current is from the head to the tail. There are already over 80 muscular segments formed, and the breast-fin is developing at *f*.

Fig. 12.—Embryo, 94½ hours old, viewed as a transparent object. The notochord is shown as a broad black line, and the lateral yelk-vessels *v' v''* are much more developed than in Fig. 11.

Fig. 13.—Diagram to show the origin of the mode of anastomosis of the larger vessels, enlarged 52 times.

EXPLANATION OF PLATE XXI.

Fig. 14.—Embryo silver gar, 116 hours and 40 minutes after impregnation, showing the further development of the heart and blood-vessels traversing the surface of the yelk. Those on the opposite side of the yelk are indicated by the dotted lines. Pigment cells have made their appearance on the body beneath the superficial epiblast and on the yelk and the heart. The intestine and urinary vesicle *b* are well developed, as seen in the tail end of the embryo on the opposite of the egg through the vitellus.

Fig. 15.—Sketch of heart and vessels which empty into it in an embryo 140 hours old; the formation of the blood is in active progress where the vessels converge to join the heart, which is now blotched with pigment cells of two colors in life. Enlarged 26 times.

Fig 16.—Embryo silver gar, viewed from the side as a transparent object 165½ hours after impregnation, to show the progress of development of the blood vessels over the yelk on the right side. The heart or pericardiac cavity *p* is now enormously developed, and the development of blood cells is going on with great activity in its lower part, where the venous end *a* of the heart is attached. The heart itself is now greatly elongated downwardly, and is one-third as long as the whole embryo.

ON THE REARING OF WHITEFISH IN SPRING-WATER AND ITS RELATION TO THEIR SUBSEQUENT DISTRIBUTION.

By FRANK N. CLARK.

[Letter to Prof. S. F. Baird.]

I am not prepared to say whether or not eggs of the whitefish are prematurely hatched in spring-water. I take it that the question is a scientific problem for scientists to solve; that it is a point on which even "doctors disagree."

If we could "reap what we sow" from our plants of fish in bodies of water like the great lakes we would soon have a practical test of the respective value of "premature" or "retarded" development of eggs or embryos; but this is impossible, and so if there is any difference we must detect it from evidence that is circumstantial or theoretical. It seems reasonable to assume that if the little fellows are vigorous when hatched, whether of three or five months' incubation, and are released when and where aliment for their sustenance is abundant, a large percentage of those not destroyed by predaceous fishes ought to become adults. There is no difference in size and activity between fish brought out in three or six months, where the same water is used; neither are there points about the former that can be construed into evidence of abnormal de-

velopment or "prematurity." We have had a good chance to test this here, where the spring-water is raised or lowered in temperature, according to the weather, before it reaches the hatchery. Our hatching seasons are long or short, according as the winter is severe or moderate. Last year our eggs were laid in fully two weeks earlier and hatched nearly a month later than this, yet the fish of this year are equal in vigor and identical in appearance with those produced last season. But there is a very slight difference between the fry of the Northville hatchery, and of the Detroit, Toledo, and Sandusky hatcheries; the latter are a little darker, a trifle less transparent. I used to think that this difference was due to difference of hatching-periods; but since the fry of this season that hatched earlier than ever before are identical with previous hatchings, and since there is always the same difference between the spring-water and lake-water fry, no matter whether the former are hastened or retarded, I am constrained to think that the difference, which, however, is almost imperceptible, is due to the *character* rather than the temperature of the water. Last year our fish were "kept back" nearly as late as were those in hatcheries using lake-water. I know that when we made a plant at the islands (Lake Erie) the tanks of the Sandusky hatchery were full of whitefish minnows ready for distribution; and although there was not to exceed ten days in difference in times of hatching, there was that same slight difference in color and transparency.

Our spring-water is clear and sparkling, free from mechanical impurities, but holding in solution sufficient calcic salts to make it quite hard. The water used at the Sandusky and Toledo hatcheries is much softer, but is quite roily at times, and is never free from mechanical impurities. When they were laying in eggs last fall the water was so bad that they had to dispense with the wire gates through which the water discharges from the jar, as they would get clogged with sediment in a short time and overflow the jar.

We have, at the hatchery here, brought forth the young of brook trout in 80 days, and anon in 120 days; yet the former ate as readily, grew as rapidly, suffered as little loss, and in fact were the equals in every respect of the latter. The hatchery of the Michigan commission, formerly located at Pokagon, used spring-water for hatching their trout eggs, without attempting to cool it by extended exposure to the air. In consequence of using this comparatively warm water their eggs frequently hatched in mid-winter—I presume in less than 80 days, but do not not know positively. They had no trouble in rearing their fish.

I am well satisfied that where we have had a chance to test this matter, as with the young of fishes readily adapted to being grown in confinement in ponds or tanks, or "artificially" as brook trout, California trout, &c., it makes no difference whatever, either as to the appearance of the fish, or results in rearing, whether the eggs incubate a moderately short or a very long time. There must, of course, be a limit to the brevity of the

hatching-period, but where the line is to be drawn is more than I can say. We have no such chance for making such tests with the young of whitefish, as they are, of course, lost sight of when released in such vast bodies of water as the great lakes, and we can therefore only speculate as to their probable future. But if varying periods of incubation make no difference in the vigor or appearance of trout alevins, why should it with whitefish? Do not the facts in connection with trout establish a precedent, or basis, for calculations in regard to the number of adults to be produced from a given number of *any* kind of fish set free in waters to which they are indigenous, provided the latter are, like the former, protected from enemies, and have an abundance of their appropriate aliment at command? Is there anything wanting to make the premises and conclusions analogous? It is not possible to protect the little fishes from their enemies, when they are turned loose to "seek their own salvation." But it *should* be incumbent on the fish-culturist to see to it that they are released only when and where their particular food is found; and not only found, but in sufficient quantities for the purpose, so that we might reasonably expect as large percentages to survive, outside of those destroyed by enemies, as we do of those grown in our ponds.

It is one thing to hatch a large number of fish; it is quite another to know just when and where to place them within the jurisdiction of conditions absolutely essential to their existence. The former is now a matter of comparative ease; but as this amounts to nothing, so far as the results sought after are concerned, if the proper conditions are not subsequently supplied, there ought to be a certainty, which scientific investigation alone must determine, that these conditions *do* exist. The tendency with fish-culturists generally has been to see how many fishes can be brought into existence, and to see how cheaply it can be done, then planting them with a reckless indifference, trusting to "luck" for good results.

Perhaps, though, this random and indiscriminate distribution is the best that can be done in many instances where the exact requirements are not known.

Professor Forbes' recent researches to determine the food of the young of whitefish throw a good deal of light on this subject, that will apply with equal force, in some respects, to other fishes; and his prospective experiments will doubtless reveal still greater light, if indeed they do not, incidentally, settle the question of prematurity so far as the young of whitefish are concerned. What he proposes to do, as I understood him in a recent conversation on our way from Racine to Chicago, is to set two or more seines or prisons in Geneva Lake, Wisconsin, where the alleged food of the young whitefishes, entomostraca, &c., is found.

Into these separately will be put some fry from the Northville hatchery—if I can keep them alive until he is ready for them—and some from the Detroit hatchery, later on. If the little fellows partake of the entomostraca freely and thrive, this will verify Mr. Forbes' prior conclusions that this is their earliest food. If the Detroit fish live and mine do not, it will look as though mine were premature, unless indeed they

shall have been kept too long before the test is made. If the Detroit fish suffer as great loss as mine, it will look as though there was no advantage or nothing to be gained by retarding the eggs, so far as the vigor of the fish is concerned. If Mr. Forbes finds that the entomostraca are much more abundant later on than when he made investigations at Racine the day following our plant of fish at that point, it will signify that we should keep back the eggs, so that the fry may have the greatest possible amount of food at their disposal. Or, if Mr. Forbes' experiments show, or, if it can be shown, that our spring-water brings out weak or immature fish, then certainly other water should be used, even though the whitefish branch of the work is removed to some other locality, which I shall be perfectly willing to have done.

We have other water near the hatchery (branch of river Rouge, see map), that is as cold as can be found anywhere during the winter; but it is lower than the hatchery, and would have to be pumped. This would entail some expense, but would give us more water for trout purposes. We could also, by running varying proportions of spring and creek water on different sections of eggs (whitefish), hatch them at will, as wanted for distribution.

Another good way, too, if it is thought best not to hatch whitefish at Northville in the spring-water, is to put up an inexpensive hatchery adjacent to some good spawning grounds, as, for instance, at Alpena. At such a point, the hatchery could be filled at a very moderate expense, as every fisherman would lend a hearty co-operation. By using jars only and having no shipments to make, two men could easily care for a very large number of eggs. Enough could be sent on to Northville, say five or ten million, to fill orders from other points, making this headquarters for shipping, correspondence, &c.

Our whitefish hatched in from 75 to 90 days this year—an unusually brief period; but since they are the exact counterparts, both in appearance and vigor, of the fish of previous hatchings, I am forced to admit that the opinions I have hitherto held in regard to this matter were erroneous. But I think there is a very good reason why the use of spring-water for hatching these fish should be discontinued, unless, indeed, we can devise some means of reducing it to the proper temperature to "keep the fish back" later than this; for, although the "premature" fish are perfectly normal, it is altogether probable that the proper food exists in much greater abundance later on.

I can but think, too, as Professor Forbes says, substantially, that a great mistake is made in planting the fish in such large numbers in one place. The water should be teeming with the appropriate food at the time and place the fish are set free, to meet the requirements of so vast a number of minnows as are usually released in one place.

According to Professor Forbes' recent investigations off Racine, each minnow would have to skirmish around through a vast deal of water to find sufficient nourishment, even though he had no comrades with which to divide the spoils. Grown fish might easily migrate to rich feeding-

grounds; but this can hardly be expected of those of such tender age. I think they should be as widely scattered as possible when turned loose. Doubtless more of them would get eaten up, but less would starve to death. This should apply to other kinds of fish as well. It might be argued that the parent fish themselves congregate in large numbers in one locality to deposit their eggs. This is true, but it is very doubtful if any hatch except those isolated individuals carried into the crevice of some rock or reef, thus becoming protected from spawn-eaters and the confervaceous growth that must generate and destroy all eggs *en masse;* so that but a comparatively small number of the young are turned out, and these are considerably scattered.

Touching on these points, I will quote from Professor Forbes' recent letters:

From February 3: "I have not forgotten the food of the young whitefish, but have kept the subject in mind in making collections from Lake Michigan and adjacent waters this fall and winter. Entomostraca of great variety occur in considerable numbers in the lake at all seasons, as is shown by surface collections made there by me in October and November, off Chicago, and in Grand Traverse Bay, and by the straining of the water supply of Chicago. A fine lot of the common forms was obtained by the latter method, January 20, of this year. Everything of the sort is much more abundant, however, about the time of the melting of the snow than at any earlier period, and the chances of young fish finding sufficient food would certainly be much better then than earlier." * * *

Mr. Forbes had arranged to be with us on our trip with fish to Racine and Sheboygan, but missing our train, came on to Racine the day following our plant of fish. He then made his searches for entomostraca, and returned with us to Chicago that evening. A few live fish were found in one of the cans, and these Mr. Forbes took home with him. Since then he writes, as follows:

"The little whitefish came through all right, and I have about two-thirds of them yet in an aquarium. I have kept them supplied with entomostraca from pools about here, but, although the little fellows will follow a cyclops around for some time, making little jumps at him, and nibbling at his heels, yet I haven't seen any actual captures, and don't think that any have been made. Their teeth are already developed, but there are considerable remnants of the egg-sac remaining. I shall probably lose them all before they are positively compelled to eat, as our well-water don't seem to be altogether agreeable to them.

"I am very well satisfied that nothing much larger than a cyclops could be taken by them at first, and the small number of the larger entomostraca which I found at Racine consequently wouldn't signify *at first.* Possibly they might find a scarcity of appropriate food a little later, when they had gained strength and courage enough to attack a daphnia.

"Without really *knowing* about it, I have a strong impression that the little fishes' chances would be improved if they were as widely scattered as posssble when deposited. Certainly, if they are disposed to keep together at all after being released, any large school of them would have found poor hunting off Racine.

"I have made as careful a count and estimate as I could of the abundance of small entomostraca there, and have concluded that there were not more than one or two to the cubic foot of water, and that there were probably less than this.

"These calculations will have more value, however, after it is absolutely certain that entomostraca make the principal food of the fishes.

"I have taken the first steps towards the Geneva Lake experiment, and hope that we shall make that clinch the matter."

Mr. Forbes wrote again the same day (February 20) as follows:

"Since my letter of this morning the little whitefish have realized the situation, and the entomostraca are rapidly diminishing in number. Several of the little fellows have been bottled with *Corpusus delicti* in their bowels, always of the smallest species, cylops or canthocamptus. They pay no attention whatever to the algæ in their jar, and seem afraid of the daphnias, and larger entomostraca generally."

I have no further communications from Mr. Forbes relative to this matter.

NORTHVILLE, MICH., *February* 22, 1882.

DESCRIPTIONS OF NINETEEN NEW SPECIES OF FISHES FROM THE BAY OF PANAMA.

By DAVID S. JORDAN and CHARLES H. GILBERT.

The greater part of the months of February and March, 1881, were spent by Mr. Gilbert at Panama, in making collections of fishes for the United States National Museum. About 145 species were obtained at Panama, 80 of which are identical with species previously obtained at Mazatlan. The following species appear to be new to science, and are described in the present paper:

1. *Urolophus aspidurus.*
2. *Tylosurus scapularis.*
3. *Caranx* (*Carangops*) *atrimanus.*
4. *Sciæna imiceps.*
5. *Sciæna* (*Stelliferus*) *ericymba.*
6. *Sciæna* (*Stelliferus*) *oscitans.*
7. *Sciæna* (*Bairdiella*) *ensifera.*
8. *Odontoscion archidium.*
9. *Cynoscion phoxocephalum.*
10. *Isopisthus remifer.*
11. *Serranus* (*Plectropoma*) *lamprurus.*
12. *Diabasis steindachneri.*
13. *Xenichthys xenops.*
14. *Pimelepterus ocyurus.*
15. *Gerres aureolus.*
16. *Gobius* (*Lepidogobius*) *emblematicus.*
17. *Microdesmus retropinnis.*
18. *Cerdale ionthas.*
19. *Citharichthys* (*Hemirhombus*) *latifrons.*