,	10
May	13.	J. S. Wagner, Reading, Berks county,	10
May	13.	B. L. Hewit, Hollidaysburg, Blair county,	25
May	13.	W. S. Singerley, Gwynedd, Montgomery county,	15
May	13.	J. R. McAfee, Westmoreland county,	13
June	16.	Hon. B. L. Hewit, Hollidaysburg, Blair county,	25
Sept.	23.	G. M. Miller, Wilkes-Barre, Luzerne county,	90
Nov.	18.	D. L. Chapen, New Columbus, Luzerne county,	10
Nov.	18.	Abram Nesbit, Kingston, Luzerne county,	10
Dec.	1.	T. K. Stubbs, Oxford, Chester county,	30
Dec.	2.	J. H. Frank, Ligonier, Westmoreland county,	30
Dec.	2.	J. N. Muntz, Butler, Butler county,	45
Dec.	2.	John Emery, New Castle, Lawrence county,	30
Dec.	5.	Joseph N. McClure, Sharon, Mercer county,	50
Dec.	5.	J. J. Snellenburg, New Brighton, Beaver county,	30
Dec.	5.	Samuel B. Myers, Franklin, Venango county,	30
Dec.	15.	Senator L. R. Keefer, Cressona, Schuylkill county,	35
Dec.	20.	M. D. McKinsley, Mercersburg, Franklin county,	30
			1,023

The German carp are also distributed at the adult age. The above distribution promises well. It is believed that a little care bestowed on their deposits will cause them to increase and multiply indefinitely.

BLACK BASS, 1881.

March	2.	John N. Muntz, Butler, Butler county, . . .	60
March	2.	C. Z. Gordon, Brookville, Jefferson county,	60
March	2.	J. T. Smiley, Titusville, Crawford county, .	40
April	1.	John Boland, Pottsville, Schuylkill county, .	18
April	2.	John Sumey, Chambersburg, Franklin county,	18
April	2.	Daniel Huffman, Greensburg, Westmoreland county, ...	18
April	2.	Marshal & Kennedy, Pittsburgh, Allegheny county, ...	18
April	2.	Joseph A. McClure, Sharon, Mercer county,	18
April	2.	J. P. Clutter, Lindley's Mills, Washington county, . .	18
April	2.	W. McCullough, Greensburg, Westmoreland county, ...	18
April	8.	A. M. Rhoads, Carlisle, Cumberland county,	15
April	8.	W. B. Erdman, Macungie, Lehigh county, . .	15
April	8.	John Boland, Pottsville, Schuylkill county .	15
April	8.	C. A. Sidle, Hamburg, Berks county,	15
April	15.	J. M. Jamison, Richborough, Bucks county,	15
April	15.	E. Schlicher, Tamaqua, Schuylkill county, .	15
April	22.	T. B. Klein, Palmyra, Lebanon county, . . .	16
April	22.	A. Seiger, Orefield, Lehigh county, . . .	16
April	26.	Bassler Boyer, Lebanon, Lebanon county, .	30
April	26.	J. G. Adams, Lebanon, Lebanon county, . .	30
April	26.	A. S. Light, Lebanon, Lebanon county, .	30
April	28.	James E. Stott, Germantown, Philadelphia county, ...	35
April	28.	James Shore, Germantown, Philadelphia county, ...	35
Nov.	5.	G. T. Gross, Allentown, Lehigh county, . .	30
Nov.	9.	T. B. Klein, Palmyra, Lebanon county, . .	30
Nov.	9.	Senator C. H. Smiley, Bloomfield, Perry county, . . .	30
Nov.	12.	Robert McCracken, Newville, Cumberland county, ...	30
Nov.	12.	A. M. Rhoads, Carlisle, Cumberland county,	30
Nov.	12.	G. A. Eckerd, Allentown, Lehigh county, .	30
Nov.	14.	J. A. Reynolds, Atglen, Chester county, .	30
Nov.	19.	J. A. Rhay, Ebensburg, Cambria county, . .	30
Dec.	1.	T. K. Stubbs, Oxford, Chester county, . .	30
Dec.	2.	J. H. Frank, Ligonier, Westmoreland county,	30
Dec.	2.	John Gay, Greensburg, Westmoreland county,	45
Dec.	2.	J. N. Muntz, Butler, Butler county, ...	60
Dec.	2.	F. H. Kennedy, Pittsburgh, Allegheny county,	15

Dec.	5.	Joseph N. McClure, Sharon, Mercer county,	60	
Dec.	5.	J. J. Snellenburg, New Brighton, Beaver county, ...	45	
Dec.	5.	Samuel B. Myers, Franklin, Venango county,	30	
Dec.	5.	William Lintner, Blairsville, Indiana county,	30	
Dec.	14.	Senator L. R. Keefer, Cressona, Schuylkill county, . . .	30	
Dec.	14.	H. L. Thompson, Pottsville, Schuylkill county,	30	
Dec.	23.	J. C. Deveny, Smyser's, York county	25	
Dec.	23.	G. A. Eckerd, Allentown, Lehigh county, .	30	
Dec.	24.	Senator F. Grof, Stoystown, Somerset county,	40	
				1,308

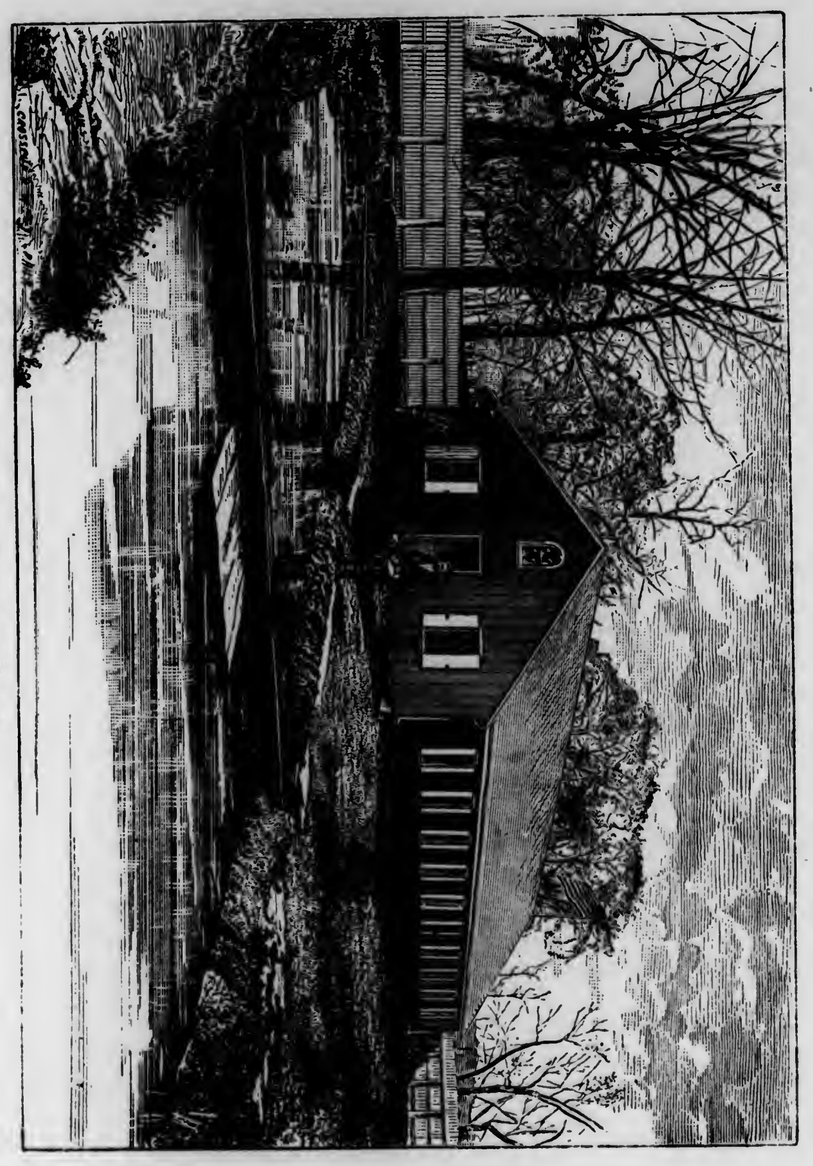
Black bass have always proved a success, on account of their strong individuality and care for their own welfare. Those to whose care they have been intrusted it is to be hoped will bestow such attention upon them as to cause their increase throughout the extended region in which they have been deposited.

BROOK TROUT, 1881.

March	25.	D. W. Seiler, Harrisburg, Dauphin county, .	7,500
March	29.	Bassler Boyer, Lebanon, Lebanon county, .	2,000
March	29.	J. G. Adams, Lebanon, Lebanon county, . .	2,000
March	29.	A. S. Light, Lebanon, Lebanon county, . .	2,000
March	29.	E. R. Schall, Reading, Berks county, . .	3,000
March	30.	G. W. Harder, Tyrone, Blair county, . . .	2,000
March	30.	James Louther, Bell's Mills, Blair county, .	1,000
March	30.	James Borsall, Mifflin, Juniata county,	2,500
March	30.	T. Alderson, Shamokin, Northumberland county, ...	2,500
March	31.	H. B. Taylor, Chester, Delaware county, . .	3,000
April	2.	Johnston Moore, Carlisle, Cumberland county,	2,000
April	2.	John Swiney, Chambersburg, Franklin county,	3,500
April	5.	W. McCullough, Greensburg, Westmoreland county, ...	2,000
April	5.	W. H. Aiken, New Castle, Lawrence county,	2,500
April	8.	A. M. Rhoads, Carlisle, Cumberland county,	1,500
April	8.	Isaac Bruner, Muncy, Lycoming county, .	2,000
April	8.	T. J. Higgins, Shenandoah, Schuylkill county,	1,500
April	8.	W. B. Erdman, Macungie, Lehigh county, .	2,000
April	8.	C. A. Seidel, Hamburg, Berks county, . .	2,000
April	8.	A. J. Quigley, North Point, Clinton county,	2,000
April	11.	Clinton Lloyd, Williamsport, Lycoming county, ...	2,500
April	11.	J. C. Green, Williamsport, Lycoming county,	2,000

April	11.	Dr. Richards, Lock Haven, Clinton county,	2,000
April	11.	R. C. Kembal, Canton, Bradford county,	2,000
April	11.	E. G. Snyder, Lancaster, Lancaster county,	2,000
April	15.	L. D. Taylor, Grandville Centre, Bradford county,	2,000
April	15.	J. H. Marsh, Leroyville, Bradford county,	2,000
April	15.	Senator John Parker, Mahanoy City, Schuylkill county,	3,000
April	15.	J. M. Pomeroy, Chambersburg, Franklin county,	2,000
April	15.	Ed. Schlicher, Tamaqua, Schuylkill county,	2,000
April	15.	T. J. Vanderslice, Bloomsburg, Columbia county,	3,000
April	15.	A. F. Thompson, Lykens, Dauphin county,	2,000
April	18.	John Vallerchamp, Harrisburg, Dauphin county,	2,500
April	18.	General John P. Taylor, Reedsville, Mifflin county,	2,000
April	18.	Lattemer Small, York, York county,	1,500
April	19.	Albert Lewis, White Haven, Carbon county,	2,000
April	19.	John Leisenring, Mauch Chunk, Carbon county,	3,000
April	19.	D. O. Conor, Girardville, Schuylkill county,	4,000
April	22.	C. G. Jackson, Berwick, Columbia county,	3,000
April	22.	Senator L. R. Keefer, Cressona, Schuylkid county,	2,000
April	22.	J. H. Reigle, Centreport, Berks county,	2,000
April	22.	A. Seiger, Oreville, Lehigh county,	2,000
April	22.	H. Scholl, Bath, Northampton county,	2,000
May	27.	W. H. Kremer, Allentown, Lehigh county,	2,000
May	27.	McThadden, Harrisburg, Dauphin county,	1,500
June	3.	A. K. Nebinger, Harrisburg, Dauphin county,	2,000
June	7.	Dr. John Everhart, West Chester, Chester county,	2,500
June	14.	T. K. Stubbs, Oxford, Chester county,	2,500
June	16.	John Lutz, Bedford, Bedford county,	2,500
June	23.	Dr. H. Muhlenberg, Lancaster, Lancaster county,	2,000
June	23.	E. Dellinger, Gordonville, Lancaster county,	500
June	25.	John Boland, Pottsville, Schuylkill county,	2,500
June	25.	Charles Shelby, Pottsville, Schuylkill county,	2,500
			121,500

Such numerous distributions as the above cannot but cause an increase in the number of the queen of all game fishes. But the custodians must



EASTERN HATCHING-HOUSE.

INTERIOR EASTERN HATCHING-HOUSE.

INTERIOR EASTERN HATCHING-HOUSE.

watch their *habitat*—prowling pirates are always after the speckled beauties, nor can they be preserved without constant vigilance.

Very respectfully,

Your obedient servant,

JOHN P. CREVELING.

To the Honorable The State Commissioners of Fisheries, Harrisburg, Pa.

Distribution from the Eastern Hatching House, 1882.

BLACK BASS.

Jan.	4. A. J. Cassatt, Berwyn, Chester county, . .	120
March	14. H. H. Hewit, Phillipsburg, Centre county, .	20
March	22. William L. Marshall, Blairsville, Indiana county.	30
March	22. W. S. Ackerman, Greensburg, Westmoreland county, ...	20
March	31. Rev. J. F. Kore, Florance, Westmoreland county, ...	50
April	5. T. M. Arnold, Clarion, Clarion county, . .	102
April	8. J. R. Yohe. Mifflinville, Columbia county, .	30
April	13. W. J. McCaa, Churchtown, Lancaster county,	15
April	13. A.W. Snader, New Holland, Lancaster county,	15
April	13. John Sheldon, Linnie Mills, Delaware county,	50
April	17. Hon. Edwin Schlicher, Tamaqua, Schuylkill county, ...	30
April	17. Charles A. Seidel, Hamburg, Berks county,	10
April	19. Lewis H. Ross, Hartsville, Bucks county, .	30
April	22. W. Osterhout, Harford, Susquehanna county,	50
April	25. Thomas Bell, Huntingdon, Huntingdon county, ...	45
April	27. Dr. Kingston Goddard, Philadelphia, Philadelphia county, ...	45
May	7. Joel Wenger, West End, Lancaster county,	40
May	3. Hon. A. M. Rhoads, Carlisle, Cumberland county, ...	73
May	6. W. J. McCaa, Churchtown, Lancaster county,	36
May	6. A.W. Snader, New Holland, Lancaster county,	36
Dec.	6. Hon. John A. Reynolds, Atglen, Chester county, ...	40
Dec.	6. Rev. S. W. Gehrett, Coatesville, Chester county, ...	30
Dec.	6. Harrison Johnson, Chester, Delaware county,	30
Dec.	7. Hon. Robert McCachran, Newville, Cumberland county, ...	30
Dec.	7. J. G. Adams, Lebanon, Lebanon county, . .	30
Dec.	7. Hon. T. B. Klein, Palmyra, Lebanon county,	30

Dec.	7.	Heber S. Thompson, Pottsville, Schuylkill county,	30
Dec.	13.	W. H. Herbertson, Brownsville, Fayette county,	88
Dec.	13.	F. M. Arnold, Clarion, Clarion county,	88
Dec.	13.	F. H. Kennedy, Pittsburgh, Allegheny county,	44
Dec.	15.	J. N. McClure, Sharon, Mercer county,	88
Dec.	15.	J. F. Mansfield, Cannelton, Mercer county,	44
Dec.	15.	Luther Platt, New Brighton, Mercer county,	88
Dec.	27.	Joseph Buffington, Kittanning, Armstrong county,	44
Dec.	27.	John N. Muntz, Butler, Butler county,	88
Dec.	27.	C. A. Myers, Franklin, Venango county,	44
1883.			
Jan.	19.	Hon. J. L. Brown, Wilcox, Elk county,	35
Jan.	31.	Senator L. R. Keefer, Cressona, Schuylkill county,	48
			1,776

GERMAN CARP.

Jan.	7.	Hon. J. B. Knittle, Catawissa, Columbia county,	35
Jan.	7.	Hon. H. J. Reeder, Easton, Northampton county,	40
Jan.	14.	R. D. Campbell, Reedsville, Mifflin county,	35
Jan.	18.	Ebenezer Worth, Marshalton, Chester county,	30
Feb.	2.	Jacob Gundy, Lewisburg, Union county,	30
Feb.	2.	James Stewart, Eldersville, Washington county,	30
Feb.	4.	L. C. Templin, St. Peter's, Chester county,	25
Feb.	4.	Hiram Peoples, New Providence, Lancaster county,	30
Feb.	4.	Daniel Herr, Refton, Lancaster county,	15
Feb.	4.	C. B. Herr, Refton, Lancaster county,	15
March	2.	John L. Bolds, Eldersville, Washington county,	22
March	9,	Robert McCachran, Newville, Cumberland county,	20
March	14.	H. H. Hewit, Phillipsburg, Centre county,	20
March	14.	Hon. B. L. Hewit, Hollidaysburg, Blair county,	75
March	17.	Senator E. H. Shearer, Reading, Berks county,	45
March	24.	Samuel Smith, Bedford, Bedford county,	22
March	24.	G. A. Eckert, Allentown, Lehigh county,	20

March	31.	J. H. Richesler, Indiana, Indiana county,	20
April	4.	H. B. Taylor, Chester, Delaware county,	22
April	5.	Hon. Lee Thompson, Templeton, Armstrong county,	25
April	5.	Senator W. J. McKnight, Brookville, Jefferson county,	25
April	8.	Hon. T. J. Vanderslice, Bloomsburg, Columbia county,	20
April	8.	Hon. J. B. Knittle, Catawissa, Columbia county,	35
April	8.	A. J. Ackerly, Chinchilla, Lackawanna county,	60
April	13.	Dr. Grandville Prizer, Lionsville, Chester county,	40
April	17.	Hon. Edwin Schlicher, Tamaqua, Schuylkill county,	20
April	19.	Lewis H. Ross, Hartsville, Bucks county,	20
April	22.	C. A. Hungerford, Springville, Susquehanna county,	15
April	22.	J. C. Maul, Quarryville, Lancaster county,	15
April	25.	J. P. Sharp, New Sheffield, Beaver county,	10
April	25.	Hon. A. J. Colborn, Somerset, Somerset county,	30
April	25.	R. B. McKee, Freeport, Armstrong county,	12
April	27.	Hon. A. W. Snader, Holland, Lancaster county,	10
May	2.	Hon. B. L. Hewit, Hollidaysburg, Blair county,	15
May	2.	J. M. Work, Brady, Indiana county,	12
May	2.	J. E. Long, Brookville, Jefferson county,	12
May	2.	Hon. F. Martin, Kittanning, Armstrong county,	12
May	9.	William Watts, Mechanicsburg, Cumberland county,	14
May	16.	T. M. Harvey, West Grove, Chester county,	16
May	23.	John Gay, Greensburg, Westmoreland county,	10
Dec.	6.	Hon. John A. Reynolds, Atglen, Chester county,	20
Dec.	6.	Rev. S. W. Gehrett, Coatesville, Chester county,	15
Dec.	7.	Hon. W. B. Erdman, Macungie, Lehigh county,	20
Dec.	7.	Hon. Robert McCachran, Newville, Cumberland county,	20
Dec.	7.	J. G. Adams, Lebanon, Lebanon county,	20

Dec.	13.	W. H. Herbtson, Brownville, Fayette county,	20
Dec.	13.	F. M. Arnold, Clarion, Clarion county, . .	15
Dec.	13.	F. H. Kennedy, Pittsburgh, Allegheny county,	20
Dec.	13.	R. J. Lamborn, Glen Hall, Chester county, .	15
Dec.	13.	R. B. Lamborn, Glen Hall, Chester county, .	15
Dec.	15.	J. N. McClure, Sharon, Mercer county, . .	20
Dec.	15.	J. F. Mansfield, Cannelton, Beaver county, .	15
Dec.	15.	Luther Platt, New Brighton, Beaver county,	20
Dec.	27.	John N. Muntz, Butler, Butler county, . .	20
Dec.	27.	C. A. Myers, Franklin, Venango county, . .	20
Dec.	27.	John Hogl, Greensburg, Westmoreland county, ...	15
Dec.	27.	L. L. Daubenspeck, Martinsburg, Butler county, ...	15
Dec.	27.	W. W. Levier, Emlenton, Venango county, .	15
Dec.	27.	W. K. Hill, Schenley, Armstrong county, .	15
Dec.	27.	W. Oller Odell, Vanceville, Washington county, ...	20
Dec.	27.	W. Hartley, Bedford, Bedford county, . .	20
Dec.	27.	James Sill, New Enterprise, Bedford county,	20
Dec.	27.	J. K. Smith, Minersville, Armstrong county,	20
Dec.	28.	N. M. Marker, Ligonier, Westmoreland county, ...	20
Dec.	28.	G. F. Huff, Greensburg, Westmoreland county,	20
1883.			
Jan.	2.	George Silvey, Hollidaysburg, Blair county,	20
Jan.	2.	F. Jaskiel, Hollidaysburg, Blair county, . .	20
Jan.	2.	Amos G. Bonsall, Mifflin, Juniata county, .	20
Jan.	2.	John Shirley, Cove Station, Huntingdon county, ...	20
Jan.	2.	Nelson Gaymon, Sunbury, Northumberland county, ...	20
Jan.	2.	A. B. Brumbay, Huntingdon, Huntingdon county, ...	20
Jan.	2.	S. B. Seidel, Shoemakersville, Berks county,	20
Jan.	2.	L. D. Woodruff, Johnstown, Cambria county,	20
Jan.	3.	T. G. Rodebaugh, Bowmansville, Chester county, ...	15
Jan.	3.	Howard N. Woodward, Marshalton, Chester county, ...	15
Jan.	3.	C. H. White, Doland's Mills, Chester county,	15
Jan.	3.	Samuel Hartman, Arnedtsville, Adams county, ...	15
Jan.	3.	W. A. Himes, Arnedtsville, Adams county,	15
Jan.	3.	John B. Gemmill, New Park, York county,	15

FIG. 18. *Rhinichthys atronasus*—Mitch. From Storer.

FIG. 19. *Oncorhnychus quinnat*—Richardson. From the Sacramento river. From Mr. Redding.

FIG. 16. *Luxilus cornutus*—Mitch. From New England. Two thirds natural size.

FIG. 17. *Semotilus bullaris*—Raf. From Packard.

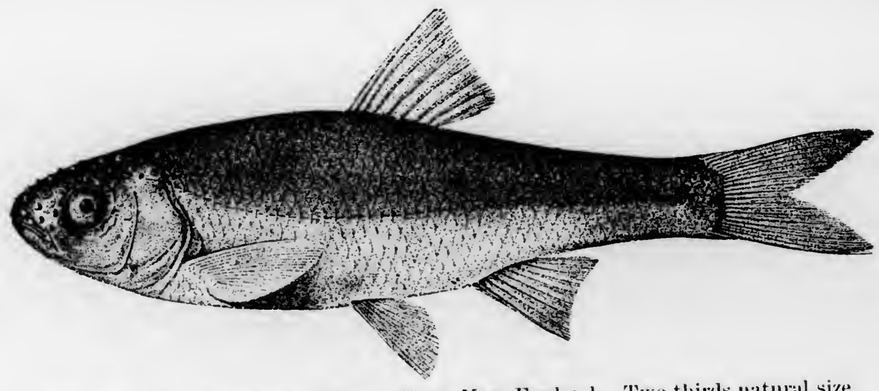


FIG. 16. *Luxilus cornutus*—Mitch. From New England. Two thirds natural size.

FIG. 17. *Semotilus bullaris*—Raf. From Packard.

FIG. 18. *Rhinichthys atronasus*—Mitch. From Storer.

FIG. 19. *Oncorhynchus quinnat*—Richardson. From the Sacramento river. From Mr. Redding.

Jan.	8.	D. L. Chapin, Shickshinny, Luzerne county,	20
Jan.	8.	Glasgow A. Read, Clearfield, Clearfield county,	20
Jan.	8.	John M. Greer, Butler, Butler county,	15
Jan.	8.	John Bealston, Butler, Butler county,	15
Jan.	8.	Senator F. Groff, Stoystown, Somerset county,	20
Jan.	8.	George Bauchman, Brookville, Jefferson county,	20
Jan.	10.	Hon. B. L. Hewit, Hollidaysburg, Blair county,	20
Jan.	10.	Charles Schwardt, Hollidaysburg, Blair county,	20
Jan.	16.	Thomas A. Hicks, Coalmont, Huntingdon county,	20
Jan.	16.	Rev. H. C. Shindle, Port Royal, Juniata county,	20
Jan.	16.	Jacob S. Pittman, McConnellsburg, Fulton county,	20
Jan.	16.	A. B. Biddle, Pattonville, Bedford county,	20
Jan.	19.	Hon. T. B. Klein, Palmyra, Lebanon county,	20
Jan.	26.	Hon. Charles A. Seidel, Hamburg, Berks county,	20
Jan.	26.	H. S. Shoffer, Smyser's, York county.	20
Jan.	26.	William J. Weist, York, York county,	20
Jan.	31.	Joseph McDonough, Vanceville, Washington county,	20
Jan.	31.	Dewit C. Gerow, Charleston, Tioga county,	20
Jan.	31.	Senator L. R. Keefer, Cressona, Schuylkill county,	20
		Total,	2,064

BROOK TROUT.

March	8.	T. K. Stubbs, Oxford, Chester county,	2,500
March	9.	Johnson Moor, Carlisle, Cumberland county,	2,500
March	9.	W. A. Trittle, Waynesboro', Franklin county,	4,000
March	13.	A. M. Rhoads, Carlisle, Cumberland county,	2,500
March	13.	D. W. Seiler, Harrisburg, Dauphin county,	2,500
March	14.	John Daily, Altoona, Blair county,	2,000
March	14.	Hon. B. L. Hewit, Hollidaysburg, Blair county,	3,500
March	14.	G. W. Harder, Tyrone, Blair county,	2,000
March	16.	A. F. Peters, White Haven, Luzerne county,	4,000
March	16.	H. G. Schantz, Zionville, Lehigh county,	2,000
March	16.	Senator E. H. Shearer, Reading, Berks county,	2,500

March 16.	R. D. Lingley, Reading, Berks county, . . .	2,000
March 16.	W. A. Leisenring, Mauch Chunk, Carbon county, ...	3,000
March 17.	J. Hutchison, Branch Dale, Schuylkill county,	1,500
March 17.	J. J. Edwards, St. Clair, Schuylkill county,	4,000
March 17.	E. F. Stees, Pine Grove, Schuylkill county,	4,000
March 22.	J. E. Harder, Clearfield, Clearfield county, .	3,000
March 22.	Hon. W. C. Brown, Indiana, Indiana county,	4,000
March 22.	W. S. Ackerman, Greensburg, Westmoreland county, ...	2,000
March 24.	Wm. Hartley, Bedford, Bedford county. . .	2,000
March 24.	John Lutz, Bedford, Bedford county, . .	2,000
March 24.	E. L. Knupp, Somerset, Somerset county, .	3,000
March 24.	W. P. Snyder, Allentown, Lehigh county, .	1,500
March 24.	G. W. Eckerd, Allentown, Lehigh county .	2,000
March 28.	Dr. P. F. Fulmer, Dingman's Ferry, Pike county, ...	7,000
March 28.	E. D. Huffman, Stroudsburg, Monroe county,	7,000
March 31.	T. W. Myton, Huntingdon, Huntingdon county, ...	4,000
March 31.	John Brown, New Florence, Westmoreland county, ...	2,000
March 31.	J. F. Core, New Florence, Westmoreland county, ...	2,000
March 31.	Boles McColly, Ligonier, Westmoreland county, ...	2,500
April 4.	J. G. Adams, Lebanon, Lebanon county, . .	2,000
April 4.	H. Maltzburg, Reading, Berks county, . . .	2,000
April 4.	M. C. Luckenbach, Bethlehem, Northampton county, ...	7,000
April 4.	H. B. Taylor, Chester, Delaware county, . .	2,000
April 8.	J. T. Vanderslice, Bloomsburg, Columbia county.	2,000
April 8.	A. F. Thompson, Lykens, Dauphin county, .	2,500
April 8.	F. R. Leib, Harrisburg, Dauphin county, . .	2,000
April 11.	John Wister, Duncannon, Perry county, . .	3,000
April 11.	W. H. Kramer, Allentown, Lehigh county, .	2,000
April 12.	H. E. Packerton, Packerton, Carbon county,	1,500
April 12.	George Twining, Mauch Chunk, Carbon county, ...	1,500
April 12.	William Spenser, Rockport, Carbon county,	1,500
April 12.	Z. T. Trout, Girardville, Schuylkill county,	3,000
April 13.	John. A. Reynolds, Atglen, Chester county,	2,000
April 15.	T. K. Stubbs, Oxford, Chester county, . . .	1,500
April 17.	E. Schlicher, Tamaqua, Schuylkill county, .	1,500

April 17.	C. H. Seidel, Hamburg, Berks county, . .	1,500	
April 11.	T. B. Klein, Palmyra, Lebanon county, . . .	1,500	
April 22.	C. A. Hungerford, Springville, Susquehanna county, ...	2,500	
May 12.	John Glosser, Berwyn, Chester county, . .	1,500	
			133,000

Trout Spawn Shipped to Western Hatching-House.

1881.			
Dec. 2.	Shipped, ...	18,000	
Dec. 9.	Shipped, ...	55,000	
Dec. 13.	Shipped, ...	60,000	
Dec. 24.	Shipped, ...	45,000	
1882.			
Jan. 5.	Shipped, ...	60,000	
	Number of eggs shipped to Corry, ...		238,000
Nov. 14.	Number of eggs shipped to date, ...		168,000

1883.

Jan. 1. There are now in the ponds, at the hatching-house, to be kept as spawners the following number of fish:

Brook trout, four years old, ...	1,800	
Brook trout, three years old, ...	1,200	
Brook trout, two years old, ...	1,500	
		4,500
California Trout, two years old, ...		900
Eggs taken, brook trout, ...		362,000
I expect to take from the California trout at least,		25,000

I am, gentlemen,

Very respectfully,

Your obedient servant,

J. P. CREVELING,

Superintendent Eastern Hatching-House.

To the Honorable, the State Fishery Commissioners, Harrisburg.

Western Hatching-House.

The Honorable the Commissioners of Fisheries of the State of Pennsylvania:

GENTLEMEN: I have the honor to submit the following report, for the years 1881 and 1882:

FISH ON HAND JANUARY 1, 1881.

Brook Trout, from three to four years old, ...	250	
Brook Trout, two years old, ...	2,500	
Brook Trout, one year old, ...	800	
Brook Trout, last Spring's hatching, ...	500	
Brook Trout, Total number on hand, ...		4,050

Lake Trout, six years old,	45	
Lake Trout, two years old,	1,000	
Lake Trout, Total number on hand,		1,045
California Salmon, two years old,	500	
California Mountain Trout, last Spring's hatching,	700	
Land Locked Salmon, last Spring's hatching,	250	
German Carp, one and a half years old,	25	
Whole number of Fish at Western Hatch House,		6,570

EGGS ON HAND JANUARY 1, 1881.

Brook Trout Eggs,	210,000	
Lake Trout Eggs,	10,000	
Total number of Eggs,		220,000

WHOLE NUMBER OF VARIOUS KINDS OF EGGS TAKEN AND RECEIVED AFTER JANUARY 1, FOR THE SEASON OF 1881.

White Fish Eggs, Kindness Prof. S. F. Baird.	100,000	
Schoodic Salmon Eggs, Kindness Prof. S. F. Baird,	12,500	
Kennebec Salmon Eggs, Kindness Prof. S. F. Baird,	100,000	
Brook Trout Eggs, Taken at the Ponds,	75,000	
Total Number of Eggs Taken and Received,		507,500

DISTRIBUTION OF FISH FOR 1881.

White fish, George R. Wright, Luzerne county, Harvey's lake,	70,000	
White fish, Seth Weeks, Erie county, Lake Pleasant,	10,000	
White fish, J. P. Creveling and Seth Weeks, Crawford county, Oil Creek lake,	15,000	
Total,		95,000
Kennebec salmon, Hon. J. M. Shaffer and others, waters of Sinnamahoning river, Cameron county,	70,000	
By order of Hon. B. L. Hewit, North Branch Susquehanna river, at Towanda, Bradford county,	20,000	
Total,		90,000
Scoodic salmon, Hon. William N. Reynolds, Wyoming county, Tunkhannock waters,	8,000	
Sportsmen Club, Erie, Erie county, Lake Pleasant,	2,000	
Sportsmen Club of Erie, for Oil Creek lake, Crawford county,	2,000	
Total,		12,000

Salmon trout, Seth Weeks, in Oil Creek lake and Lake Pleasant, Erie county,		10,000

BROOK TROUT.

March 14. A. J. McLeary, Avonia, Erie county, in Trout run,	5,000	
March 23. D. H. Walker, Hadley, Mercer county, in Little Shenango creek,	4,000	
March 17. J. C. Shaw, Wolf Creek, Mercer county, Wolf creek,	10,000	
March 25. Rev. R. Cartwright, Burrell, Westmoreland county,	3,000	
March 27. George L. Seigel, Erie, Erie county, in Le Bœuf creek,	15,000	
April 10. Joseph M. Shaffer, Sinnamahoning, Cameron county, for tributaries of Sinnamahoning river,	10,000	
April 10. George E. Mapes, Titusville, Crawford county, in Coldwell creek,	2,500	49,500
April 13. John Hestor, Richmond Station, Clarion county, Beaver creek,	2,000	
April 13. Frank Arnold, Clarion Station, Clarion county, in Little Silo creek,	6,000	
April 13. E. C. Harmon, Brinkerton, Clarion county, branches Clarion river,	5,000	
April 15. John W. Titley, Sherrett, Pa., in waters Red Bank creek,	10,000	
April 30. C. Z. Gordon, Brookville, Jefferson county, several small spring brooks,	12,500	
April 10. T. J. Smiley, Pleasantville, Crawford county, Five Mile creek,	8,000	
May 7. D. E. Castle, Tryonville, Crawford county, Prescott creek,	5,000	
May 9. E. S. Crossman, Warren and Crawford counties, Six Mile run,	4,000	
May 16. D. Slagle, Pine Creek Furnace, Armstrong county, in Pine creek,	2,000	
May 25. Sheriff of Armstrong county, Kittanning, in several small streams,	5,000	
May 18. M. C. Gross, Pleasantville, Venango county, in Cherry run,	10,000	69,500

April	23. Senator McKnight, Ridgway, Elk county, branch of Clarion river,	10,000	
May	18. C. A. Myers, Franklin, Venango county, Sugar creek and Sandy creek,	8,000	
May	R. H. Reedy, Deanville, Armstrong county, waters of Mahoning river,	10,000	
May	25. Charles Seaton, Uniontown, Fayette county, Brown's run,	5,000	
April	20. A. W. Hayes, Wattsburg, Erie county, French creek,	12,500	
April	20. William Vananden, Union city,	1,500	
April	13. G. B. Kiser, Shippenville, Clarion county, Deer creek,	5,000	
June	10. John F. Fulton, Hunkers, Westmoreland county, small streams,	18,000	
May	10. J. P. Creveling, for distribution,	25,000	
June	13. J. S. Brooks, New Castle, Lawrence county, Slippery Rock creek,	11,000	
			106,000

REPORT OF 1882.

Fish on hand January 1, 1882:		
Brook trout, three and four years old,	2,600	
Brook trout, two years old,	500	
Brook trout, one year old,	300	
Brook trout, last spring's hatching,	1,500	
		4,900
Lake trout, seven years old,	40	
Lake trout, three years old,	700	
Lake trout, two years old,	000	
Lake trout, one year old,	1,200	
Lake trout, last year's hatching,	100	
		2,040
California Salmon, three years old,		300
California trout, two years old, purchased of New York Commission,		1,000
California mountain trout,		500
Scoodic salmon, last spring's hatching,		300
Hybrids, lake and brook trout, crossed,		200
German carp, two and a half years old,		25
Whole number of fish on hand January 1, 1882,		9,265
Whole number of eggs on hand January 1, 1882:		
Brook trout,	215,000	

Lake trout,	12,000	
Kennebec salmon eggs,	100,000	
California salmon eggs,	100,000	
Scoodic salmon eggs,	10,000	
California mountain trout,	6,600	
Total number taken and received,		443,600
Received from J. P. Creveling, brook trout,		177,000
Total number on hand after January 1, 1882,		620,600

DISTRIBUTION OF FISH FOR 1882.

California Salmon.

Jan.	3. Jos. M. Shaffer, Cameron county, for West Branch of Susquehanna,	25,000	
Jan.	6. Order of Hon. B. L. Hewit, planted in same waters at Driftwood,	50,000	
Jan.	24. S. B. Myers, Franklin, Venango county, for Sugar Lake,	10,000	
Jan.	26. Dr. C. B. Kibler, Girard, Erie county, in Elk Creek Pond, Tributary of Lake Erie,	10,000	
	Total,		95,000

Kennebec Salmon.

April	22. Order of B. L. Hewit, in West Branch of Susquehanna, at Emporium, Driftwood, and Sinnamahoning, in four trips,	85,000

Salmon Trout.

April	24. M. F. Coolbaugh, Strausburgh, Monroe county, Three Small Lakes,	5,000	
June	4. Erie Sportsman's Club, Erie county,	5,000	
April	18. E. Troxell, Kingston, Luzerne county,	6,000	
	Total,		16,000

California Mountain Trout.

July	10. Seth Weeks, Wayne, Erie county,	2,000

German Carp.

Nov.	20. A. L. Ackerman, Titusville, Crawford county, adult carp,	6
	small carp,	7

Nov.	20. Jas. Prather, Troy Centre, Crawford county, small carp,	10	
	Total No. Carp,		23

Scoodic Salmon.

April	18. Jas. Millham, Hawley, Wayne county,	6,500	
April	18. T. M. Nealon, Carbondale, Lackawanna county,	6,000	
	Total,		12,500

Brook Trout.

Feb.	20. Dr. Kitler and friends, Girard, Erie county, Trout run and Elk creek, (3,000 each creek,)	6,000	
Feb.	20. Sportsman's Club of Erie county, North branch French creek and Black run,	5,000	
Feb.	23. E. B. Hyde, Springburg, Warren county, Spring creek,	6,000	
Feb.	28. J. Hunter, Tidioute, Warren county, Tidioute creek,	8,000	
March	1. J. T. Riley, New Florence, Westmoreland county, Roaring river,	8,000	
March	1. J. O. H. Denny, Latrobe, Westmoreland county, Loyalhanna creek,	12,000	44,000
March	1. Z. B. Springer, Uniontown, Fayette county, Dunbar creek,	4,500	
March	6. W. Loverock, Titusville, Crawford county, Five-mile run,	6,500	
March	8. C. Z. Gorden, Brookville, Jefferson county, Sandy Lick creek,	10,000	
March	28. J. Franklin Core, Johnstown, Cambria county, Paint creek,	6,500	
March	25. M. C. Goss, Pleasant valley, Venango county, Stewart's run, and Pithole creek,	15,000	
March	30. William Heydrick, Carlton, Mercer county, Deer creek and Sandy run,	10,000	52,500
April	10. J. H. Riley, Braddocks, fish planted in Westmoreland county, Greenlick creek,	10,000	
April	10. J. N. Dickson, Black Lick Station, Indiana county, Black Lick creek,	8,000	
April	10. C. W. Gester, Indiana, Indiana county, Crooked creek,	5,000	

FIG. 20. *Salmo salar*—L. From Storer.

April	15.	D. R. Pope, Lansboro', Susquehanna county, Starucca creek,	4,500
April	15.	Hon. James Millham, Hawley, Wayne county, Middle creek,	10,000
April	15.	J. M. Nealon, Carbondale, Lackawanna county, Lackawanna river,	10,000
April	15.	J. W. Atkin, Carbondale, Lackawanna county, east branch Tunckhannock creek,	6,500
April	24.	W. H. Thomas, Mansfield, Tioga county, Canoe creek,	10,000
			74,000
April	27.	B. Ellsworth, Warren, Warren county, Little Broken Straw creek,	10,000
May	2.	Lalhy & Agnew, Tionesta, Forest county, Coon creek,	6,500
May	8.	G. B. Kiser, Shippenville, Clarion county, Paint creek,	5,000
May	8.	C. H. Seaton, Uniontown, Fayette county, Stone creek,	7,000
May	8.	Samuel S. Brown, Connellsville, Fayette county, Mount's creek,	2,000
May	22.	Harry H. Mullen, Emporium, Cameron county, Deep creek,	6,000
May	24.	William T. Smith, Scranton, Luzerne county, Bear run,	10,000
			46,500
May	21.	T. J. Vanderslice, Columbia county, Fish creek,	6,000
May	24.	W. Osterhaut, Harford, Susquehanna county, Van Winkle's creek,	3,000
May	24.	M. F. Coolbaugh, Stroudsborough, Monroe county, Broadhead's creek,	10,000
June	6.	E. Troxel, Kingston, Luzerne county, Harvey's creek and Huntington creek,	15,000
June	6.	Harrison Wright, Shickshinny, Luzerne county, Wopwallopen creek,	7,000
June	13.	Frederick Ahlborn, Wilkes-Barre, Luzerne county, Bowman's creek,	6,000
			47,000
June	13.	G. M. Harding, Wilkes-Barre, Luzerne county, Bear creek,	5,000
June	13.	W. M. Stoddart, Wilkes-Barre, Luzerne county, Spring brook,	8,000
June	13.	L. T. Smith, Forks Station, Luzerne county, Muddy creek,	5,000

Nov.	20. Jas. Prather, Troy Centre, Crawford county, small carp,	10	
	Total No. Carp,		23

Scoodic Salmon.

April	18. Jas. Millham, Hawley, Wayne county,	6,500	
April	18. T. M. Nealon, Carbondale, Lackawanna county,	6,000	
	Total,		12,500

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Feb.	20. Sportsman's Club of Erie county, North branch French creek and Black run,	5,000	
Feb.	23. E. B. Hyde, Springburg, Warren county, Spring creek,	6,000	
Feb.	28. J. Hunter, Tidioute, Warren county, Tidioute creek,	8,000	
March	1. J. T. Riley, New Florence, Westmoreland county, Roaring river,	8,000	
March	1. J. O. H. Denny, Latrobe, Westmoreland county, Loyalhanna creek,	12,000	44,000
March	1. Z. B. Springer, Uniontown, Fayette county, Dunbar creek,	4,500	
March	6. W. Loverock, Titusville, Crawford county, Five-mile run,	6,500	
March	8. C. Z. Gorden, Brookville, Jefferson county, Sandy Lick creek,	10,000	
March	28. J. Franklin Core, Johnstown, Cambria county, Paint creek,	6,500	
March	25. M. C. Goss, Pleasant valley, Venango county, Stewart's run, and Pithole creek,	15,000	
March	30. William Heydrick, Carlton, Mercer county, Deer creek and Sandy run,	10,000	52,500
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FIG. 20. *Salmo salar*—L. From Storer.

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April	15.	J. W. Atkin, Carbondale, Lackawanna county, east branch Tunckhannock creek,	6,500	
April	24.	W. H. Thomas, Mansfield, Tioga county, Canoe creek,	10,000	
				74,000
April	27.	B. Ellsworth, Warren, Warren county, Little Broken Straw creek,	10,000	
May	2.	Lalhy & Agnew, Tionesta, Forest county, Coon creek,	6,500	
May	8.	G. B. Kiser, Shippenville, Clarion county, Paint creek,	5,000	
May	8.	C. H. Seaton, Uniontown, Fayette county, Stone creek,	7,000	
May	8.	Samuel S. Brown, Connellsville, Fayette county, Mount's creek,	2,000	
May	22.	Harry H. Mullen, Emporium, Cameron county, Deep creek,	6,000	
May	24.	William T. Smith, Scranton, Luzerne county, Bear run,	10,000	
				46,500
May	21.	T. J. Vanderslice, Columbia county, Fish creek,	6,000	
May	24.	W. Osterhaut, Harford, Susquehanna county, Van Winkle's creek,	3,000	
May	24.	M. F. Coolbaugh, Stroudsborough, Monroe county, Broadhead's creek,	10,000	
June	6.	E. Troxel, Kingston, Luzerne county, Harvey's creek and Huntington creek,	15,000	
June	6.	Harrison Wright, Shickshinny, Luzerne county, Wopwallopen creek,	7,000	
June	13.	Frederick Ahlborn, Wilkes-Barre, Luzerne county, Bowman's creek,	6,000	
				47,000
June	13.	G. M. Harding, Wilkes-Barre, Luzerne county, Bear creek,	5,000	
June	13.	W. M. Stoddart, Wilkes-Barre, Luzerne county, Spring brook,	8,000	
June	13.	L. T. Smith, Forks Station, Luzerne county, Muddy creek,	5,000	

June	20. J. O. Barker, Williamsport, Lycoming county, West Mill creek branches, . . .	8,000	
June	20. John Piatt, Williamsport, Lycoming county, Seeley's run and Larry's creek, . . .	6,000	
June	24. A. F. Clapp, Sunbury, Northumberland county, Shamokin creek, ...	3,200	
			35,200
June	10. W. H. H. Pipe, Kittanning, Armstrong county, Crooked creek, ...	7,500	
June	12. R. Brennen, Wilcox, McKean and Elk counties. Cooper's creek and Kinzua creek, .	10,000	
			17,500

REMARKS.

White fish reported were hatched and distributed by request of Hon. H. B. Wright, he paying the expense of shipping the eggs and young fish.

California Mountain Trout.

We have a fine stock of spawners, and think we can at least put out two hundred thousand of these beautiful fish in 1883.

The Railroads

have always carried our cans free, and kindly assisted in taking care of the fish. The officers should have our thanks.

CORRY, *November 13, 1882.*

To the Honorable Commissioners of Fisheries of Pennsylvania:

STATEMENT OF FISH AND EGGS NOW AT THE WESTERN HATCHING-HOUSE.

Brook trout, ...	4,000 stock fish.
California trout, ...	1,000 stock fish.
California trout, fry, ...	2,000
Salmon trout, of all ages, ...	1,800
Carp, we have stock fish, ...	19

These carp spawned for the first time last June. As we have not drawn the pond off we cannot give the exact number of fry.

Brook trout eggs, ...	140,000
Salmon trout eggs, ...	30,000
Eggs now in hatch house, ...	170,000

Your humble servant,

SETH WEEKS.

REMARKS.

Carp have spawned here in June last for the first time. For some reason this first spawning has not produced many fish. As I have not drawn the pond off I cannot tell how many fry we have. I let Mr. A. L. Akerman, of Titusville, have six carp, (three year old.) He has a good pond to propagate them in, and he will care for them, and give at least one half of the young for free distribution.

I am, gentlemen, very respectfully,

Your obedient servant,

SETH WEEKS,

Superintendent Western Hatching-House.

CORRY, *January 6, 1883.*

COLONEL: I am instructed to give you an estimate of the eggs now on hand. That I can do. We have now, with the eggs sent by Creveling, and those taken, 445,000. How many more Creveling will send, and how many more we will take here, we cannot tell yet, but will keep you posted. Hope to take one hundred thousand California trout eggs.

Yours truly,

SETH WEEKS.

To Colonel JAMES WORRALL, *Harrisburg.*

CORRY, *January 19, 1883.*

COLONEL: Will have 2,000,000 White fish eggs in the house for Erie as soon as they are hatched and put out. Will report to you.

Yours truly,

SETH WEEKS.

To Colonel JAMES WORRALL, *Harrisburg.*

P. S.—These fish were hatched and successfully planted in the bay at Erie.

Police.

A rigid police system must be adopted if we are to protect our fisheries; in fact every citizen feeling an interest should be authorized to arrest and have punished whoever he may find violating our fishing laws. It has already been seen what a little care may do in adding to the food supply of the countryside, and the system has only to be carried out further to add materially to the effects.

There is no good reason why our streams shall not be filled with fishes from the vast varieties which may be cultivated in Pennsylvania, as may be seen from Professor Cope's Report on the Icthyology of the State. But we would seem, from the appearance of things, to be a long way from a consummation so devoutly to be wished.

The action of our Wardens does not seem to be seconded. Laws are passed, officers are created to enforce them, but they are not seconded by the officials of the counties. The grand juries even do not seem to consider our fishing interests of any importance.

Our officers arrest the offenders *in flagrante delicto*, but their oaths seem to have no influence on some of our grand juries.

We give below the affidavit of one of our Wardens who has displayed some energy in the performance of his duty, but the grand juries of Perry and Dauphin counties seem to regard his presentations with supreme indifference.

Is there no remedy for this? If there be not, there is but little use in endeavoring to police our streams, or the power and method of prosecution must be placed in different hands.

Affidavits of Peter Williamson, Fish Warden on the Susquehanna, from below Columbia to Clark's Ferry and the Juniata:

On the afternoon of Monday, October 30, 1882, I went before the grand jury of Perry county, at New Bloomfield, and testified as follows, in the case of the Commonwealth against William A. Grubb:

In the Juniata river, June 22, 1882, near Newport, this man with three others was fishing with a seine. Taylor Grubb told me his name, also the names of the other three of the party, all of whom I saw drawing the net down into a fish dam that was within one hundred and fifty yards of the Newport dam; with me was Joseph Bates, a man that I had taken along from Harrisburg, and Taylor Grubb, one who was fishing with rod and line from the shore. Joseph Bates and myself got into a boat, and was pushed across to the fish dam by one of the party who had been fishing with the seine. When we got to the dam I measured the meshes of the seine, that they had been using, from knot to knot, diagonally, and found that the meshes measured scant two inches, when the law of 1881 requires that they shall "measure from knot to knot, diagonally, not less than four and one half inches in the mesh." I used this rule (showing one in use among mechanics generally.)

I would have given the same testimony in the three other cases of the Commonwealth against William Grubb, Jr., Commonwealth against Horace Grubb, and the Commonwealth against Henry Sorver, had I been called upon.

PETER WILLIAMSON.

STATE OF PENNSYLVANIA, }
Dauphin County, } *ss:*

Personally appeared before me, the subscriber, a notary public, in and for said county and State, Peter Williamson, who being duly sworn, according to law, saith that the facts set forth in the above written statement are true and correct as he verily believes.

Witness my hand and notarial seal this 8th day of January, 1883.

[L. S.] STEWART P. KEELING,
Notary Public.

"On the morning of Sunday, August 13, at twenty minutes of one o'clock, I caught Henry Reagle fishing."

Officer Weltmer and John Lingle, and James Sellers and George Druit, gave the same testimony before the grand jury as that above stated.

PETER WILLIAMSON.

On page 85, in note, for "Montour" read "Monroe."

STATE OF PENNSYLVANIA, }
County of Dauphin, } *ss:*

Personally appeared before me, the subscriber, a notary public in and for said county and State, Peter Williamson, who being duly sworn according to law, saith that the facts set forth in the above written statement are true and correct, as he verily believes.

Witness my hand and notarial seal, this 8th day of January, 1883.

STEWART P. KEELING, *Notary Public.*

Not the slightest notice of these affidavits was taken by either of the grand juries in either case.

Would it not be well to enact such legislation as would remedy such evils as the above?

The treatise of Professor Cope on the Icthyology of Pennsylvania has been so well received, and is so undeniably useful and appropriate, that we again add it as an appendix to our report. The question whether any State in the Union possesses amongst her citizens one who so thoroughly understands the zoology of the land in which he lives, and Professor Cope's science in that direction seems especially to have embraced icthyology, to which subject the attention of the people has been specially directed.

Pennsylvania may well feel proud of such citizens as Professor Cope.

We have the honor to be, very respectfully,

Your obedient servants,

JAMES DUFFY, *Marietta*,
* H. J. REEDER, *Easton*,
BENJAMIN L. HEWIT, *Hollidaysburg*,
JOHN HUMMEL, *Selinsgrove*,
G. M. MILLER, *Wilkes-Barre*,
ROBERT DALZELL, *Pittsburgh*.

To R. E. PATTISON, *Governor of Pennsylvania*, *Harrisburg*.

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*Since resigned, and Arthur Maginnis, of Montour county, (Swift Water,) takes his place.

EXPENDITURE OF THE APPROPRIATION OF JUNE 11, 1879.

1880.			
Feb.	3.	Paid J. P. Creveling, transportation,	$100 00
March	15.	J. P. Creveling, transportation,	100 00
March	29.	Reisinger, meat bill,	9 55
March	30.	Miller & Co., hardware,	33 03
April	3.	Bink, meat bill,	81 49
April	3.	Creveling, salary,	450 00
April	8.	Hoover, teaming,	135 92
April	9.	D. Coble, deceased, detective,	27 00
April	20.	Creveling, transportation,	100 00
May	1.	Hoffman & Co., fry,	227 50
May	12.	Worrall, actuary, account '79,	112 15
May	12.	Worrall, actuary, account '79,	300 00
May	15.	Creveling, transportation,	100 00
May	22.	Willis, police,	28 22
May	31.	Creveling, salary,	150 00
May	31.	Creveling, transporting carp,	25 00
June	16.	Buller, labor,	295 00
July	12.	Bink, meat bill,	57 78
July	19.	Dalzell, commissioner's expenses,	63 68
July	28.	Worrall, expenses,	3 50
July	31.	Creveling, transportation,	25 00
Sept.	14.	Creveling, salary,	225 00
Oct.	2.	Ludwick, warden,	100 00
Oct.	12.	Plumb, bass,	5 30
Oct.	22.	Creveling, bass,	100 00
Nov.	2	Bell, bass,	67 00
Nov.	3.	Berrier, boat,	16 00
Dec.	4.	Dalzell, expenses, &c.,	86 49
Dec.	9.	Worrall, on account,	150 00
Dec.	10.	Atlee, fees,	75 00
Dec.	12.	DeWitt, fees,	50 00
Dec.	20.	G. M. Miller, commissioner, 9 yrs.,	292 77
Dec.	22.	Buller, labor,	90 62
Dec.	31.	Hummel, commissioner, 3 yrs.,	128 00
1881.			
Jan.	1.	Hewit, commissioner, Western district, 9 yrs.,	1,658 84
Jan.	10.	Bink, meat bill,	55 90
Jan.	22.	Creveling, salary,	200 00

Jan.	26.	Paid Musser & Weiller, lumber,	$39 41
March	21.	Creveling, transportation,	50 00
March	25.	Hoffman & Co., trout fry,	192 50
March	25.	A. Bowman, services,	100 00
April	1.	Ludwick, warden, 9 yrs.,	373 87
April	1.	Ludwick, police, &c., 8 yrs.,	333 47
April	4.	Creveling, transportation,	100 00
April	5.	J. Duffy, personal expense,	100 00
April	5.	Hoffman, fry,	70 00
April	5.	Stibgen, labor,	7 69
April	6.	Miller & Co., hardware,	7 76
April	6.	Rudesill, improvements, &c.,	9 16
April	9.	Hoover, milk, &c.,	75 75
April	9.	Bink, meat bill,	48 00
April	12.	Harman, assistant, H. H.,	10 00
April	12.	Creveling, salary,	325 00
April	16.	Buller, services,	50 00
April	30.	Creveling, transportation,	50 00
May	1.	Reeder, commissioner, 4 yrs.,	857 70
May	12.	Creveling, transporting carp, &c.,	100 00
May	14.	Nicholas, warden,	58 32
May	17.	Worrall, account, '80,	300 00
May	17.	Worrall, account, '81,	126 50
May	28.	Creveling, transporting shad,	200 00
June	1.	Lynch, warden,	50 00
July	5.	Bink, meat bill,	67 14
July	21.	Buller, labor,	170 00
July	22.	Worrall, actuary,	77 76
July	22.	Worrall, actuary,	34 74
August	2.	Creveling, salary,	250 00
Oct.	4.	Bink, meat bill,	48 44
Oct.	5.	Bink, meat bill,	66 00
Oct.	19.	Lowe, bass,	78 00
Oct.	20.	Bell, bass,	48 20
Oct.	27.	Jones, warden,	100 00
Nov.	2.	Lowe, bass,	72 00
Nov.	9.	Hewit, commissioner, 26 yrs.,	2,533 13
Nov.	16.	Creveling, transportation,	100 00
Nov.	18.	Bell, bass,	57 00
Nov.	23.	Worrall, actuary,	112 50
Nov.	25.	Nicholas, warden,	200 00
Nov.	28.	Buller, labor,	68 75
Nov.	29.	Tauma Bros., coal,	33 36
Dec.	10.	Lowe, salmon,	15 00
Dec.	10.	Jno. Hummel, transportation,	125 00
Dec.	15.	Creveling, salary,	250 00

1882.			
Jan.	7.	Paid Bink, meat bill,	$64 30
Jan.	31.	Worrall, actuary,	112 50
March	8.	Creveling, transportation,	100 00
March	27.	Creveling, transportation,	100 00
March	31.	Longenecker, labor,	36 55
March	31.	Miller & Co., hardware,	6 47
March	31.	Grieme, transportation,	14 37
March	31.	Bink, meat bill,	47 68
April	5.	Hoover, transportation,	110 75
April	8.	Creveling, salary,	400 00
April	14.	Worrall, actuary,	112 50
April	15.	Creveling, transportation,	100 00
May	2.	Williamson, warden,	40 00
May	3.	Musser & Miller, lumber,	10 70
May	15.	Tucker, transportation,	38 12
May	31.	Creveling, salary,	100 00
June	13.	Williamson, warden,	120 50
June	15.	Rudesill, improvements, &c.,	7 80
July	7.	Williamson, warden,	10 46
July	8.	Bink, meat bill,	77 79
July	14.	Worrall, actuary,	112 50
July	18.	Williamson, warden,	25 00
July	21.	Creveling, salary,	100 00
Sept.	1.	Williamson, warden,	30 00
Sept.	26.	Buller, labor,	16 00
Sept.	30.	Creveling, transportation,	100 00
Oct.	4.	Bink, meat bill,	94 44
Oct.	5.	Worrall, actuary,	112 50
Oct.	12.	Lowe, bass,	72 00
Oct.	16.	Creveling, salary,	150 00
Oct.	20.	Lowe, bass,	72 36
Oct.	31.	Williamson, warden,	3 86
Nov.	14.	Hewit, western district, 13 yrs.,	1,759 96
Nov.	25.	Lowe, salmon,	14 00
Nov.	28.	Williamson, warden,	55 19
Dec.	1.	Bowman, office expense,	6 86
Dec.	8.	C. Dull, fees, warden cases,	75 00
Dec.	9.	Williamson, warden,	44 81
Dec.	14.	R. Dalzell, commissioner,	58 19
Dec.	26.	G. M. Miller, commissioner, 3 yrs.,	193 76
1883.			
Jan.	1.	H. J. Reeder, commissioner, Delaware Int.,	1,060 00

FIG. 20 a. *Salmo salar sebago.* Original.

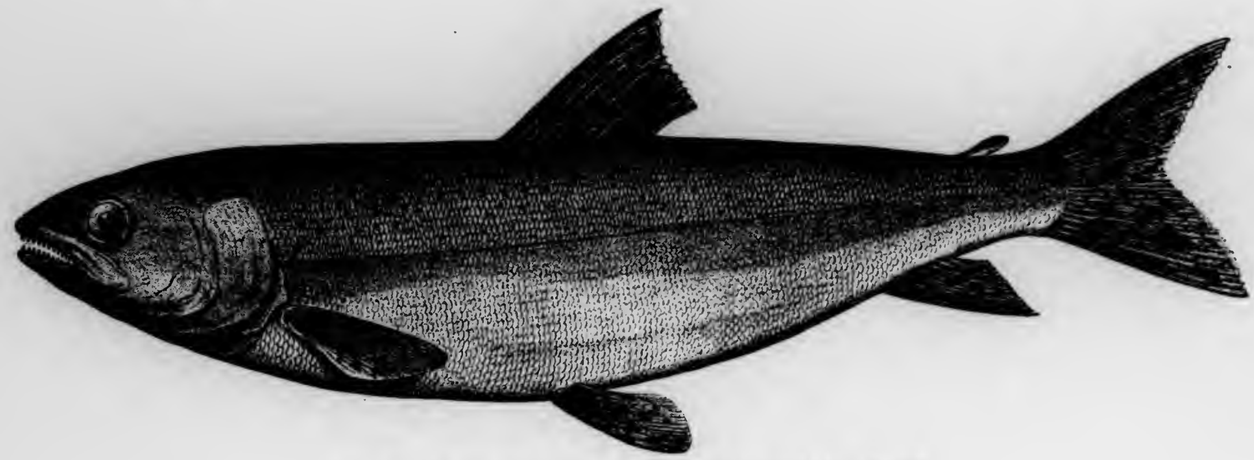


FIG. 21. *Salmo irideo*—Gibb. From Klamath Lake, Oregon.

On page 89, eighth line from bottom, for " therfur" read " further."

Jan.	6.	Paid B. L. Hewit, commissioner, Western district, 3 yrs., ...	$252 69	
Jan.	12.	Worrall, actuary, ...	112 50	
		Total, ...		$20,000 00

DEPARTMENT OF THE AUDITOR GENERAL,
HARRISBURG, *March 14, 1883.*

I do hereby certify that the State Commissioners of Fisheries have filed in this Department vouchers, as mentioned in the annexed statement, covering the appropriation made by section 1, act of June 11, 1879, (Pamphlet Laws 1879, pages 154 and 155), and that the said vouchers have been compared with the annexed statement and found to be correct. And I do therfur certify that the affidavits verifying the correctness of said vouchers by James Duffy, Benjamin L. Hewit, Robert Dalzell and J. P. Creveling, are also on file in this Department.

Witness my hand and seal of Auditor General's Office, the day and year first above written.

[L. S.]

THOMAS McCAMANT,
For JOHN A. LEMON,
Auditor General.

LIST OF FISH COMMISSIONERS IN THE UNITED STATES AND TERRITORIES, AND IN THE BRITISH POSSESSIONS OF NORTH AMERICA.

DOMINION OF CANADA.

W. F. Whitcher, Commissioner, ... Ottawa, Ontario.

PROVINCE OF NEW BRUNSWICK.

W. H. Venning, Inspector of Fisheries, ... St. John.

PROVINCE OF NOVA SCOTIA.

W. H. Rogers, Inspector, ... Amherst.

PROVINCE OF PRINCE EDWARD ISLAND.

J. H. Duvar, Inspector, ... Alberton.

PROVINCE OF BRITISH COLUMBIA.

A. C. Anderson, ... Victoria.

THE UNITED STATES.

Prof. Spencer F. Baird, ... Washington, D. C.

ALABAMA.

C. S. G. Doster, ... Prattville.
D. B. Huntley, ... Courtland.

ARIZONA.

John J. Gosper, ... Prescott.
Richard Rule, ... Tombstone.
Dr. J. H. Taggart, Business Manager, ... Yuma.

ARKANSAS.

John E. Reardon, ... Little Rock.
James H. Hornibrook, ... Little Rock.
H. H. Rottaken, ... Little Rock.

CALIFORNIA.

S. R. Throckmorton, ... San Francisco.
J. D. Farwell, ... Niles, Almeda Co.
W. W. Traylor, ... San Francisco.

COLORADO.

Wilson E. Sisty, ... Idaho Springs.

CONNECTICUT.

Dr. William H. Hudson, ... Hartford.
Robert G. Pike, ... Middletown.
George N. Woodruff, ... Sherman.

DELAWARE.

Enoch Moore, Jr., ... Wilmington.

GEORGIA.

J. T. Henderson, Commissioner of Agriculture and *ex officio* Commissioner of Fish and Fisheries, ... Atlanta.
Dr. H. H. Cary, Superintendent, ... La Grange.

ILLINOIS.

N. K. Fairbank, President, ... Chicago.
S. P. Bartlett, ... Quincy.
S. P. McDoel, ... Aurora.

INDIANA.

Calvin Fletcher, ... Spencer, Owen Co.

IOWA.

B. F. Shaw, ... Anamosa.
A. A. Mosher, Assistant, ... Spirit Lake.

KANSAS.

Hon. D. B. Long, ... Ellsworth.

KENTUCKY.

William Griffith, President, ... Louisville.
Hon. John A. Steele, ... Versailles.
Dr. William Van Antwerp, ... Mount Sterling.
A. H. Goble, ... Catlettsburg.
Hon. C. J. Walton, ... Munfordville.
Dr. S. W. Coombs, ... Bowling Green.
John B. Walker, ... Madisonville.
P. H. Darby, ... Princeton.
Hon. J. M. Chambers, ... Independence, Kenton county.
W. C. Price, ... Danville.

MAINE.

E. M. Stilwell, ... Bangor.
Henry O. Stanley, ... Dixfield.

MARYLAND.

Thomas Hughlett, ... Easton.
G. W. Delawder, ... Oakland.

MASSACHUSETTS.

E. A. Brackett, ... Winchester.
Asa French, ... South Braintree.
F. W. Putnam, ... Cambridge.

MICHIGAN.

Eli R. Miller, ... Richland.
A. J. Kellogg, ... Detroit.
Dr. J. C. Parker, ... Grand Rapids.

MINNESOTA.

1st District—Daniel Cameron, ... La Crescent.
2d District—Dr. Wm. M. Sweney, ... Red Wing.
3d District—Dr. Robert Ormsby Sweeny, ... St. Paul.
4th District—No appointment until January.
5th District—No appointment until January.

MISSOURI.

Dr. J. G. W. Steedman, Chairman, ... 2803 Pine Street, St. Louis.
John Reid, ... Lexington, Lafayette County.
Dr. J. S. Logan, ... St. Joseph.

NEBRASKA.

W. L. May, ... Fremont.
R. R. Livingston, ... Plattsmouth.
B. E. B. Kennedy, ... Omaha.

NEVADA.

Hon. Hubb G. Parker, ... Carson City.

NEW HAMPSHIRE.

George W. Riddle, ... Manchester.
Luther Hayes, ... Milton.
Albina H. Powers, ... Grantham.

NEW JERSEY.

Major Edward J. Anderson, ... Trenton.
Theodore Morford, ... Newton.

NEW YORK.

Hon. R. Barnwell Roosevelt, ... 76 Chambers St., New York.
Edward M. Smith, ... Rochester.
Richard U. Sherman, ... New Hartford, Oneida Co.
Eugene G. Blackford, (Fulton Market, New York City),
809 Bedford Avenue, Brooklyn.

NORTH CAROLINA.

S. G. Worth, ... Raleigh.

OHIO.

Col. L. A. Harris, President, ... Cincinnati.
Charles W. Bond, Treasurer, ... Toledo.
Halsey C. Post, Secretary, ... Sandusky.

PENNSYLVANIA.

Hon B. L. Hewit, ... Hollidaysburg.
James Duffy, ... Marietta.
John Hummel, ... Selinsgrove.
Robert Dalzell, ... Pittsburgh.
G. M. Miller, ... Wilkes-Barre.
Arthur Maginnis, ... Swift Water.

RHODE ISLAND.

Alfred A. Reed, ... Providence.
Newton Dexter, ... Providence.
John H. Barden, ... Rockland.

SOUTH CAROLINA.

A. P. Butler, Commissioner of Agriculture, and *ex officio* of Fish and Fisheries, ... Columbia.
C. J. Huske, Superintendent, ... Columbia.

TENNESSEE.

W. W. McDowell, ... Memphis.
H. H. Sneed, ... Chattanooga.
Edward D. Hicks, ... Nashville.

TEXAS.

R. R. Robertson, ... Austin.

UTAH.

No appointment since the death of Prof. J. L. Barfoot in April last.

VERMONT.

Hiram A. Cutting, ... Lunenburg, Essex Co.
Herbert Brainerd, ... St. Albans.

VIRGINIA.

Col. M. McDonald, ... Berryville.

WEST VIRGINIA.

Henry B. Miller, President, ... Wheeling.
C. S. White, Secretary, ... Romney.
N. M. Lowry, ... Hinton.

WISCONSIN.

The Governor, *ex officio*, ... Madison.
Philo Dunning, President, ... Madison.
C. L. Valentine, Secretary and Treasurer, ... Janesville.
J. V. Jones, ... Oshkosh.
John F. Antisdel, ... Milwaukee.
Mark Douglas, ... Melrose.
Christopher Hutchinson, ... Beetown.

WYOMING TERRITORY.

Dr. M. C. Barkwell, Chairman and Superintendent, . Cheyenne.
Otto Gramm, Secretary, ... Laramie.
Hon. N. L. Andrews, ... Johnson county.
Hon. E. W. Bennet, ... Carbon county.
Hon. P. J. Downs, ... Uinta county.
Hon. T. W. Quinn, ... Sweetwater county.

APPENDIX.

[From report of 1879-80.]

THE FISHING STREAMS OF PENNSYLVANIA.

During the session of the Legislature in 1879 the following circular was addressed by the Commissioners of Fisheries to members of the Legislature from the several counties:

"OFFICE STATE COMMISSIONERS OF FISHERIES,
HARRISBURG, PA., ... , *1879.*

To the Hon. . . . . , of . . . . . county, Pa.:

SIR: You are respectfully requested to fill up the following blanks as far as it may conveniently be in your power to do so. It has been suggested advisable by the commission, with a view to afford reliable information as to the character of the streams in the Commonwealth, and the better to enable them to send fish specially adapted to the waters. Many hundreds of miles of river coast within the State have already been furnished with new tribes of edible fishes, and there seems no reason why the movement should not be carried to an extent which would guarantee a still greater measure of success.

JAMES DUFFY,
HOWARD J. REEDER,
BEN. L. HEWIT,
State Commissioners of Fisheries."

And the queries were answered, as follows:

FISHING STREAMS

COUNTIES.	Names of Streams.	Heads of Streams.	Emptying into	Dimensions. Length—miles.	Width—feet.	Depth—feet.
Armstrong, . .	Crooked creek, ...	. . . . .	Allegheny river, .	. .	. . .	. .
	Cowanshannock, ...	. . . . .	do.			
	Red Bank, ...	. . . . .	do.			
	Mahoning creek, ...	. . . . .	do.			
	Kiskiminitas, ...	. . . . .	do.			
Beaver, ...	Big Beaver, ...	Formed by Mahoning and Shenango, at New Castle.	Ohio river, ...	20	300	10
	Connoquenessing, . . .	South-east part of Butler county.	Big Beaver, ...	25	50	4
	Little Beaver, ...	South-west part of Lawrence county.	Ohio river, ...	15	30	2
Bedford, ...	Raystown Branch, . . .	Allegheny mountains, .	Juniata, ...	60	100	2½
	Yellow creek, ...	Dunning's do.	Raystown branch,	15	40	2½
	Dunning's do.	Allegheny do.	do.	18	25	2½
	George's do.	do. do.	do.	14	18	2
	And tributaries, . . .	do. do.	do.			
Berks, (No. 1,)	Schuylkill river, ...	Schuylkill river, ...	Delaware river, . .	38	250	3½
	Hay creek, ...	South-west part Berks co	Schuylkill river, .	10	12	1½
	Monocacy, ...	Oley township, do.	do.	12	20	2
	Sixpenny, ...	South-west part do.	do.	6	8	1
	Conestoga, ...	Southern part do.	Susquehanna river,	2	15	2
	Allegheny, ...	do. do.	Schuylkill river, .	8	15	2
Berks, (No. 2,)	Tulpehocken, ...	Lebanon county, . . .	do.	21	150	2½
	Northkill, ...	Northern part Berks co.,	Tulpehocken, . . .	10	100	2
	Irish or Plum creek, . .	do. do.	Schuylkill river, .	8	20	2
Berks, (No. 3,)	Schuylkill river, ...	Schuylkill county, . . .	Delaware river, . .	38	250	4
	Ontelaunee, ...	Lehigh county, ...	Schuylkill river, .	25	50	3
	Mill creek, ...	Berks county, ...	Ontelaunee, . . .	4	4	1½
	Pine do.	do.	do.	5	5	2
	Furnace do.	do.	do.	6	7	2
	Saucony do.	do.	do.	5	3	1½
	Stony run, ...	do.	do. . . .	3	3	1½
Blair, ...	Reservoir, ...	Blair county, ...	Juniata, ...	3	¾	15
	Juniata, ...	do.	Susquehanna, . . .	80	200	5½
	Piney creek, ...	do.	Juniata, ...	8	20	2
	Clover do.	do.	do.	8	25	3
	Bell's run, ...	do.	do.	7	15	2
	Tipton run, ...	do.	do.	7	12	2
	Foot of Eight stream, .	do.	do.	6	15	2
	Bald Eagle creek, . . .	Centre county, ...	do.	10	12	3
	Arch spring, ...	Blair county, ...	do.	6	12	2
	Beaver dams, ...	do.	do.	9	10	2
	Roaring springs, ...	do.	Reservoir, ...	3	15	3
	Bot's creek, ...	do.	do.	6	10	2
Bucks, ...	Perkiomen, ...	Bedminster township, . .	Delaware river, . .	20	. . . .	. . . .
	Tohickon, ...	Bucks county, ...	do. . .			
	Neshaminy, ...	do.	do. . .	45		
	Durham, ...	do.	do. . .	10		
	Tinicum, ...	do.	do. . .			
	Pitcock, ...	do.	do. . .	14		
Cambria, . . .	South Fork, ...	From one to six miles of	Conemaugh, ...	. .	16	3
	Chest creek, ...	Ebensburg, do.	do.	. .	10	3
	Clearfield do.	do. do.	do.	. .	10	2
	Conemaugh, ...	do. do.	Kiskiminitas, . . .	.	18	3
	About twelve streams, the headwaters of Susquehanna.	do. do.	Susquehanna, . .	. .	3 to 5	1½
Carbon, ...	Poho Poco and branches,	Monroe county and Carbon county, do.	Lehigh river, . .	20	12½	2½
	Mud run, ...	do. do.	do. . . .	10	8	2
	Hickory run, ...	do. do.	do. . . .	10	10	2
	Mahoning creek, . . .	do. do.	do. . . .	10	15	3
	And other small streams,	do. do.	do. . . .	. .	. . . .	. .
Chester, ...	Octoraro creek, ...	Lancaster county, . . .	Susquehanna river,	30	50	. .
	Glenn's run, ...	South side Chester Valley	Octoraro creek, .	5	20	. .
	Miller's run, ...	Lancaster county, . . .	do. . .	5	20	. .
	Buck run, ...	do. . . .	Brandywine, . . .	10	30	. .

FIG. 22. *Salmo namaycush.* From DeKay.

FIG. 23. *Salmo fontinalis*—Mitchill. From Storer.

FIG. 24. *Osmerus mordax*—Mitchill. From Storer.

FIG. 25. *Thynnus tvcolor*. From Klippart.

FIG. 27. *Clupea pseudoharengus*—Wils.

OF PENNSYLVANIA.

Temperature	Names of Edible Fish.	Polluted or not by Tanneries, etc.	Remarks, and Name of Authority.
. . . . .	Sun-fish, bass, perch, suckers, pike, and cat-fish.	Are not, ...	We have no streams amounting to anything for fishing.—E. D. GRAFF.
Warm, . . . do. do.	Bass, cat-fish, salmon, suckers, red horse, and their varieties.	Generally free, except the two lower pools of the Big Beaver where tanneries, gas works, and manufactories pollute the water.	There are three dams, from ten to eighteen feet high, near the mouth of Big Beaver. Before they were built, the fish mentioned as also white and jack salmon, pike, and eels, were very abundant. The scarcity of fish is attributed to want of fish-ways on the dams. The Connoquenessing is very favorable for propagating bass, as also both of the Beavers. — FIELD AND RIVER SPORTING CLUB.
Cool, ... do. do. do.	Trout, black bass, suckers, eels, and cat-fish.	Are not, ...	The streams are fed from mountain springs and generally clear and cool. Will give more information after further inquiry. J. E. NOBLE.
Temperate. do. do. Cool.	Black bass, cat-fish, eels, suckers, sun-fish, trout, pike, chubs.	The Schuylkill is uninhabitable by fish, on account of coal mine drippings.	All streams mentioned are clear, cool water, suitable for propagating the fish mentioned. Sixpenny is a spring water trout stream.—JAMES LIGGETT.
Temperate. do. do. do. do. do.	Cat-fish, eels, pike, suckers, trout, sun-fish, chubbs.	Are not, ...	This only includes the northwestern part of the county.—JNO. H. RIEGEL.
do. do. Cool, do. do. do. do.	Suckers, pike, trout, cat-fish, sun-fish, chubbs, eels.	Schuylkill from sulphuric acid and dirt from coal. The others are not.	The creeks and runs are spring water, fresh and cool.—S. J. SMITH.
Warm, . . 60°. . . . Cold, 53°. do. Cold, 60°. Cool, 55°. do. 50°. do. 50°. do. 49°. Warm, 60°. Cool, 49°. do.	Bass, cat-fish, eels, Lake Erie suckers, rock bass, sun-fish, pike, brook trout, suckers, &c.	Reservoir and Roaring springs from paper-mills; Tipton run from saw-mills; Juniata from tanneries and lime kilns. The others are not.	
. . . . .	Common creek fish.	Are not, ...	Most of the streams of the county are mentioned, but with very brief description. Some black bass have been placed in the Neshaminy.—W. B. WORTHINGTON.
57° F., ... do. do. do. do.	Black bass, cat-fish, trout, perch, eels, sun-fish, suckers, chubs.	To a very small extent.	There are numerous dams across these streams. Would like to be supplied at Ebensburg as soon as possible with fifteen hundred to two thousand trout, and one hundred and fifty to two hundred black bass.—JOHN FENLON.
Cold, ... Temperate, do. do. Cool.	Black bass, suckers, trout, white chub, cat-fish.	Are not, ...	The Poho Poco and branches are pretty well stocked with trout, but the main stream wants attention. It is a natural breeding place, but large and small go there in autumn, and the small fry are eaten by the large. A slight outlay would remedy this.—J. G. FERN.
50° F., ... do. do. do..	Black bass, pickerel, pike, mullets, cat-fish, fall-fish.	Are not, ...	JOHN A. REYNOLDS.

FISHING STREAMS OF

COUNTIES.	Name of Streams.	Heads of Streams.	Emptying into.	Dimensions. Length—miles.	Width—feet.	Depth—feet.
Clarion,	Hemlock,	Clarion county,	Allegheny river,	12		
Clinton,	Susquehanna,	In the Allegheny and Bald Eagle mountains,		50	650	4
	Bald Eagle,	do. do.	Susquehanna river,	20	200	2
	Fishing Creek,	do. do.	do. do.	30	80	1
	Youngwoman's creek, Beech creek, Cedar run, Chatham, McElhatan's, etc.	do. do.	do. do.			
Cumberland,	Conodoguinet creek,	Not given,	Susquehanna river,		20	2
	Yellow Breeches creek,	do.	do. do.		20	3
	Big Spring, Letort spring	do.	Conodoguinet creek			
	Silver spring, Cedar run,	do.	Yellow Breeches do.			
Delaware,	Cobb's creek,	In Chester county,	Delaware river,	20	40	2
	Darby do.	do. do.	do. do.	15	60	6
	Crum do.	do. do.	do. do.	15	30	4
	Ridley do.	do. do.	do. do.	18	30	4
	Chester do.	do. do.	do. do.	18	20	5
	Hook do.	do. do.	do. do.	15	12	3
Elk,	Clarion river,	W. side Allegheny mts.,	Allegheny river,			
	Spring creek,	do. do.	Clarion river,			
	Bear do.	do. do.	do. do.			
	Little Toby, Mill creek, Elk creek, etc.,	do. do.	do. do.			
	Bennett's branch,	E. side do.	Sinnemahoning,			
	Sinnemahoning,	do. do.	Susquehanna river,			
	Trout run & West creek,	do. do.	do. do.			
Erie,	French creek,	In New York State,	Allegheny river,			
	Conneaut do.	Crawford county, Pa.,	Lake Erie,			
	Elk do.	Erie county, Pa.,	do.			
Forest,	Allegheny river,	Not given,				
	Tionesta,	do.	Allegheny river,	40		
	Salmon creek,	do.	do. do.	25		
	Hickory,	do.	do. do.	20		
	Minister,	do.	do. do.	8		
	Ross run,	do.	do. do.	6		
	Beaver, and others,	do.	do. do.	6		
Fulton,	Sideling Hill creek,	Siding Hill,				
	Aukwick do.	Cowen's Gap and McConnell's Cove,	Juniata & Potomac,			
	Licken do.	do. do.	do. do.			
	Patterson run,	do. do.	do. do.			
	Big Cove, Brush, etc.,	do. do.	do. do.			
Indiana,	Conemaugh,	In Indiana county and Cambria county,	Allegheny river,	70	200	4
	Black Lick,	do. do.	do. do.	50	100	3
	Two Lick,	do. do.	do. do.	30	30	3
	Yellow creek,	do. do.	do. do.			
	Crooked do.	do. do.	do. do.			
Lackawanna,	Garner's creek,	Lackawanna county,	Susquehanna river,	8	10	6
	Leggit's creek,	do. do.	Lackawanna river,	10	10	6
	Roaring brook,	do. do.	do. do.	20	30	6
	Spring do.	do. do.	do. do.	20	20	5
Lebanon,	Swatara,	Not given,	Susquehanna,	15	75	4
	Quittabahilla,	At Lebanon,	Swatara,	15	50	4
	Tulpehocken,	Not given,	Schuylkill,			3
	Soltz creek,	do.				3
Lehigh,	Ontelaunee,	Blue Mountain springs,	Maiden Creek,	12	25	3
	Spring creek,	Upper Milford, Lehigh county,	Little Lehigh,	4	8	2
Luzerne,	Fairmount creek,	North mountain,	Susquehanna river,			
	Hunting do.	do. do.	do. do.			
	Lake do.	do. do.	do. do.			

PENNSYLVANIA—*Continued.*

Temperature	Names of Edible Fish.	Polluted or not by Tanneries, etc.	Remarks, and Name of Authority.
Cool,	Brook trout,	Are not,	The shores of the stream are unimproved. It used to be full of trout, and some years ago they were taken fifteen inches long.—J. W. KAHL.
Temperate, do. Cool. do.	Bass, cat-fish, suckers, sun-fish, eels, speckled trout, etc.	Very little, except with saw-dust.	The practice of running lumber, floating logs, etc., no doubt interferes materially with the spawning and propagating of fish.—G. I. ELDRED.
Temperate, do. do. do.	Cat-fish, pike, mullets, suckers, bass, trout.	Not given,	No signature for report from Cumberland county.
Temperate, do. do. do. do. do.	Cat-fish, eels, chubs, rock bass, etc.	By the refuse of cotton factories and dye-houses.	There is tide-water in Hook, Darby, Ridley, and Crum creeks for two or three miles. Ridley creek, above tide-water, was partially stocked with trout and black bass last fall.—(signed) "WALTER."
Cool, do. do. do. do. do. do. do.	Pike and trout,	By drainage from coal mines and tanneries.	The water is nice and good, and is not injured by the drainage, as our streams flow very rapidly.—C. R. EARLY.
Temperate, do. do.	Pickerel, black bass, rock bass.	Not given,	Lakes Pleasant, Lehoeuf, and Conneaut are excellent fishing waters. Lehoeuf has some large pike and Susquehanna salmon. Lake Pleasant is deep, clear, and cold, nearly all spring water.—ALFRED SHORT.
Temperate, Clear & cold, do. do. do. do. do.	Muscolonge, suckers, bass, salmon, and brook trout.	Tanneries and oil refineries.	The Tionesta and some of its tributaries, once full of trout and other fine fish, are now so polluted by tanneries that no fish can live in them. Since the oil refineries have generally left our region fish are increasing in the Allegheny.—N. P. WHEELER.
Not given, do. do. do. do.	Pike, trout, sun-fish, white bass, cat-fish, suckers, etc.	Are not,	A. C. DAVIS.
Not given, do. do. do. do.	Pike, perch, sun-fish, suckers, trout, cat-fish.	Are not,	These fish are in limited quantities, owing to the former practice of seining and brush netting in our streams, but are becoming more numerous under the protection of existing laws.—JOHN HILL.
Cold, do. do. do.	Trout, horned dace, suckers, eels.	Are not,	These streams have stony beds, and are well adapted to trout. Benton township has a large number of small lakes, fed almost entirely by springs.—A. I. ACKERLY.
Temperate, do. do. do.	Cat-fish, perch, black bass, trout, California salmon.	Are not,	The Quittapahilla is a fine stream of spring water, formerly well stocked with fish, of late years have become almost exterminated.—(Two reports, no signatures.)
Not given, do.	Not given, do.	Are not,	Ontelaunee was stocked up to Leuhardsville with black bass. Twelve miles, at the upper end, were not stocked, but now the creek is fully stocked.—C. H. FOSTER.
Cold, do. do.	Not given, do. do.	Are not,	The creeks are pure water. Send the four thousand fish to Abram Nesbit, Kingston, Luzerne county; he will divide them.—JOHN B. SMITH.

FISHING STREAMS OF

Counties.	Name of Sreams.	Heads of Streams.	Emptying into.	Dimensions. Length—miles.	Width—feet.	Depth—feet.
Clarion,	Hemlock,	Clarion county,	Allegheny river,	12		
Clinton,	Susquehanna,	In the Allegheny and Bald Eagle mountains,		50	650	4
	Bald Eagle,		Susquehanna river,	20	200	2
	Fishing Creek,	do. do.	do. do.	30	80	1
	Youngwoman's creek, Beech creek, Cedar run, Chatham, McElhatan's, etc.	do. do.	do. do.			
Cumberland,	Conodoguinet creek,	Not given,	Susquehanna river,		20	2
	Yellow Breeches creek,	do.	do. do.		20	3
	Big Spring, Letort spring	do.	Conodoguinet creek			
	Silver spring, Cedar run,	do.	Yellow Breeches do.			
Delaware,	Cobb's creek,	In Chester county,	Delaware river,	20	40	2
	Darby do.	do. do.	do. do.	15	60	6
	Crum do.	do. do.	do. do.	15	30	4
	Ridley do.	do. do.	do. do.	18	30	4
	Chester do.	do. do.	do. do.	18	20	5
	Hook do.	do. do.	do. do.	15	12	3
Elk,	Clarion river,	W. side Allegheny mts.,	Allegheny river,			
	Spring creek,	do. do.	Clarion river,			
	Bear do.	do. do.	do. do.			
	Little Toby, Mill creek, Elk creek, etc.,	do. do.	do. do.			
	Bennett's branch,	E. side do.	Sinnemahoning,			
	Sinnemahoning,	do. do.	Susquehanna river,			
	Trout run & West creek,	do. do.	do. do.			
Erie,	French creek,	In New York State,	Allegheny river,			
	Conneaut do.	Crawford county, Pa.,	Lake Erie,			
	Elk do.	Erie county, Pa.,	do.			
Forest,	Allegheny river,	Not given,				
	Tionesta,	do.	Allegheny river,	40		
	Salmon creek,	do.	do. do.	25		
	Hickory,	do.	do. do.	20		
	Minister,	do.	do. do.	8		
	Ross run,	do.	do. do.	6		
	Beaver, and others,	do.	do. do.	6		
Fulton,	Sideling Hill creek,	Siding Hill,				
	Aukwick do.	Cowen's Gap and McConnell's Cove,	Juniata & Potomac,			
	Licken do.		do. do.			
	Patterson run,	do. do.	do. do.			
	Big Cove, Brush, etc.,	do. do.	do. do.			
Indiana,	Conemaugh,	In Indiana county and Cambria county,	Allegheny river,	70	200	4
	Black Lick,	do. do.	do. do.	50	100	3
	Two Lick,	do. do.	do. do.	30	30	3
	Yellow creek,	do. do.	do. do.			
	Crooked do.	do. do.	do. do.			
Lackawanna,	Garner's creek,	Lackawanna county,	Susquehanna river,	8	10	6
	Leggit's creek,	do. do.	Lackawanna river,	10	10	6
	Roaring brook,	do. do.	do. do.	20	30	6
	Spring do.	do. do.	do. do.	20	20	5
Lebanon,	Swatara,	Not given,	Susquehanna,	15	75	4
	Quittabahilla,	At Lebanon,	Swatara,	15	50	4
	Tulpehocken,	Not given,	Schuylkill,			3
	Snitz creek,	do.				3
Lehigh,	Ontelaunee,	Blue Mountain springs,	Malden Creek,	12	25	3
	Spring creek,	Upper Milford, Lehigh county,	Little Lehigh,	4	8	2
Luzerne,	Fairmount creek,	North mountain,	Susquehanna river,			
	Huntlug do.	do. do.	do. do.			
	Lake do.	do. do.	do. do.			

PENNSYLVANIA—*Continued.*

Temperature	Names of Edible Fish.	Polluted or not by Tanneries, etc.	Remarks, and Name of Authority.
Cool,	Brook trout,	Are not,	The shores of the stream are unimproved. It used to be full of trout, and some years ago they were taken fifteen inches long.—J. W. KAHL.
Temperate, do. Cool. do.	Bass, cat-fish, suckers, sun-fish, eels, speckled trout, etc.	Very little, except with saw-dust.	The practice of running lumber, floating logs, etc., no doubt interferes materially with the spawning and propagating of fish.—G. I. ELDRED.
Temperate, do. do. do.	Cat-fish, pike, mullets, suckers, bass, trout.	Not given,	No signature for report from Cumberland county.
Temperate, do. do. do. do.	Cat-fish, eels, chubs, rock bass, etc.	By the refuse of cotton factories and dye-houses.	There is tide-water in Hook, Darby, Ridley, and Crum creeks for two or three miles. Ridley creek, above tide-water, was partially stocked with trout and black bass last fall.—(signed) "WALTER."
Cool, do. do. do. do. do. do. do.	Pike and trout,	By drainage from coal mines and tanneries.	The water is nice and good, and is not injured by the drainage, as our streams flow very rapidly.—C. R. EARLY.
Temperate, do. do.	Pickerel, black bass, rock bass.	Not given,	Lakes Pleasant, Leboeuf, and Conneaut are excellent fishing waters. Leboeuf has some large pike and Susquehanna salmon. Lake Pleasant is deep, clear, and cold, nearly all spring water.—ALFRED SHORT.
Temperate, Clear & cold, do. do. do. do. do.	Muscolonge, suckers, bass, salmon, and brook trout.	Tanneries and oil refineries.	The Tionesta and some of its tributaries, once full of trout and other fine fish, are now so polluted by tanneries that no fish can live in them. Since the oil refineries have generally left our region fish are increasing in the Allegheny.—N. P. WHEELER.
Not given, do. do. do. do.	Pike, trout, sun-fish, white bass, cat-fish, suckers, etc.	Are not,	A. C. DAVIS.
Not given, do. do. do. do.	Pike, perch, sun-fish, suckers, trout, cat-fish.	Are not,	These fish are in limited quantities, owing to the former practice of seining and brush netting in our streams, but are becoming more numerous under the protection of existing laws.—JOHN HILL.
Cold, do. do. do.	Trout, horned dace, suckers, eels.	Are not,	These streams have stony beds, and are well adapted to trout. Benton township has a large number of small lakes, fed almost entirely by springs.—A. I. ACKERLY.
Temperate, do. do. do.	Cat-fish, perch, black bass, trout, California salmon.	Are not,	The Quittapahilla is a fine stream of spring water, formerly well stocked with fish, of late years have become almost exterminated.—(Two reports, no signatures.)
Not given, do.	Not given, do.	Are not,	Ontelaunee was stocked up to Leinhardsville with black bass. Twelve miles, at the upper end, were not stocked, but now the creek is fully stocked.—C. H. FOSTER.
Cold, do. do.	Not given, do. do.	Are not,	The creeks are pure water. Send the four thousand fish to Abram Nesbit, Kingston, Luzerne county; he will divide them.—JOHN B. SMITH.

FISHING STREAMS OF PENNSYLVANIA—*Continued.*

Counties.	Names of Streams.	Heads of Streams.	Emptying into.	Dimensions. Length—miles.	Width—feet.	Depth—feet.	Temperature	Names of Edible Fish.	Polluted or not by Tanneries, etc.	Remarks, and Name of Authority.
Lycoming, . .	W. Branch Susquehanna	. . . . .	. . . . .	. .	. . .	. .	Very cold, . .	Cat-fish, eels, chubs, pike, black bass, salmon, trout.	Some by tanneries and saw dust.	Such pollution and saw-mill ponds as are in the streams does not interfere with the growth of fish.—FRANK PORTER.
	Pine creek, ...	In the mountains of Lycoming county,	West Branch of the Susquehanna river	. .	. . .	. .	do.			
	Larry's do.	do.	do.	. .	. . .	. .	do.			
	Lycoming do.	do. do.	do.	. .	. . .	. .	do.			
	Loyalsock do.	do. do.	do.	. .	. . .	. .	do.			
	Muncy do.	do. do.	do.	. .	. . .	. .	do.			Two reports received; the other indefinite and unsigned.
Mercer, ...	Shenango river, ...	Crawford county, .	Beaver river, . .	100	160	5	Not given, .	Black bass, pike, and speckled bass.	Are not, ...	The Shenango river deserves more attention by your honorable body than all the streams in the county, as it is the principal in size, etc.—N. C. PACKARD, Fish Warden.
	Little Shenango, ...	Mercer do. . . .	Shenango do. . .	20	80	4	do.			
	Crooked creek, ...	Crawford do. . . .	Little Shenango, .	20	60	4	do.			
	Big run, ...	Mercer do. . . .	Shenango river, .	12	60	3	do.			
	Pymatuning, ...	Ohio.	do.	50	120	7	do.			
	Slade's run, ...	Mercer county, . . .	Mill creek, ...	10	16	3	do.			
	Sandy creek, ...	do.	Sandy lake, ...	10	16	3	do.			
Montour, . .	Chilesquaque creek, . .	Columbia county, . . .	Susquehanna river,	20	18	3	do.	Cat-fish, pike, eels, sun-fish.	Partially by a tannery.	Also other smaller streams in the county inhabited by the same varieties of fish.—P. C. NEWHAKER.
Northampton,	Monocacy, ...	Blue mountain, ...	Lehigh river, . . .	. .	.	. .	Not given, .	Suckers, pike, trout, cat-fish, eels.	Are not, ...	Streams generally of clear spring water.—HENRY SCHOLL.
	Hockendauqua, ...	do.	do. . . .	. .	. . .	. .	do.			
	Lehigh river, ...	do.	Delaware river, . .	. .	. . .	. .	Cool.			If fish are furnished to stock the streams, success will follow.—A. W. LERCH.
	Indian creek, ...	do.	Lehigh do. . .	12	16	3½	do.	Black bass, suckers, pike, perch, trout, eels.	The Blooming Grove creek by tanneries. The others are not.	The county is filled with beautiful lakes, well stocked with black bass, pickerel, perch, eels, cat-fish, etc.—C. A. SMITH.
Pike, ...	Big Bushkill, ...	Pike county, ...	Delaware river, . .	. .	. . .	. .	do.			
	Bright Brook, . .	do.	do.	. .	. . .	. .	do.			
	Blooming Grove creek,	do.	do.	. .	. . .	. .	do.			
	Vandermark do.	do.	do.	. .	. . .	. .	do.			
	And others, ...	do.	do.	. .	. . .	. .	do. . . .	Brook trout, chubs, eels, etc.	Are not, ...	It is considered advisable by competent judges to stock the Allegheny with black bass. No signature.
Potter, ...	Genesee, ...	Centre county, ...	Not given, ...	10	30	2	Temperate.			
	Allegheny, ...	do.	do.	20	100	6	Cold.			
	Kettle creek, ...	do.	do.	20	30	4	do.			
	Sinnemahoning, ...	do.	do.	20	40	3	do.			
	Pine creek, ...	do.	do.	20	40	3	do.			
Schuylkill, . .	Locust Mountain brook,	Locust mountain, . . .	Mahanoy creek, . .	4	8	2½	do.	Trout, ...	No, ...	PATRICK CONRY.
	West Branch, . .	Buck ridge, ...	Schuylkill river, .	60		. .	do. . . .	Trout and cat-fish,	Coal dirt, ...	JOHN F. WELSH.
Somerset, . . .	Castleman's river, . .	Somerset county, ...	Youghiogh'y river,	70	160	6	Cool, ...	Black bass, speckled trout, chubs, eels, sun-fish, etc.	Are not, ...	Have abundance of trout. Black bass increase rapidly in these streams. Have not tried trout.—A. J. CALHAUER.
	Laurel Hill creek, . . .	do.	Castleman's do.	25	40	3	do.			
	White's do. . . .	do.	Potomac do.	10	8	2	do.			
	Deder's run, ...	do.	Raystown branch,	10	10	2	do.			
	Paint creek, ...	do.	Conemaugh river,	10	30	2	do.			
	Quemahoning, ...	do.	Paint creek, . . .	30	50	4	do.			
	Stony creek, ...	do.	Quemahoning, .	30	20	3	do.			I have requests for black bass mostly. Could use a few trout.—E. M. SCHROCK.
Venango, . . .	Allegheny river, ...	Potter county, ...	Ohio river, . .	40	300	5	do.			
	Oil creek, ...	Crawford do.	Allegheny river, .	15	100	4	Not given, .	Yellow bass, suckers, wall-eyed salmon, pike, sun-fish, cat-fish.	Allegheny river and Oil creek by oil refineries; Pithole creek by oil wells, etc. The others are not.	Think if stocked with trout and bass many of the streams might be restored as fishing streams.—GEO. E. MAPES.
	French do.	Erie do.	do.	12	100	4	do.			
	Sugar do.	Crawford do.	French creek, . .	14	50	3	do.			
	Big Sandy, ...	Mercer do.	Allegheny river, .	10	40	3	do.			
	Pithole creek, ...	Forest do.	do.	15	50	3	do.			
	Cherry run, ...	Venango do.	do.	10	20	2	do.			
Washington, .	Monongahela river, . .	Laurel Ridge, Va., . .	Ohio, ...	280	1,000	6	Temperate, .	Not given, ...	Coal dirt, ...	JOHN C. MESSENGER.
Westmoreland,	Loyalhanna & branches,	Donegal township, . .	Kiskiminitas, . . .	20	90	3				We have no streams in the interior of the county in which to propagate fish. They dry up. This is particularly so in my district, west part of county.—FINDLEY PATTERSON.
Wayne, ...	Delaware river, ...	New York, ...	Delaware bay, . .	40	100	6	Cold, ...	Suckers, sun-fish, etc.	No, ...	The Loyalhanna has a number of tributaries large enough for mill streams of pure spring water, inhabited exclusively by trout.—N. M. MARKER.
	Lackawaxen river, . . .	Moosic mountain, ...	Delaware river,	35	80	5	Cool, ...	Trout, black bass, pickerel, cat-fish, perch, eels, chubs, suckers, sun-fish.	. . . . .	Numerous lakes of from 50 to 200 acres in area are stocked with these fish more or less. Some attempts at trout culture have not succeeded well.—N. F. UNDERWOOD.
	Dyberry, ...	do. . . .	Lackawaxen river,	15	40	3	Cold.			
	Paupack, ...	do. . . .	do.	30	75	3	do.			
	Middle, ...	do. . . .	Paupack, ...	15	20	2	do.			
	Equinunk, ...	do. . . .	Delaware river, . .	30	30	4	do.			
	Shehawkin, ...	do. . . .	do.	20	15	3	do.			
	Starrucca, ...	do. . . .	Susquehanna river,	10	20	3	do.			
York, ...	Codorus creek, ...	Maryland, ...	do.	50	50	3	do.			
	Conewago do.	Conewago mountains, .	do.	40	50	3	Temperate, .	Bass, pike, cat-fish, carp, eels, suckers, chubs, etc.	Paper-mills, tanneries, ore washings, etc.	J. F. WEIST.
	Fishing do.	do.	do.	35	40	3	Cool.			G. E. SHERWOOD.
	Plum do.	do.	do.	25	20	2	do.			
	Fox do.	do.	do.	15	15	2	do.			
	Yellow Breeches creek,	do.	do.	12	30	4	do.			
	Muddy do.	do.	do.	20	30	3	do.			
	Bunch do.	Pigeon hills, ...	do.	10	15	2	do.			

THE FISHERIES OF PENNSYLVANIA.

By Prof. E. D. COPE, *of Philadelphia.*

LETTER OF TRANSMITTAL.

PHILADELPHIA, *January 1, 1881.*

The Honorable Commissioners of Fisheries of the State of Pennsylvania:

GENTLEMEN: I have the honor to submit a descriptive and systematic account of the species of fishes known or supposed to exist in the waters of Pennsylvania. It is hoped that by its aid it will be possible for many persons to become acquainted with this portion of the animal population of our State, who have not hitherto had the opportunity to do so, and that every person may be able to ascertain the character and names of the species of fishes found in the waters of his vicinity. In preparing this review, I have brought to bear an acquaintance with the anatomy and characters derived from a study of large representative collections. Although additions to the list will yet be made, especially in the western part of the State, the present report will be found to embrace by far the greater number of species.

In preparing this work, I have employed the system proposed by myself in 1871, which has been largely adopted in works on the subject. For descriptions of the species, I have relied extensively on Professor D. S. Jordan's Vertebrata of Eastern North America, second edition, even in the case of genera which I was first to characterize. This has been done because his descriptions are short and popular, and also because his knowledge of their nomenclature is superior to my own. I have also derived material aid from Doctor D. H. Storer's report on the fishes of Massachusetts. The figures are, in part, copied from the latter work, and from Klippart's report to the Ohio Fish Commission for 1875–6, and they are, in part, original. I have been compelled to rely on these sources of illustration because the means placed at your disposal were not sufficient to enable me to furnish original drawings.

I am, very respectfully,

EDWARD D. COPE.

INTRODUCTION.

In order to understand the descriptions of fishes contained in the following pages, it will be necessary to give a brief account of the principal parts of the structure of a fish. This will be restricted to the organs used in the diagnoses that follow, and will refer more to the osseous system than to any other.

1. THE MUCODERMAL SYSTEM.

To this system belong the scales and fin-rays. The latter are attached to the peripheral parts (interspinous bones) of the osseous system, and correspond with them in number in the higher fishes. In the *Chondrostei*, and the extinct order *Lysopteri*,* the fin-rays do not correspond with the skeletal basis, resembling, in this respect, the lowest *vertebrata*, as the lampreys. The fins are first, the unpaired ones, the dorsal, the caudal, and the anal: and second, the paired fins, the pectoral and ventral, which are attached to parts of the skeleton homologous with the basal portions of the fore and hind limbs respectively, of land vertebrates. The rays are of two kinds, osseous and cartilaginous. The osseous are undivided and generally acute, and are hence called spines. The cartilaginous, or soft rays, are generally split lengthwise once or twice, and are divided into sections by transverse joints. The numbers of the fin-rays are important as definitions of fish species.

The scales are either true scales or shields. They are ossifications which lie between the true skin and the epidermis, and their anterior borders are generally received into pockets of the former. True scales are either ganoid, cycloid, or ctenoid. The first named are smooth-edged, and are covered with a layer of a dense substance called ganoine. A few living and many extinct species possess them. Cycloid and ctenoid scales do not exhibit ganoine; the former have smooth free edges, while the latter have rough points or bristles on the margin, and corresponding roughness of the body surface.

There is a row of tubes or pores along the side, from the head to the base of the caudal fin. Certain nerves terminate in "buttons" within these tubes, and the structure is supposed to be an organ of sense.

Fig. 1. Page 32. *Gronias nigrilabris*. Cope; a blind Silurid. Op. operculum; Pop. preoperculum. Iop. interoperculum, D. dorsal fin; Ad. adipose-dorsal fin; C. caudal, A. anal fin; P. pectoral, and V. ventral fins; Ll. lateral line.

2. DIGESTIVE SYSTEM.

This system includes in fishes, a mouth cavity with its teeth, œsophagus,

*American Naturalist, 18—, p. —.

Fig. 28. *Engraulis vittatus*—Mitch. From Storer.

Fig. 29. *Coregonus albus*—Lesueur. From Klippart.

FIG. 26 *a*. *Clupea sapidissima*—Wilson. *Alosa praestabilis*—DeKay. Vul. Shad.

stomach, intestine, liver, and pancreas. The stomach is generally a simple bag, curved more or less abruptly at its intestinal or pyloric extremity. There are frequently blind tubes, or cœca, extending from it, which may be short or long, few or many. They are exceedingly numerous in some of the *Salmonidæ*. The intestine is very long in herbivorous fishes, and short in the carnivorous. In *Chondrostei*, *Selachii*, and various others, it contains a more or less complete septum, which is tranversely extended at any point of section, but winds spirally from one extremity of the bowel to the other.

3. RESPIRATORY SYSTEM.

This, which originates in all *vertebrata*, as a diverticulum from the digestive system, is very little developed in fishes. It is in most of them a simple sac, the swim bladder. In some fishes it is wanting, while in some of the lower *Hyopomata* its walls are more or less divided into coarse cells. These are very numerous in the *Lepidosteidæ* and the *Crossopterygia*. Blood is aerated to a limited extent in this organ, but the respiratory function of fishes is, as is well known, performed by the hyoid apparatus of the bony system, and its appendages.

4. CIRCULATORY SYSTEM.

The heart of fishes primarily consists of only two chambers, an auricle and a ventricle, each of which is represented by two divisions in higher *vertebrata*. Besides these, fishes have an enlarged space at the point of entrance into the auricle of the *venae cavae*, which is called the sinus venosus. There is also a fourth chamber usually present, which forms the basal part of the aorta immediately after leaving the ventricle, which is called the *bulbus arteriosus*. Its walls in the *Crossopterygia* and *Chondrostei* are muscular, so that it "forms part of the pulsating heart," (Gunther.) The families of the Actinopterous orders, *Ginglymodi* and *Halecomorphi*, present the same characters. In these cases its interior wall supports a number of valves, which vary very much in number and form. In the *Dipnoi* they are confluent lengthwise. In most Actinopterous fishes the walls of the bulbus are not muscular, and there are only two valves, which are placed at its base.

5. OSSEOUS SYSTEM.

The skeleton of fishes presents many peculiarities as compared with that of other *vertebrata*, the principal of which are seen in the limbs and in the hyoid apparatus. A list of the elements is here gvien, and reference may be had to Fig. 2, for their recognition.

For convenience, the skeleton may be considered in three divisions: The skull, the vertebral column, and the scapular and pelvic arches. The first and second consist of segments, and each segment consists of a superior and inferior arch and a centrum or body. Each of these arches consists of separate elements and of appendages; the latter of which may be superior, lateral, or inferior.

A. VERTEBRAE.

Superior arch—Elements; neurapophysis; neural spine; interneural bone; basilar interneural.

Inferior arch—Diapophysis; ribs; haemal spine; interhaemal bone; basilar interhaemal bone, (the ribs in the abdominal region; the haemal spine and interhaemal bones only in the caudal region.)

B. SKULL.

The first segment is the posterior part of the skull; the fourth terminates the muzzle.

First segment; superior arch. Exoccipital bone; supraoccipital; *body*, basioccipital. *Inferior arch;* superior pharyngeals; superior branchihyals; inferior branchihyals; basal branchihyals; basihyals; *appendices*, urohyals and branchial processes.

Second segment; superior arch; parietal; pterotic; periotic bones; *body*, parasphenoid; *inferior arch;* hyomandibular; stylohyal; ceratohyal; glossohyals. *Appendices*, branchiostigal rays; operculum; suboperculum; interoperculum.

Third segment; superior arch; frontals, postfrontals; *body*, parasphenoid; *inferior arch*, metapterygoid, preoperculum quadrate; symplectic; articular, angular, coronoid, splenial, dentary.

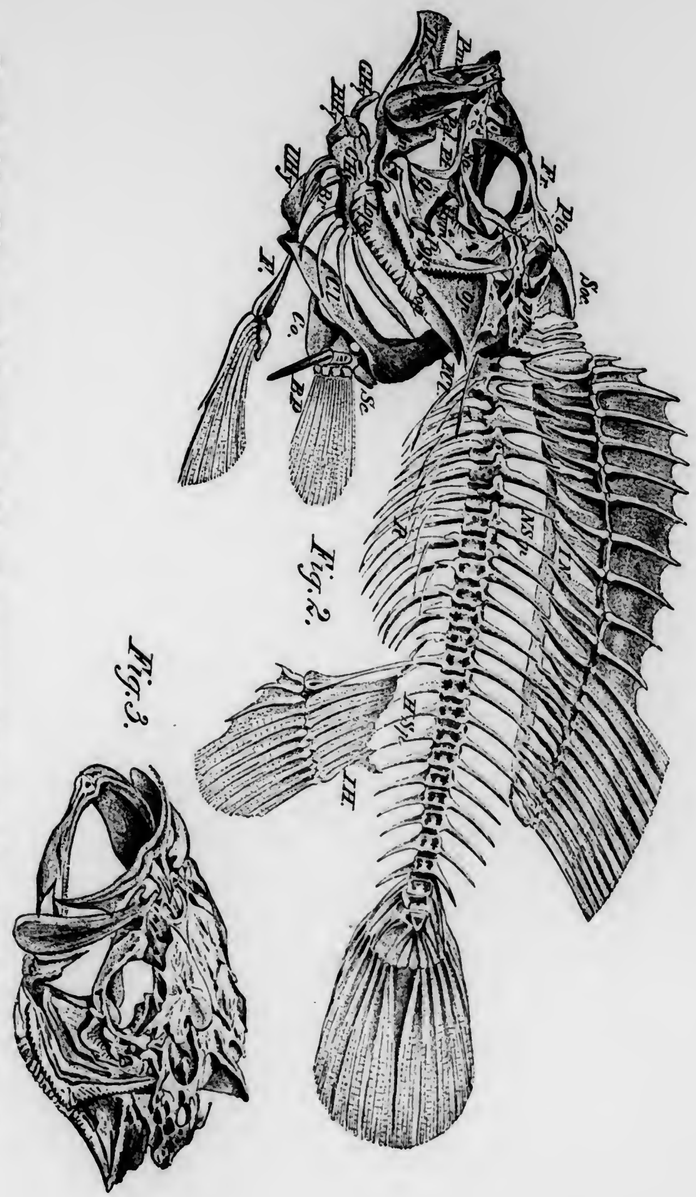
Fourth segment; superior arch. Nasal; ethmoid; lachrymal; *body*; vomer; *inferior arch;* prefrontal, maxillary, premaxillary; *appendices;* malar, palatine, mesopterygoid, pterygoid, ectopterygoid.

The preceding classification of the bones of the skull does not take into account their different origins, whether it be within the cranial cartilages or the membranes which inclose them. This difference is indicated by the typography, the names of the membrane bones being spaced. It is true that cartilage bones were represented in primitive vertebrates by corresponding membrane bones, and that the former are probably derived from the latter by a process of deepening of the positions of the centers of ossification.

C. ARCHES.

The arches have three branches, one superior and two inferior. The limbs are appendages arising at the point of union of these parts.

1. *Scapular arch; superior branch;* scapula; *inferior arches; anterior*; posttemporal; epiclavicle; clavicle; *posterior;* coracoid, precoracoid, postcoracoid; interclavicle; *appendices;* propterygium, mesopterygium, metapterygium; basilar pectorals.
2. *Pelvic arch; superior branch;* ilium (wanting in fishes); *inferior branch; anterior;* pubis, (wanting in most fishes); *posterior*, ischium, (absent in fishes); *appendices;* femur tibia and fibula; the last two rep-



FIGS. 2 and 3. *Skeleton and skull of a percoid fish.* The letters are abbreviations of the names of the bones given.

resented by one or two basilar ventrals; tarsus, represented by basilar ventrals.

Fig. 2, Skeleton of a percoid fish. The letters are abbreviations of the names of the bones above given.

NSp, Neural spines; *IN*, Interneural bones; *HSp*, Hæmal spines; *IH*, Interhæmal bones; *R*, ribs; *Soc*, Suproccipital; *PT*, Pterotic; *EOl*, Epiclavicle; *Cl*, Clavicle; *Sc*, Scapula; *BP*, Pectoral basilars; *Co*, Coracoid; the slender bone behind it is postcoracoid; *Op*, operculum; *Sop*, Suboperculum; *Iop*, Interoperculum; *Pa*, parietal; *Hym*, hyomandibular; *Q*, quadrate: at the right hand upper corner is situated the symplectic; *CHy*, Ceratohyal; *Br*, Branchiostegal rays; *BHy*, Basihyal; *GHy*, Glossohyal; *UHy*, Urohyal; *Fr*, frontal; *So*, Suborbital; *An*, angular; *D*, Dentary; *Pmx*, premaxillary; *Mx*, maxillary; *Pal*, palatine; *Pt*, Pterygoid; *F*, femur.

Fig. 3, Oblique vertical view of the skull represented in Fig. 2.

THE FISHES OF PENNSYLVANIA.

Under the popular term fishes, a great variety of animals is included. While these are all members of the grand division of the *vertebrata*, and occupy the lowest position in it, they do not all belong to the same class. Three classes are recognized by zoölogists among the vertebrates usually called fishes. The first class includes only the sand lances, which are the lowest of the *vertebrata*. Their skeleton is membranous; they have no brain proper, but only an enlargement of the anterior part of the spinal cord; and their heart is only represented by a pulsating tube. In the second class the preceding usual characters of *vertebrata* are present, but they differ from the true fishes and all the other classes, in the absence of the lower jaw, and of the scapular and pelvic arches, and as a consequence of the limbs. This class includes only the lampreys. The third class includes the true fishes. The definitions of the three classes may be contrasted as follows:

A. Notochord extending to the anterior extremity of the body; no skull, brain, or renal organs; heart, a simple tube.

1. No auditory organs; liver saccular; no lower jaw, limb arches nor limbs. . . . . *Leptocardii.*

B. Notochord ending behind the pituitary fossa; skull, brain, and renal organs present.

2. Neither mandible nor limb arches; nasal sac single. . *Marsipobranchi.*

3. Mandible and limb arches present; two nasal sacs. *Pisces.*

Representatives of the second and third classes are found in the waters of the State of Pennsylvania. The few known species of the *Leptocardii* belong to two genera, *Branchiostoma* and *Epigonichthys*. They are found on the shores of all oceans, and although aerating their blood by a branchial apparatus, burrow in the sand on the edge of the water. Their structure throws great light on the systematic relations and origin of the *vertebrata*. No species has yet been found in fresh waters, so that the class cannot be included in the fauna of Pennsylvania.

MARSIPOBRANCHI.

The species of this class are few in number at the present geological epoch. They abound in fresh waters, as well as in some parts of the ocean. Without lower jaw, they do not take food in the manner possible to other vertebrates, but perforate the bodies they devour, by suction. The mouth is a wide funnel-shaped basin, whose interior is surrounded by conical horny bodies, which perform the function of teeth. While attached to their prey by this suctorial mouth, the teeth rasp the flesh. The lampreys are

destructive to fishes, but it is only the large species which inflict any serious loss.

In all the known members of this class, the nasal chamber opens by a single short tubular orifice on the middle line of the top of the head.

There are two orders of the *Marsipobranchi*, as follows:

1. Water conducted to the branchiae through a distinct tube below the œsophagus. . . . . *Hyperoarti.*

2. Water conducted to the branchiae directly from the œsophagus. *Hyperotreti.*

The first of these orders is the only one found in the waters of the State.

HYPEROARTI.—*Lampreys.*

Our lampreys belong to a single family, the *Petromyzontiæ*, wich is represented by two genera. These are distinguished, as follows:

Dorsal fins two, nearly or quite distinct; median tooth bicuspid. *Petromyzon.*

Dorsal fin one, continuous with the caudal; median tooth tricuspid. *Lampetra.*

PETROMYZON—*Linn.*

The species of this genus are long and slender, and have the head but little larger in diameter than the body. The mouth looks obliquely downwards, and has a widely expanded border. This can be contracted from the sides so as to leave a narrow longitudinal opening. The eyes are covered by a thickened cornea, and are not bounded by eyelids or any inversion of the integument. There are seven branchial fissures on each side.

In their early stages the species of this and the following genus present various peculiarities, especially in the mouth, and in reaching maturity pass through a metamorphosis. Before the history of this change was known, the larvæ of *Petromyzon* were thought to be adult animals of a distinct genus, which was named *Ammocœtes*. The larvæ in this early stage have the minute eyes sunk in fossae on the upper surface of the head, and the branchial openings are connected by a longitudinal slit. There is a distinct upper lip on each side of the inferiorly placed mouth, and the inner wall of the latter is closely set with fringes of filaments. This is significant, since the mouth of the inferior type, *Branchiostoma*, is fringed in a somewhat similar manner throughout life. As growth advances, the eyes become lateral and more distinct, and the lateral lips become fused with the posterior border of the mouth. The fringes shorten into papillae, and the branchial orifices become slit-like, and lose their connecting groove. Finally the teeth appear on the summits of the still shorter papillae, and the external urogenital organs assume the characters of the adult lamprey.

PETROMYZON MARINUS. Linn. (*Great Sea Lamprey. P. Americanus Lesueur.*)

Resembles the next, but larger, with a shorter head, which is but little longer than the "chest," (=space occupied by the branchial openings;)

resented by one or two basilar ventrals; tarsus, represented by basilar ventrals.

Fig. 2, Skeleton of a percoid fish. The letters are abbreviations of the names of the bones above given.

NSp, Neural spines; *IN*, Interneural bones; *HSp*, Hæmal spines; *IH*, Interhæmal bones; *R*, ribs; *Soc*, Suproccipital; *PT*, Pterotic; *EOl*, Epiclavicle; *Cl*, Clavicle: *Sc*, Scapula; *BP*, Pectoral basilars; *Co*, Coracoid; the slender bone behind it is postcoracoid; *Op*, operculum; *Sop*, Suboperculum; *Iop*, Interoperculum; *Pa*, parietal; *Hym*, hyomandibular; *Q*, quadrate: at the right hand upper corner is situated the symplectic; *CHy*, Ceratohyal; *Br*, Branchiostegal rays; *BHy*, Basihyal; *GHy*, Glossohyal; *UHy*, Urohyal; *Fr*, frontal; *So*, Suborbital; *An*, angular; *D*, Dentary; *Pmx*, premaxillary; *Mx*, maxillary; *Pal*, palatine; *Pt*, Pterygoid; *F*, femur.

Fig. 3, Oblique vertical view of the skull represented in Fig. 2.

THE FISHES OF PENNSYLVANIA.

Under the popular term fishes, a great variety of animals is included. While these are all members of the grand division of the *vertebrata*, and occupy the lowest position in it, they do not all belong to the same class. Three classes are recognized by zoölogists among the vertebrates usually called fishes. The first class includes only the sand lances, which are the lowest of the *vertebrata*. Their skeleton is membranous; they have no brain proper, but only an enlargement of the anterior part of the spinal cord; and their heart is only represented by a pulsating tube. In the second class the preceding usual characters of *vertebrata* are present, but they differ from the true fishes and all the other classes, in the absence of the lower jaw, and of the scapular and pelvic arches, and as a consequence of the limbs. This class includes only the lampreys. The third class includes the true fishes. The definitions of the three classes may be contrasted as follows:

A. Notochord extending to the anterior extremity of the body; no skull, brain, or renal organs; heart, a simple tube.

1. No auditory organs; liver saccular; no lower jaw, limb arches nor limbs. . . . . *Leptocardii.*

B. Notochord ending behind the pituitary fossa; skull, brain, and renal organs present.

2. Neither mandible nor limb arches; nasal sac single. . *Marsipobranchi.*

3. Mandible and limb arches present; two nasal sacs. *Pisces.*

Representatives of the second and third classes are found in the waters of the State of Pennsylvania. The few known species of the *Leptocardii* belong to two genera, *Branchiostoma* and *Epigonichthys*. They are found on the shores of all oceans, and although aerating their blood by a branchial apparatus, burrow in the sand on the edge of the water. Their structure throws great light on the systematic relations and origin of the *vertebrata*. No species has yet been found in fresh waters, so that the class cannot be included in the fauna of Pennsylvania.

MARSIPOBRANCHI.

The species of this class are few in number at the present geological epoch. They abound in fresh waters, as well as in some parts of the ocean. Without lower jaw, they do not take food in the manner possible to other vertebrates, but perforate the bodies they devour, by suction. The mouth is a wide funnel-shaped basin, whose interior is surrounded by conical horny bodies, which perform the function of teeth. While attached to their prey by this suctorial mouth, the teeth rasp the flesh. The lampreys are

destructive to fishes, but it is only the large species which inflict any serious loss.

In all the known members of this class, the nasal chamber opens by a single short tubular orifice on the middle line of the top of the head.

There are two orders of the *Marsipobranchi*, as follows:

1. Water conducted to the branchiae through a distinct tube below the œsophagus. . . . . *Hyperoarti.*

2. Water conducted to the branchiae directly from the œsophagus. *Hyperotreti.*

The first of these orders is the only one found in the waters of the State.

HYPEROARTI.—*Lampreys.*

Our lampreys belong to a single family, the *Petromyzontiæ*, wich is represented by two genera. These are distinguished, as follows:

Dorsal fins two, nearly or quite distinct; median tooth bicuspid. *Petromyzon.*

Dorsal fin one, continuous with the caudal; median tooth tricuspid. *Lampetra.*

PETROMYZON—*Linn.*

The species of this genus are long and slender, and have the head but little larger in diameter than the body. The mouth looks obliquely downwards, and has a widely expanded border. This can be contracted from the sides so as to leave a narrow longitudinal opening. The eyes are covered by a thickened cornea, and are not bounded by eyelids or any inversion of the integument. There are seven branchial fissures on each side.

In their early stages the species of this and the following genus present various peculiarities, especially in the mouth, and in reaching maturity pass through a metamorphosis. Before the history of this change was known, the larvæ of *Petromyzon* were thought to be adult animals of a distinct genus, which was named *Ammocœtes*. The larvæ in this early stage have the minute eyes sunk in fossae on the upper surface of the head, and the branchial openings are connected by a longitudinal slit. There is a distinct upper lip on each side of the inferiorly placed mouth, and the inner wall of the latter is closely set with fringes of filaments. This is significant, since the mouth of the inferior type, *Branchiostoma*, is fringed in a somewhat similar manner throughout life. As growth advances, the eyes become lateral and more distinct, and the lateral lips become fused with the posterior border of the mouth. The fringes shorten into papillae, and the branchial orifices become slit-like, and lose their connecting groove. Finally the teeth appear on the summits of the still shorter papillae, and the external urogenital organs assume the characters of the adult lamprey.

PETROMYZON MARINUS. Linn. (*Great Sea Lamprey. P. Americanus Lesueur.*)

Resembles the next, but larger, with a shorter head, which is but little longer than the "chest," (=space occupied by the branchial openings;)

color, olive brown, mottled with black; length, thirty to forty inches. Marine, ascending rivers; not uncommon in the Delaware and Susquehanna, and their tributaries. Our largest lamprey.

LAMPETRA—*Gray.*

(*Ichthomyzon and Scolecosoma Girard.*)

LAMPETRA FLUVIATILIS—Linn. (*Large Black Lamprey.*)

Head very large, longer than the "chest," six and a half times in length; depth about thirteen times; body little compressed; dorsal fins rather low, distinctly separated; eyes and mouth very large; a depression between eyes and snout; a single bicuspid tooth in front of œsophagus; mandibulary plate curved, with about eight pointed teeth; rest of mouth covered with rather large teeth, disposed in oblique cross-rows, five or more in each row; lips fringed. Length 12 inches. Lakes and streams Cayuga L., N. Y., (Wilder) and E.; properly a marine species. Also in Europe, (P. nigricans, Les., the American form.) Several other Lampreys have been described from our eastern streams and coast; but they are very doubtful.

LAMPETRA NIGRA, Raf. (*Small Black Lamprey.*)

Head moderate, longer than "chest," eight and a third in total length; depth, fourteen; body scarcely compressed, except behind; dorsal fins rather high, slightly connected; eyes large; mouth rather small; one tooth with two cusps well apart in front of œsophagus; mandibulary plate nearly straight, with about eight sub-equal teeth; a few scattering teeth on sides of mouth; snout rounded; dark blue-black, unspotted; silvery below. L. 8 to 11 inches. Great lakes, upper Mississippi and Ohio valley, abundant in many localities; ascending small brooks in the spring.

LAMPETRA ARGENTEA, Kirtland. (*Silvery Lamprey.*)

Head quite small, shorter than "chest," about ten inches in length; depth nearly the same in adult; body stout, compressed; dorsal fin very high, with a shallow depression; eyes distinct in adult, concealed in young; mouth small, with inconspicuous teeth; color ashey silvery, with numerous small black dots; larger ones above the gill openings. L. 12. Great lakes and Ohio valley. E. to N. Y., Frequent. *Ammocaetes concolor* Kirt, *A. aepyptera*, Abbott.

PISCES.

The fishes proper, include the sharks, chimeras, etc., as well as the ordinary forms. Traces of their existence during the upper Silurian period of geological time have been found, which is earlier than the date of appearance of air-breathing *vertebrata*. The first of the latter, the *Batrachia*, have not been obtained from beds lower than the carboniferous period. At the present time the fishes are the most numerous class of the *vertebrata*, ten thousand species being known.

There are at least one hundred and forty species of fishes in the waters

of Pennsylvania, of which eighty species are important as food. Thirty-one species exist in the Deleware and its tributaries, which are either now used as food, or will be at some future time. About the same number are found in the Susquehanna, while there are forty-one inhabiting the Allegheny and its branches. When we reflect that each female of these species spawns several thousands or hundreds of thousands of eggs in a season, we can readily estimate the great importance this crop might be to us as a source of cheap animal food, were it cultivated to the extent of the capacity of our streams. That capacity in Pennsylvania is very great, for it depends chiefly on the supply of food for fishes furnished by nature. This is ultimately derived from a strong vegetation, either directly, or through the insects which feed upon it, which sustain insectivorous, and indirectly the carnivorous species. Ultimately, then, a productive soil is as much the condition of fish production as of any other, and thus our State possesses, evidently, extensive advantages in this respect.

Some of these species migrate to salt water in autumn, and remain there during the winter; others descend the creeks to the rivers, and the rivers to their deeper waters, and congregate in them during cold weather; others remain all winter in their usual haunts, burying themselves in mud, and undergoing a kind of hibernation; while some—for example, certain catfishes—do not take even this precaution. With a few exceptions, on the advent of spring and the breaking up of the ice, they ascend to the upper and clear waters, or to the gravelly bottoms, to deposit their spawn. The exceptions are the eels and the trout. The former descend the rivers in autumn, and deposit their eggs in salt water. The latter spawn in the upper waters in late autumn, prior to their riverward—or in the case of the salmon, seaward—migration.

Fishes are divided into four primary divisions by the peculiarities of structure presented by their skeletons. These are as follows: *

I. *Suspensorium continuous with the cartilaginous cranium, with no hyomandibular nor rudimental opercular bone; no maxillary arch; pelvic bones present; axial series of fore limb shortened, the derivative radii sessile on the basal pieces; axial series of hinder limb prolonged in male.* . . . . . HOLOCEPHALI.

This sub-class includes the *Chimaerae*, etc., and is represented by numerous extinct, and but few recent species. The latter are all marine and none therefore are included in the present book.

II. *Suspensorium articulated with the cranium; no maxillary arch; no opercular or pelvic bones; bones of limbs as in the last.* SELACHII.

The sharks, rays, saw fish, etc., constitute the members of this sub-class, and none of them enter Pennsylvania waters. Though the living species are numerous, a still larger number are extinct.

III. *Suspensorium rudimental, articulated with cranium, supporting one or more opercular bones; cranium with superior membrane bones; no*

*See Cope, Proceedings, American Philosophical Society, May, 1877.

maxillary arch; a median pelvic element; the limbs supported by segmented unmodified axes. . . . . . DIPNOI.

There are but few recent species of the *Dipnoi*, and they are confined to the fresh waters of the Southern Hemisphere.

Numerous extinct species are known from Mesozoic and Palæozoic formations, especially those of the genera *Ctenodus* and *Ceratodus*.

IV. *Hyomandibular and palatoquadrate bones articulated with cranium, supporting opercular bones; a maxillary arch; no pelvic element; axes of the limbs shortened, the derivative radii sessile on the basal pieces.*— HYOPOMATA.

This sub-class includes a great number of existing fishes, and fewer, though numerous, extinct species. Many of the latter have been arranged under a supposed order called *Ganoidea*, which the author has not adopted in the form originally proposed. The primary divisions of *Hyopomata* are indicated by the structure of the fins, of which there are three principal modifications. These divisions form a regular and natural succession from those which resemble the limbs of the *Dipnoi*, and hence approach those of other vertebrates, to the most specialized fins of the most typical fishes.

A. *Derivative radii present in both limbs; in the anterior supported by an axial segment with one or more basal or derivative radii, forming a peduncle; in the hind limbs the derivative radii sessile on axial segment only.* . . . . . CROSSOPTERYGIA.

This tribe includes the only fishes originally referred to the "Ganoidea," which, it appears to me, should be widely distinguished from the typical fishes. They date from the Carboniferous period and are mostly extinct. One family, the *Polypteridæ*, remains, and is represented by a limited number of species in the fresh waters of Africa.

B. *Derivative radii few in fore limb, sessile on scapula; present in hind limb, and sessile on axial segment.* . . . . . CHONDROSTEI.

This tribe includes the sturgeons, paddle-fish, etc., and is confined at the present period to the fresh waters of the Northern Hemisphere. There are numerous extinct species.

C. *Derivative radii few in the fore limb, sessile on the scapula; wanting or very few and rudimental on the hind limb, so that the dermal radii rest on the axial element.* . . . . . ACTINOPTERI.

In this tribe we have the representative type of fishes of the present geological age. Although the extinct species are numerous, they do not constitute nearly so large a percentage of the whole as is the case with the *Chondrostei*, the *Crossopterygia*, and the other sub-classes.

HYOPOMATA.

CHONDROSTEI.

The living *Chondrostei* have a persistent chorda dorsalis, which is surrounded by the imperfectly ossified vertebral bodies. The ventral fins are situated on the abdomen, and the vertebral column is not especially modi-

FIG. 30. *Esox lucius*—Linn. From Klippart.

FIG. 29. *Esox nobilior*—Thomps. From Klippart.

FIG. 31. *Esox reticulatus*—Les. Original.

FIG. 32. *Gadus morrhua*—The Haddock. From Storer.

fied at its posterior extremity to support a caudal fin. The latter is attached along the inferior edge of the gradually diminishing column, as in the sharks, forming the type called homocercal. The radii of the fins do not agree in number and articulate with their osseous supports, as in higher fishes. There are two orders in this tribe, as follows:

1. A praecoracoid arch; no symplectic bone; premaxillary forming mouth border; no subopercelum nor preopercelum; mesopterygium distinct; basihyals and superior ceratohyal not ossified; interclavicles present; no interopercelum nor maxillary; branchihyals cartilaginous.
Selachostomi, the paddle-fish.

2. Similar to the last, but with interopercle, maxillary bones, and osseous branchihyal, ... *Glaniostomi*, the sturgeons.

The first order embraces the single family of *Polyodontidae*, the second only that of *Accipenseridæ*. In both, the osseous cranium is little developed. The basal and radial elements of the limbs, with the coracoids, are not ossified.

SELACHOSTOMI.

POLYODONTIDAE—*Spoonbill.*

Two genera from this family are known, *Polyodon*, from North America, and *Psephurus*, from Eastern Asia. The former has a long, flat, spoon-shaped snout, and numerous fulcra extending along the superior border of the caudal fin. The latter has a subcylindric snout, and a few very large caudal fulcra. Both genera are adapted for living in muddy bottoms, using their long snouts for the purpose of stirring up and digging out their food.

POLYDON—Lacep. *Spatularia Shaw; Planirostra Les.*

POLYODON FOLIUM, Lac. *Duck-billed cat; spoon-billed sturgeon.*

Snout nearly one third of length; opercular flap reaching much beyond pectorals; fins all more or less falcate; color, gray; D. 55 to 60; A. 56; length, 5 feet or more. Mississippi and its larger tributaries, abundant; a singular fish bearing considerable resemblance to a shark.

The mouth and gill openings of this fish are very wide, and the gill arches are set with very numerous and elongate bristles or gill-rakers directed inwards. The fish stirs up the mud with its muzzle, and, taking enormous quantities of the muddy water into its mouth, passes it through the fringe of rakers, and out through the gill fissures. In this way it takes its food, which is caught on the rakers, as the food of the whale is arrested by the bristles of the whalebone. This food has been shown by Prof. Forbes to consist of minute crustacea of various species.

Polyodon folium is common in the Allegheny river and other large tributaries of the Ohio.

GLANIOSTOMI.

ACCIPENSERIDAE—Sturgeons.

The sturgeons are the largest of fresh water fishes, and are found in all the waters of the Northern Hemisphere. Though of low organization as

compared with the typical fishes, they are of great utility to man, forming an important article of food. They live preferably on muddy bottoms, and derive their nourishment from the refuse organic material there found.

Two recent genera only are known, and both of these are found in North America, and in Pennsylvania. These are:

No spiracles; bony bucklers completely inclosing tail; *Scaphirhynchops.*
Spiracles present; bony bucklers always distinct; . . *Accipenser.*

SCAPHIRHYNCHOPS—Gill. (*Scaphirhynchus Heckel, preoccupied.*)

Three species of this genus have been found in temperate Asia, and one in North America.

SCAPHIRHYNCHOPS PLATYRHYNCHUS—Rafinesque. (*Shovel-nosed Sturgeon.*)

Fig. 5, p. 40.

Tail wider than deep, extending beyond caudal rays, and ending in a filament; snout nearly the form of a spade; whole body rough with small prickles; dorsal shield, 15 or 16; lateral shield, 40 to 46; abdominal, 10 to 13; all the shields rough and strongly carinated; the keel ending behind in a spine which points backward; size large; Mississippi valley, from Montana to Pennsylvania; Rio Grande, of Texas.

ACCIPENSER—Linn.

The species of sturgeons are numerous, and it is not yet certain how many inhabit the waters of the United States. Besides the four named below there are forms with few or no lateral bony shields, which are found in the great lakes and Mississippi river. They have been thought to be aged individuals of other species.

A. Marine species ascending rivers; lateral shields, 22 to 23.

ACCIPENSER STURIO—Linn.

Fig. 6a, p. 41.

Common Sea Sturgeon. Sharp-nosed Sturgeon—Snout pointed, half the length of head; dorsal shields, 11 to 13; lateral shields, 26 to 31; D. 37 to 44 rays. Atlantic Ocean, south to Africa, and West Indies. (*A. oxyrhynchus*, Mit., the American form.)

The common sturgeon is abundant in the lower parts of the Delaware river, and great numbers of them are taken every year and brought to the market of Philadelphia.

ACCIPENSER BREVIROSTRIS—Lesueur.

Blunt-nosed Sturgeon—Snout blunt, one quarter length of head; dorsal shields, 8 to 10; lateral shields, 22 to 28; abdominal, 8 to 10; D. 30 rays; skin with minute scattered prickles and stellate ossifications. Cape Cod to Florida.

Like the *A. sturio*, this species is sold in the markets of Philadelphia and

adjacent cities. Numerous fishing boats are engaged in taking them in strong nets, and the catch is often very large.

AA. Species of fresh water; lateral shields, 33 to 38.

ACCIPENSER MACULOSUS—Lesueur.

Rock Sturgeon—Bony Sturgeon—Snout pointed, nearly as long as rest of head; head $3\frac{1}{3}$ in length of body; bony shields large, close together, 13 to 16 in front of dorsal, 33 to 38 on sides, 9 or 10 on abdomen, all of them rough and strongly radiated, with more or less hooked or incurved tips; skin rough; D. 37 to 45. Great lakes (?), Ohio river, and southward. Abundant in the Allegheny river.

ACCIPENSER RUBICUNDUS—Lesueur.

Red sturgeon—Lake sturgeon—Head $4\frac{1}{2}$ in length; eye 10 in head, nearly midway; dorsal scutes 16, (to base of D.,) relatively small and rather distant; lateral scutes, 35; ventral scutes, 9; snout rather blunt, becoming more so with age, rather shorter than rest of head; barbels nearer to end of snout than to eye; scutes relatively smaller, smoother, and less crowded than in the preceding; blackish, sides paler or reddish; length, 2 to 6 feet; D. 37. Great lakes and western rivers.

The naked and semi-naked species above mentioned, are sometimes referred to this and the preceding species. They have received the names *A. serotinus*, Raf, and *A. calvus.* They are from the Ohio and the lakes.

ACTINOPTERI.

This tribe corresponds to the *Teleostei* of previous authors, together with a considerable part of the *Ganoidei* of Agassiz and others. A study of the skeleton shows that a number of the fishes formerly included under the latter head, are only primitive types of ordinary fishes, without agreement in any marked characteristics by which they can be separated from them. It is true that some of these fishes are exceptional in some of their features, but they differ from each other in many of them, and agree with each other in very few. I allude especially to the bony gars, the dog fishes, and numerous extinct genera.

Two great divisions of the bony fishes were perceived by Cuvier, and as they are easily recognized, I retain them here. They have been called the *Physoclysti* and *Physostomi.* The presence of the ductus pneumaticus which characterizes it, is always associated with the abdominal position of ventral fins and with cycloid scales; and mostly with the presence of the praecoracoid arch, the entrance of the maxillary bone into the border of the mouth, and the non-separation of the parietal bones by the supraoccipital. Yet none of these characters are precisely associated at the point of transition in each sub-division, for there are physostomous fishes with separated parietals and etenoid scales, (some Cyprinodontidæ,) and there are Physoclysti with abdominal ventrals. Nevertheless, two prominent

types stand out in the Actinopteri, the Physostomi, and the Physoclysti, which may be considered as tribes.

Basilar segments of ventrals rudimental, position of fins abdominal; parietal bones usually united; swim bladder connected with the stomach or œsophagus by a ductus pneumaticus, . . PHYSOSTOMI.

No ductus pneumaticus; parietal bones separated by the supraoccipital; ventral fins usually thoracic or jugular; no basilar segments, PHYSOCLYSTI.

These divisions were called *Malacopterygii* and *Acanthopterygii* by Cuvier, the names being based on a general peculiarity of the fins of the species included. In the former or *Physostomi*, the rays of the dorsal fin are generally soft or cartilaginous; in the latter or *Physoclysti* the anterior rays of the dorsal, ventral and anal fins are osseous. There are, however, many exceptions to this rule, so that it is only of general application. Still less uniform is the other general rule, that the scales of spinous rayed fishes are serrate or dentate on their fore edges, and those of soft rayed fishes, smooth.

The *Physostomi* as the least specialized group, presents more numerous points of affinity to the lower divisions already reviewed, and precedes the *Physoclysti*. This is also the order of their succession in geological time.

PHYSOSTOMI.

The following key will express the leading features of the orders of this division.

I. A praecoracoid arch.

A. A coronoid bone.

Vertebrae opisthocœlian, ... 3. *Ginglymodi*, the bony Gar.

Maxillary not transversely divided; vertebrae amphicœlian. 4. *Halecomorphi*, the dog fish.

A. A. No coronoid bone.

* No symplectic bone.

Pterotic simple, anterior vertebrae with ossicula auditus; supraoccipital and parietals coössified, . . 5. *Nematognathi*, the cat fishes.

Pterotic annular, including a cavity closed by a special bone; parietals distinct, vertebrae simple, . . . 6. *Scyphophori*, the Mormyri.

** Symplectic present.

Anterior vertebrae coössified, and with ossicula auditus. 7. *Plectospondyli*, the suckers, etc.

Anterior vertebrae similar, distinct, without ossicula auditus. 8. *Isospondyli*, herring, etc.

II. No praecoracoid arch.

A. Scapular arch suspended to cranium.

B. A symplectic.

Pterotic and anterior vertebrae simple, parietal separated by supraoccipital, ... 9. *Haplomi*, pike, etc.

Anterior vertebrae modified; parietals united; pectoral fins. 10. *Glanencheli*, Electric eel.

B. B. No symplectic.

Anterior vertebrae simple: a praeoperculum and maxillary; no pectoral fins, ... 11. *Ichthyocephali*, Java eels.

A. A. Scapular arch free behind the cranium.

* A preoperculum.

A symplectic; maxillary well developed; no pectoral fins. 12. *Holostomi*, Symbranchi.

No symplectic; maxillary lost or connate: pectoral fins. 13. *Enchelycephali*, eels proper.

* * Preoperculum wanting or rudimental.

No symplectic, maxillary, nor pectoral fins; no pterygoid. 14. *Colocephali*, Muraenae.

Of the above orders the Haplomi (pike, etc.) approach nearest the Physoclysti of the families Opheocephalidae and Atherinidae, and the Holostomi of the family Symbranchidae, to the Physoclyst family of Mastacembelidae. The affinities between these families is, in both cases, so close as to render the distinction of the primary divisions in question hardly worth preserving.

In tracing the affinities of the Physostomi, I have pointed out the relation between the Chrondrostei and the Nematognathi, and between the Halecomorphi and the Isospondyli. In each of these pairs the first named is the structural, and probably genetic predecessor of the second. The series commenced with the cat fishes may be continued into the Mormyri, and then to the families of the Plectospondyli, where the series with altered vertebræ and with ossicula auditus terminates.

The Characins have, however, considerable affinity to the Isospondyli, especially in the type of their branchial bones. From the latter group we pass to the Haplomi, and thence to the Physoclyst groups. The eel-like groups form a special line. The Glanencheli have cranial characters of the groups with modified vertebræ, with fins of the more typical eels. The latter show a steady approach in some points to the conditions characterizing the Chondrostei. The loss of the maxillary, of opercular bones, and of pharyngeal elements, reminds one of these, but in the loss of the premaxillary, and great development of the ethmoid, in the Colocephali, we have features quite unique. The vertebral position of the scapular arch is the only shark character they possess; while on the other hand, the Holostomi are undoubtedly related to the Mastacembelus, a real Physoclyst with spinous dorsal fin. These relations are as yet entirely inexplicable.

GINGLYMODI.

Parietals in contact; pterotic and opisthotic absent; symplectic present. Mandible with coronoid, opercular, angular, articular, and dentary bones. Basis cranii simple. Third superior pharyngeal bone small, lying on fourth;

upper basihyal wanting. A præcoracoid arch. Vertebræ opisthocœlous. Pectoral fins with mesopterygium and five other basal elements.

One family, the *Lepidosteidæ*, with heterocercal tail, cartilaginous præcoracoid, one axial hyoid, three basal branchihyals, and the maxillary bone subdivided into segments.

LEPIDOSTEIDÆ—*Bony Gars.*

The bony gars form one of the marked features of the fish fauna of North America. Although they resemble various extinct fishes of the more ancient (palæozoic) formations, they have little real affinity with them. The family first appeared in the lower Tertiary formations (Eocene) of Europe and North America, and soon became extinct in the former country.

The *Lepidosteidæ* are covered with rhombic ganoid scales; there is one dorsal fin situated far back; and all the fin rays are cartilaginous and equal in number to their supporting bones in the vertical fins. The dentine of the teeth is thrown into deep folds.

There are two recent genera of the family, and two extinct ones. But one of the former enters the waters of Pennsylvania. This is *Lepidosteus*, in which the large teeth of the jaws are in one row.

LEPIDOSTEUS—*Lacep.*

Six or eight species of this genus occur in North America, east of the Rocky Mountains, but two or three of which enter the limits of our State. They are not valued as food.

LEPIDOSTEUS OSSEUS—*Linn.* (*Gar Pike, Bony Gar, Bill Fish.*)

Head nearly 3 times in length; depth nearly 12; snout more than twice the length of rest of head; eye nearly 2½ in distance to margin of preopercle, more than 2 in interorbital space; ventrals mid-way between pectorals and anal; olivaceous, white below; sides with obscure spots, more evident posteriorly; vertical fins with distinct round black spots; D. 7; A. 9: lat. line 64 to 66; length 2 to 5 feet. New York to the plains and south, abundant in large bodies of water.

Two well marked varieties of this species, if not distinct species, occur in the waters of the State. The larger, the *Lepidosteus semiradiatus*, Agass. (*L. crassus* Cope,) is abundant in the Susquehanna, and the lower waters of the Delaware. It is of robust proportions, has the face and opercula rather short, and the scales on the anterior part of the body roughened. The other form is the *Lepidosteus huronensis*, Richardson, and is the species of the lakes, and abounds in the Allegheny river also. Its head and opercula are of more slender proportions, and the size is less. The scales are nearly all smooth, and the color of the body is plumbeous above, and white below, and without spots.

The *Lepidosteus productus* Cope, a species intermediate between these

and the *L. platystomus*, is found in the western tributaries of the Mississippi, and will probably occur in the Ohio.

LEPIDOSTEUS PLATYSTOMUS—*Raf.* (*Short-nosed Gar.*)

Snout shortened, rather broad, about as long as the rest of the head. Depth 7 to 8 in length; head 3.5; eye 10 times in head, three times nearer opercular margin than end of snout; ventrals much nearer P. than A.; length of head notably shorter than from P. to V.; olivaceous, sides and fins spotted with black; D. 7; A. 8; lat. 1, 60 to 65. Great Lakes and streams south and west of New York to Rocky Mountains. In Pennsylvania only in the Allegheny river.

HALECOMORPHI.

Parietals in contact; pterotic and opisthotic present, and with basis cranii and anterior vertebrae simple. Mandible with opercular and coronoid bones; maxillary bordering the mouth. Third superior pharyngeal lying on enlarged fourth; upper basihyal wanting. Vertebrae amphicœlian. Pectoral fins with mesopterygium, and eight other elements.

One family, the *Amiidae*, with heterocercal tail, cartilaginous praecoracoid, one axial and four basal branchihyals.

AMIIDAE—*Dog Fishes.*

In this family the swim bladder is somewhat cellular, and the valves of the bulbus arteriosus are fewer than in the *Lepidosteidae*, though more numerous than in most Physoclystous genera. There is a spiral valve of the intestines, and the scales are cycloid.

But two genera have been found in the United States, one of which, *Pappichthys* Cope, is extinct, and occurs in eocene beds. Extinct species of the recent genus *Amia* have been obtained from the Tertiary Amyzon shales of Colorado.

AMIA—*Linn.*

Only one recent species of this genus has been properly defined.

AMIA CALVA—*Linn.*

Bowfin.—Dog Fish.—Mud Fish.—Depth 4 to 4½ in length; head nearly 4; eye 8 in head; anterior nostrils each with a short barbel; dark olive or blackish above, nearly white below; sides with traces of greenish markings; lower jaw and gular plate with round blackish spots; fins mostly dark; ♀ reaching a length of 18 inches, with a roundish black spot on the upper base of caudal, which is surrounded by an orange or yellowish shade; ♂ larger, 2 feet or more in length, without the black caudal spot; D. 42 to 53; A. 10 to 13; lat. 1, 65 to 70. E. U. S.; abundant in the great lakes.

In Pennsylvania this species abounds in the tributaries of the Ohio river and in Lake Erie. One specimen is recorded by Jacob Stauffer as taken in the Susquehanna. It has never otherwise been recorded from the Dela-

ware nor any Atlantic stream north of the Roanoke. The flesh of this species is of bad flavor, and soft consistence, though of course it has nutritious properties.

NEMATOGNATHI.

Parietals and supraoccipital confluent; four anterior vertebrae coössified, and with ossicula auditus. No mesopterygium. Basis cranii and pterotic bone simple; no coronoid bone. Third superior pharyngeal bone wanting, or small and resting on the fourth; second directed backward. One or two pairs basal branchihyals; two pairs branchihyals. Suboperculum wanting, premaxillary forming mouth-border above. Interaclavicles present.

This great order is represented by the catfishes in North America, and by numerous species and genera in the fresh waters of all tropical regions. Very few species are marine. It embraces at least three families, which are distinguished as follows:

1. Anterior vertebræ modified; inferior pharyngeal bones distinct; fewer branchiostegal radii.

Operculum present, ... *Siluridæ.*
Operculum wanting, ... *Aspredinidæ.*

2. Vertebræ unmodified; inferior pharyngeal bones united their whole length; many branchistegal rays.

Operculum present, ... *Hypophthalmidæ.*

In the *Siluridæ* we have other modifications of importance. Thus in *Plotosus* the second superior pharyngeal is wanting. In *Loricaria* and its allies, the pterotic is greatly expanded, so as to unite with the hyomandibular and opercular bones. The *Aspredinidæ* and *Hypophthalmidæ* are confined to South America.

SILURIDÆ—*Cat-fishes.*

Members of this family abound in all parts of North America, excepting the Pacific slope and great Colorado basin, extending well northwards. They are all, when large enough, valuable as food fishes.

In the western States they are among the first kinds in importance, from the large seize they attain. The species of the Ohio are mostly different from those of the East, and some of them (*Amiurus olivaris*) attain 150 pounds in weight. The most valued is the "blue cat," (*Icthælurus cœrulescens,*) and it is deservedly so. It is sold everywhere, from Pittsburgh to New Orleans and Knoxville, and might be naturalized eastward to advantage.

The genera found in Pennsylvania are the following:

I. Adipose fin continuous with the caudal fin.

Supraoccipital bone free behind, ... *Noturus.*

II. Adipose fin free behind.

Supraoccipital bone free; eyes rudimental and concealed, . . *Gronias.*
Supraoccipital bone free posteriorly; eyes well developed, . . *Amiurus.*

FIG. 34. *Stizostedion vitreum*—Mitch. Pike Perch. From Klippart.

FIG. 33. *Lota lacustris*—Walb. Ling. From stoner.

FIG. 35. *Stizostethium vitreum v. salmoneum*—Raf. From Klippart.

FIG. 36. *Stizostethium canadense*—Smith. From Klippart, (not good.)

FIG. 37. *Micropterus pallidus:* Black bass. From Klippart.

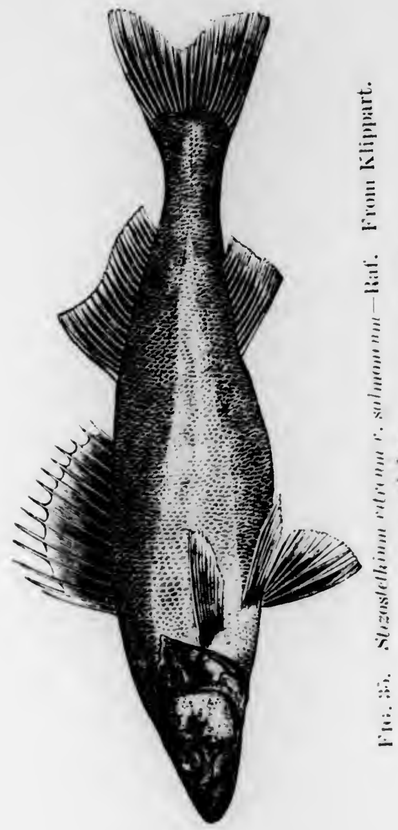


Fig. 35. *Stizostethium vitreum v. salmoneum*—Raf. From Klippart.

Fig. 37. *Micropterus pallidus*: Black bass. From Klippart.

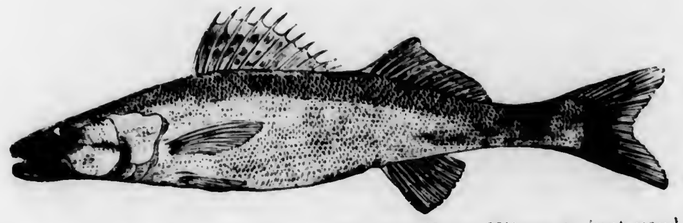


Fig. 36. *Stizostethium canadense*—Smith. From Klippart. (not good.)

Supraoccipital bone articulating with the second interneural bone, forming a bridge from the skull to the base of the dorsal spine; eyes distinct, *Ichthælurus.*

About thirty species of cat-fishes occur in North America, of which thirteen enter the waters of Pennsylvania.

NOTURUS—*Raf.*

The species of this genus are of small and medium size, and generally live in small streams, where they take refuge under rocks and stones rather than in the mud. Their movements are often rapid, and they are well defended by their small acute spines, which inflict painful wounds. There are eight species known.

**Intermaxillary band of teeth without lateral backward process. (Schilbeodes, Bleeker.)

† Pectoral spines more or less serrate on the inner edge; adipose fin notched.

Pectoral spines rather small, their internal serrae feeble, less than half the diameter of the spine; anal rather long, of more than fourteen rays.

NOTURUS INSIGNIS—*Richdsn.*

Margined stone cat.—Upper jaw decidedly longest; pectoral spine about half length of head, pretty strongly retrorse-serrate externally, dorsal spine much nearer anal than snout; the distance from snout to dorsal more than one third the length; anal fin with 16 to 19 rays; body elongate; head flattened; dusky, a distinct black margin to dorsal and caudal fins; size rather large. Pennsylvania to South Carolina, abundant.—*N. lemniscatus*, (Val.) Grd. *N. marginatus*, Baird.

Common in the tributaries of the Susquehanna.

†† Pectoral spines groved on the inner edge, not serrated; adipose fin continuous.

NOTURUS GYRINUS—*Mitchill.*

Tadpole stone cat.—A "starved" representative of the last; slimmer in every way; head shorter and smaller; body more elongate, and more compressed, almost ribbon-shaped behind; barbels pale; anals 13. Southeastern New York, and eastern Pennsylvania and New Jersey. Found in the tributaries of the Delaware.

†† Intermaxillary teeth with strong lateral backward processes.

NOTURUS FLAVUS—*Raf.*

Yellow stone cat.—Head much depressed and flattened, little longer than broad; barbels rather short; head $4\frac{1}{4}$ in length; depth $5\frac{2}{3}$; distance from snout to dorsal 3; middle of body cylindrical, somewhat carinate above; adipose fin notched; spine of pectorals roughish behind, slightly retrorse-serrate in front. St. Lawrence to Kentucky and Upper Missouri, abund-

ant; the largest species, reaching a length of a foot. It is abundant in the tributaries of the Ohio.

AMIURUS—*Raf. Gill.* (*Amiurus and Pelodichthys—Gill.*)

A. Intermaxillary teeth with strong lateral backward processes.

AMIURUS OLIVARIS—*Raf.* (*Mud Cat fish.*)

Body very long and slender, much depressed forwards, closely compressed behind; head very long and flat, tapering downwards and forwards, broadly rounded in front; head 3½ in length, depth 6 in length; dorsal spine somewhat enveloped in thick skin; pectoral spine very long, flattened, serrated behind; adipose fin high and long; jaws thin and flat the lower always the longer; colors much mottled; anal fin quite short, of 15 rays. A singular species, reaching a very large size, abounding in the muddy portions of all the waters of the Mississippi Valley. Not found in the Atlantic rivers.

B. Intermaxillary band of teeth without lateral backward processes.

*Caudal fin rounded or slightly emarginate, usually truncate when spread open.

†Anal fin very long, its base one fourth or more the length of the body; of 24 to 27 rays.

b. Head broad, mouth wide; form stout.

AMIURUS NATALIS—*Les.*

Fig. 6b, p. 41.

Yellow cat.—Chubby cat.—Body stout and heavy, with large head; dorsal spine nearer snout than adipose fin. A widely diffused species running into many varieties. The following are those that probably occur in Pennsylvania.

A. N. LIVIDUS, Raf. More elongate; dark colored; jaws equal. Ohio river.

A. N. CUPREUS, Raf. Yellowish brown, upper jaw longer; common. Ohio River.

A. N. COENOSUS, Richdsn. Greenish or black; upper jaw longer. Great lakes.

This species is not found in the Atlantic rivers.

†† Anal fin moderate, of 18—22 rays.

c. Lower jaw longer than upper.

AMIURUS VULGARIS—*Thompson.*

Long-jawed cat.—Body rather elongate, the depth 4½ to 5 in length; head 3½; barbels long; mouth wide; head longer than broad; dorsal nearer snout than adipose fin; head broad forwards; A. 20, dark reddish brown, varying to blackish. Great lakes and tributaries, generally abundant. [A Dekayi, (Grd.) Gill.]

cc. Jaws about equal in length.

e. Body not much elongate.

f. Head moderately broad; an even slope from snout to elevated base of dorsal fin.

AMIURUS NEBULOSUS—*Les.*

Fig. 7, p. 48.

Bull-Head.—Horn-Pout.—Small cat-fish.—Body rather elongate, depth 4 to 4½ in length; head broader than in the next, the front less steep, but its slope more uniform; body less rapidly narrowed behind; and fin longer, its base 4½ in body, the rays 21 or 22 in number; upper jaw distinctly the longer; color dark yellowish brown, varying to blackish, sometimes marbled, the young often quite black. Great lakes to Maine to South Carolina, the common eastern species. (*A. atrarius, catus, hoyi*, etc., of authors.)

This species is caught in great numbers in the Delaware and Susquehanna rivers, and is a good food fish.

AMIURUS MELAS—*Raf.*

Black cat.—Body very stout and deep; the depth 3½ to 4¼ in length; head not very broad, rather contracted forwards, the front steeply elevated, the body thick across the "shoulders," rather rapidly narrowed behind; anal fin short and deep, of 18 or 20 rays, its base nearly five in length, the color of the rays forming a sharp contrast with that of the membranes; upper jaw scarcely longest; size small; color almost black. Mississippi valley, abundant. (*A. catulus, obesus, confinis*, etc., of authors.)

* * Caudal fin forked, its lower lobe the larger; colors more or less olivaceous or silvery.

a. Head rather broad, anal rays 25 or 26.

AMIURUS NIGRICANS—*Les.*

Great forked-tail cat.—Cat-fish of the lakes, Mississippi cat, Florida cat, great blue cat.—Head comparatively small, 4¼ in length, its width 5; barbels long; spines short and stout, serrated; body rather low and moderately stout; colors dark, mottled with paler; size very large. Great lakes, Mississippi valley, and South to Florida, much the largest of our cat-fishes, reaching a weight of 100 to 200 pounds.

a. a. Head narrow, decidedly longer than broad.

† Anal rays, 23 or 24.

AMIURUS ALBIDUS—*Les.*

White cat, channel cat of the Potomac.—Head narrowed, very wide in adults, quite narrow in young, its width 4 to 5 in length of body; upper jaw considerably the longer; dorsal spine nearer adipose fin than snout; caudal deeply forked; base of anal fin 4½ in length; A. 21. Pennsylvania to South Carolina, abundant. [*A. lynx*, (Grd..) Gill.]

This is the "Schuylkill cat," of Philadelphia, and is consumed in great numbers in the eastern cities between New York and Richmond. It is one of the best of food fishes, although of too small size to sustain any extensive industry. It has been introduced into the Sacramento river, California, and flourishes there so as to have become an article of food in San Francisco.

AMIURUS LOPHIUS—*Cope.* (*Big Mouthed Cat.*)

Head extremely wide, its width $3\frac{3}{4}$ in length, as great as the length of the head: upper jaw slightly the longer; caudal shallow forked; base of anal fin 6 in length; A. 21; color silvery as in the preceding. Tributaries of Chesapeake Bay, rather common. Very old specimens of *A. albidus* resemble *A. lophius*, but may be recognized by the characters above noted. *A. lophius* has the largest mouth of any North American cat-fish.

This species is seen in the markets of Washington and Baltimore, and is probably found in the Susquehanna. It is not known from the Delaware, nor west of the Alleghenies.

GRONIAS—*Cope.*

GRONIAS NIGRILABRIS—*Cope.*

Fig. 1, p. 32.

Cave cat-fish.—Form, &c., nearly of *Amiurus melus;* but the eyes little developed; anal short, of about 19 rays. Subterranean streams, tributaries of Conestoga river, east Pennsylvania.

This singular blind fish was originally discovered by Mr. Jacob Stauffer, near Lancaster, Pennsylvania, and has been obtained a number of times subsequently by different persons.

ICHTHÆLURUS—*Raf.*

This genus includes three species of a more slender build and more active habits than most of the species of *Amiurus*.

ICHTHÆLURUS PUNCTATUS—*Raf.*

Fig. 8, p. 48.

Common channel cat, blue cat, white cat, &c. Head moderate, about 4 in length; dorsal region not especially elevated; spines long; coloration of the others, bluish silvery, young spotted with olive. New York to South Carolina, west to the Rocky Mountains and Mexico, very abundant. It has been described under some twenty-three different specific names. [*I. punctatus*, (Raf.,) Jord.]

A valuable food fish, two feet in length, common in the Ohio and its tributaries, and absent from streams flowing into the Atlantic.

SCYPHOPHORI.

Parietals narrow, distinct from each other and the supraoccipital. Pterotic large, funnel-shaped, enclosing a chamber which expands externally, and is covered by a lid-like bone. No symplectic. Opercular bones present. Anterior vertebræ unaltered. No mesopterygium. Basis cranii simple. No interclavicles.

This order includes only two families, the *Gymnarchidae* and the *Mormyridae*, both of which are confined to the African continent.

PLECTOSPONDYLI.

Parietals broad, distinct; pterotic normal; symplectic present. Opercular bones all present; no interclavicles. Anterior four vertebræ much modified, and with ossicula auditus.

This order embraces a larger number of species of fresh water fishes than any other, and is represented in all the regions of the earth, excepting Australia. There are six recent families which have the following characters:

1. Brain case produced between orbits; only two superior pharyngeal bones; basis cranii simple.

a. Only two basal branchihyals.

Tail diphycercal; maxillary entering mouth border, . . *Catostomidae.*

a. a. Three basal branchihyals.

Tail heterocercal; mouth bounded by premaxillary. *Cyprinidae. Cobitidae.*

Tail protocercal, ... *Sternopygidae.*

2. Brain case not produced between orbits; basis cranii double, with muscular canal in many; four to one superior pharyngeal bones.

Three basal branchihyals, . . . *Characinidae. Erythrinidae.*

Of these families, the *Erythrinidae* and *Characinidae* and *Sternopygidae* are found only in the tropics and southern hemisphere, and the *Cobitidae* belong exclusively to the Old World. The *Cyprinidae*, the most extensive family of fresh water fishes, belongs to the northern hemisphere and Africa, having nearly the distribution of the raniform anurous *Batrachia*, and insectivorous *Mammalia*. The *Catostomidae* are entirely North American excepting two species, which are Asiatic.

The fishes of the two families last named, or the carp, chub, and sucker families are not valued in America, though in Europe they form a very important part of the food of the inland population. But there is no doubt of their prospective importance here, and on that ground alone they should share in the protection afforded to our more valued species. They form, in fact, the bulk of the piscine population of the United States, and besides furnishing food for man and bird, form the sustenance of the perch, bass, jack, pike, and other carnivorous fishes. The American carp (*Carpiodes cyprinus*,) a 2.5-pound fish, is eaten along the Susquehanna; and the Ohio species (*C. difformis*, *C. cutisanserinus*, and *C. velifer*,) of about the same size, are also sold in the market. The buffalo (*Bubalichthys urus*) reaches 50 pounds' weight, and is proportionately important, though by no means a fish of fine flavor. The Missouri sucker (*Cycleptus nigricans*) appears in the Pittsburgh market, and is second in size, reaching 15 pounds. The other species are numerous; two come occasionally to Philadelphia market,

and others occur all over the State. Of the whole group, nine species are valuable food-fishes, but rather on account of quantity than quality. None suffer more from the want of protection than these fishes. They inhabit the upper waters of all our streams, and are cut off in thousands by every mill-dam on the many smaller and larger creeks in the country. Their enormous productiveness (some deposit at one time 500,000 eggs) does not make up for this, in the case of any particular stream from which they may have been finally driven. The fish-ways, which preserve the shad and alewives, will also protect the *Cyprinidae*.

CATOSTOMIDAE—*Suckers.*

The suckers are peculiarly North American in their distribution, occurring in all the waters of the continent. One hundred species are distinguished, which fall into eleven genera. These are defined as follows:

A. Dorsal fin elongate, its rays numerous.—*Bubalichthyinae.*
† Cranium with a median fontanelle, ... *Ichthyobus.*
†† No cranial fontanelle. Body elongate, ... *Cycleptus.*
AA. Dorsal fin short, quadrate, with few rays.—*Catostomidae.*
† Pharyngeal teeth flat, of small size.
α Upper lip not very long; lower lip entire or emarginate.
β Air bladder bicellular.
γ No cranial fontanelle.
A lateral line; mouth inferior; lips enlarged, ... *Pantosteus.*
γγ A cranial fontanelle;
A lateral line; mouth terminal; lips thin, ... *Chasmistes.*
A lateral line; mouth inferior; lips thick. . . . . *Catostomus.*
No lateral line; lips not thickened, ... *Erimyzon.*
ββ Air bladder tricellular.
A cranial fontanelle and lateral line, ... *Myxostoma.*
αα Upper lip greatly enlarged; lower lip divided into two separate lobes.
Air bladder tricellular; a fontanelle and lateral line, . *Quassilabia.*
†† Pharyngeal basal teeth robust, molariform.
Swim-bladder tricellular; a cranial fontanelle, and lateral line. *Placopharynx.*

ICHTHYOBUS—*Raf.*

The anterior part of the dorsal fin of these fishes is elevated, sometimes into an elongate filament. They are of more or less compressed form, and their scales are generally large. They do not occur in Atlantic streams east of the Delaware.

† Pharyngeal bones flat, more slender; mouth inferior.

* First rays of dorsal fin much elevated and attenuated, about as long as the base of the fin.

† Muzzle very abruptly obtuse, and anterior suborbital bone much deeper than long.

ICHTHYOBUS DIFFORMIS—*Cope.*

Deformed Carp Sucker.—Eye very large and well anterior; the front edge of the lower jaw in line with the anterior rim of the orbit, and the end of the upper lip reaching the line of the anterior rim of the orbit, the physiognomy being, therefore, peculiar in the great obtuseness of the head; insertion of dorsal anterior to middle of the head; D. 24; A. 8; V. 9; lat. 1. 35. Ohio river.

This species has a peculiar physiognomy. Its very small and inferior mouth indicates finely divided food from the bottom.

ICHTHYOBUS CUTISANSERINUS—*Cope.*

Long-finned carp sucker.—Mouth usual in position, the upper lip in advance of the nostrils, etc.; dorsal fin beginning mid-way of body, more elevated than in any other species; snout with small tubercles in spring males; head 4 in length; depth $2\frac{3}{5}$; D. 26; V. 10; A. 8. Ohio valley, abundant. Allegheny river.

†† Muzzle conic, projecting.

ICHTHYOBUS VELIFER—*Raf.*

Spear Fish—Sail Fish—Quill-back—Skim-back. Muzzle conic, much less obtuse than in the next; depth $2\frac{1}{2}$ in length; head $3\frac{3}{4}$; eye $4\frac{1}{4}$ in head; color pale, scarcely silvery, as in all the species; D. 22; lat. 1, 37. Ohio river.

** Anterior rays of dorsal scarcely filamentous, little more than half the length of the base of the fin,

b. Head comparatively large, $3\frac{1}{2}$ to 4 in length.

ICHTHYOBUS CYPRINUS—*Raf.*

Silvery carp sucker.—Muzzle prominent, but rather obtuse; eye small, anterior, 5 in head's depth, $2\frac{3}{4}$ in length; longest dorsal rays about $\frac{2}{3}$ the length of the base of the fin; D. 28; ar. 29; lat. 1, 40. New York to Alabama, east of the Alleghenies.

This species is abundant in the Susquehanna river, and is a prominent fish in the markets of the towns along its course. Its flesh is of good, but not exceptional, quality.

bb. Head smaller, $4\frac{1}{4}$ to 5 times in length.

ICHTHYOBUS THOMPSONI—*Agass.*

Lake carp sucker.—Short and stout; dorsal region much arched; scales narrowly exposed; longest dorsal ray reaching the 22d; eye small, $5\frac{1}{4}$ in head; head $4\frac{1}{4}$ in length: depth $2\frac{1}{2}$; D. 28; lat. 1, 41. Great lakes.

A good food fish.

2. Mouth terminal, larger.

ICHTHYOBUS BUBALUS—*Raf.*

Brown buffalo fish.—Depth $3\frac{1}{2}$ in length; head the same; eye small $6\frac{1}{2}$ in head; depth of head five sixths its length; opercle very wide, forming

nearly half the length of head—convex and furrowed; scales large; dull brownish olive, not silvery; D. 27; A. 10; lat. 1, 40; length, very (of specimen,) 27 inches; weight 15 pounds. Mississippi valley. A common species of the streams of the Mississippi valley, not found east of the Alleghenies. Extensively used for food.

3. Mouth inferior, small; pharyngeal bones with triangular section.

ICHTHYOBUS URUS—*Agass.*

Black Buffalo, big-mouthed buffalo. Body much less elevated and less compressed than in *B. altus*, the back not at all carinated, axis of body over the ventrals about at the lateral line, and but an eighth or tenth further from the dorsal line than the ventral; greatest depth midway of body over ventrals and just in advance of dorsal; depth $3\frac{1}{8}$ in length; head strongly transversely convex, almost ridged above, less narrowed downwards than in *altus;* greatest depth of head $1\frac{1}{8}$ in its length; interorbital space $2\frac{1}{8}$; snout scarcely projecting; no depression at occiput; an almost even curve from snout to dorsal; head bounded by curves; therefore no triangular, thicker, larger, and less pointed than in *altus;* mouth large, with a large and pappillose lower lip, mandible longer than eye; scales 8—41—7; fin rays D. I., 30; A. I., 11; dorsal not so high nor so rapidly depressed as in *altus*, the longest ray scarcely half the length of the base of the fin, reaching to the 15th, the 9th ray, half the height of the first; anal reaching caudal, its middle rays more rounded, not so much shorter than the first; pectorals as long as ventrals, both longer than anal and less than head; colors very dark; fins all black. Mississippi and Ohio rivers. Used as food in large quantities.

ICHTHYOBUS ALTUS—*Nels.*

Small mouthed Buffalo. Body considerably elevated and compressed above; the dorsal region sub-carinate; belly thicker; depth $2\frac{3}{4}$ in length; axis of the body above the ventrals, below the laterial line and nearly twice as far from the back as the belly; greatest depth of body at beginning of dorsal, which is in advance of ventrals, and a trifle nearer the snout than the caudal; head wide, rounded across the top, wider above the eyes than across the cheeks; interorbital space 2 in head; head 4 in length of body, its greatest depth $1\frac{1}{8}$ in its length; eye-snout 4 in head, much larger than in *B. niger;* mouth small, notably smaller than in *B. niger*, and with thinner lips which are granulated and feebly plicate; mandible about equal to eye; pharyngeal bones very strong, with large teeth, which grow larger downward; intestinal canal long, longer than body; a decided occipital depression; head triangular in outline, viewed from the side; ante-orbital region strongly elevated and curved; length of top of head $2\frac{3}{4}$ in distance from snout to occiput; nostril large; scales 8—40—6 in two specimens, 8—36—6 in one, 7—39—5 in the fourth; fin rays D. I. 28 in two, I. 29 in rest; A. I. 10; V. 10; dorsal elevated in front and rapidly declined, the

FIG. 40. *Ambloplites rupestris*—Raf. From Klippart.

FIG. 38. *Lepidopomus palladus*—Mitch. From Klippart.

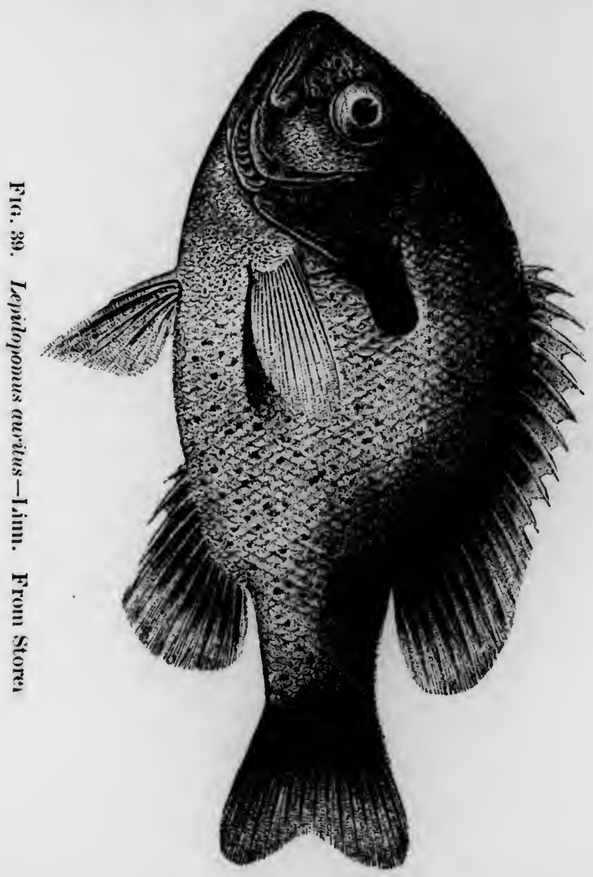


FIG. 39. *Lepidopomus auritus*—Linn. From Storer.

FIG. 41. *Pomotis aureus*—Walb. From Klippart.

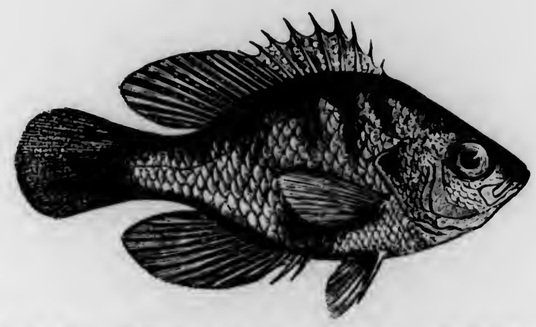


FIG. 42. *Enneacanthus obesus*—Baird. From Abbott.

FIG. 43. *Pamoxys annularis*—Raf. From Klippart.

seventh ray half the length of the third or longest; the latter reaches to the base of the eighteenth ray, or more than half the base of the fin: anal reaching caudal, its rays rapidly shortened; pectorals shorter than anal, anal than ventrals, all than head. Mississippi valley, abundant.

CYCLEPTUS—*Raf.*

CYCLEPTUS ELONGATUS—*Lesueur.*

Black Horse, Gourd-Seed sucker, Missouri sucker.—Body fusiform, not greatly compressed; head and mouth very small; depth 4 to 5 in length; head $6\frac{1}{4}$; eye small, well back, 6 to 7 in head; lobes of dorsal and caudal much attenuated; longest dorsal rays a little longer than head; pectorals falcate, as long as head; anal fin small; scales with the exposed surfaces broad. ♂ Jet black above; sides black with a coppery luster; snout minutely tuberculated in spring; ♀ olivaceous; D. 30; A. 7; lat. 1.56; length 2 to 3 feet; weight 2 to 15 pounds. Mississippi valley, in large streams. A singular species, quite unlike any other. Occasionally taken in the Allegheny river.

CATOSTOMUS—*Les.*

Hypentelium—Raf. Minytrema—Jordan.

This genus includes the ordinary suckers, and is distributed throughout North America.

*Scales large, lateral line imperfect.

CATOSTOMUS MELANOPS—*Raf.* Spotted mullet. Striped sucker.

Each scale with a large, square, blackish spot at its base, these forming more or less conspicuous stripes along the sides; body subterete, becoming deeper with age Head $4\frac{2}{3}$ in length; depth about 4; scales very large; blackish above; sides coppery, with black stripes; D. I., 12; lat. 1. 47; size large; adult males with the sides of the head profusely tuberculate in spring; young specimens of this species have no trace of lateral line, as in *Erimyzon;* older ones (6–8 inches) show a deepening of the furrows along the median series of scales; adults of 12 to 18 inches show a series of completely developed tubes, which, however, are wanting on some of the scales, especially behind; as *Erimyzon* never shows any traces of the tubes of the lateral line. Great lakes, Ohio valley, and south, abundant; one of our handsomest suckers, strangely overlooked by recent writers. This and the next, unlike most of our suckers, are very hardy in the aquarium.

** Scales large, lateral line imperfect.

CATOSTOMUS NIGRICANS—*Les.*

Banded Sucker.—Stone Roller.—Hog Sucker.—"Mud Sucker."—Depth $4\frac{3}{4}$ in length; head 4; depth of head $\frac{2}{3}$ its length; eyes small, very high up and far back; lower fins very large; pectoral nearly as long as head;

brownish, often beautifully marbled; D. I., 11; A. 8; lat. 1,52. Lakes and streams from New York south and west; abundant; one of the most characteristic fishes. It frequents clear streams and rapids, and it is not at all a "mud fish," as some writers seem to suppose. It is most abundant in the tributaries of the Ohio and Susquehanna, but is rare in those of the Delaware.

*** Scales small; lateral line perfect.

a. Lateral line with 60–65 scales.

CATOSTOMUS TERES—*Mitchill.* Fig. 9, p. 49.

Common Sucker.—White Sucker.—Depth about equal to length of head, 4 to $4\frac{1}{2}$ in length; olivaceous, sides silvery, with bright reflections; males with the sides roseate in spring; D. I., 12; lat. 1,63. United States, abundant everywhere east of the Rocky Mountains. (*C. commersonii*, *C. communis*, *bostoniensis*, *sucklii*, etc., of authors.)

Familiar to everyone as "the sucker" par excellence, and found in all waters. It is extensively used for food, but is not distinguished for either good or bad qualities.

aa. Lateral line with about 100 scales.

CATOSTOMUS LONGIROSTRUM—*Les.*

Red-sided sucker.—Long-nosed sucker.—Slender, depth less than length of head; sides with a bright red band, and upper part of head with small tubercles in males in spring; D. I., 10; lat. 1, 110. Great lakes, upper Mississippi, and northward; abundant; [*C. hudsonius*, Les.; *C. aurora*, Ag.; *C. griseus* and *C. lactarius*, Grd.; *C. forsterianus*, (Rich.,) not *C. forsterianus*, Ag.; which is probably *C. teres*, *Mitch.*] Size large.

Lake Erie.

ERIMYZON, *Jordan—Moxostoma, "Raf.," Agass, not Raf.*

ERIMYZON SUCCETTA—*Lac.*

Fig. 10, p. 49.

Chub sucker.—No stripes along the rows of scales, body rather short and deep; head 4 to $4\frac{1}{2}$ in length; depth $2\frac{3}{4}$ in adult; eye 5 in head; scales crowded, deeper than long; no trace of lateral line; dusky above, brassy on sides and below; very variable; young much less compressed, with black bands or bars, and pale lateral and vertebral streaks; spring males with six tubercles on head; D. I, 11; lat. 1,40. New England, south and west abundant.—[*E. oblongus*, (Mit.) Jor.]

Found in muddy and slow streams in all parts of the State, especially the east.

MYXOSTOMA—*Raf.*

Ptychostomus, Agass.—Teretulus, Raf.

This genus includes numerous species, which mostly have large scales. Its great center of abundance is in the southern rivers, which flow into the

Atlantic, but species occur everywhere east of the Rocky Mountains. It is not known from waters flowing into the Pacific.

*Lips thick, not infolded and v-shaped, plicate;

a. Dorsal rays 15–18; mouth large.

MYXOSTOMA CARPIO—*Valenc.*

White Lake Mullet.—Body deep, strongly compressed, the back somewhat elevated; head large, broad above; mouth large with full lips, which are strongly plicate; lower lip full, truncate behind; eye large; dorsal fin high and large, more developed than in any other species of this genus, the first ray about as long as the base of the fin, the rays 15 to 18 in number; coloration very pale and silvery, the lower fins pale; head $3\frac{2}{3}$ to $4\frac{1}{2}$; depth $3\frac{1}{4}$; D. 17; scales 5–43–4. Length 18 to 24 inches.

Habitat, Ohio river and Great lake region. Lake Erie (Jordan.)

aa. Dorsal rays 12–14; scales 1. 1. 41–50.

MYXOSTOMA MACROLEPIDOTUM—*Les.*

Red horse.—Common mullet.—Head comparatively elongate, 4 to 5 in length; mouth large; size large, reach a length of two feet or more. United States, east of the great plains, everywhere common, except in New England and streams east of the Delaware.

VAR. DUQUESNEI—*Les.*

Common red horse.—White sucker.—Head quite elongate, 4 to $4\frac{3}{5}$ in length; back little elevated; body rather elongate, not greatly compressed: scales pretty large, 6–42 to 49–5; back bluish or olive; sides brilliantly silvery, with bright reflections; dorsal fin dusky above; lower fins bright red. Ohio river and southward, very abundant, the common "red horse" in most regions. A common article of food in western Pennsylvania.

VAR. MACROLEPIDOTUM—*Les.*

Lake mullet.—Eastern red horse.—Head still shorter and deeper, $4\frac{1}{2}$ to 5 in length; its upper profile concurrent with the curve of the back, which is considerably elevated; the form being thus somewhat elliptical; sides compressed; dorsal rays usually 13; coloration little silvery, the sides reflecting brownish and golden; back smoky, some of the scales dusky at base; scales 6—42 to 50—5. Great lakes and streams eastward, from Vermont to South Carolina. Very abundant in the Susquehanna, less so in the Delaware. Brought in numbers to Philadelphia market.

MYXOSTOMA AUREOLUM—*Les.*

Golden red horse.—Lake mullet.—Head comparatively short, low and small, 5 to $5\frac{1}{2}$ in length; back elevated and compressed; depth $3\frac{1}{3}$ in length: mouth rather small, more or less overpassed by the snout; coloration bright yellowish brown, etc., not silvery; lower fins bright red; dorsal rays 13: scales 6—42 to 48—5; size large. Great lakes. Ohio Valley and northward.

MYXOSTOMA BREVICEPS—*Cope.*

Long-tail red horse.—Body compressed, the back somewhat elevated; head short, conic, flattish, formed as in *M. aureolum;* mouth very small, the lips plicate, the lower full and truncate behind; dorsal fin short and high, falcate, the anterior rays being elevated, and the free border deeply incised, the height of the largest rays being half greater than the base of the fin; caudal fin with the upper lobe much larger than the lower, falcate, at least in the adult; colors olivaceous, sides silvery with coppery reflections; head $5\frac{1}{4}$; depth $3\frac{1}{2}$; D. 12 or 13; scales 6–46–5. Length one foot. Habitat, Ohio Valley, West Pennsylvania. Known by the unequal lengths of the lobes of the caudal fin.

** Lower lips infolded, Λ-shaped when viewed from below, with a distinct median crease, in which the two halves of the lip meet, forming an acute angle; mouth small.

† Lips plicate, the folds not broken up into papillae.

g. Dorsal rays (developed) 16 (15 to 17.)

MYXOSTOMA VELATUM—*Cope.* (*White Nose.*)

Small-mouthed red-horse.—White nose.—Body stout, deep, compressed, the back elevated, the depth 3 to 4 in length; head short, heavy, flattish and broad above, thick through the cheeks, $3\frac{3}{4}$ to $4\frac{1}{2}$ in length; eye rather large, midway in head, 4 to 5 in its length; muzzle rather prominent, bluntish, overhanging the very small mouth; fins very large; dorsal long and high, its height five sixths the length of the head; pectorals nearly reaching ventrals; color silvery, smoky above; lower fins red; size large. Great lakes to North Carolina and Alabama, rather common. (*P. collapsus*, and *P. velatus*, Cope.) Western Pennsylvania. Generally confounded by fishermen with the red horse. Common in Lake Erie and the Allegheny river.

PLACOPHARYNX—*Cope.*

This genus resembles the last in every respect excepting in the teeth, some of which approach those of some *Cyprinidae.*

PLACOPHARYNX CARINATUS—*Cope.*

Cope's sucker.—Resembles the red horse, but the lips and pharyngeal bones quite different; eye $4\frac{1}{2}$ in head; head 4 in length; depth $3\frac{2}{3}$; head strongly ridged above; pharyngeal bones very heavy, the lower 7 to 12 teeth on each side very large, scarcely compressed; truncate, irregularly placed; D. I, 14; A. I, 7; lat. l. 41; head with a median ridge on top; a large, coarse species similar in general characters to *Myxostoma*, but with the physiognomy approaching somewhat that of *Ichthyobus.* It is probably common in the western streams, although it was not noticed until 1870. Specimens from the Illinois, Wabash, Detroit, Falls of the Ohio and the Scioto, are noted by Prof. Jordan.

CYPRINIDÆ—(*Carp.*)

This family is represented by more numerous species than any other of those of the Northern Hemisphere. Its genera present a great variety of detailed structure, while adhering very closely to the definitions which comprise them all. In habits, there are both carnivorous and herbivorous forms, which differ in the structure of their pharyngeal teeth and alimentary canal. There are also forms which are distinguished by still more radical peculiarities, which form the definitions of the four sub-families below mentioned.

In an economical point of view the *Cyprinidæ* are not as important in the United States as in Europe and Asia, on account of their generally inferior size. The only ones in Pennsylvania which grow to a valuable size, are the two species of *Semotilus.* A number of the other species are valued as pan fish, and are caught in large numbers by anglers. The European carp is a large and valuable fish, and is likely to be acclimated in the State by the labors of the United States and Pennsylvania fish commissioners.

The four sub-families are defined as follows:

I. The natatory bladder free from the dorsal peritonaeum, and surrounded by numerous convolutions of the alimentary canal.

Jaws and opercula normal, ... *Mesocysti.*

II. Swim bladder enclosed in the dorsal peritonaeum, not surrounded by the alimentary canal.

a Mandibular rami distinct from each other.

Cranial bones not cavernous, ... *Epicysti.*

Cranial bones supporting laminæ, which enclose superficial chambers.—*Coelophori.*

a a Dentary bones of opposite sides united together by their lower edges throughout their length.

Cranial bones not cavernous, ... *Cochlobori.*

MESOCYSTI.

Only one genus of this sub-family is known.

CAMPOSTOMA.—*Agass.*

Alimentary canal very elongate; teeth of the external row 4—4, obliquely truncate and without hook; anterior dorsal spine short, closely adherent to the soft rays; dorsal fin above ventrals; lips acute, with a cartilaginous sheath; The intestinal canal six to nine times the total length of the body, its numerous convolutions passing above and around the air-bladder; an arrangement found in Campostoma alone among all the vertebrates.

The species are not numerous, and have a wide range. They are only found in streams east of the Rocky Mountains.

CAMPOSTOMA ANOMALUM—*Raf.*

Stone lugger.—Stone roller.—Brownish, with a brassy luster above, the scales more or less mottled with dark; a black vertical bar behind opercle;

iris usually orange-red ; dorsal and anal each with a dusky cross-bar about half way up ; the rest of the fin olivaceous, or in spring males fiery orange ; males in spring with many rounded tubercles on head, and usually the whole upper surface—in no other genus are these nuptial appendages so extensively developed—scales deep, rather small and crowded anteriorly ; intestinal D. 1, 7 ; lat. 1, 50 to 55 ; L. 4 to 8 ; herbivorous. Mississippi valley, everywhere abundant ; one of the most curious and interesting of American fishes. It takes its food on the bottom, and its movements are rather sluggish, unless it is alarmed, when it darts with great swiftness. In its spring color it is a conspicuous fish —*C. dubium*, (Kirt.) Cope.

EPICYSTI.

This sub-family embraces the greater number of the genera of the family. Those found within the limits of Pennsylvania are the following :

I. Alimentary canal elongate ; teeth grinding or sharply truncate. Herbivorous.

α Dorsal fin long, anal short, each preceded by a spine.

Molar teeth, 1, 3–3, 1 ; mouth with barbels : (introduced.)—*Cyprinus.*

Teeth compressed, 4–4 ; no barbels ; (introduced.) . . . . *Carassius.*

α α Dorsal fin short ; no strong spines in front of it or of the anal ; teeth compressed.

β Rudimentary dorsal spine separated from soft rays by a membrane.

Lateral line imperfect, ... *Pimephales.*

Lateral line complete, ... *Hyborhynchus.*

β β First dorsal spine adherent.

γ Teeth 4–4.

Lateral line complete, ... *Hybognathus.*

Lateral line incomplete, ... *Chrosomus.*

γ γ Teeth, 5–5.

Lateral line complete ; teeth crenate, ... *Notemigonus.*

II. Alimentary canal short ; teeth hooked, mostly without grinding surface. (Carnivorous.)

α No barbel at the angle of the mouth.

β Teeth with grinding surface.

γ Lateral line incomplete.

Teeth, 4–5 or 4–4 ; dorsal fins over ventrals, ... *Hemitremia.*

γγ Lateral line complete.

Dorsal fin standing over some part of base of ventral fins ; teeth 4–4.—*Luxilus.*

Dorsal fin originating behind ventrals ; teeth 4–4, ... *Lythrurus.*

β β Teeth without grinding surface.

γ Teeth 4–4.

Lips thick, fleshy, mouth inferior ; dorsal fin beginning anterior to ventrals, ... *Phenacobius.*

Lips normal ; dorsal fin beginning above ventrals, ... *Cliola.*

FIG. 44. *Ambloden grunniens*—Raf. From Klippart.

Lips normal; dorsal fin beginning behind ventrals, ... *Minnilus.*

γγ Teeth 5–4 and 5–5.

Lips normal; dorsal fin entirely behind ventrals, ... *Gila.*

αα A barbel at the angle of the mouth.

Upper jaw projectile (dermal groove the crossing muzzle) teeth 4–5.—*Semotilus.*

Upper jaw projectile; teeth 4–4, ... *Ceratichthys.*

Upper jaw not projectile, (dermal groove not crossing muzzle;) teeth 4–4, ... *Rhinichthys.*

CYPRINUS—*Linn.*

This genus is distributed in Europe and temperate Asia. One species has been introduced into Pennsylvania.

CYPRINUS CARPIO—*Linn.* (*European Carp.*)

Figs. 12, 13*a*, 13*b*.

Olivacous; D. III, 5; lat. 1.37. European, introduced into some eastern rivers.

CARASSIUS—*Niles.*

Another European and temperate Asiatic genus, of which one species has become abundant in Pennsylvania.

CARASSIUS AURATUS—*L.* (*Gold Fish. Silver Fish.*)

Fig. 14, p. 65.

Orange or blackish, rarely pale; D. I, 19; A. I, 8; lat. 1.26; exceedingly variable in domestication. Asia; common everywhere in aquaria, and now naturalized in many of our eastern streams. Abundant in the Delaware and Schuylkill.

PIMEPHALES—*Raf.*

A genus containing but few species of singular appearance.

PIMEPHALES PROMELAS—*Raf.*

Fat head.—Black head.—Head almost globular, black in adult males; snout in ♂ with several large tubercles; body very short and deep; scales crowded; eye small; mouth very small and short; a large black dorsal blotch; males dusky; females olivaceous; D. I, 7; lat. l. 46; L. 2½. Ohio valley to Upper Missouri. "Known at sight, as it resembles nothing else" (Jordan;) common in the tributaries of the Ohio in Pennsylvania. The heads of the males are especially swollen and are studded with horny tubercles symmetrically arranged.

HYBORHYNCHUS—*Agass.*

The species of this genus resemble those of the last, and are not numerous. They are mud lovers and live on decomposing vegetable matter. Their dark colors enable them to escape observation.

HYBORHYNCHUS NOTATUS—*Raf.*

Blunt-nosed minnow.—Brownish or bluish, a dusky shade along sides, sometimes forming a caudal spot on middle of front rays of dorsal; head short; snout in spring males with disproportionately large tubercles, usually fourteen in all; no distinct barbel at each angle of the mouth; scales in front of dorsal small and crowded; D. 1, 8; A. 1, 7; lat. 1, 45; L. 3 to 4. New York to Tennessee, Wisconsin, and Missouri; very abundant in the Ohio valley.

HYBOGNATHUS—*Agass.*

The species of this genus are numerous and are found in all the Mississippi and Atlantic streams, excepting those of New England.

HYBOGNATHUS NUCHALIS—*Agass.*

Blunt-jawed minnow. Suborbital bones broad and short, not long and narrow as in the next; head $4\frac{2}{3}$ in length; eye small, shorter than snout, 4 to $4\frac{1}{2}$ in head; depth $4\frac{1}{2}$ in length, about equal to length of head; D. 1, 8; lat. 1, 38; L. $2\frac{1}{2}$. Ohio valley and W. This and the next may be readily known from the *Luxili*, which they strongly resemble externally, by the peculiarities of the intestines.

In Pennsylvania from tributaries of the Ohio only.

HYBOGNATHUS ARGYRITIS—*Gird.*

Silvery minnow.—Olivaceous green above, sides clear silvery with bright reflections; fins unspotted; eye large, longer than muzzle, 3 to 4 in head; depth $4\frac{1}{8}$ in length; scales in front of dorsal quite large; lateral line decurved; head large, upper jaw heavy; D. 1, 8; A. 1, 8; lat. 38; L. 5. New Jersey to South Carolina, and west to the Upper Missouri, abundant in the larger streams; one of our handsomest dace. Probably occurs in the Delaware, in Pennsylvania, as it has been taken by Dr. Charles Abbott, in the Raritan, which it ascends with the smelt in the spring.

HYBOGNATHUS REGIUS—*Girard—Smelt Minnow.*

Head 5 in length; mouth small; bright silvery; D. 1, 9; A. 1, 9; L. 7; lat. 1, 38. Maryland and Virginia; a species similar to the preceding, but apparently much larger; the two need further comparison. Probably found in the Susquehanna.

CHROSOMUS—*Raf.*

This genus includes a few small pieces of remarkably brilliant coloration.

CHROSOMUS ERYTHROGASTER—*Raf.*

Red-bellied dace.—Brownish olive, with black spots on the back, a black or brown band from above the eye, straight to the tail; another below, running through eye, decurved along the lateral line; belly and space between bands bright silvery, brilliant scarlet red in spring, males, as are

the bases of the vertical fins; a dark vertebral line; females obscurely marked; D. 1, 8; A. 1, 9 lat. 1, 80 to 90. Pennsylvania to Wisconsin and Tennessee, abundant in small streams; one of the most beautiful of our fishes; in high coloration the fins are bright yellow, and the body is minutely tuberculate. There seems to be but one well-defined species. It is the most desirable of all our minnows for aquarium purposes, being hardy, graceful and brilliantly colored.

Common in the streams of Western Pennsylvania. A variety or distinct species (*C. eos.*) is found in the Susquehanna river, but the genus is not represented in the Delaware.

NOTOMIGONUS—Raf.

There are but few species of this genus, and they are distributed throughout North America. They represent the bream (*Abramis*) of Europe-Asia in their form.

NOTEMIGONUS CHRYSOLEUCUS.—*Mitch.*

Fig. 15, p. 65.

Shiner.—Bream.—Body much compressed; abdomen trenchant; head small, about 4 in length; depth 3 ($2\frac{1}{2}$ to 4); lateral line much decurred; scales small on the back, much larger below; dark steel-blue or green above, sides silvery or golden, every where with brilliant reflections, green, yellow, and red; young specimens paler, looking like young *Luxili*, but the adults are among the largest in the family and bear a strong resumblance to shad, a circumstance which has mislead many observers, and among them Rafinesque; D. 1, 7; A. 1, 14; lat. 1, 45 to 50. New England to Minnesota and S.; abundant in bayous, ponds, and weedy streams; this species is much more tenacious of life than is any other of our cyprinoids.

This fish is the most abundant cyprinoid of tide-water streams, and the ditches and ponds which connect with them. It sometimes reaches one and a half pounds weight, but is of little value as a pan-fish. It affords much sport to the amateur fisher-boys of the eastern cities.

HEMITREMIA.—*Cope.*

HEMITREMIA BIFRENATA.—*Cope.*

Eastern hemitremia.—Head—depth; 4 1-5 in length; snout blunt; olive, a burnished jet-black lateral band of a deeper color than in any other small minnow; D. 1, 8; A. 17; lat. 1, 36. Massachusetts to Maryland, abundant in the tributaries of the Delaware.

The *Hemitremia heterodon*, a species heretofore found in Michigan, may be looked for in the north-western part of the State.

LUXILUS—*Raf.*

Hypsilepis, Bd.—Alburnops, Gir.—Hybopsis, "Agass.," Cope.

This genus embraces a large number of species, many of them of very small size, and some of them larger. Many are distinguished by brilliant colors, which are especially developed in the waters in spring. The

most prominent of these colors is red; next is a silver white pigment; in some there are beautiful shades of blue; less frequently, pale yellow and black are found. In the young of all the species the edges of the pharyngeal teeth are denticulate, and in some of them, *e. g.*, *L. analostanus*, this condition persists throughout life. Such species are difficult to distinguish generically, from those of *Cyprinella*, but the latter possess no grinding surface.

Species of this genus are found in all the drainage basins of North America.

A. Scales of the anterior parts of the body with exposed faces not much elevated.

* Mouth inferior, horizontal; teeth 4-4, (*Alburnops*, Gir.)

† Scales 38-42 on lateral line.

LUXILUS HUDSONIUS—*Clinton.*

Spawn eater.—Silvery, often with dark shades; snout much shorter than eye, bluntly round; depth 4 in length; D. I., 8; A. I., 8; lat. 1, 37; teeth usually 2, 4-4, 2. Lakes and rivers; abundant eastward. (*Hudsonius fluviatilis*, Gir.) Delaware river.

LUXILUS STORERIANUS—*Kirtl.*

"Smelt."—Very similar, but paler and with the snout much less decurved, less blunt than the preceding species; D. I., 7; A. I., 8; lat. 1, 38; teeth usually 1, 4-4, 1. Pennsylvania to Georgia. Lake Erie. (*H. phaënna*, Cope.)

Abundant in the Susquehanna river, especially in the lower part of its course. A bright silvery fish, the largest of the genus.

†† Scales 31-33 on the lateral line.

LUXILUS PROCNE—*Cope.*

Scales large; caudal peduncle contracted and slender; dorsal region compressed and elevated; muzzle very obtuse; a plumbeous band over black pigment; D. I., 8; A. I., 7. Pennsylvania, New Jersey, etc., common; one of the small species.

Abundant in the tributaries of the Delaware and Susquehanna, avoiding rapid water. Often seen in aquaria.

** Mouth oblique, jaws equal; teeth two rowed. *Hydrophlox* Jordan.

LUXILUS CHALYBÆUS—*Cope.*

Pigmy minnow.—Muzzle flat; head 4 in length; caudal peduncle abruptly slender, lateral band very distinct, shining black; A. 1, 8; lat. 1, 36, Penn., N. J.; one of the smallest of the Cyprinidæ; length 1½ inches; (resembles *Hemitremia bifrenata.*) The males in the spring are brilliantly colored, the lower parts being largely orange

Tributaries of the Delaware, especially in dams and ponds.

A A Scales with the exposed surfaces narrowed, vertical, especially anteriorly.

*Teeth 2, 4-4, 2; fins with red pigment, no white.

LUXILUS CORNUTUS—*Mitch.* Fig. 16, p. 72.

Common shiner.—Red-finned shiner.—Rough-head.—Red-fin. Adult deep steel blue or olivaceous above, with golden vertebral and lateral bands, very conspicuous in life; sides silvery, rosy in males in spring; fins plain olivaceous or somewhat dusky, becoming crimson in spring; young olivaceous and silvery, not closely resembling the adult; depth 3 to 5 in length, greater than length of head in adults; head large; mouth moderately oblique, the lower jaw not projecting; lateral line much decurved; D. 1, 8; A. 1, 9; lat. 1, 40 to 45; L. L. 6. U. S. from Main to the Rocky Mountains, everywhere abundant and extremely variable. The adults may be known at once by the high and narrow exposed surfaces of the scales; the young often need close attention. (*Plargyrus typicus*, Grd.; *L. chysocephalus*, Raf.; *L. diplemius and plargyrus*, Kirt.; *Leuciscus frontalis*, Ag., a stout variety from the great lakes.)

The well-known "red-fin" is common in all parts of the State. It is brilliantly colored in spring but becomes pale in the autumn.

** Teeth 1.4-4.1; fins with white pigment; no red.

LUXILUS ANALOSTANUS—*Girard.*

Silver fin. Leaden silvery; fins satin white in the breeding season; dorsal with a conspicuous black spot posteriorily; head 4 in length, rather short and deep; mouth rather small, very oblique, yet the lower jaw received within the upper in the closed mouth; body much compressed; depth 3¾ in length; D. 1, 8; A. I, 8; lat. 1, 35 to 40; L. 3½. Teeth usually more or less serrate. Cayuga L., N. Y., (S. H. Gage,) to N. J., Va., and Ind., abundant. In full breeding dress one of the most exquisite of all our fishes. *L. kentuckiensis*, Kirt, not of Raf. Found in all the rivers and creeks of the State, but least common in those flowing into the Delaware.

LYTPRURUS—*Jordan.*

The species of this genus are few, and are distinguished for brilliancy of color.

LYTHRURUS DIPLAEMIUS—*Cope.*

Red-fin.—Bright steel-blue, with polished shades, silvery below; a large black spot on the anterior rays of dorsal in front; fins otherwise unicolor, plain olivaceous in ♂, brilliant brick-red in spring males; scales with more or less dark edging; nuptial tubercles minute, very numerous, whitish, chiefly on the upper surface of the head; body much compressed; back elevated; head deep, rather obtuse; depth 3¾ in length; D. 1, 9; A. 1, 10; lat. 1, 44; L. 3. Western streams, generally abundant; an exceedingly brilliant fish in the breeding season; known at all times by the dorsal spot and compressed body, with large fins and long caudal peduncle. (Not *Leuciscus diplemius*, Kirt.) Only known from the tributaries of the Ohio in Pennsylvania.

PHENACOBIUS.—*Cope.*

A genus embracing five or six species from the region east of the plains.

They have a general resemblance to the suckers, and doubtless obtain their food like those fishes, from the bottom. This is, however, entirely distinct in character, being animal instead of vegetable. The name of the genus has reference to this deceptive resemblance.

PHENACOBIUS TERETULUS—*Cope.*

Head—depth, $4\frac{1}{4}$ in length; form stouter than in *P. uranops*, Cope; chest scaled; lips transversely plicate; a dusky lateral band; D. I. 8, A. I. 7; lat. l. 43.

A pretty species having the lips thrown into transverse ridges like those of the large-scaled suckers. It has been found in the tributaries of the Kanawha in West Virginia, and will probably occur in west Pennsylvania.

CLIOLA.—*Gird.*

A genus near the *Alburnus* of Europe, represented by about seven species, all of small size. They are always silvery and without bright colors.

CLIOLA SCABRICEPS—*Cope. Rough-Headed Shiner.*

Head broad, prickly in spring; eye large, 3 in head; head flattish above; mouth little oblique; greenish, sides leaden silvery; D. 1, 8; A. 1, 8; lat. 1, 38. Ohio valley and probably in Western Pennsylvania.

MINNILUS—*Raf. Alburnellus, Gird.*

A genus of small species, some of them the least of the cyprinidae, allied to *Alburnus*. The species are numerous, and are all silvery, some of them, displaying red on the head in spring.

MINNILUS RUBRIFRONS—*Cope.*

Rosy-faced minnow.—Olive above, with a clear green luster; sides silvery; a dark vertebral line; forehead, opercular region, base of dorsal, etc., flushed with red in spring; upper surface of head minutely tuberculate in males at that season; head rather pointed, about $3\frac{4}{5}$ in length; depth $4\frac{1}{2}$; eye about 4 in head; D. 1, 8; A. 1, 10; lat. 1, 38; L. 3 or less. Ohio valley, abundant; an elegant little fish, well distinguished from *N. rubellus* by the smaller size, deeper body and much longer head, as well as by peculiarities of form.

Common in west Pennsylvania.

MINNILUS DINEMUS—*Raf.*

Emerald minnow. Coloration exactly as in *M. rubellus*, but the body very slender and less compressed, more elongated than any other of our cyprinidae, the depth being only from one sixth to one seventh of the length; eye $3\frac{1}{8}$ in head; fins as in preceding; L. 4 to 5. Lake Michigan and Ohio valley, in the larger streams, like the others, going in shoals. (*A. jaculus* and *A. arge*, Cope.) (This is Rafinesque's "Emerald minnow," the type of his genus Minnilus, but the name Notropis is still older.)

Found in rapidly flowing streams and swimming in shoals. The clear green with the lateral gold thread gives this species an elegant appearance.

MINNILUS PHOTOGENIS—*Cope.*

White-eyed shiner.—An extremely variable species, differing from all the preceding in the less posterior position of the dorsal, and in the rather more compressed form; depth $4\frac{1}{2}$ to 7 in length; head 4 to $4\frac{1}{2}$ in length; eye $3\frac{1}{3}$ in head, large and white. Olive green; no red pigment; sides silvery; male minutely tuberculate about the head in spring; dorsal fin beginning much nearer caudal than end of muzzle; D. 1, 8; A. 1, 10; lat. 1, 40. Streams of the Allegheny region from Pennsylvania south. (*Photogenis leucops*, Cope.) Very abundant in all western streams.

GILA, *Bd. Gird. Clinostomus—Gir.*

A genus which embraces a large number of species, especially from the Rocky Mountain region.

GILA ELONGATA—*Kirtl.*

Red-sided minnow. Dark bluish, mottled with paler scales; sides with a broad black band, the front half of which is a bright crimson in the spring; a dark dorsal stripe; mouth very large, the lower jaw narrowed and projecting farther than in any other of the Dace; a little knob at the tip which overlaps the end of the upper jaw; body much elongated, but little compressed; depth 5 in length; head $4\frac{1}{4}$; eye moderate, about $3\frac{1}{2}$ in head; D. 1, 8; lat. l. 70 to 75; L. 4. Great Lakes, Ohio Valley, etc.; a handsome species, brilliantly colored in spring. Western Pennsylvania only.

GILA FUNDULOIDES—*Girard.*

Rosy dace. A light and dark lateral band; snout pointed; mandible shorter than in the preceding, less compressed; eye larger, 3 in head; depth 5 in length; head $4\frac{1}{4}$; D. 1, 9; A. 1, 8; lat. 1.48. Streams about Chesapeake Bay and South. The most brilliantly-colored fish known in Pennsylvania. It is only abundant in the Susquehanna basin, although it occurs in Delaware streams.

GILA MARGARITA—*Cope.*

Pearl minnow. Head equal depth and 4 in body; scales small, much crowded forwards; lateral line hardly complete, the tubes wanting on the last 3 to 8 scales; head blunt, short and rounded; mouth quite small, oblique, the upper jaw the longer, the lower jaw not compressed; color light olive; sides dusky; belly in summer bright crimson; D. I, 8; A. I.; lat. 1.58. Teeth 25—4, 2; a stout-bodied species of small size, confined to the tributaries of the Susquehanna. Colors brilliant.

SEMOTILUS—*Raf.*

This genus commences the series of those with beards at the angle of the mouth. In *Semotilus* they are very small and sometimes abnormally wanting. The species are the largest of our *Cyprinidæ*.

* Dorsal fin well behind the ventrals, with a black spot at the base; scales small crowded forward, 45—70 in the lateral line.

SEMOTILUS CORPORALIS—*Mitch.*

Common chub.—Horned dace.—Body stout; depth $4\frac{1}{2}$ in length; head large, $3\frac{3}{4}$; dusky above, especially along edges of scales; sides bluish, a black lateral band in young; silvery below, sides and fins flushed with crimson in spring; D. I, 8; A. 1, 8; lat. 1, 55 to 65; L. 10 to 12. New England (Housatonic R Jordan) to the Missouri region and S.; the most widely diffused of our *Cyprinidæ*, excepting *Nocomis biguttatus*. It may be known under all circumstances by the large head and the peculiar dorsal spot. S. atromaculatus, dorsalis, cephalus, speciosus, etc., etc., of authors.

The most abundant *Cyprinoid* of the Allegheny and Susquehanna basins, not rare in the Delaware. It sometimes reaches four lbs. weight, and is a fair food fish.

** Dorsal very slightly behind ventrals, without black spot at base in front; scales large, about 50 in lateral line, not much crowded forwards.

SEMOTILUS BULLARIS—*Raf.*

Fig. 17, p. 72.

Fall fish, dace, roach.—Brownish above, with blue reflections; side silvery, rosy in spring; depth $4\frac{1}{2}$ in length, head 4; D. I, 8; A. I, 8; lat. 1, 46 to 50; largest of our eastern cyprinidæ, reaching a length of 18 inches. New England to Virginia, generally abundant in the rapids of the larger streams. *Semotilus rotheus*, *argenteus* and *pulchellus*, auct.

This is a beautiful fish, and the most gamey of the family, taking the hook with the energy of a trout. It abounds in the Delaware basin, is less common in the Susquehanna, and is absent from the tributaries of the Mississippi.

CERATICHTHYS—*Baird.*

This genus corresponds to the Palaearctic genus *Gobio*, but the pharyngeal teeth are less numerous. There are many species, which are distributed everywhere east of the Rocky mountains excepting in New England.

* Mouth terminal, large; teeth 4–4, (rarely 1, 4-4, 1;) dorsal fin over ventrals.

CERATICHTHYS BIGUTTATUS—*Kirtl.*

Horned chub; jerker.—Bluish olive, sides with bright green and coppery reflections; a curved blotch behind the opercle; fins, pale orange, unspotted; white below, rosy in spring; adult males in the spring with the top of the head very much swollen, elevated into a sort of crest, sometimes nearly one third of an inch higher than the level of the neck, covered with large tubercles; a stout species, with large scales which are not crowded anteriorly; young with a dark caudal spot; head 4 in length; depth nearly the same; D. I, 8; A. I, 7; lat. 1, 40 to 45; L. 6 to 9. Penn to Utah and S.; abundant almost everywhere; the most widely diffused of all our fresh water fishes. Breeding males sometimes have a red spot on each side head, hence the specific name. Not found in the Delaware basin, but common everywhere west and south of it. A good pan fish.

CERATICHTHYS MICROPODON—*Cope.*

Head short, almost exactly as in Luxilus cornutus; barbel small; caudal peduncle slender; teeth 4–4; lat. 1.40. Conestoga R.; but one specimen known—perhaps a hybrid.

** Mouth sub-inferior, rather small, the upper jaw the longer; size not large; teeth 4–4, or 1, 4–4, 1.

† Dorsal fin in advance of ventrals.

a. Lateral line 36 to 40; head short; lips little developed; teeth 1, 4–4, 1.

CERATICHTHYS DISSIMILIS—*Kirtl.*

Spotted shiner.—Pale olivaceous, sides bright silvery, with a bluish lateral band, widened at intervals into spots; fins immaculate; depth 5 in length; head 4; eye large, $3\frac{1}{2}$ in head; D. I, 8; A. I, 7; lat. 1, 47 to 50; L. 6. Ohio valley and lake region, not uncommon. Especially numerous in the creeks of Western Pennsylvania.

RHINICHTHYS.—*Agass.*

A genus which includes as yet only small species, which are distinguished by the non-protractillity of the upper jaw. The muzzle is usually prominent.

* Snout projecting considerably beyond the mouth; body slender, depth usually 5 to 6 in length; barbels evident.

RHINICHTHYS CATARACTAE—*C. V.*

Long-nosed Dace.—Brownish, mottled, not banded; eye half the length of the long snout; head $3\frac{4}{5}$ in length; D. I, 8; A. I, 7; lat. 1.63; L. 5. New England to Va. and Wis. [*R. nasutus*, (Ayres) Ag.] Found only in rapids and swift water in Eastern Pennsylvania.

** Snout scarcely projecting; body stout, depth 4–5 times in length; barbels minute.

RHINICHTHYS ATRONASUS—*Mitch.*

Fig. 18, p. 73.

Black-nosed dace.—Dusky, belly silvery; lateral band bright crimson in spring, becoming orange in summer, black at other times; fins often rosy in spring; depth $4\frac{2}{3}$ in length; head $3\frac{3}{4}$; D. I, 8; A. I, 7; lat. 1.65. New England to Ohio valley, in clear brooks; abundant eastward.

A very common fish in Eastern Pennsylvania and an ornament to aquaria. The rays of the pectorial fin are much thickened in males.

RHINICHTHYS OBTUSUS—*Agass.*

Brown-nose dace.—Similar; sides with a brown band, edged above and below with paler; head 4 or more in length; D. I, 8; A I, 8; lat. 1.63 to 70. Western streams. Usually paler than the preceding and more robust in form; probably a variety rather than a distinct species. In Pennsylvania in the West only.

COCHLOBORI.

But one genus of this sub-family is known.

EXOGLOSSUM—*Raf.*

But one species is known. Its peculiarly formed lower jaw is apparently an adaptation for scraping molluscs from their hold on rocks. Its stomach is generally found to contain these animals, the shells being crushed to pieces.

EXOGLOSSUM MAXILLINGUA.—*Lesueur.*

Exoglossum.—Chub.—Cut-lips.—Nigger chub.—Body stout; depth 4½ in length, head 4; eye small, nearly 5 in head; dorsal behind midway between snout and caudal; dusky above, a blackish shade along caudal peduncle; D. I, 8; A. 1, 8; lat. 1, 50 to 55; L. 4 to 6. W. N. Y. (Susquehanna basin) to Virginia; a fish of remarkable appearance, singularly distinguished from all our other Cyprinidae by the three-lobed lower jaw. The limited distribution of this fish is one of its peculiarities. In Pennsylvania it is confined to the Susquehanna basin, where it is abundant.

COELOPHORI.

This sub-family is entirely North American. But one genus is known.

ERICYMBA—*Cope.*

A genus of a single species. It repeats in the Cyprinidae the peculiar cranial septary ridges of the genus of fresh water *Percidae Acerina*, of the Palæarctic fauna.

ERICYMBA BUCCATA—*Cope. Silver-mouthed Dace.*

Elongate; depth nearly 5 in length; head 4; eye large, 3 in head; olivaceous above, sides brilliantly silvery, a narrow vertebral line, and a lateral chain of brown dots; upper jaw rather large, its profile angulated; mucous channels in lower jaw very conspicuous; D. 1, 8; A. 1, 8; lat. 1. 33; L. 5. Ohio valley, Penn., to Kentucky and Illinois, abundant. A beautiful little fish, singularly distinguished from all other species by the cavernous bones of the head. Not found in Atlantic streams.

ISOSPONDYLI.

Parietals separate; symplectic present; no interclavicles. Anterior vertebræ simple, unmodified. Pharyngeal bones separate above and below.

An extensive order presenting many subordinate modifications.

1. Tail sub-protocercal; pterotic externally annular, enclosing a large cavity; basis cranii double. . . . *Notopteridæ.*

2. Tail heterocercal; pterotic normal; basis cranii double; superior pharygeals four, distinct; third largest, directed forwards; basal branchihyals three, (typical.)

a. Parietals united.

Two tail vertebrae, ... { *Hyodontidae.* *Albulidae.* *Elopidae.*

One tail vertebra, ... { *Aulopidæ.* *Coregonidæ.* *Lutodiridæ.*

No tail vertebra, ... { *Gonorhynchidæ.* *Sauridæ.*

aa. Parietals separated by supraoccipital.

Two tail vertebræ, ... { *Alepocephalidæ.* *Salmonidæ.*

One tail vertebra, ... { *Chirocentridæ.* *Clupeidae.*

3. Tail heterocercal; pterotic normal; basis cranii simple.

Basal branchihyals and superior pharyngeals, each three: . *Osteoglossidæ.*

The same bones each two, ... { *Galaxiidæ.* *Heteroiidæ.*

Of the above families but four are found in the fresh waters of this State. These are further distinguished as follows:

I. Upper jaw formed of premaxillary bone only.

An adipose fin; scales ctenoid; . . . . . *Percopsidæ.*

II. Upper jaw formed of maxillary and premaxillary bones.

An adipose fin; pseudobranchiæ present; . . . . . *Salmonidæ.*

No adipose fin; pseudobranchiæ none; stomach simple: . *Hyodontidæ.*

No adipose fin; pseudobranchiæ present; stomach with a blind sac; *Clupeidæ.*

PERCOPSIDÆ.

But one genus of this family is known. The characters are essentially those of the *Salmonidæ*, but the bones of the mouth are those of a cyprinoid or a percoid.

PERCOPSIS—*Agass.*

This genus further resembles the perches in having a serrate preoperculum. The jaw teeth are villiform, and there are none on the vomer or palate. There is but one well-ascertained species, and this has a wide range.

PERCOPSIS GUTTATUS—*Agass.*

Depth 4½ in length; head 3⅔; silvery, almost pellucid; upper parts with rounded dark spots made up of minute dots; D. 11; A. 7; L. 10; great lakes; Ohio R. (Jordan;) Potomac R. (Baird); Delaware R. (Abbott.) A rare species in Pennsylvania.

SALMONIDÆ—*Salmon.*

The salmon and trout family embrace a larger number of fresh water fishes of economic importance than any other. The genera found in Pennsylvania are as follows:

I. Dentition strong.

Pyloric caeca numerous; anal fin long, with fourteen or more rays, *Oncorhynchus.*

Pyloric caeca numerous; anal fin short, with twelve rays or fewer, . *Salmo.*

Pyloric caeca few; anal fin short, ... *Osmerus.*

II. Dentition weak or wanting.

Dorsal fin short; pyloric caeca numerous, ... *Coregonus.*

Dorsal fin long; pyloric caeca numerous, ... *Thymallus.*

Of the salmon family, the brook-trout (*Salmo fontinalis*) is our best known species. This fish, if properly protected, will always be important to the inhabitants of the mountainous portions of our State, where other species are less abundant. It cannot fail to be valued, if allowed to increase sufficiently, by that class of our people who in those rough countries may find beef and mutton more or less expensive, or otherwise beyond their reach. The sea salmon (*S. salar*) will perhaps never be an important feature of our fisheries. The Hudson is its southern limit of migration, and it has been extremely rare there for a very long period. The Delaware has rarely furnished a specimen; and though the experiment of cultivation in our waters is certainly worth trying, it would probably only result in the production of a smaller breed of limited numbers. Southern latitude always produces this effect on northern forms of fishes. The transplanting to the Susquehanna would most likely fail, while it is utterly useless to try it in the Allegheny. The tributaries of the Ohio are entirely without any resident species of trout, except in a few of the highest mountain streams. The whitefish (*Coregonus*) of the lakes are too valuable to be neglected, and our Fish Commissioners have followed the example of those of Ohio in forbidding the destructive modes of fishing for them practised in Lake Erie. Our smaller lakes in the north and west of the State probably harbor several small but useful species of whitefish.

California furnishes species which are most useful to the pisciculturist. The quinnat (*Oncorhynchus quinnat*) is selected as the most hardy, and its propagation is already an important branch of industry.

ONCORHYNCHUS—*Suckley.*

The species of this genus are confined to the coasts of the Pacific ocean, and run up the rivers to breed in immense numbers. They furnish an important part of the food of the people of the Pacific States of North America. One species has been introduced into the eastern States by the United States fish commission.

ONCORHYNCHUS QUINNAT—*Rich'dsn.*

Fig. 19.

Body moderately compressed, rather short and deep; caudal fin well forked. Scales large, in 120—140 transverse rows. Branchiostegal rays, 15. Olivaceous above, silvery below; back and sides with numerous small black spots, interspersed on the back with large ones. Snout of males in

spring distorted, the premaxilliaries greatly prolonged, hooking over the lower jaw, which is turned up and hooked at the tip. The teeth on these prolongations are much enlarged.

Abundant on the pacific coast, inhabiting waters of higher temperature than those necessary for the *Salmar salar*. It should thrive in the Delaware and Susquehanna rivers, where it has been introduced.

SALMO—*Linn.*

Only two species of this genus are indigenous to Pennsylvania.

* Anadromous salmon with the vomerine teeth few and deciduous; no hyoid teeth.

SALMO SALAR—*L.*

Fig. 20, p. 80.

Great sea salmon.—No red spots; young (known as Parr or Smolt) with dusky cross bars; males in the spawning season with the lower jaw strongly decurved and hooked; body covered with black and red patches; others silvery, with small black dots; eleven or twelve scales in a transverse series from behind the adipose fin obliquely forward to the lateral line; D. 14; A. 11; lat. 120. Northern Europe and America, S. to Cape Cod.

The salmon was rarely caught as far south as the Hudson river in former times. At present it is slowly increasing in the Delaware through transplantation.

**River and lake salmon, with their vomerine teeth largely developed. No hyoid teeth.

SALMO IRIDEUS—*Gibbons. California Trout.*

Fig. 21, p. 89.

Form stout, head short, rather blunt; mouth small, the maxillary bone scarcely reaching the eye. Fins and tail black, spotted; a few small black spots on the back and ribs. Sides and belly rosy, red, or silvery.

Abundant in California and Oregon; introduced into Pennsylvania by the State Commission, and planted in the Susquehanna river.

*** Lake trout with vomerine teeth raised on the crest of a bone; hyoid teeth present.

SALMO NAMAYCUSH—*Bloch.*

Fig. 22, p. 96.

Mackinaw Trout—Great Lake Trout.—Stout; head very large, 3½ in length; bones of head strong; posterior point of juncture of opercle and sub-opercle much nearer the upper end of the gill opening than to the lower anterior angle of the sub-opercle; teeth strong; fins large, the caudal deeply forked; color greyish, more or less spotted, varying much with circumstances: D. 13 to 14; A. 12; V. 9; lat. 1.220; length 2 to 6 feet. All the great lakes, north to the Arctic Sea; a fish of firmer flesh; (*S. amethystus, Mitch.*)

Occurring in Lake Erie, this species belongs to the Pennsylvania fauna.

**** Vomer flat, toothless, no hyoid teeth. River and creek species.

SALMO FONTINALIS.—*Mitchill.*

Fig. 23, p. 96.

Speckled Trout.—Mouth wide; teeth moderate; body olivaceous, variagated with blackish, with red spots; lower fins usually orange with black spots and edges; colors variable; young barred; D. 12; lat. 1.200. A well-known and beautiful fish, in clear brooks from the French Broad R. to the Arctic regions.

The most beautiful game fish of the State, abundant in the mountains and the eastern counties everywhere, in clear water.

OSMERUS—*Linnaeus—Smelts.*

OSMERUS MORDAX—*Mitch.*

Fig. 24, p. 97.

Common Smelt.—Head 4 in length; eye 4 to $4\frac{1}{2}$ in head; teeth stout, especially large on the tongue; transparent greenish, a silvery band along sides; scales very loose; D. 11; A. 15; lat. 1.66. Coast Nova Scotia to Virginia; also "land-locked" in fresh water ponds in Maine, etc. (*O. viridescens—Mitch.*) Common in spring in the Delaware and Schuylkill rivers. An excellent pan fish.

THYMALLUS—*Cuv.*

A genus which embraces a few species of the Northern Hemisphere. The American forms are nearly allied to each other.

THYMALLUS TRICOLOR—*Cope.*

Fig. 25, p. 97.

Michigan Grayling.—Depth $4\frac{2}{3}$ in length; head about the same; purplish gray, silvery below; dorsal with rosy markings and rows of green or blue spots; D. 27; A. 13; lat. 2.97. Waters of the north part of the S. peninsula of Michigan; a beautiful fish. It has been propagated in New York and other States, and some have been introduced in Pennsylvania waters. An excellent food and game fish, but rather delicate.

COREGONUS—*Linn.*

The white fishes form an important article of food in all northern countries.

§Lower jaw longest; Ciscoes. (*Argyrosomus, Agassiz.*) Body subfusiform; depth 4 to 5 in length.

COREGONUS TULLIBEE—*Rchdsn.*

Tullibee.—Body short, deep, compressed, shad-like, the dorsal and ventral curves similar; caudal peduncle short and deep; head conic, compressed, much as in C. *nigripinnis;* mouth large, the maxillary as long as the eye, extending past the front of the pupil, its supplemental bone narrowly ovate, with prolonged points; jaws equal when closed; eye large, as long as snout, $4\frac{1}{2}$ in head; preorbital narrow; supra-orbital elongate, rectangular; scales anteriorly considerably enlarged, their diameter half larger than the diameter of those on the caudal peduncle; color bluish above; sides white, punctate with fire dots; each scale with a silvery area, these forming a series of distinct longitudinal stripes; head 4; depth 2; D. 11; A. 11; scales 8–74–7. Length, 18 inches.

Habitat, Great lakes and northwards, Lake Erie. (Jordan.)

The tullibee has the deep, compressed form of the shad, with the projecting lower jaw of the lake herring. These particulars distinguish it at once from the other white fishes. (Jordan.)

COREGONUS ARTEDI—*Linn.*

Lake Herring.—Head $4\frac{3}{4}$ in length ($4\frac{1}{2}$ to $5\frac{1}{4}$;) depth 4 ($3\frac{2}{3}$ to $4\frac{1}{3}$;) eye 4 in head; maxillary $3\frac{1}{2}$ to $3\frac{3}{4}$; mandible $2\frac{1}{8}$; scales rather large and loose; bluish above, silvery on sides and below; D. 12; A. 13; lat. 1, 76; length 12 to 18 inches. Great lakes, etc., very abundant; a shallow water species. *Coregonus albus, clupeiformis, lucidus, harengus,* etc., of authors. Common in Lake Erie.

** Upper jaw projecting beyond the lower. (*Coregonus* proper.)

COREGONUS ALBUS—*Lesueur.*

Fig. 26, p. 104.

Lake white fish.—Depth $3\frac{1}{2}$ in length; head small, $5\frac{1}{4}$; eye 4 in head, about as long as snout; form varying much with age, sex and food; the back generally elevated, and the sides compressed; pale olive above; sides white; D. 13; A. 13; lat. 1. 75 to 86. Great lakes and bodies of water tributary to them, north to the Arctic Sea. This species is the basis of an extensive industry in the region of the great lakes. It is, in the writer's estimation, the best fresh-water table-fish of North America, but must be eaten fresh from the water.

COREGONUS QUADRILATRALIS—*Rchdsn.*

"Shad waiter."—Body elongate, not elevated, nor much compressed, the back rather broad, the form rather more terete than in any other species; mouth very small and narrow, inferior, the broad maxillary not reaching to opposite the eye, $5\frac{1}{2}$ in head; head long, the snout compressed and bluntly pointed, but not strongly decurved; mandible originating under middle of eye, $3\frac{1}{8}$ in head; adipose fin small; gill raker short and strutish; snout scarcely below level of lower edge of eye; preorbital wider than pupil; head 5 in length; depth $4\frac{3}{4}$; D. 11; A. 10; scales 9–80 to 90–8; color dark bluish above, silvery below. Length about 1 foot.

Habitat, deep cold lakes, New Hampshire, upper Great lake region, and

northward to Alaska. "I have seen no specimens from Lake Erie, but it undoubtedly occurs there." (Jordan.)

HYODONTIDAE.

There is but one genus of this family, which is confined to North America.

HYODON—*Lesueur.*

*Belly scarcely carinate; dorsal rays 12. (*Hyodon.*)

HYODON TERGISUS—*Les.*

Moon eye.—Silver bass.—Toothed herring.—Depth $3\frac{1}{8}$ in length; head $4\frac{2}{3}$; snout rounded, shorter than the large eye, which is $3\frac{1}{3}$ in head; scales largest on the flanks; pale olivaceous above, sides brilliantly silvery; D. 3, 12; A. 30; V. 7; lat. 1. 59; length 1 foot. Great lakes and Mississippi Valley, abundant; one of our most beautiful fresh-water fishes; variable it has been described under many names. Not found in the Susquehanna or Delaware rivers.

CLUPEIDAE—*Herring.*

The family of the herring is not less useful to man than the that of the *Salmonidæ*, but unlike it, is principally marine in distribution. Many species, however, ascend rivers in spring to deposit their spawn, and at that time they furnish food for great numbers of people. There is much variety of type in the *Clupeidæ*, certain forms ranging near the *Elopidæ*, which in turn are not far removed from the order *Halecomorphi* (*Amia.*) A genus, *Diplomystus*, allied to *Clupea*, is found in abundance in the shales of the lower Eocene period in the Rocky mountain region. The important family of the *Saurodontidae* which abounded in North America and Europe during the cretaceous period is allied to the *Clupeidae.*

The most valuable food-fishes in the State are members of the *Clupeidae.* Two species of little value occur in the Allegheny; but those of the Atlantic streams are important. The shad, *Clupea sapidissima*, is well known to the inhabitants of our eastern cities as the best of table-fishes. It had been almost exterminated from the Susquehanna, but legislation has restored it. In the Delaware it is still abundant, but reduced, and further legislation is needed to protect it. The herring (*Clupea pseudoharengus*,) or properly, ale-wife, is immensely numerous, and is caught in the Delaware and Susquehanna. The fisheries at the mouth of the latter river supply an extensive region.

An anchovy (*Engraulis vittatus*) visits the Delaware river and Bay in immense numbers every spring, and might furnish quite as large a supply of food as the European species of the same name.

The genera of Clupeidæ which enter Pennsylvania waters are the following:

I. Upper jaw not overlapping the lower; abdomen serrated.
An accessory branchial sac, ... *Brevurtia.*
No accessory branchial sac, ... *Clupea.*

II. Mouth transverse, inferior or sub-inferior; abdomen serrated;
Last dorsal ray filamentus; branchial arches with a double bend, *Dorysoma.*

III. Mouth very wide; intermaxillary bone very small, coössified with the maxillary, which is very long;
Muzzle very short, projecting beyond the mouth; belly not serrate, *Engraulis.*

BREVURTIA—*Gill.*

A genus of species from the coasts of North and South America.

BREVURTIA MENHADEN—*Mitch.*

D. 19. d. 19—20. v. 7. Scales irregularly arranged; their free portion is very narrow and deep, with the margin ciliated. The height of the body is rather less than the length of the head, which is one third of the total (without caudal.) Lower jaw shutting within the upper; maxillary reaching to the vertical from the hind margin of the orbit. No teeth on the palate or tongue. Operculum finely striated; suboperculum large, tapering above. Gill rakers very fine and exceedingly long; the horizontal branch of the outer branchial arch consists of two portions joined at an obtuse angle. Ventral fins opposite to the anterior third of the dorsal, the origin of which is somewhat nearer to the caudal than to the end of the snout. Basal half of the caudal fin covered with small scales. There are from twelve to thirteen abdominal scutes behind the base of the ventral fins. A blackish blotch in the scapulary region.

This fish ascends the Delaware for a short time in the spring in large numbers. As it is well known, it visits the coast of the eastern and middle States in immence shoals, and is caught for the manufacture of oil, manure, etc.

CLUPEA.—*Linn.*

A genus of some sixty species from all seas. Many of them, *e. g.*, the herring and shad, reproduce in incredible numbers, and furnish food for many other fishes, and for man.

CLUPEA SAPIDISSIMA—*Wilson.*

Fig. 26 a., p. 105.

Shad.—Head $4\frac{1}{4}$ in length; eye 5 in head; bluish, sides silvery with a few large indistinct blackish spots; scales large; D. 18; A. 21; V. 9; lat. 1.68. Newfoundland to Florida, entering rivers; also, lately introduced into western streams; a valuable food fish. *Alosa praestabilis*, De K.) Ascends the Delaware in great numbers. Was formerly abundant in the Susquehanna, but was extirpated by the erection of dams. It is likely to become abundant again through the exertions of the State Fish Commission. The most important indigenous food fish of the State.

CLUPEA PSEUDOHARENGUS—*Wils.*

Fig. 27.

Alewife; Gaspereau.—Spring herring. Head 5 in length; eye 4 in head; bluish, sides iridescent, D. 18; A. 18; N. 9; New Foundland to Florida, entering rivers, sometimes land-locked in ponds; a common food fish. *A tyrannus*, De K. *Alosa cyanonoton*, Stor, etc. etc.) It ascends the Delaware and Susquehanna and their tributary streams in great numbers in spring. An important herring fishery is located at the mouth of the latter river.

CLUPEA CHRYSOCHLORIS—*Raf.*

Ohio gold shad, skip jack. Jaws with distinct teeth; head 4 in length; eye $4\frac{1}{4}$ in head; body elliptical, much compressed; scales large, high, rather firm; depth of head $5\frac{1}{2}$ in length of body; caudal peduncle about twice width of eye; brilliant blue, with green and golden reflections, silvery below; D. 18; A. 18; lat. 1.55; 17 scutes behind ventrals. Ohio R. and lower Mississippi; a handsome species, of little value as food. Western Pennsylvania only.

DORYSOMA—*Raf.*

Chatoessus—Cuvier.

A genus of several species, mostly from the East India seas.

DORYSOMA CEPEDIANUM—*Les.*

Hickory shad. Gizzard shad. Head 4 in length; depth $2\frac{3}{5}$; origin of dorsal behind ventrals, nearer snout than caudal; uniform bluish gray often with a dark shoulder blotch; D. 13; A. 32; lat. 1.55. Cape Cod to Hatteras; chiefly marine, but often land-locked in ponds, where it becomes *D. insociable*—Abbott.

ENGRAULIS.—*Cuv.*

The anchovies are very numerous in species, and inhabit all seas. They are readily distinguished by the enormous mouth, short muzzle, and anteriorily placed eye, with long anal fin.

ENGRAULIS VITTATUS—*Mitchell.*

Fig. 28.

Anchovy.—Length three and a half inches. D. 8; P. 17; V. 5; A. 14; C. 18; Head elongated, sharp, wedge-shaped; broad above posteriorly, attenuated below. Length of head one fifth the length of the body, and a third longer than the greatest depth of the body; its greatest width above one third its length, its width below a mere line. Eyes large, situated on the anterior third of the head; their diameter is equal to two thirds of the distance between them. Jaws unequal; the upper much the longer, and nearly concealing the lower, which shuts into it as into a groove. Jaws armed with very minute teeth. Gill-covers elongated, yet rounded. Scales very large and deciduous.

Color: Top of head bluish-slate; back light green, dotted with fuliginous. A greenish blue stripe high up on the side, shadowed out on the head from the upper orbit of the eye, more defined above the posterior opercle, and thence extending nearly to the tail. Sides below greenish-silvery, with metallic reflections. Gill-covers and abdomen silvery, with nacreous iridescence.

Ascends the Delaware river in shoals in spring, filling the ditches at some localities. An elegant fish.

HAPLOMI.

No praecoracoid arch. Parietal bones separated by the supraoccipital A symplectic; opercular bones present; anterior vertebræ unaltered. Pharyngeal bones distinct, the superior directed forwards, three or four in number. No interclavicles.

The species of this order are not so numerous as those of the last, but they include the pike, which are among the most important fresh water fishes. The families are defined as follows:

1. Basis cranii double; maxillary entering mouth border, . . . *Esocidae.*
2. Basis cranii simple; maxillary bounding mouth, ... *Umbridae.*
3. Basis cranii simple; mouth bounded by premaxillary only; third upper pharyngeal enlarged.

a. Vent posterior; . . . . . *Cyprinodontidae.*
b. Vent between the jaws, ... *Amblyopsidae.*

The species of this order are all of fresh or brackish water habitat.

ESOCIDAE—*Pike.*

There is but one genus of this family, and it containes but eight or ten species. The majority of these belong to North America. Six of these are indigenous to Pennsylvania waters, but one of these is identical with a species of the old world.

ESOX—*Linn.*

There is much difference of opinion as to the merits of the pike, and their fitness to receive State protection. Two species occur in the Delaware, (*Esox reticulatus* and *E. porosus*;) three in the Susquehanna, (the same with *E. umbrosus*,) and three in the Allegheny, (the two last and *E. nobilior.*) Those of the latter river are scarcely worth considering, as they are few in number. The *E. reticulatus* of the east is, however, a large and abundant fish, which sells well, and is generally esteemed. For ourselves, we do not join the condemnation visited on the pike by some, and have a liking for its flesh. If its increase can be restrained, instead of favored, in waters which produce the best species, it will cease to inflict much injury by its voracious habits, for it naturally haunts still or grassy waters, where it devours fishes inferior to itself, as eels, and catfish, and frogs. On the other hand, we do not think the pike needs any protection, as he has many natural advantages in the struggle for life; but he should not be destroyed, except for the table.

* Lower half of cheeks as well as opercles scaleless; branchiostegals 18–19.

ESOX NOBILIOR—*Thomson.*

Fig. 29.

Muskallunge—Blue Pike.—Top of head without a longitudinal cavity; cheeks as well as opercles half bare; grayish with round black spots; a magnificient fish, reaching a length of 6 feet; B. 18; D. 3, 17; A. 3, 15 lat. 1, 155. Great lakes, etc. *E. estor* of some authors.

This is the largest species of the genus, and the largest game fish of America. Specimens of sixty pounds, weight have been caught. An individual taken in Conneaut Lake, in Crawford county, Pennsylvania, measured seventeen inches in circumference behind the eyes.

** Lower half of cheeks scaly, of opercle bare; branchiostegal rays, 15–16.

ESOX LUCIUS—*Linn.*

Fig. 30.

Lake Pike—Grass Pike.—Cheeks entirely scaly: depth 7 in length; head $3\frac{1}{2}$, with a median frontal concavity; olive gray; sides with round yellowish spots as large as peas; each scale with a shining V-shaped mark opening downward; B, 15; D. 20; A. 17; lat. 1, 122. Great lakes and headwaters of the Mississippi. A fine species, reaching a length of 3 to 4 feet. (*E. estor*, *lucioides*, *boreus*, etc., of authors.) An abundant species in the Great lakes, and an important article of commerce. It is the same as the common pike of Europe, as the writer was the first to show. Not found in Ohio or Atlantic streams.

*** Cheeks and opercles scaly; branchiostegals 12 to 15; species of moderate or small size, reticulated or barred with dark green on a lighter ground—sometimes plain. (Pickerels.)

† Branchiostegals 14 to 15; snout prolonged; front of eye nearly midway in head.

ESOX RETICULATUS—*Lesueur.*

Fig. 31.

Common eastern pickerel.—Green pike.—Head $3\frac{1}{8}$ in length; the snout much prolonged; front of eye about midway in head; eye more than three times in snout; green, sides with net-work of brown streaks; B. 14 to 16; D. 16 to 18; A. 15 to 17; lat. 1. 129 to 130. Streams of Atlantic States abundant, but not found far in the interior; smaller than the preceeding, but much larger than the next. The common pike of the markets of the eastern cities, and pickerel of the interior, a good food-fish, but destructive to other species.

†† Branchiostegals normally 12; front of eye nearer tip of snout than gill border.

ESOX VERMICULATUS—*Les.*

Little Pickerel.—Western trout pickeral.

End of muzzle to pectoral fin longer than from pectoral to ventral fin; same to orbit, equal from orbit to opercular margin; scales between pectorals and ventrals small; 44—50 rows. Olivaceous green above; white below; sides with many reticulations and curved streaks, instead of bars; a black streak in front of eye as well as below; B. 12; D. 13; A. 14; lat. 112. Western streams, abundant in the Ohio valley. (E. umbrosus, Kirtland.) Resembles *E. reticulatus* more than *E. americanus*. Found also in the Susquehanna river.

ESOX POROSUS—*Cope.*

End of muzzle to pectoral longer than from pectoral to ventral; same to orbit less than from orbit to opercular margin; scales between ventrals and pectorals small, 44—50 rows. Abdominal and most lateral scales perforated by tubes like those of the lateral line. Head four times in length to end of caudal fin. Anal rays, III. 12; scales, 11. 109—113. 12.

Broad brown bars directed obliquely forwards on the sides, which may be divided into more numerous black lines.

A small species from Eastern Pennsylvania, found in still water.

ESOX CYPHO—*Cope.*

End of muzzle to pectoral fin longer than from pectoral to ventral; same to orbit less than from orbit to opercular margin; scales between ventrals and pectorals small, 44—50 rows. Anal rays, III. 12; scales, 11. 109—113. 12. Length of head three and one half times in length to end of caudal fin. Sides with broad oblique brown cross-bars. Differs from the last species in its wide and convex back, and in the absence of the tubes from the scales excepting those of the lateral line.

Western States, probably Western Pennsylvania, a small species.

UMBRIDÆ.

A family which includes but one genius and few species.

UMBRA.—*Kramer, Melanura, Agassiz.*

A genus of three species, one European (*U. krameri*), and two North American.

UMBRA LIMI—*Kirtland.*

Mud minnow.—Mud dace.—Dog fish.—Depth about 4 in length; head $3\frac{1}{2}$; head rather large, flattish above; greenish or dark olive, sides with narrow pale bars, often secure; a distinct black bar at base of caudal; D. 14; A. 9; V. 6; lat. 1.35; length 2 to 4 inches. Lake Champlain to Minnesota, chiefly northward and westward; most abundant in Wisconsin; rare in Ohio valley; probably found in Northwestern Pennsylvania; usually associated with Eucalia inconstans.

UMBRA PYGMAEA—*De Kay.*

Eastern mud minnow.—Dark brown with longitudinal streaks and no trace of cross bars; body less compressed than in M. limi; head broader, less depressed, with larger eye; snout shorter; profile more gibbous; D. 13; A. 7; lat. 1.35. New York to S. C., only in Atlantic streams. Very common near Philadelphia. An interesting and hardy fish in aquaria.

CYPRINODONTIDÆ.

A family of wide distribution, of which the majority of the species inhabit brackish water. A few are marine coast fishes, and others are purely fresh water.

The genera found in our waters are the following:

I. Teeth pointed, in bands.

* Dorsal fin beginning in advance of anal.

Branchiostegals, 6, ... *Hydrargyra.*

Branchiostegals, 5, ... *Fundulus.*

** Dorsal fin beginning behind front of anal

Branchiostegals, 5, ... *Zygonectes*

HYDRARGYRA.—*Lac.*

HYDRARGYRA MAJALIS—*Bloch Schn.*

B. 6; D. 13–16; A. 11; V. 6; L. lat. 35; L. trasv. 13. The height of the body is one fourth of the total length, (without caudal,) the length of the head two sevenths. Head low, and rather elongate, with the snout produced, the lower jaw scarcely projecting beyond the upper; mandible longer than the eye. The width of the interorbital space is contained twice and three fifths in the length of the head. The diameter of the eye is two thirds of the length of the snout or the width of the interorbital space, and one fifth of the length of the head. The origin of the dorsal fin is midway between the extremity of the caudal and the anterior or posterior margin of the orbit, and corresponds to the sixteenth scale of the lateral line. The first anal ray corresponds to the second of the dorsal fin. Anal much higher than long. Greenish, with three more or less interrupted irregular longitudinal bands in the female, and with many broad cross-bands in the male.

The common coastwise species, largest of our *Cyprinodontidae*, probably ascending the Delaware as far as the boundary of the State.

FUNDULUS—*Lac.*

FUNDULUS DIAPHANUS—*Lesueur.*

Barred Killifish.—Spring Mummichog. Sides silvery olive, with twelve to fifteen distinct, narrow, blackish, vertical bars; head rather narrow; D. 13; A. 13; lat. 1, 42. Coastwise, abundant, but ascending streams to their sources, hence found in clear springs as far inland as Michigan (Cope,) Wisconsin (Copeland,) Illinois, Colorado (Yarrow,) Texas (Cope,) etc. [*F. multifasciatus* (Les.) Val.] This Cyprinodont has the widest range of the family in North America. Common.

FUNDULUS HETEROCLITUS—*Linn.*

A common species of the coast, ascending streams; D. 11; A. 11; lat. 1, 35. Delaware river.

FUNDULUS PISCULENTUS—*Mitch.*

D. 12–14; A. 13; lat. 1, 34; body more elongate; coastwise, ascending streams. Delaware river.

FUNDULUS NIGROFASCIATUS—*Les.*

D. 10; A. 9; lat. 1, 33; males with numerous silvery cross bars; females with black ones. With the preceding. Delaware river.

ZYGONECTES—*Agass.*

The species of this genus are, in North America, more especially fresh water in habitat than those of *Fundulus.*

ZYGONECTES NOTATUS—Raf.

Black-sided Killifish. Top minnow. Depth $4\frac{1}{2}$ in length; head 4; head broad, depressed; clear pale olive with a few dots above; a wide purplish-black band along sides from snout through eye to caudal, its margin usually serrated; D. 9; A. 11; lat. 1.34; length $2\frac{1}{2}$ inches. Mississippi Valley, abundant. (Z. pulchellus and tenellus, Grd. F. aureus Cope. Z. olivaceus, Ag., etc.)

GLANENCHELI.

Parietal bones extensively in contact, distinct; pterotic normal; a symplectic. Opercular bones complete; mouth bounded by premaxilliary chiefly; six or seven basilar pectoral rays; no praecoracoid or interclavicles. Anterior vertebræ united, modified and with ossicula auditus. Superior pharyngeal bones subequal, continuous.

This order includes only the family *Gymnotidae*, the electric eels of South America. No species is known from North America.

ICHTHYOCEPHALI.

Epiclavicle suspended to posttemporal and to cranium; mouth bounded above by premaxillaries, which are in contact on the median line, and in contact with a distinct maxillary by the posterior margin; no interneural spines, pectoral fins, or symplectic bone; two basal branchihyal pairs. Vertebræ unaltered. Two pairs basihyals.

This order only includes the family *Monopteridæ*, which are confined to the East Indies.

HOLOSTOMI.

Epiclavicle suspended to fourth vertebæ, posttemporal wanting. Parietals in contact. Mouth bounded by the premaxillaries, which are in con-

tact medially and bounded behind by maxillary. Symplectic present; vertebræ unaltered; no pectoral. Third superior pharyngeal not smaller than fourth.

One family, the *Symbranchidæ* from the tropics of both hemispheres.

ENCHELYCEPHALI.

Parietals in contact; lower pair of basihyals wanting. Scapular arch suspended to anterior vertebræ; no posttemporal; no symplectic; maxilliary bone absent or comate with premaxillary, which forms border of mouth. Premaxillaries separated on the median line by the ethmoid. Superior branchihyals and inferior and superior pharyngeals well developed; the latter of three bones. Of these the fourth is largest and supports the third, which with the second is directed forwards.

1. Palatopterygoid arch completed: pectoral fins, ... *Congridæ.*
2. Palatopterygoid arch represented by incomplete pterygoid; premaxillaries are widely separated; pectoral fins, ... *Muraenesocidae.* *Anguillidae.*

The only family of this order represented in the fresh waters of North America is that of the *Anguillidae.*

ANGUILLIDAE—*Eels.*

Body much elongate; vent posterior; pectoral fins present; vertical fins confluent, stomach coecal. Two or three genera.

ANGUILLA—*Thumb.*

ANGUILLA ROSTRATA.

Common eel.—Even distance between dorsal and anal shorter than head. U. S., chiefly coastwise, but ascending all rivers and introduced into the Great lakes. (*A. bostoniensis*, etc., of authors.) But one species is recognizable in the Northern Hemisphere, according to a recent French writer, M. Dareste, who unites our species with the European A. vulgaris. An important food-fish in Pennsylvania.

Eels require no protection, as they pass round obstructions by land, and breed in the ocean. Their numbers have not diminished in our waters to the same extent as other species, and their capture and barreling has long been an important industry on the Susquehanna. When our State is more densely populated, they will be more constantly sought, and will require protection, as other fishes.

Until recently the breeding habits of the eel were a mystery. A few years ago M. M. Ercolani and Balsamo Crivelli endeavored to solve the question, but were only partially successful. In 1873 Dr. Syrski added a contribution to the subject. Later Prof. A. S. Packard "detected the mother cells, and Mr. Kingsley observed moving, active spermatozoa." The knowledge of the breeding grounds of the eel is contained in the following expression, taken from page 447 of Packard's *Zoölogy:* "It is probable that the eel descends rivers in October and November, spawning in autumn and early

winter at the mouth of rivers, and in harbors and estuaries in shallow waters." M. W. H. Ballou gives the following account of the food habits of the eel: "They are among the most voracious of carnivorous fishes. They eat most inland fishes, except the gar-fish and the chub. Investigation of 600 stomachs by Oswego fishermen showed that the latter bony fish never had a place on their bill of fare. They are particularly fond of game fishes, and show the delicate taste of a connoisseur in their selection from choice trout, bass, pickerel, and shad. They fear not to attack any object when disposed, and their bite in human flesh shows even a vicious attitude toward man. On their hunting excursions they overturn huge and small stones alike, working for hours, if necessary, beneath which they find species of shrimp and cray-fish, of which they are exceedingly fond. Of shrimps they devour vast numbers. Their noses are poked into every imaginable hole, in their search for food, to the terror of innumerable small fishes."

"Eels are to the water what the fish-hawk is to the air. They are, perhaps, the most powerful and rapid of natatorians. Again, they hide in the mud beneath some log or overhanging rock, and dart out with tremendous fury at the unsuspecting prey. They attack the spawn of other fishes open-mouthed, and are even said to suck the eggs from an impaled female. They fearlessly and rapidly dive head foremost in the mud, disappearing from view in the twinkling of a star. They are owl-like in their habits, committing many of their depredations at night."

"No fish is yet reported to utilize a grown eel as food. Pickerel, garfish, and bass, which are particularly numerous in these lakes, are supposed to literally devour the young fry. Mr. Sawyer describes the operation of the pickerel darting through a long column of young eels, open-mouthed, and devouring vast numbers of them."

COLOCEPALI.

Parietals largely in contact; opercular bones rudimental; the preoperculum generally wanting. Pterygoids rudimental or wanting; ethmoid very wide. Symplectic, maxillary, basal branchihyals, superior and inferior pharyngeal bones, all wanting except the fourth superior pharyngeal. This is jaw-like, and supported by a strong superior branchihyal; other superior branchihyals wanting or cartilaginous. This peculiar order embraces several families and many species of eels, which are mostly marine in their habitat.

PHYSOCLYSTI.

The following is an analytic synopsis of the orders of this sub-tribe. They all have the parietals entirely separated by the supraoccipital, and lack the praecoracoid; the symplectic is present, except in Ostracium, where it is not ossified.

A. Scapular arch not suspended from the cranium.

Superior branchihyals and pharyngeals developed; inferiors and maxillary distinct, ... 15. *Opisthomi.*

AA. Scapular arch suspended from the cranium.

I. Ventral fins abdominal.

Branchial arches well developed, the bones present, except fourth superior pharyngeal; third much enlarged; inferior pharyngeals distinct, 16. *Percesoces*—Mullet, etc.

Third and fourth superior pharyngeals much enlarged, inferior pharyngeals coössified, ... 17. *Synentognathi*—Soft Gar

Superior branchials and pharyngeals reduced in number; inferiors separate; interclavicles present, ... 18. *Hemibranchi*—Pipe fishes.

Superior branchihyals and pharyngeals, and basal branchihyals, wanting; gills tufted, ... 19. *Lophobranchi*—Sea horse.

II. Ventral fins thoracic or jugular.

First vertebra united to cranium by suture; parietals united behind superoccipital; basal pectoral radial bones elongate, 20. *Pediculati*—Goose fish, etc.

Posterior cephalic region normal, anterior twisted so as to bring both orbits on one side; inferior pharyngeals distinct, 21. *Heterosomati*—Flounders.

Cranium normal; the premaxillaries usually coössified with the maxillaries behind, and the dentary with the articular; pharyngeal bones distinct, ... 22. *Plectognathi*—File fishes.

Cranium normal; bones of the jaws distinct; inferior pharyngeal bones distinct, ... 23. *Percomorphi*—Perch.

Cranium normal; bones of the jaws distinct, third superior pharyngeal much enlarged, articulating with cranium; inferior pharyngeals coössified, 24. *Pharyngognathi*—Burgall, Parrot fish.

These orders will be more fully defined, and the families which are referable to them pointed out.

The affinities among the *Physoclysti* are clear. Omitting the order *Opisthomi*, we find the four orders with ventral fins to form a true series, with a synentognath variation, terminating in the greatly degraded order of Lophobranchii. The *Percesoces* give us our nearest connection with the groups with abdominal ventral fins, and lead at once to the *Percomorphi*. From this center radiate many lines of affinity. One leads from the *Chaetodontidae*, through the *Acroneuridae* and to the Plectognathi, by the similarity in the arrangement of the posttemporal and forms of the pharyngeal apparatus. An important division of the Percomorphi has the basis cranii simple, and the branchials above, reduced in number, viz: the Scyphobranchi. The Cottidae are the most generalized family of this group, and lead on the one hand to the Triglidae of the Distegi, with which they are generally arranged, and, on the other, to the Blenniidae. Some of the latter elongate the basal pectoral bones considerably, and lead to the Batrachidae on the one side, where the number of these bones is increased, and on the other to the Pediculati, where the number is diminished. To these groups the Anacanthini and Heterosomata are less allied.

The third upper pharyngeal bone has already prevented an increase of mass and use in the first orders of Physoclysti with the ventral fins. Among the Percomorphi the same increase makes its appearance by little beginnings in some Sciaenidae, and reaches to a great development in other members of that family. It is quite noteworthy in most of the Carangidae, a group whose separation from the Scombridae by Günther is supported by this part of their organism. Through forms not now specified, approach to the Pharyngognathi is made. Here the pharyngeals are modified into a mill-like structure, which is least specialized in the Embiotocidae, and most so in the Scaridae. In the latter family it is a most effective apparatus for grinding the shells of the *Mollusca* and other substances on which they feed.

PERCESOCES.

Ventrals anteriorily abnominal. Mouth formed by premaxillaries; posttemporal furcate anteriorly, not saturally attached. Three basal branchihyals; all those of superior series generally present. Superior pharyngeals with the third very largely devloped, but not articulated to the cranium. Inferior pharyngeals distinct; basal pectoral rays four, short. Basis cranii without muscular tube, but with rudimental upper floor.

This order is found in the fresh waters of all the continents, but principally within the tropics. There are also many marine species. The families are the following:

1. Dorsal fin or branched radii; no second floor of brain case: a transverse wing on inside of hyomandibular; second superior pharyngeal rod-like; first present, third simple, *Opheocephalidæ*.

2. Dorsal fin of spinous and soft portion; no hyomandibular wing; second superior pharyngeal subconic; third very large, of two horizontal laminæ, the superior supported by the inferior by a verticle rod. Superior branchihyals; second a triangular plate with superior exterior process; third and fourth triradial, ... *Mugilidæ*.

3. Dorsal fin of spinous and soft portions, ventrals more abdominal; third superior pharyngeal long and wide, simple; second rod-like. Basis cranii with upper floor better developed, ... *Atherinidæ*

ATHERINIDÆ.

Two genera are represented in Pennsylvania.

Maxillary arcade narrow, ... *Atherina*.

Maxilliary arcade produced into a beak, ... *Labidesthes*.

LABIDESTHES—*Cope*.

LABIDESTHES SICCULUS—*Cope*.

Silver Skip Jack—River silverside.—Depth 6 in length; head $4\frac{1}{2}$; eye $3\frac{1}{2}$ in head; anal long, nearly one third of length of body; scales small; pale olive, translucent, dotted with black, the silver lateral band very distinct; D. IV—11; A. 1, 23; lat. 1, 75; length 3 to 4 inches. Western

streams and ponds, Mich. to Ills. and Tenn.; abundant where found; not in Atlantic streams. A very slender and elegant species of delicate organism. The peculiar "duck-like muzzle" resembles that of some Cyprinodonts, especially the Central American *Belonesox*.

ATHERINA—*L.*

ATHERINA BERYLLINA—*Cope.*

Form of body shorter than usual; posterior margin of first dorsal far in advance of second dorsal, and just in front of opposite first anal ray; last anal a little behind last ray of second dorsal; tips of ventrals opposite of first ray of first dorsal. Head 4.25 times to base of caudal. Orbit large, one third head; mouth small, mandible slightly longer, curve forming a quadrant. Greatest depth (in front of anal) six times in length to basis of caudal. Scales large; ten longitudinal, thirty-six transverse rows; lateral line represented by a pore on the anterior part of the posterior field of each scale, except on the caudal peduncle where there is a groove. The anterior separated portion of the line is on two adjacent series of 2–4 scales each. Radical formula D. V., last well developed; I. 11, C. 17, deeply furcate; A. I. 18; V. I. 5, four interior twice furcate; P. 15 acuminate.

Total length 2.5 inches; end muzzle to base of first dorsal 1.06 inches. Color, bright pale olive, a silver band from axilla to caudal on two half rows of scales, leaden margined above; basis of anal leaden. Sides of head silvery. Originally found in the Potomac, and probably occurring in the tributaries of the Susquehanna.

SYNENTOGNATHI.

Mouth bounded by the premaxillary only; parietal bone very much reduced; posttemporal slender, furcate; epiclavicle not distinct. Pectoral fin with elevated basis; no interclavicle. Superior pharyngeals; second and third large, oval, not articulated to cranium, sending process forward; fourth wanting. Inferior pharyngeals coössified. Basis cranii double in front, but without muscular tube.

The two families of this order possess a heterocercal tail and no spinous dorsal fin. In its rather weak superior branchihyals it shows resemblance to the *Hemibranchi*. The families are characterized as follows:

Vertebræ with zygapophyses; the coronoid bone distinct, *Belonidæ*.

No zygapophyses, nor distinct coronoid bone of the mandible, *Scombresocidæ*.

The first-named of these families is the only one that enters fresh waters.

BELONIDAE—*Soft gar.*

BELONE—*Cuv.*

There are several species of this genus found off our Atlantic coast. But few of these enter fresh water, and only one the streams of Pennsylvania.

BELONE TRUNCATA—*Les*—Soft Gar.

Fin rays:—D. 15, P. 12, V. 6, A. 19, C. 19.

The caudal fin is slightly emarginated. The anal is of the same form as the dorsal; it commences just in front of that fin, and is coterminal with it; its anterior rays are longer than the corresponding ones of the dorsal fin. The ventrals are situated upon the posterior half of the body. The dorsal fin is situated on the posterior fourth of the body. The body is elongated; the scales small and arbicular. The lateral line arises at the inferior angle of the operculum, and, passing gradually up to the inferior base of the pectorals, assumes thence a straight line, which is continued to the base of the caudal rays. Its greatest depth is equal to about one fifteenth its entire length; the length of the head, from the angle of the jaws to the posterior portion of the operculum, is equal to one tenth the length of the body. The jaws are armed with distant, very sharp, conical teeth, between which are numerous others very minute; the lower mandible projects beyond the upper and is fleshy at its tip. The head is flattened above and compressed laterally; the eyes are longitudinally oval; the distance between the eyes is equal to their longer diameter.

Light green above; beneath silvery, including opercles and lower mandible. Just above the base of the pectorals a band of a darker color arises, and passes in a straight line to the origin of the dorsal fin. Minute fuliginious spots upon the upper portion of opercles.

Common in the Delaware and Susquehanna in their lower courses.

HEMIBRANCHII.

Mouth bounded above by premaxillary only; posttemporal not furcate. Pectoral fins elevated; interclavicles developed. Superior pharyngeals small, weak; second, third, and generally fourth present; branchihyals rudimental; the fourth and sometimes others wanting. Inferior pharyngeals distinct. Branchial processes, narrow laminæ. Basis cranii simple; no tube.

Found in all seas; a few species of *Gasterosteidæ* entering fresh water. This order connects the ordinary *Physoclysti* with the *Lophobranchi*. The families are as follows:

1. No first dorsal fin; dorsal vertebræ moderately elongate, united by sutures; no suboperculum; second and third superior branchihyals, and third superior pharyngeal only present, *Pegasidæ*

2. Anterior vertebræ but little enlarged; dorsal spines strong; first, second, and third superior branchihyals, and second and third superior pharyngeals present, ... *Gasterosteidæ*.

3. Four anterior dorsal vertebræ much elongate; (centrum and spine united by suture in Fistularia,) dorsal spines very weak or none. *Fistulariidæ*.

4. Four anterior vertebræ much elongate, with strong diapophyses, and normal articulations. Fourth superior branchihyals and first and fourth superior pharyngeal only wanting, ... *Centriscidæ*.

5. Six anterior vertebræ extremely elongate, with normal articulations

of centra. Fourth supra-branchihyal and all the superior pharyngeals wanting, ... *Amphisilidæ.*

GASTEROSTEIDÆ—*Sticklebacks.*

Only two species of the Sticklebacks occur in Pennsylvania, and they are referrible to as many genera.

Sides naked; no caudal keel; ventral cuirass reduced, not serrated.
Ventral plates two, lateral, ... *Apeltes.*
Ventral plate single, median, ... *Eucalia.*

APELTES—*Dekay.*

APELTES QUADRACUS—*Mitch.*

D. 3 or 4, 1—12; P. 11; V. 1; A. 10; C. 13. Body slightly convex in front of the first dorsal spine. Length of the head equal to nearly one fifth the length of the body. Three or four movable spines are situated in front of the dorsal fin, and connected with it by a membrane at its base is a fifth spine, which is equal to about two thirds the height of the rays of this fin. Commencing at the base of the first spine, and terminating at the spine of the dorsal fin, is situated a groove into which the larger spines are received when recumbent. The first and second spines are each equal in length to one third of the head. When erect, one or more of these spines frequently project outward from the straight line, the others are shorter; the fourth, when there are five, is the shortest.

When alive, greenish-brown above the lateral line; beneath this line, which is very perceptible, the color is darker, and is broken irregularly by the extension of the whiteness of the abdomen. In young specimens the color is distributed in four or five transverse bands, which are indistinct in the mature fish. The membranous portion attached to the posterior inferior part of the vertebral spine is of a bright scarlet color, which causes this part to appear as if covered with blood, when the fish is suddenly darting through the water, with the spine projecting.

A small species, abundant in the tide-water streams and ditches of the Delaware. An interesting species for the aquarium.

EUCALIA—*Jordan.*

EUCALIA INCONSTANS—*Kirt.*

Brook stickleback.—Ohio stickleback.—Head about $3\frac{1}{2}$ in length; depth nearly 4; spines rather low; ventral spine about equal to eye; color olivaceous, marbled with darker; males in spring jet black, finely punctate; D. III to V—I, 10; A. I, 10; length $2\frac{1}{2}$ inches. Ohio to Minnesota and Kansas, chiefly northward; abundant in sluggish streams; an interesting species, remarkable, according to Jordan, for its pugnacity and for its nest-building habits.

LOPHOBRANCHII.

Mouth bounded by the premaxillary above; posttemporal simple, coössified with the cranium. Basis cranii simple. Pectoral fins with elevated

basis; well-developed interclavicles. Anterior vertebræ modified; the diapophyses much expanded. Inferior and superior branchihyals wanting or unossified. Branchial processes in tufts.

The sea horses and pipe fishes abound in tropical seas, and a few species are common on our Atlantic coast. None enter the fresh waters of Pennsylvania.

PEDICULATI.

Basal radii of pectoral fin elongate, reduced in number; no interclavicles. Epiotics united above behind supraoccipital, and the first vertebræ with the cranium by suture; posttemporal broad, flat, simple. Superior pharyngeals two, similar, spatulate with anterior stem and transverse blade. Basis cranii simple.

This order includes bottom fishes of the ocean; some of them living at great depths, others float in the masses of sea-weed. The goose-fish is the best known species of our coasts. None enter fresh water.

HETEROSOMATA.

Cranium posteriorly normal; basis nearly simple; dorsal fin without spinous radii. Cranium anteriorly with twisted vertex, to allow of two orbits on one side, or one sub-vertical and one lateral. Superior pharyngeals four, the third longest much extended forwards, inferiors separate.

Embraces the family of *Pleuronectidæ*, or flounders, which includes many marine and a few fresh water species. None in Pennsylvania.

PLECTOGNATHI.

Cranium posteriorly normal, the posttemporal undivided, coössified with the epiotic. The elements of the mandible, and usually the premaxillary and maxillary, coössified. Interoperculum a slender rod. Superior pharyngeals liminar, usually vertical and transverse. A suboperculum.

This order is a very degenerate type of *Physoclysti.* It includes five or six families of fishes of singular form, which chiefly abound in tropical oceans. A very few enter fresh waters, and none those of Pennsylvania.

PERCOMORPHI.

Bones of the mandible distinct; maxillary distinct. Cranium symmetrical; epiotics normal; no interclavicles; posttemporal not coössified with cranium. Basal pectoral radii not enlarged; humeri suspended (generally) from the scapular arch. Basibranchihyals three; inferior pharyngeals distinct, superior pharyngeals with the third generally largest. Sub and inter operculum present, plate-like.

This extensive order embraces a great variety of forms, some of which may yet be regarded as forming distinct orders. At present I am not sufficiently sure of their exact definition to admit them as such. The species exist in all waters in all parts of the globe, but the marine species greatly outnumber those of fresh water.

I. ANACANTHINI.

Basis cranii simple, no tube; posttemporal bifurcate; scapular foramen between scapula and coracoid. Superior pharyngeals three, horizontal, third little longer. Dorsal fin-rays flexible, jointed. Includes the families *Gadidae* and *Macruridae*, both with protocercal caudal vertebrae.

The *Lota lacustris* (Ling) is the only species which inhabits Pennsylvanian waters.

Fig. 32.

II. HAPLODOCI.

Basis cranii simple, flat; posttemporal simple, undivided. Scapular foramen in center of scapula. Basal segments of pectoral fin five, elongate; superior pharyngeals contracted; first and fourth wanting; third basin-shaped with second adherent. Dorsal fin with some spinous rays. One family, the *Batrachidae*, which is found chiefly in salt water, and does not enter the Pennsylvania fauna.

III. SCYPHOBRANCHII.

Basis cranii simple, no tube; posttemporal furcate; superior pharyngeals shortened; fourth and first generally wanting; third large, basin-shaped; second generally scale-like or coössified with third. Scapula with median foramen. Doral radii usually soft.

The families are distinguished as follows:

I. An osseous rod connecting infraorbital ring with preopercular spine.
Ventrals thoracic, ... *Cottidæ.*

II. No osseous check-rod.
*Ventrals of very few rays are wanting.
Ventrals jugular; spinous dorsal as long as soft dorsal, . . *Blenniidæ.*
** Ventrals with 5 or more rays.
Ventrals modified into a suctorial organ, ... *Gobiesocidæ.*
Ventrals not suctorial; first dorsal fin short.
First dorsal soft, ... *Gobiidæ.*
First dorsal spinous, ... *Uranoscopidæ.*

IV. EPELASMIA.

Basis cranii double, with basal muscular tube; posttemporal often undivided. Second, third and fourth superior pharyngeals transverse vertical laminæ. Scapula with median foraman; basal pectoral bones four, short. Dorsal spines strong. Families; *Acronuridæ*, (with *Amphacanthus*, *Acanthurus*, *&c.*,) and *Chaetodontidæ* with *Chaetodon*, *Chelmo*, *Zanclus*, *Alatax*, *Heniochus*, *Taurichthys*, *Ephippus*, *and Toxotes.*) Marine fishes, mostly from tropical seas.

V. RHEGNOPTERI.

Basis cranii double with tube; posttemporal bifurcate; scapula with median foramen; superior pharyngeal bones four; third largest, narrow, directed forwards; basal pectoral bones divided; two normal, supporting fin; one longitude without rays, and one a plate on coracoid, supporting elongate rays. Dorsal spines. One family, the *Trichidiontidæ*, which does not enter the fresh waters of Pennsylvania.

VI. DISTEGI.

Basis cranii double, with muscular tube. Posttemporal bifurcate; scapula with median foramen; basal pectorals three or four, short, quadrate. Superior pharyngeal bones four; third always the largest, longitudinal more or less elongate, not articulated to cranium. Inferior pharyngeals separated. Dorsal fin with strong spines.

This extensive sub-order includes the greater number of the species of the spinous rayed Physoclystous fishes. There are a number of families, but only four of them enter the scope of the present work. They are distinguished as follows:

I. Ventrals 7-rayed; anus jugular, vomerine teeth, ... *Aphododiridæ*
II. Ventrals 5-rayed;
Anus posterior, no vomerine teeth; head not cavernous, . *Elassomidæ*
Vomerine teeth; skull not cavetnous, *Percidæ*
No vomerine teeth; skull cavernous with superficial chambers, *Sciaenidæ*

GADIDAE—*The Cods.*

LOTA—*Cuvier.*

LOTA LACUSTRIS—*Walb.* Fig. 33.

Ling, Burbot.—Lake Lawyer.—Eel-Pout.—Lake Cusk. Dark olive, thickly marbled with blackish; yellowish or dusky beneath; head broad, depressed; body sublindrical in front, compressed behind; upper jaw (usually) longest; D. 13—76; A. 68; V. 7; length $1\frac{1}{2}$ to $2\frac{1}{2}$ feet. Great lakes and streams of New England, north to the Arctic circle, abundant; rather rare in the Miss. valley. A curious fish, rarely used for food, although the livers are said to be delicious. [L. maculosa (Les.) Cuv. L. compressa, (Les') and L. brosmiana, Storer. L. inornato, DeK., etc.] The common European species (L. vulgaris, Cuv.,) seems to be the same, but the American name, lacustris, is the older (Jordan.) In Pennsylvania in Lake Erie. One specimen was taken in the Susquehanna, near Muncy, Lycoming county.

COTTIDÆ—*Sculpins.*

Two genera are represented in the waters of the State, as follows:
No teeth on the palate; ventral radii I. 3, ... *Uranidea.*
Teeth on the palate; ventral radii I. 4, ... *Potamocottus.*

URANIDEA—*Dekay.*

URANIDEA GRACILIS—*Heckel.*

Miller's thumb.—Little Star-gazer.—A slender, fusiform species; depth 6 to $6\frac{1}{2}$ in length. Tips of pectorals reaching fourth ray of second D., and

first of anal; head 4 in total length; eye 4 in head; grayish, mottled, D. VIII—16; A. 11 or 12. New England and New York; the common eastern species found "quiescent" under stones, after the manner of the darters. (U. quiescens—DeKay, [U. boleoides (Grd.,) from Vermont, is said to be slenderer, and with larger fins. U. formosa, (Grd.) from stomachs of Lota, in deep water, L. Ontario, is more elongate, with shorter fins.` In Pennsylvania from the head waters of the Susquehanna or Allegheny rivers.

URANIDEA VISCOSA—*Haldeman.*

Slippery Miller's thumb.—Pectorals scarcely reaching second dorsals; head $4\frac{1}{2}$ in total length; eye 5 in head; body subcylindrical, covered with a viscid skin; dusky, mottled; D. VIII—17; A. 12: first dorsal fin with a vermillion border. Streams of Penna., Md., Va., etc., frequent, often found in caves. (C. copei, Abbott.)

URANIDEA FRANKLINI—*Agass.*

Olivaceous, mottled; both dorsals and anal with a broad dark bar on the distal half; pectoral and caudal broadly blotched with dusky; jaws equal; preopercular spine stout, short, pretty strongly hooked upwards and inwards; first dorsal rather high, not much lower than second; pectorals short, not reaching anal; axil prickly, as in L. *richardsoni;* head $3\frac{1}{2}$; depth 5; D. VIII—17; A. 11 or 12; length 3 inches.

According to Jordan, probably occurring in Lake Erie.

URANIDEA SPILOTA—*Cope.*

Cow-faced sculpin.—Body moderately elongate, depressed, the head especially so; quite abruptly contracted opposite the base of anal, the body behind the head nearly as deep as wide; body behind the vent rather slender, subterete, giving a tadpole-like form; jaws about equal, the lower narrower, but projecting in front; mouth rather contracted, the maxillary scarcely reaching to eye; palatine teeth; eye $4\frac{1}{2}$ in head, half wider than the interorbital space, about equal to snout; eyes close together, entirely superior; head very broad and flat, as broad or broader than long, including the perpendicular spines; its depth half its length; profile rising rapidly from head to base of dorsal, which runs along a decided ridge or carina; preopercular spine extremely large, more than three times as large as in other of our fresh-water cottoids, and as long as the eye; this spine is hooked backwards, and is slightly spiral, giving the fish a decidedly buffalo-like or cow-like physiognomy; three spines hooked downwards below the large one, the lower concealed; a strong spine directed forward at base of opercle; isthmus as wide as from snout to middle of orbit; head 3. 3. 5; depth $5\frac{1}{3}$; fin-rays, D. VIII, 17; A. 12; ventrals 1—4; pectorals 16; brachiostegals 6; base of pectorals crescentic, their tips just short of anal, the rays all simple; ventrals under pectorals reaching two thirds to vent, their membrane decurrent; dorsals beginning a trifle beyond ventrals, rather nearer anal than snout; depth at first ray of anal less than

half length of head, the thickness at the same point a little more than one third; least depth one fourth of head; caudal peduncle slenderer than in any other cottoid known from our fresh waters; head smooth; space above lateral line behind head covered with small, stiff prickles, slightly hooked backwards, readily visible as little black specks when the skin is dry; axillary region not provided with spines; color pale brown, rather finely specked and mottled with darker brown; pectorals mottled; belly white: length of smaller specimens $2\frac{5}{6}$ inches; of larger $3\frac{2}{3}$.

Habitat, great lakes, in deep water; Lake Michigan (Nelson, Rice, Jordan); Lake Ontario (Jordan); near Hudson's bay (Bean); also in Grand river (Cope). Not yet known from Ohio, but probably occurring in Lake Erie (Jordan).

POTAMOCOTTUS—*Gill.*

POTAMOCOTTUS MERIDIONALIS—*Girard.*

Cave bull-head.—Goblin.—Blob.—Muffle-jaws.—Head $3\frac{1}{2}$ in length; depth 5; width of head $3\frac{1}{2}$; reaching beyond beginning of soft dorsal, to oval; preopercle with a stout erect spine and two smaller ones below; mouth wide; palatine teeth unusually strong; lateral line very distinct, chainlike, sometimes vanishing behind, and sometimes not. Grayish, mottled, three cross blotches on back; D. VI to VIII—16; A. 12 or 13; V. 1, 4. N. C. to Ala., Tenn., and Ind., abounding in many of the streams issuing from the caves in the limestone region; the largest species of the genus reaching a length of 6 inches. (*C. meridionalis* Grd., *P. carolinae*, Gill, *P. zopherus*, Jor.) Probably in Western Pennsylvania.

POTAMOCOTTUS WILSONI—*Girard.*

Wilson's bullhead.—Rather larger than the last; spinous dorsal higher; and the upper rays of the pectoral fins branched. Pennsylvania to Indiana.

APHODODIRIDÆ.

One genus of this family exists, and several extinct ones have been found in the eocene beds of the Rocky mountains.

APHODODIRUS—*Lesueur.*

The dorsal fin is single and elevated and has but few spines. There is no ventral spine. The bones of the face are serrate, and the scales are ctenoid. Two species of this genus are known. The position of the vent in young fishes has been shown by Jordan to be posterior to that which it has in adults. In the western species it is more posterior.

APHODODIRUS SAYANUS—*Gill.*

Pirate Perch.—Head $3\frac{1}{4}$ in length; depth $3\frac{3}{4}$; greenish olive; a suborbital bar, and dark bars at base of caudal rounded; lower jaw longest; D. IV, II; 7; lat. 1.48; length 5 inches. N. Y. to La., in sluggish fresh water near the coast. One of the most interesting of North American fishes. It does well in aquaria.

PERCIDÆ—*Perch.*

After the *Cyprinidæ*, this family embraces the greatest number of species of the fresh waters of North America.

Many of the most important food fishes belong to the *Aercidæ*. The finest fishes among these are the pike-perch (*Stizostedium.*)

The blackish water lovers, the yellow perch, and white and striped bass, are well known. They have suffered great diminution of numbers from improper spring fishing, and fishing through the ice at the mouths of streams in winter. Both these practices should be put a stop to, in accordance with law.

The black bass (*Micropterus fasciatus*) is only native of our State in the tributaries of the Ohio. The public remembers its recent introduction into the Delaware, and attendant discussions. The James river is the most northern of the eastern rivers which contain species of the same group, (the green bass,) but the introduction of both species and the present one into the Delaware has been fully successful. It is a valuable acquisition, and though carnivorous, will not interfere materially with the spawn and fry of ale-wives (herring of our fishermen) and shad, if the latter are protected against improper fishing. It attains the maximum weight of from eight to twelve pounds, and is a good table-fish.

The "white perch," or "moon perch," of the Allegheny (*Pomoxys hexacanthus.*) is only less valuable than the black and green bass. An occasional straggler is taken in the Delaware, and it occurs in the Susquehanna. It is an excellent table-fish, and ought to be protected and cultivated. Its weight is from one to five pounds; in form it is flat and round, like the sunfish.

The smaller sunfishes also have considerable market value. The common species appears, as is known, in large numbers in winter on our stalls. The "red eye" is equally important in Pittsburgh markets, (*Ambloplites rupestris*,) and would, if protected, increase to an almost incredible extent. In the same way, the mud sunfish, (*A. pomotis*, Baird,) which grows to the size of the white bass in the sluggish tidewater streams of the Delaware, should become at some future day a source of food to a considerable population. In fact, all these fishes could be easily rendered so abundant in a few years as to sell for a cent a piece, instead of five and ten cents per pound.

There are three divisions of the *Percidæ* found in North American waters. They are defined as follows:

Branchiostegal rays 6; swim bladder rudimental, . . *Etheostomatinæ.*
Branchiostegal rays 7; swim bladder well developed, . *Percinæ.*
Branchiostegal rays 6; swim bladder well developed, . . *Centrarchinæ.*

ETHEOSTOMATINÆ.

The species of this division are all of small size, some of them of very small size. They are very numerous in the streams of the Mississippi valley, but none exist west of the Rocky mountains. They are generally of much beauty, especially in their coloration, in which males exceed the females. Their habit is to lie on the bottom of the stream, and their movements are sudden and quick, and are produced by powerful movements of the caudal part of the body. They can only rise to the surface in this way, owing to the imperfect character of their natatory bladder. In describing the *Nothonotus camurus*, I made the following observations on these fishes and their habitat: "All of these species lie on the bottom, frequently beneath stones, with the head only projecting, on the lookout for prey. Ordinarily they lie motionless, except occasionally inclining their position and exhibiting their gorgeous colors. The effect of this is heightened by the crystal clearness of the waters of the southern mountain streams, which reflect as well the beauty of a southern sky and the noble trees and flowering shrubs that border them in the rich wilderness of the Cumberland range. Few more attractive spots to the naturalist can be found, and among its natural treasures these peculiar little fishes are among the most curious. All the fishes of this group can turn the head from side to side, and they frequently lie in a curved position, or partially on one side of the body." There are about sixty species known, which, though they present considerable range of characters, require close examination for their discrimination. For human consumption these fishes are worthless. Their food consists chiefly of minute crustacea and of larvæ of small insects (Forbes.) The genera are distinguished as follows:

A. Lateral line complete; body translucent.

Dorsal fins distinct; one anal spine; vomerine teeth; lip subprotractile, *Pleurolepis.*

B. Lateral line complete; body not translucent.

† Second dorsal not larger than spinuous dorsal and little or not larger than anal.

α Upper jaw not protractile; vomerine teeth.

β Mouth inferior, overlapped by the snout, ventral plates present, (when not shed.) . . . . . *Percina.*

ββ Mouth terminal, wider.

Ventral plates normally present, ... *Alvordius.*
Ventral plates absent, ... *Hadropterus.*

†† Second dorsal fin considerably larger than anal; no ventral plates.

α Upper jaw protractile.

No teeth on the vomer, ... *Diplesium.*
Vomerine teeth, ... *Boleosoma.*

αα Upper jaw not protractile.

Anal spines two, ... *Nothonotus.*

C. Lateral line present, incomplete.

Spinous rays acute, ... *Pœcilichthys.*
Spinous rays knobbed at apices in males, ... *Etheostoma.*

D. Lateral line absent.

Jaws equal, ... *Microperca.*

AMMOCRYPTA—*Jord.*

Four species of this genus are known: *A. asprellus*, Jordan, from Illinois; *A. vitreus*, Cope, from North Carolina; *A. beani*, Jordan, from Louisiana, and the following:

AMMOCRYPTA PELLUCIDA—*Bd.*

Sand Darter.—Depth 6 to 8 in length; body nearly cylindrical; head elongated, pointed; scales small, finely dotted, far apart, and deeply imbedded; fins small: color pinkish white, pellucid in life, with a series of small, squarish, olive (blue) blotches along back, and another along sides, the spots connected by a gilt line; D. X—9; A. II, 6; length 2 to 3 inches. Ohio Valley, in sandy streams; one of the most interesting of our fishes. Western Pennsylvania only. The muscles of this fish are transparent, as in the youngest stages of all fishes. This character renders it nearly invisible when in the water or in the clear silicious sand which it frequents.

PERCINA—*Hald.*

PERCINA CAPRODES—*Raf.*

Log Perch, Hog Fish, Rock Fish.—Salmon yellow or greenish, with about fifteen transverse dark bands from back to belly, these usually alternating with shorter and fainter ones reaching about to lateral line; a black spot at base of caudal; belly with a row of enlarged plates, shed at seasons; neck above scaly; D. XIII—12; A. II, 10. Great lakes and western streams, abundant east to Lake Champlain; the largest of the Darters reaching a length of six or eight inches, (P. zebra, semifasciata, nebulosa and bimaculata of authors.)

Lake Erie and Allegheny river.

ALVORDIUS—*Girard.*

ALVORDIUS MACULATUS—*Grd.*

Black-sided Darter, Blenny Darter.—Head long and pointed, 4 in length; depth 5 to 5½; belly with a series of caducous plates along the middle line (shed at some seasons.) Straw yellow with dark tesselations and about seven large blotches along the sides, partly confluent, thus forming a moniliform band; D. XIII, to XV—12; A. II, 9. Ohio valley, Great lakes and eastward; one of the most curious and elegant of all the darters. (*A. aspro*, Cope and Jor.? *Alvordius* and *Hadropterus maculatus*, Grd. (*Etheostoma blennioides*, Ag.) In Pennsylvania in western streams only.

ALVORDIUS VARIATUS—*Kirt.*

Shielded Darter.—Head shorter; sides with broad, brownish shades; ventral shields much larger; D. XII—13; A. I, 9; lat. 1.53, Penn.

A large and handsome species from the west; also found by Jacob Stauffer in Conestoga creek, in Lancaster county.

ALVORDIUS MACROCEPHALUS—*Cope.*

Long-headed Darter.—Head much elongated; 3½ in length, the snout much longer than the eye; cheeks and opercles naked; colorations nearly that of A. Maculatus; scales quite small; D. XV, 13; A. II, 11; lat. 1, 77. Headwaters of Ohio river in Pennsylvania.

DIPLESIUM—*Raf.*

Hyostoma, Agassiz.

DIPLESIUM BLENNIOIDES—*Raf.*

Green-sided Darter.—Olive green and tessellated above; sides with a series of about seven double transverse bars, each pair forming a Y-shaped figure; these are joined above, making a sort of wavy lateral band; in life, these markings are of a clear deep green; sides sprinkled with orange dots; head with olive stripes and the usual dark bars; first dorsal dark orange brown at base, blue above, becoming pale at tip; second dorsal and anal of a rich blue green with some reddish; caudal greenish; young specimens much duller, but the peculiar pattern is unmistakable; body stout; head short and thick; D. XIII to XIII—.3; A. II, 8; length 3 inches. Penn. to Kas. and S.; one of the handsomest of fishes.

BOLEOSOMA—*DeKay.*

The species of this genus range further to the east than those of any of this group.

* Anal spine single, weak.

BOLEOSOMA OLMSTEDI—*Storer.*

Common Darter.—Fins stouter and higher than in the next; depth 5¼ in length; head 4¼; olivaceous, fins barred; back tessellated; a black streak forward; and another downward from the eye; cheeks and opercles scaly: neck and throat bare; D. IX—14; A. 1, 8; lat 1, 50. New England to Wisconsin abundant eastward. (*B. tessellatum*, De K.)

The common species of eastern Pennsylvania. The males are larger than the females and are marked with black in spring, especially on the head.

BOLEOSOMA MACULATUM—*Ag.*—*Johnny Darter.*

Paler and more distinctly tessellated; brownish yellow, upper surface dotted with brown, the spots forming a few dark bars on back; a dark line from eye to snout; and sometimes a bar below eye; smaller and slenderer than the preceding; with smaller fins; eye as large as the narrow pointed snout; cheeks, neck, and throat naked; opercles scaly; D. IX—12; A. 1, 10; lat. 1.45, E. U. S., abundant, west of the Alleghenies. *B. brevipinne*, (Cope.)

** Anal spine wanting.

BOLEOSOMA ÆSOPUS—*Cope.*

Caudal peduncle contracted; dorsal outline curved; fins high; brownish, with spots on back and sides; D. VII—14; A. 10; lat. 1.47. Susquehanna river, Penn.

NOTHONOTUS—*Agass.*

Nanostoma—Putnam.

NOTHONOTUS ZONALIS—*Cope.*

Zoned Darter.—Olivaceous, golden below; six dark brown quadrate spots along the back; connected by alternating spots with a brown lateral band from which eight narrow bands encircle the belly; lower fins yellow with brown spots; spinous dorsal with a crimson band; a series of crimson spots on base of soft dorsal; black spot on opercle, occiput, and base of pectorals; black bars downward from eye and forward; D. PI—12; A. 11, 7; lat 1.52. Indiana to Tenn. Probably western Pennsylvania.

NOTHONOTUS TESSELLATUS—*Jordan.*

Head broad and heavy; mouth large; cheeks and opercles naked, or nearly so; D. X.—A. II, 8. Allegheny river.

NOTHONOTUS CAMURUS—*Cope.*

Blue-breasted Darter.—Body stout; head short; muzzle abruptly decurved, the mouth somewhat inferior; lower jaw included; males very dark olive or blackish, with an obscure band of a paler shade; belly paler; breast and throat deep rich blue; sides profusely sprinkled with crimson dots, like a brook trout; these spots sometimes arranged in short longitudinal series of threes and fours; series of olivaceous lines along the rows of scales; first dorsal with black spot at base in front and a crimson one on the margin between the first and second rays; second dorsal, caudal, and anal crimson, bordered with yellow, which again is bordered with black or dark blue on the edge of the fin; the crimson is deepest next the yellow; pectoral and ventral fins with a broad red margin; females less distinctly marked, olivaceous, somewhat barred; head 4; depth $4\frac{1}{2}$; D. XI.—13; A 11, 8; scales 7—53—8; length $2\frac{1}{2}$ inches. Habitat, Ohio valley, Cumberland river; Tennessee, White river; Indiana, Mahoning river; Ohio, French creek; Pennsylvania, not abundant.

Habits.—This species is one of the most brilliant and delicate of all our fishes. It is found in clear cold streams, and thus far nowhere in great abundance.

NOTHONOTUS MACULATUS—*Kirtl.*

Trout Darter.—Body moderately elongated, deep, and compressed, head 4 in length; depth $4\frac{2}{3}$; head long and rather pointed; mouth pretty large; jaws equal; dorsal fin elevated, the longest rays reaching caudal; olive sides with rather large spots of brilliant carmine; vertical fins more or less

barred with red and white; D. XII, 13; A. 11, 8; lat. 1.60. Mahoning river, Ohio, a rare and handsome species.

POECILICHTHYS—*Agass.*

This genus embraces the most brilliantly colored of our fresh water *Percomorphi.* They are the most abundant of the group in western waters.

POECILICHTHYS COERULEUS—*Storer.*

Blue darter.—Rainbow fish.—Blue Johnny.—Olivaceous, tessellated above, the spots running together in blotches; back without black lengthwise stripes; sides with about twelve indigo blue bars running obliquely downward, most distinct behind, separated by rich orange interspaces; caudal deep orange, edged with bright blue; anal orange, with deep blue in front and behind; soft dorsal chiefly orange, blue at base and tip; spinous dorsal crimson at base, then orange, with blue edgings; ventrals bluish, often deep indigo blue; cheeks blue; throat and breast orange; these two shades very constant; ♀ much duller, with but little or no blue or orange; the vertical fins barred or checked; colors fade in alcohol; body short and stout; head large; D. X—12; A. 11, 7; lat. 1. 45; length 2 to 3 inches. Mississippi valley, abundant; the most gaily colored of all the darters.

ETHEOSTOMA—*Raf.*

The characters which distinguish this genus from *Pœcilichthys* are only to be found in the male fish.

ETHEOSTOMA FLABELLARE—*Raf.*—Fan-tailed darter.

Head entirely scaleless; lateral line short; lower jaw longest; olivaceous, dusky above; sides with obscure dusky bars; each scale with a brownish spot, these sometimes forming series of longitudinal lines, but never very distinct ones; head narrow; mouth oblique; body rather slender; fins strongly barred; D. VIII.—12; A. 11. 8; length $2\frac{1}{2}$ inches. Great lakes and streams from N. Y. and W., abundant. E. linsleyi, H. R. Storer. Western Pennsylvania. The knobbed spinous dorsal rays distinguish the males of this species from every other.

MICROPERCA—*Putnam.*

MICROPERCA PUNCTULATA—*Putnam.*

Least darter.—Greenish olive; sides with irregular dark bars and zigzag markings; dusky lines along the row of scales; a dark shoulder blotch; a black streak forward from eye and a vertical bar below it; D. VI to VII—9 to 12; A. 11, 5 or 6; length $1\frac{1}{4}$ inches. Western States.

PERCINÆ.

The following are the genera of this sub-family:

I. Anal spines two; dorsal fins more numerous.

Canine teeth mixed with the bristle-like ones, ... *Stizostethium.*
No canine teeth, ... *Perca.*
II. Anal spines three; dorsal spines less numerous.
No canine teeth, ... *Labrax.*

STIZOSTETHIUM—*Raf.*

The species of this genus are of rather elongate form, and resemble in their proportions those of Etheostomine group.

The *S. vitreum* or jack, sometimes called jack-salmon, or even salmon, for flavor and general character of flesh, and for large size, is only exceeded in value by the shad, yet it is almost unknown to our markets, except as an imported article from the lakes. It exists in the Susquehanna, and ought to be so protected as to be very abundant there. It is common in the Allegheny and tributaries, and is associated with another fine species of smaller size, the *S. salmoneum, Raf.* Both of these fishes ought to be cultivated. The jack reaches, occasionally, forty pounds, and like the trout, seeks the highest and coolest waters that will float it. It possesses great activity and strength, and is a ravenous destroyer of perch and other species. Were it not so superior in every way to all others, this habit might condemn it; as it is we regard it as one of the best species we possess. In the South, it is eagerly bought, and forms the principal table-fish for the various places of resort, springs, etc., where it can be obtained. It is supplied with means of defense in its powerful teeth, with which it will inflict wounds. Yet this large species is almost unknown in many parts of our State, and, as a source of food, is comparatively insignificant. As its mode of life combines those of the brook-trout and bass, there is no reason why some enterprising person should not make it an object of culture on the Delaware or westward. Proper protection would also have as much effect in increasing its numbers as in the case of any other species we have.

STIZOSTETHIUM VITREUM—*Mitchill.* Fig. 34.

Wall-eyed Pike.—"Salmon."—"Dory."—Glass Eye.—Yellow Pike.—Body slender, becoming compressed with age, the back not especially depressed; dorsal spines high, more than half length of head; eye $4\frac{1}{2}$ to 5 in head. General color a heavy olive, finely mottled with brassy; a large black spot on last rays of spinous dorsal, the fin otherwise nearly or quite unmarked; D. XIII—1, 21; A. 11, 12; lat. 1, 99. Size very large; this species reaches a length of nearly three feet, and a weight of 20 to 30 lbs. Great lake region and some Atlantic streams, north to the fur countries; an abundant and valued food fish, (*Lucioperca americana*, Cuv.)

VAR. SALMONEUM—*Raf.* Fig 35.

Blue Pike.—"White Salmon."—Body shorter, thicker and deeper, with slenderer caudal peduncle; mouth smaller; eye larger; dorsal spines

lower, $2\frac{1}{3}$ in head; coloration bluer; with silvery instead of brass mottlings; fin coloration darker; young pale, with traces of vertical bars; D. XIV—1, 20; A. 11, 13; lat. 1, 95. This species or variety is very similar to the preceding, but it is distinguished at sight by the fisherman, and seems to rarely attain a length of more than one foot. Lake Erie, Ohio river and South. Common in the Susquehanna river.

STIOSTETHIUM CANADENSE—*Smith.*

Fig. 36.

Sauger.—Sand Pike.—Gray Pike.—Body little compressed, broad across the back and rather depressed; cheeks, top of head, etc., usually thickly scaled; colors rather paler and more translucent than in S. vitreum, the shades less blended; olive gray, sides pale orange with much black mottling, the black gathered into several definite dark transverse areas; spinous dorsal with two or three rows of round black spots; a large black blotch at base of pectorals; dorsal XII—1, 17; A. 11, 12; lat. 1, 95; size not large; length 12 to 15 inches. Ohio river and Great lake region to upper Missouri; a strongly marked species. (*L. grisea*, De K., *L. borea*, Gird.)

PERCA—*Linn.*

PERCA FLUVIATILIS—*Linn.*

1. VAR. AMERICANA—*Schrank.*

Common Yellow Perch.—Olivaceous; sides yellowish, with broad dark bars; head $3\frac{1}{4}$ in length; depth about the same; D. XIII—14; A. 11, 7; lat. 1, 63. Fresh waters E. U. S; chiefly northward and eastward. [P. *flavescens* (Mit.) Cuv.] Abundant in the Delaware and Susquehanna rivers.

LABRAX—*Cuv.*

Morone and Roccus—Mitch.—Gill.

* Body little compressed; depth less than $\frac{1}{3}$ of length; teeth on tongue in more than one patch; chiefly marine. (*Roccus.*)

LABRAX LINEATUS—*Bl. Schn.*

Striped Bass.—Rock Fish.—Silvery or yellowish, with seven or eight longitudinal bands; D. IX—1, 12; A. III, 11; lat. 62. Atlantic coast, entering rivers. Ascending the Delaware and Susquehanna rivers.

** Body much compressed; depth less than one third of length; teeth on tongue in more than one patch.

LABRAX CHRYSOPS—*Raf.*

White Bass, Striped Lake Bass. Silvery, with six or more dark stripes,

sometimes "so interrupted as to appear like ancient church music." D. IX—1, 12; A. 111, 13; lat. 1.55. Great Lakes, Upper Mississippi Valley and north. (*Labrax multilineatus*, *notatus*, *albidus* and *osculatii* of authors.) Rivers of west Pennsylvania.

*** No patch of teeth at base of tongue; scales on cheek ctenoid; dorsal fins not connected. (*Morone.*)

LABRAX AMERICANUS—*Gmel.*

White Perch.—Whitish, usually faintly striped; depth 3 in length; D. IX—1, 12; A. 111, 9; lat. 1.50. Atlantic coast, abundant also in fresh water ponds, etc., coastwise; variable. (L. *mucronatus*, *rufus* and *pallidus* of authors.) Common in the Delaware and Susquehanna rivers.

CENTRARCHINAE.

A. Dorsal fin much more developed than anal.

* Body elongate; spines little developed; operculum ending in two points.

Gill rakers long and stout, ... *Micropterus.*

** Body elevated and compressed; spines robust.

a Tongue and pterygoid bones with teeth; gill rakers long.

Operculum with two points, ... *Ambloplites.*

Operculum ending in a convex flap, ... *Chaenobryttus.*

aa Tongue and pterygoid bones toothless.

β Operculum ending in a convex flap.

Caudal fin emarginate; . . . . . *Lepidopomus.*

β,β Operculum notched, or with two posterior apices, caudal fin

γ Dorsal fin with middle spines longest.

Anal spines 3; dorsals 10, ... *Mesogonistius.*

γγ Dorsal fin with regular outline.

Anal spines 3 or 4; dorsals 9; . . . . . *Enneacanthus.*

AA. Dorsal and annal fins about equal in extent.

Spinous dorsal longer than soft dorsal, its rays not steeply graduated, *Centrarchus.*

Spinous dorsal fin shorter than soft part, its rays steeply graded in length; . . . . . *Pomoxys.*

MICROPTERUS—*Lac.*

Calliurus, Raf., *Grystes* and *Huro*, Cuvier.

This genus embraces only two well-marked species, which are found everywhere in eastern North America south and west of the Potomac river. They approach the *Labraces* in form, but are most like the extinct genus *Mioplosus* from the eocene of the Rocky Mountains, in the structure of their fins and other parts.

MICROPTERUS SALMOIDES, *Lac.—Small mouthed black bass.*

Small-mouthed; scales of trunk small (*e. g.*, *lat. line*, 72–75; between lateral line, and back, 11 rows.) Scales on nape and breast much smaller than those of sides. Scales of cheek minute (*e. g.*, between orbit and preoperculum, about 17 rows in an oblique line and about 9 in a horizontal one.) Scales of interoperculum uniserial, covering only about half the width of the bone. Scales of preopercular limb none. Scales on dorsal developed as a deep sheet (involving last spine) of small scales differentiated from those on the back, and with series advancing high up the membrane behind each ray (except last two or three.) Scales on anal ascending high behind each ray. Mouth moderate. Supramaxillary ending considerably in front of hinder margin of orbit (about under hinder border of pupil.) Dorsal rays articulated 13, anal III, 10—11, pectoral, 1·16—1.17. Dorsal fin little depressed, the ninth spine being only about a half shorter than the longest (3, 4, 5) and a fourth shorter than the tenth. *Centrarchus obscurus Dekay*, *Grystes fasciatus*, *Les.*

MICROPTERUS PALLIDUS, Fig. 37. *Raf.—Large mouthed black bass.*

Large mouthed. Scales of trunk moderate (*e. g. lat. line*, 65–70; between lateral line and back, 7½ or 8 rows.) Scales on nape and breast scarcely (on nape,) or not much (on breast) smaller than those of sides. Scales of cheeks moderately small (*e. g.* between orbit and preoperculum, about 10 rows in an oblique line and about 5-6 in a horizontal one.) Scales of interoperculum uniserial covering the entire width of the bone. Scales of preopercular limb developed in an imperfect row (*e. g.* 3–5 in number.) Scales on dorsal developed as a low (obsolete) shallow sheath, and with series ascending comparatively little on membrane behind the rays (none behind last five or six.) Scales one anal none (or very few.) Mouth large. Supramaxillary extending considerably behind the posterior margin of orbit. Dorsal rays articulated, 12 (1.11;) anal III, 10 pectoral, 1.14 (1.14.) Dorsal fin much compressed, the ninth spine being only about a fourth as long as the longest and half as long as the tenth. *Huro nigricans C. & V.* *Micropterus floridanus*, Les., Great lakes and streams from L. Champlain S. and W.; common in N. Y. and in most regions west of the Alleghanies: introduced eastward, [*G. fasciatus*, (Les.) Ag. *obscurus* De K. (young) *M. achigan* (Raf.) Gill, etc. etc.

AMBLOPLITES—*Raf.*

Centrarchus, *Cuvier*, *pt.*

AMBLOPLITES RUPESTRIS—*Raf.*

Fig. 38.

Rock bass, goggle eye, red eye.—Depth about half length; head more than one third; eye nearly four in head, very large; cheeks scaly; front convex; longest dorsal ray two thirds depth of head at front of orbit; brassy olive with golden green and blackish markings; a dark spot at base

of each scale, which is conspicuous after death, giving a striped appearance; D. XI, 11; A. VI, 10; lat. 1, 42: L. S. Great lakes and rivers west of the Alleghenies; an abundant species. [*C. æneus*, Les. *A .ichthe-loides*, (Raf.) Ag.] An excellent pan-fish, and worthy of protection and propagation.

LEPIDOPOMUS—*Raf.*

Lepomis, Ichthelis and Pomotis—Raf. Bryttus Cuv. val-

This genus embraces the largest number of species of *Centrarchinæ*, and is distributed everywhere.

I. Pharyngeal tooth acute.

* Palatine teeth present; dorsal spines low; a black spot on second dorsal.

LEPIDOPOMUS CYANELLUS—*Raf.*

Blue spotted sun fish.—Dark clear olive-green, each scale with a blue spot and more or less of gilt edging, the body thus appearing more or less striped along the rows of scales; colors variable, golden olive, green or even almost blue; cheeks with bright blue horizontal stripes; body more or less besprinkled with irregular dark dots; vertical fins marked with green and blue, and more or less edged with pale orange; usually a distinct black dorsal spot; opercular spot small, with brassy edgings; depth $2\frac{2}{3}$ in length, head $2\frac{1}{2}$; dorsal spines low and stout; lat. 1. 48; L. 4 to 6. Great lakes, Ohio valley and W., abundant. (*A. longulus* and *A. formosus*, Grd., *A mineopas*, Cope.) Abundant in the Ohio water system. A good pan-fish.

** Palatine teeth present; usually no black bloches on last rays of dorsal and anal. (*Lepidopomus.*)

LEPIDOPOMUS NEPHELUS—*Cope. Chain side.*

Bright steel blue, with many bronze orange spots, which cover nearly the whole surface, so arranged that the ground color forms a series of vertical chain-like bars, very conspicuous in life; verticle fins mottled with bronze, and usually more or less edged with pale orange; no black dorsal spot; no distinct blue cheek stripes, but sides of head shaded with purplish; body rather elongate; head somewhat acute; opercular spot small; depth $2\frac{1}{3}$ in length; head nearly 3; lat. 1. 42; L. 3 to 4. Ohio valley. A small species and one of the handsomest; extremely hardy in aquaria, and perhaps the most voracious of the sun fishes. Western Pennsylvania.

LEPIDOPOMUS AURITUS—*Linn.*—Fig. 39.

Long-eared Pond Fish.—Red-tailed Bream.—Sun Perch.—Dusky olive; belly and vertical fins largely red; sides of body largely blue, with rusty red spots; blue stripes on head; spines rather short; body rather elongate; opercular flap very long, longer than any in other species, except the Southern *Zenotis fallax*, and extremely narrow. Maine to Alabama, east of the Alleghenies, abundant; the only long-eared sun-fish occurring in New England. A large handsome species, known at once by the peculiar

ear flap. L. 6 to 10. (I. *rubricauda*, *appendix*, etc., of authors.) Abundant in the Delaware and Susquehanna. A bright yellow variety occurs in the latter river basin.

*** No palatine teeth; dorsal spines very high; a more or less distinct black blotch on last rays of dorsal and anal.

LEPIDOPOMUS PALLIDUS—*Mich.*—Fig. 40.

Blue sunfish.—Copper-nosed Bream.—Olive green; adult dark; young more or less silvery, often uniformly so in spirits; a more or less distinct purple luster in life; sides with undulating, sometimes chain-like, transverse bars, most conspicuous in the young; a black spot on base of dorsal and anal behind; no blue stripes on cheeks; no red on fins; opercular flap moderately long and wide in adults, without pale edge, very short in young; body deep, compressed, caneral peduncle rather slender; head 3 in length; depth about 2; dorsal spines very long; D. X. 11; A. III, 10; lat. 1, 40 to 45; L. 3. Great lakes to Delaware R. (Abbott) and S., Abundant. A large and very variable species, but almost always recognizable by the characters above emphasized. (*Ichthelis incisor*, Auct.) Adult specimens are often nearly obicular and have the belly coppery red.

Abundant in Western Pennsylvania. Not found in the Atlantic streams north of Carolina.

II. Pharyngeal teeth truncate.

POMOTIS AUREUS—*Walb.*—Fig. 41.

Common sunfish.—Pumpkin seed.—Bream.—Depth more than half length; greenish olive above, sides orange-spotted; orange yellow below; cheeks orange, with blue wavy streaks; ear-flap rounded, broadly edged with scarlet, below and behind; lower fins orange, upper orange-spotted; spines rather high; D. X, 10; A. 111, 9; lat. 1. 37. Great lakes and streams, chiefly northward and E. of the Alleghenies; our most familiar species. (P. maculatus, auritus, and vulgaris of authors.) Abundant in all parts of Pennsylvania. In tide-water it attains a large size, and is an important food fish, appearing in large numbers in the eastern markets.

ENNEACANTHUS—*Gill.*

ENNEACANTHUS OBESUS—*Baird.*

Fig. 42.

Depth about half length; dorsal and anal moderately elevated in ♀; dark olive green, with eight strong black cross-bars and purplish spots; lateral line usually incomplete; cheeks with lines and spots; opercular flap velvet-black, bordered with purple; a dark bar below eye; D. IX. 10; A. III, 10; L. 3. Streams coastwise from Mass. southward; a handsome little fish.

Rare in south-eastern Pennsylvania.

ENNEACANTHUS GUTTATUS—*Morris.*

Blue-spotted sunfish.—Body without definite blackish cross bars, in males covered with round bright sky-blue spots; a pearly blue spot on opercle; body more elongated than in the others; lateral line complete; D. IX, 10; A. III, 9; lat. 1.30. New Jersey to N. C.; abundant. (*E. margarotis*—Gill and Jordan.)

Common in south-eastern Pennsylvania.

POMOXYS—*Raf.*

Dorsal spines normally 7; body much elevated; depth half length. (*Hyperistius*, Gill.)

POMOXYS NIGROMACULATUS—*Les.*

Grass Bass.—Calico Bass.—Depth 2 in length; head nearly 3; snout projecting, forming an angle with the descending profile; mouth large, very oblique, but smaller than in the next; fins very large; anal larger than dorsal; bright olive green and silvery; sides and fins much mottled; the anal fin nearly as much variegated as the dorsal; D. VIII, 15; A. VI, 18; lat. 1, 41; L. 8. Great lakes to Delaware R., (Abbott,) and S. W.; a handsome fish. [P. hexacanthus, (C. and V.,) Ag.] A valuable table fish.

** Dorsal spines normally 6; body less elevated, depth about one third length.

POMOXYS ANNULARIS—*Raf.*—Fig. 43.

Bachelor, (Ohio river,) New Light, (Ky.,) Crappie, (St. Louis.)—Depth two fifths to one third length, scarcely greater than length of head; olivaceous, silvery below; sides with irregular clusters of dark spots; the lower parts of the sides and the anal fin usually plain; D. VII, (V. to VIII) 15; A. VI, 17; lat. 1.43 (30 to 48), L. 10. Mississippi valley; a table fish of some value; abundant and exceedingly variable. (P. storerius, nitidus, intermedius, protacanthus, and brevicauda of authors.) Not found in Atlantic streams.

SCIAENDAE.

While marine species of this family are abundant on our coasts, very few are habitually fluviatile, and these are confined to the Mississippi waters and those of the Atlantic from Carolina south and west. They belong to one genus, which is distinguished by the coössification of the inferior pharyngeal bones as in *Pharyngognathi*, as shown by Prof. Gill.

AMBLODON—*Raf.*

Haploidonotus—*Raf.*

AMBLODON GRUNNIENS—*Raf.*

Fig. 44.

Sheep's Head, White Perch, Grunter, Drum.—Depth 3 in length; head $3\frac{1}{2}$; back elevated forwards, and much compressed; spines strong; first anal

spine short; the second very large, attached to a stout bone; grayish silvery, dusky above; scales rather large and irregularly placed, punctate with black; D. IX—I, 30; A. 11, 7; lat. 1.54. Great lakes, Mississippi valley, etc., abundant. (Corvina oscula and C. grisea, of authors.) Three other species of this genus have been described, but their validity is exceedingly doubtful. Southward this species is considerably valued as food, but in the Great lakes its flesh is ill-scented and worthless. Allegheny river.

VII. LABRYINTHICI.

Basis cranii double, with muscular tube. Superior pharyngeals without the fourth; third massive, articulated to cranium; one or other of the superior branchihyals developed into vertical laminae, often involuted. Inferior pharyngeals distinct. Dorsal fin spinous.

Fishes of this division form two families, which belong to tropical Asia. Their peculiar branchial structure enables them to live out of water for long periods, and to bury themselves in mud during dry seasons. A representative fish is the gourami, *Osphromenus ol fox*, which is an important article of food.

VIII. PHARYNGOGNATHI.

Basis cranii double, with tube; basilar bones of pectoral four, short; scapula with median foramen. Cranium normal posteriorly; posttemporal bifurcate. Superior branchihyals not complicated; superior pharyngeals with the third greatly developed and attached by movable articulation to cranium, the others wanting or rudimental. Inferior pharyngeal solidly coössified. Families three, the species mostly marine. The burgall and blackfish or tautog, are well-known representatives.

SYSTEMATIC SYNOPSIS.

MARSIPOBRANCHI.

HYPEROARTI.

Petromyzontidæ, species,	4

PISCES.

HYOPOMATA.

CHONDROSTEI.

SELACHOSTOMI.

Polyodontidæ,	1

GLANIOSTOMI.

Accipenseridæ,	5

ACTINOPTERI.

PHYSOSTOMI.

GINGLYMODI.

Lepidosteidæ,	3

HALECOMORPHI.

Amiidæ,	1

NEMATOGNATHI.

Siluridæ,	13

PLECTOSPONDYLI.

Catostomidæ,	19
Cyprinidæ,	36

ISOSPONDYLI.

Percopsidæ,	1
Salmonidæ,	10
Hyodontidæ,	1
Clupeidæ,	6

HAPLOMI.

Esocidæ,	6
Umbridæ,	2
Cyprinodontidæ,	6

ENCHELYCEPHALI.

Anguillidæ,	1

PHYSOCLYSTI.

PERCESOCES.

Atherinidæ,	2

SYNENTOGNATHI.

Belonidæ,	2

HEMIBRANCHI.

Gasterosteidæ,	2

PERCOMORPHI.

Gadidæ,	1
Cottidæ,	6
Aphododiridæ,	1
Percidæ,	34
Sciænidæ,	1
Total number of species, of which four have been introduced,	64

INDEX TO POPULAR NAMES.

INDEX OF SCIENTIFIC NAMES.

END OF YEAR