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## THE BREEDING HABITS OF THE PARADISE FISH,

(*POLYACANTHUS OPERCULARIS*, *Linnaeus*).

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In a former paper<sup>1</sup> I described the nesting habits of the Fighting Fish (*Betta pugnax*, Cantor) as observed in my aquaria. I have since had the good fortune to secure a number of living specimens of the Paradise or Rainbow Fish, *Polyacanthus opercularis*, Linnaeus,<sup>2</sup> which name, according to Dr. Boulenger,<sup>3</sup> represents the original species whence the domestic *Macropodus viridiauratus*, Lacépède,<sup>4</sup> is derived.

This fish is breeding very freely with me, but as its life history is well known I do not propose to do more than point out in what respects its habits differ from those of *Betta*.

The male is larger than the female, has the fins more produced and the caudal filamentous. Ordinarily the coloration of the sexes is similar, but when breeding the hues of the male are intensified, while the female becomes very pale and loses the beautiful greenish blue bars on the body. None of the illustrations I have seen do justice to this beautiful fish. My specimens exhibit ten bars as described by Linnaeus; published figures show a smaller number.<sup>5</sup>

The nest of *Polyacanthus* is usually not so extensive nor so dome-shaped as that of *Betta*: this may be accounted for by the former fish showing a greater preference for nesting beneath some shelter, as the leaf of a Nardoo (*Marsilea*) or the crossing ribbons of *Valisneria*. The first batch of eggs is frequently produced when but a few bubbles are formed, others being added below as oviposition proceeds. As a consequence the eggs are raised quite out of the water and hatched in this situation. The young ones may be seen wriggling within the egg on the surface of the nest: this lends support to the observation that some existing shelter is used, beneath which the bubbles are blown, otherwise the young would be very conspicuous to an enemy above.

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<sup>1</sup> Waite—Rec. Aust. Mus., v., 1904, p. 293, pl. xxxviii.

<sup>2</sup> Linnaeus—Syst. Nat., ed. x, 1758, p. 283.

<sup>3</sup> Boulenger—Cambridge Nat. Hist., vii., 1904, p. 669.

<sup>4</sup> Lacépède—Hist. Nat. Poiss., iii., 1802, p. 417.

<sup>5</sup> Cuvier et Valenciennes—Hist. Nat. Poiss., vii., 1831, pl. 197; Valenciennes—Reg. Anim. Ill. Poiss., pl. lxxiv., fig. 2; Pouchet—Rev. Mag. Zool., xxiii., 1872, pl. xxv.

A marked difference is observable in the relative specific gravity of the eggs of *Betta* and *Polyacanthus*. As previously described those of the former are heavier than water, and the male collects them as they sink and places them beneath the nest. In the latter the eggs are lighter than water, and thus ascend to beneath the bubbles without the aid of the male. At the moment of extrusion the female is quite inverted, so that the eggs, apart from their relative lightness, are directed upwards. As the nest may be of but little extent, say, at first, of the size of a shilling, the eggs frequently rise to the surface in the clear water beyond its margin; these are collected by the male and placed beneath the bubbles. This does not, however, occur until some little time after the eggs are produced, for, unlike the condition in *Betta*, it is the male who is most exhausted, the female being the first to move away.

The female Paradise Fish seems to have greater motherly instinct than the female *Betta*, and frequently takes part in collecting the eggs and placing them in the "cradle," though this is quite subject to the whim of the male, who assumes complete control.

I now have eight pairs of *Polyacanthus* breeding, and there is much difference in the amount of toleration extended to the female by their respective mates. Though I had three nestings of *Betta* the progeny was the result of but one pair, so that my generalisations in this respect may not be quite fair. The female *Betta* certainly devoured all eggs and young that came within her reach. One of the female *Polyacanthus*, on the other hand, obtained three or four eggs from the nest, evidently with the view, like the male, of rearranging their position. She was, however, driven away, but at the first opportunity returned the eggs to the nest, having had them in her mouth for more than a minute.

As I had so many pairs breeding I could afford to sacrifice one family in order to ascertain, if possible, what real object the male has in so zealously tending and guarding the eggs. To this end, as soon as a complement of eggs was produced I removed them *en masse*, by means of a tablespoon, to another vessel. They hatched in the usual course, and the larvæ developed, so that now, at the end of six weeks, they are as large, active and healthy as those left under the care of the male.

With the view of ascertaining the function of the bubbles, I removed from another nest some of the newly-deposited eggs, and carefully rejected all bubbles. As before, these eggs developed equally with those left under paternal care. It would seem,

therefore, that the purport of the nest and care of the parent is simply protective. The mass of spume hides the eggs or young from aerial or terrestrial enemies, while the attendance and vigilance of the male secures them from attack of aquatic foes.

In *Betta*, whose habits are, apparently, more highly specialised, the nest must have a more important function, seeing that without it, and the care of the male, the eggs would naturally sink and doubtless perish.

I had not hitherto numbered *Utricularia* among my aquatic plants, but having procured a spray, I placed it in a vessel in my study at the museum: this contained a pair of Paradise Fish and fry a few days old. Paying me a visit next day, my colleague, Mr. T. Whitelegge, warned me of the possible fate of the young, having in mind the well-known carnivorous habit of the Bladderwort.

An inspection of the vessel showed that the number of young had very seriously diminished, and the missing ones were found in the bladders of the plant. Some were seized by the head, and some by the tail, as originally described by Mr. Simms in the case of roach fry.

In the hope of seeing a fish actually caught, my assistant, Mr. A. R. McCulloch, watched the plant, and had scarcely seated himself at the aquarium before he called me. I saw one of the fry caught by the extreme tip of the tail. It had been swimming close to one of the bladders, and possibly touched the mouth, when instantly it was trapped. At intervals its struggles were frantic, and the bladder was shaken by the vibrations. At the end of seven minutes the tail was entirely engulfed, and continued to wriggle within the bladder, while the head and body were shaken without.

The little fish lived for an hour and a half, but it was not until the following morning that the whole was taken into the bladder.

Articles dealing with the carnivorous habit of *Utricularia* are very numerous. The following refer especially to its piscivorous practice:—

Moseley (Simms)—*Nature*, xxx., 1884, p. 81.

Simms—*Loc. cit.*, p. 295, figs. 1-3.

Halpérine—*Bull. U.S. Fish. Comm.*, v., 1885, p. 353, pls. i., ii.

The housing of the fry has provided an interesting example of the principle detailed by Semper<sup>6</sup> as to the influence of the volume of water on the growth of an individual.

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<sup>6</sup> Semper—*Animal Life*, 1881, p. 159, *et seq.*

In order to study the development of the young, I removed as I thought, the whole of a young family from a large aquarium, where they had been bred, to a small vessel at the Museum.

I afterwards discovered that five young ones had escaped my search and remained in the original aquarium. These grew at a rapid rate, whereas those placed in the smaller vessel showed no increase at all. So marked was the difference that I took one of the former from my home and placed it with its smaller brethren. It appeared as a veritable giant among them, and had all its fins properly differentiated, whereas in the others they had not developed beyond the larval stage.

To say that the later-introduced fish is twice the length and four or five times the bulk of the others may give some idea of its relative size, but its greater development may be better appreciated when I mention that it took to feeding on the smaller fish, so that now, after a partnership of about three weeks, it is the sole vertebrate occupant of the vessel.

As regards food, this fish may be said to have had what Semper calls its optimum, and yet about the time it assimilated the last of its companions it was noticeably inferior in size to the other four with which it was previously associated, though *they* had not been so lavishly supplied with food. They had, however, abundance of water. The removal of the fry placed the volume of water for the individual also at its optimum, so that now it appears to have regained its ratio of development. Thus Semper's conclusions receive interesting confirmation.

I may mention that we have had a tadpole of one of the *Hylidæ* in a small body of water for over a year; it has grown to a large size, but has never got beyond the larval stage. Other larvæ left in the pond, whence this was removed, completed their metamorphoses months ago.