

organs. The outer world of the polyp is confined to the objects of its prey, the outer world of the civilized man is the Universe. Our steam vehicles on land and on sea, what else are they than improved organs of locomotion; our letters, our books, our journals, our telegraphs, what else are they than organs of human language on a more extended scale? our telescopes, our microscopes, what else are they than the receptive sense of the eye extended. Thus all the inventions of our civilization tend to enlarge the horizon of the individual man. And this is the true destiny of man. I do not know of a greater motto or life-principle than that which was written on the temple of the oracle of Delphi in ancient Greece: Γνωθι σεαυτόν—"Know thyself;" but another is equally great, written by Wilhelm von Humboldt, the great philologist, (brother of the author of the *Cosmos*), it is this: "I wish to leave when dying as little as possible behind me in this world, with what I have not come in contact," that is what I have not mastered with my mind. Humboldt wanted the most perfect knowledge of the outer world, while the Greek philosopher wanted the deepest knowledge of himself. One of these sentiments is only the reverse of the other, or rather it follows immediately from the other. The most thorough knowledge of the outside world involves the deepest insight into ourselves; just as in morals, he who loves his neighbor the truest is the happiest, and thus loves himself the truest.

ART. II.—*On some unusual modes of Gestation*; by JEFFRIES WYMAN, M.D.

Communicated to the Boston Soc. of Natural History. (See Proceedings of the Society, Sept. 15, 1857.)

AMONG Batrachians the circumstances under which the young are developed, though less varied than in some of the other classes of vertebrates, still present a considerable range. By most species the eggs are deposited in the water either upon aquatic plants or on the bottoms; by others, as in *Salamandra erythronota*, they are laid in damp places under logs or stones; with some the evolution of the embryo commences a short time previous to the laying of the egg and is completed subsequently, while there are other species which are wholly viviparous.

The most remarkable deviations from the ordinary modes are to be found in those instances in which the eggs, after being laid, are again brought into a more or less intimate relation with the parent, as in the "Swamp toads" (*Pipa Americana*) of Guiana, where each ovum is developed in a sac by itself on the back of the female, in *Notodelphys* of Venezuela, where all the eggs are lodged in one large sac, also on the back, and is analogous to the

pouch of the Marsupials, and in *Alytes*, the "Obstetric toad" of Europe, where the eggs are wound in strings around the legs of the male who takes care of them until they hatch.

The species, the habits of which are noticed below, and which, in so far as I have been able to learn, have not attracted the attention of naturalists, adds another to the series just mentioned, though the relation of the foetus to the parent becomes less intimate than in any of the preceding cases.

Hylodes lineatus (Dum. and Bib.) is very common in Dutch Guiana, and its peculiar habits are well known to the colonists. The first specimen with young which came to my notice had been preserved in alcohol, and was presented to me by Mr. G. O. Wacker, residing at Osembo, on the Para Creek, Surinam, and had been captured at some distance from the water. The young, ten or twelve in number, though separated from the parent, he assured me, when found, were attached to her back.

In the month of May, 1857, during an excursion to the country inhabited by the Bush negroes, above Sara Creek on the upper Surinam River, I had an opportunity for the first time of seeing these animals carrying their young. The grass and bushes were quite wet from a recent fall of rain, and this seemed the inducement that led them from their hiding places, for when the ground was dry none had been seen. They were very quick in their movements, and when alarmed went at once into the grass and thick bushes. One of my companions, Mr. John Green, and myself succeeded in capturing some specimens, which, as we were just leaving the village, were placed at once in alcohol. In one instance the larvæ were retained permanently adherent to the back of the parent, in consequence of the coagulation of the mucus covering the surface of the body, and are still preserved in the Museum of Comparative Anatomy at Cambridge. (Fig. 1.) The young, from twelve to twenty in number, were collected upon the back of the mother, their heads directed towards the middle line. They were about three-fourths of an inch in length. No limbs were developed, though in some of them the rudiments of a leg existed in the form of a small papilla on either side of the base of the tail. No especial organ was found to aid them in adhering to the back of the parent. The adhesion may have been effected by the mouth; this is rendered probable by the fact that all of them had the mouth in contact either with the skin of the parent or with that of another larva. A viscid mucus covering the integuments undoubtedly assisted in some measure to bring about the same results. However this may be, they retained their places perfectly well, and were not displaced when the mother, closely pursued, carried them through the grass.

On dissection of the young nothing was found materially different to conditions of the larvæ of other Anoura. The external

gills had disappeared, but were replaced by internal ones which were arranged as usual on three hyoid arches. The development of the lungs had commenced and these were represented by a slender conical mass of cells, but not permeable to air. The mouth was provided with finely denticulated horny jaws, and the intestinal canal was shorter and less spirally convoluted than in ordinary larvæ of frogs and toads. The stomach was not so much developed as to be distinguished from the rest of the intestine; but this last, after passing the liver, was somewhat dilated, and contained, as was shown by the microscope, large quantities of yolk cells which had not been absorbed and which were adherent to its walls.

We have here then a larva, in all of the details of its structure, especially in the existence of gills and of a flattened tail, adapted to aquatic locomotion and respiration, yet passing a portion of its time at least on the back of its parent and at a distance from the water.

I was not able to ascertain whether the eggs were primarily deposited in the water or not, but it is well known to some of the colonists that after the larvæ have reached a certain degree of development they are carried about in the manner just described and they do not know them under any other circumstances. The existence of yolk cells in the intestine, shows that for a period at least they may have from these a supply of nutriment. But after this is exhausted, and it appeared to be nearly so in those which I have dissected, how do they obtain their food? In the absence of limbs adapted to terrestrial locomotion can they leave the body of the parent? and if they cannot, do they, as in the case of *Pipa* and probably in *Notodelphys*, depend upon a secretion from her?

Among Fishes, as far as at present known, the external conditions under which the eggs are developed are more varied than in any other class of Vertebrates. There are scarce any known conditions of the higher classes to which there are not analogies at least in the class of fishes. Besides the ordinary mode of depositing eggs upon the bottoms, some of the Salmonidæ, like the turtles, bury their eggs, the Lampreys (*Petromyzon*), the Breems, (*Pomotis*), the Hassars (*Callicthys*), the Stickle-backs (*Gasterosteus*), &c., build more or less complete nests. Among some of the Pipe fishes, (*Syngnathidæ*), the eggs and subsequently the young, are carried in a pouch analogous to that of the opossums and other marsupial animals, and among some of the Sharks there is a vitelline placenta analogous to the Allantoidian one of the Mammalia.*

* Prof. Owen (in Philos. Transactions, 1834,) has pointed out the vascular relations of the foetal Kangaroo to the parent. The chorion is not vascular, but the umbilical vesicle is largely provided with blood vessels, and, as far as his investigations go,



Fig. 1.—*Hylodes lineatus*.

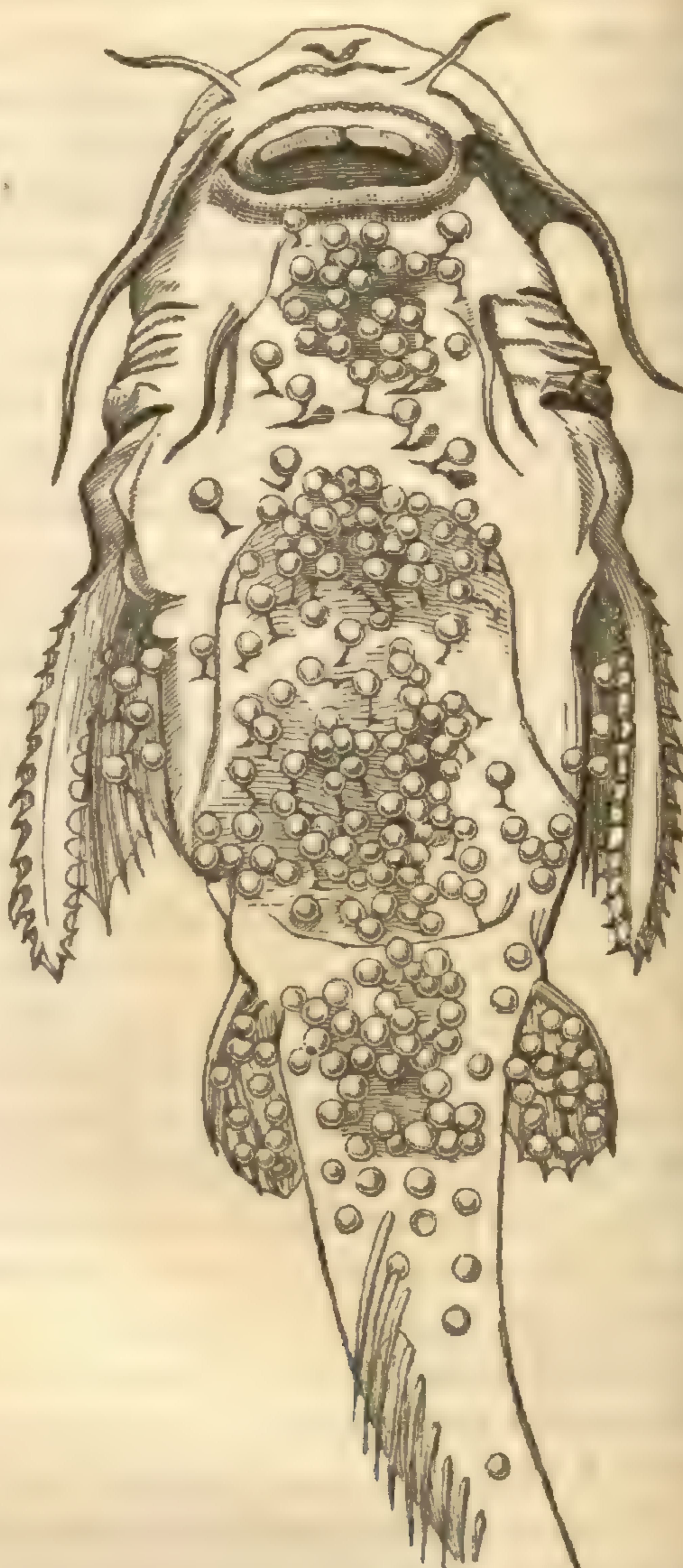


Fig. 2.—*Aspredo lævis*.



Fig. 4.—Pedicle showing capillary plexus, enlarged ten diameters.



Fig. 3.—Pedicle with an egg attached, enlarged 4 diameters.

To those species enumerated above where the eggs become more or less intimately connected with the body of the parent after they are laid may be added the *Aspredos* and some species of *Bagrus*, from Guiana.

Aspredo lævis (Cuv. and Val.), the "Trompetti" of the colonists, is about fifteen inches in length, and belongs to a remarkable genus of Siluroid fishes, which, in addition to several peculiarities of anatomical structure, are remarkable for carrying the eggs and young attached to the under surface of the body. These fishes are very abundant in the waters of the Surinam where they are taken in the nets with other kinds. They are not used as articles of food except by the negroes, who have a fancy for Siluroids generally, and in consequence these are known among the colonists as *Ningré fisi* or "nigger fish." A general account of the internal structure of *Aspredo*, is given in the *Hist. Nat. des Poissons*, by Cuvier and Valenciennes, T. xv, p. 35.

In describing the organs of reproduction, Valenciennes says: "the ovaries are small and contain very large eggs, which leads to the belief that this fish is viviparous." In those specimens which I have dissected the eggs when mature are not remarkable for their very great size, being from 0.09 to 0.11 inch in diameter, even after the commencement of the development of the foetus, and when the egg has already increased in size. The ovaries are about an inch and a half long and completely separated from each other.

Valenciennes further describes certain appendages to the under side of the body: "A certain number of individuals in each species (of *Aspredo*) are remarkable for singular appendages on the under side of the thorax and abdomen, and which, after the few observations which I have been able to make appear to indicate a certain state of the female. I have not seen them in the males and the females do not have them at all times. They first appear as pores on the under and naked surface of the trunk; and these enlarge and swell into tubercles, which subsequently elongate into filaments, and the extremity of each filament is dilated into a small cupule."*

"It was in this state that Bloch saw them in an individual with six cirrhi, and, taking them for specific characters, named the fish *Platystacus cotylophorus*. But I have seen the same appendages in three species. Artedi, in the text of Seba, had

affords the principal vascular surface by means of which an interchange takes place between the foetus and the parent. The vitelline circulation then, as in sharks, is the respiratory circulation. The allantois of the Marsupials appears to remain in a rudimentary condition, and does not form a connection with the parent. Thus the vascular relation of the foetus of some of the sharks, as *Carcharias*, with the parent is identical with that of the Marsupials.

* Cuvier and Valenciennes, *Hist. Nat. des Poissons*. T. xv, p. 430.

already described two species, to which we now add a third. All three live in the waters of Guiana and this is all we know of their habits."*

From the preceding paragraphs it does not appear that Valenciennes had supposed that the so-called "cupules" were intended to contain or had contained ova, especially as he had previously expressed the belief that the *Aspredos*, in consequence of the large size of the eggs, were viviparous. The true use of the appendages in question relates to the development of the eggs, as the following description will show. The habits of the fish are well known to the fishermen, from one of whom Mr. Green obtained information with regard to their peculiar mode of gestation. After many ineffectual efforts, we at last succeeded in procuring the specimens on which the following observations were made, and Mr. Green has kindly presented to me some very fine ones from his own collection, without which this notice would have been much less complete. †

In the month of June the eggs are found adhering to the underside of the body, to the ventral and pectoral fins, and extend as far forward as the under lip, and as far backwards as the middle of the tail. (Fig. 2.) In some, however, the distribution is much more limited. I was unable to learn anything with regard to the transfer of the ova from the genital orifice to the point of their attachment. The only organ which seems in any way adapted to such a purpose is the slender and flexible tail terminated by a delicate caudal fin. It is possible that the eggs may be deposited on the bottom of the river, and subsequently attached by pressing the under side of the body upon them.

In those individuals where the ova were still in the ovary, but approaching maturity, the integuments of the under side of the body gave no other indications of the changes about to take place than of being quite vascular; the skin was perfectly smooth, no "pores" were visible, but a large vessel was seen emerging from the region of the liver, and descending along the median line gave off branches quite freely to the integuments. This may have some relation to the future development of the pedicles which support the eggs and perhaps to the nutrition of the embryo as will be adverted to hereafter.

In all the specimens which I have had an opportunity of examining, the eggs were either somewhat advanced or quite mature; so that no observations could be made on the earlier conditions of the egg and the formation of its pedicle. The pedicle is a flexible outgrowth from the common integuments, is about two lines in length, is attached to the skin by a slightly expanded base, and spreads out at its summit into a shallow cup

* Cuvier and Valenciennes, *Hist. Nat. des Poissons*. T. xv, p. 430.

† See an account of the habits of the *Aspredo* by Mr. Green in the *Proceedings of the Boston Soc. of Nat. History* for April, 1858.

or "cupule," for the support of the egg. It is composed almost entirely of fibrous tissue, invested with a layer of tessellated epithelium. In some instances when the eggs were but little advanced, numerous fusiform cells were detected among the fibres. It is vascular, two or three vessels reaching to the cup, where they ramify and form a somewhat extended capillary plexus. (Figs. 3 and 4).

The eggs vary according to the degree of development from the 0.09 to 0.15 of an inch in diameter, and are covered with an external homogeneous membrane, containing minute punctiform depressions—within this is a second, of a brownish color and composed of epithelium. The embryos which were the most advanced and just ready to hatch, had not as yet completely absorbed the yolk, and were coiled up within the membranes, which in consequence of the irregularities of the mass formed by the embryo, had no longer a spherical form.

The eggs are retained in connection with the cup apparently by adhesion alone, for as soon as the foetus escapes, the egg membranes become very easily detached from the pedicle, and this last as shown by some of the specimens undergoes absorption.

The relation of the embryo to the parent in this singular mode of gestation cannot be determined very accurately, but the vascular plexus in the cup, seems to be more than is necessary for the mere nutrition of the part. The egg increases in size during incubation, those ova in which development had but slightly advanced measuring from 0.09 to 0.11 of an inch in diameter, while those nearly mature measured from 0.14 to 0.15 of an inch. How this increase of size of the embryo over the original size of the egg is actually obtained I have no facts to show, but either of two suppositions are probable; it may be by absorption of materials from the water which surrounds it, or from the capillary plexus of the pedicles, and in this case in a manner analogous to that of *Pipa*.

Among the Siluroid fishes of Guiana there are several species, which at certain seasons of the year have their mouths and branchial cavities filled either with eggs or young, and as is believed for the purpose of incubation. My attention was first called to this singular habit by the late Dr. Francis W. Cragin, formerly U. S. Consul at Paramaribo, Surinam. In a letter dated August, 1854, he says, "the eggs you will receive are from another fish. The different fishermen have repeatedly assured me, that these eggs in their nearly mature state are carried in the mouths of the parent, till the young are relieved by the bursting of the sac. Do you either know or believe this to be so, and if possible, where are the eggs conceived and how do they get into the mouth?"

In the month of April, 1857, on visiting the market of Paramaribo, I found that this statement, which at first seemed to be very improbable, was correct as to the existence of eggs in the mouths of several species of fish. In a tray of fish which a negro woman offered for sale, I found the mouths of several filled with either eggs or young, and subsequently an abundance of opportunities occurred for repeating the observation. The kinds most commonly known to the colonists, especially to the negroes, are *Jara-bakka*, *Njinge-njinge*, *Koepra*, *Makrede* and one or two others, all belonging either to the genus *Bagrus* or one nearly allied to it. The first two are quite common in the market and I have seen many specimens of them; for the last two I have the authority of negro fishermen but have never seen them myself. The eggs in my collection are of three different sizes, indicating so many species; one of the three having been brought to me without the fish from which they were taken.

The eggs become quite large before they leave the ovaries, and are arranged in three zones corresponding to three successive broods, and probably to be discharged in three successive years; the mature eggs of a *Jara-bakka* eighteen inches long, measure three fourths of an inch in diameter, those of the second zone one fourth; and those of the third or very minute, about one sixteenth of an inch.

A careful examination of eight specimens of *Njinge-njinge* about nine inches long, gave the following results:

The eggs in all instances were carried in the mouths of the males. This protection, or gestation of the eggs by the males, corresponds with what has been long noticed with regard to other fishes, as for example, *Syngnathus* where the marsupial pouch for the eggs or young is found in the males only, and *Gasterosteus* where the male constructs the nest and protects the eggs during incubation, from the voracity of the females.

In some individuals the eggs had been recently laid, in others they were hatched, and the foetus had grown at the expense of some other food than that derived from the yolk, as this last was not proportionally diminished in size, and the foetus weighed more than the undeveloped egg. The number of eggs contained in the mouth was between twenty and thirty. The mouth and branchial cavity were very much distended, rounding out and distorting the whole hyoid and branchiostegal region. Some of the eggs even partially protruded from the mouth.

The ova were not bruised or torn as if they had been bitten, or forcibly held by the teeth. In many instances the foetuses were still alive, though the parent had been dead for many hours.

No young or eggs were found in the stomach, although the mouth was crammed to its fullest capacity.

The above observations apply to Njinge-njinge. With regard to Jarra-bakka, I had but few opportunities for dissection, but in several instances the same conditions of the eggs were noticed as stated above; and in one instance, besides some nearly mature foetuses contained in the mouth, two or three were squeezed apparently from the stomach; but not bearing any marks of violence or of the action of the gastric fluid. It is probable that these found their way into that last cavity after death, in consequence of the relaxation of the sphincter which separates the cavities of the mouth and the stomach. These facts lead to the conclusion that this is a mouth gestation, as the eggs are found there in all stages of development, and even for some time after they are hatched.

The question will be very naturally asked, how under such circumstances, these fishes are able to secure and swallow their food. I have made no observations bearing upon such a question. Unless the food consists of very minute particles, it would seem necessary that during the time of feeding the eggs should be disgorged. If this supposition be correct, it would give a very probable explanation of the only fact which might be considered at variance with the conclusion stated above, viz., that we have in these fishes a mouth gestation. In the mass of eggs with which the mouth is filled, I have occasionally found the eggs, rarely more than one or two, of another species. The only way in which their presence may be accounted for, it seems to me, is by the supposition that while feeding, the eggs are disgorged, and as these fishes are gregarious in their habits, when the ova are recovered, the stray egg of another species may be introduced into the mouth among those which naturally belong there.

5.



Fig. 5 represents a nearly mature foetus of the natural size from the mouth of *Bagrus*, with the yolk sac partially included in the cavity of the abdomen.