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THE TADPOLE OF *RHINOPHRYNUS DORSALIS*

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IN a recent paper E. H. Taylor (1942: 37-39) has described and figured an unidentified tadpole from Guerrero, Mexico, characterized by the presence of two spiracles. He mentioned the paired spiracles of certain pipid tadpoles, but made no further comparisons with this group. Dr. Taylor has kindly sent me part of his series for comparison with similar larvae in the University of Michigan Museum of Zoology, which are believed to be *Rhinophrynus dorsalis*. The latter have formed the basis for my doctoral research on the significance of certain larval characters in salientian phylogeny, particularly with regard to the genus *Rhinophrynus*. The present paper includes preliminary taxonomic and morphological data.

The *Rhinophrynus* larvae upon which this study is based are as follows:

U.M.M.Z.¹ No. 75456(6). La Libertad, Guatemala.

U.M.M.Z. No. 80447. Near Acapulco, Guerrero, Mexico.

U.M.M.Z. No. 80448. Piste, Yucatán.

U.M.M.Z. No. 80449(2). Piste, Yucatán.

U.M.M.Z. No. 90644(28). Jalapa, Veracruz.

U.M.M.Z. No. 90645(13). La Libertad, Guatemala.

To facilitate discussion of these tadpoles and comparison with Taylor's series, detailed diagnosis and description are given.

¹ U.M.M.Z. indicates the University of Michigan Museum of Zoology.

DIAGNOSIS.—Head broad and depressed; eyes small and completely lateral; mouth a wide slit bordered by eleven short barbels; lips soft, unexpanded, with no cornified structures; Meckel's cartilages long, infrarostral region of jaw not functionally differentiated; spiracle paired; anus median.

DESCRIPTION (Pl. I, Fig. 1).—Body broad and deep; head broad and flattened with the small eyes completely lateral; interorbital distance about four times as great as internasal distance. Nostrils small, distance between them about one-half width of mouth and slightly less than their distance from margin of upper lip. Spiracles paired, one on either side, opening low on sides and fully visible from below; each spiracle bordered by a simple flap with straight or convex edge, no tube. Branchial basket large, with well-developed gill raker system but no true respiratory filaments. Anus median. Tail musculature and fins well developed, tapering to a narrow pointed tip; dorsal fin extending forward on back nearly to point above spiracles; ventral fin extending forward anterior to anus as a very short abdominal fin.

Mouth (Pl. I, Fig. 2) a wide opening with soft borders, no expanded lips, no horny beaks or teeth, no papillae. Sides of mouth with labial folds. Lower jaw with long Meckel's cartilages, and with infrarostral (symphyseal) region not functionally differentiated. Upper lip slightly overlaps lower. A series of eleven short, slender marginal barbels distributed as follows: one anterior to each nostril, four at each corner of mouth, and one on midventral line just behind jaw border; maximum total length of barbel about equal to internasal distance; all about equally developed.

A biconcave disk of cartilage intercalated between the lateral tip of the ceratohyal and the quadrate, posteroventrad of the processus muscularis. Developing hind foot with webbed toes and a large flattened metatarsal tubercle. Body more or less transparent; skin of body and tail marked with a few scattered melanophores; in general, pigmentation weakly developed.

Measurements of a large larva (in mm.): total length, 39.5; head and body (to anus), 18.5; interorbital, 9.0; internasal,

2.0; nostril to lip, 2.3; width of mouth, 4.5; distance between spiracles, 6.0; diameter of eye, 1.5; length of hind leg, 4.0; snout tip to foreleg bud (measured dorsally), 11.0; foreleg bud to hind leg (measured laterally), 7.0.

The foregoing description was based primarily upon U.M.M.Z. No. 90644, comprising the series of twenty-eight tadpoles from Jalapa, Veracruz. The tadpoles under U.M.M.Z. Nos. 75456 and 80449 are very poorly preserved. Because of the softness and transparency of the tissues, the barbels are rather obscure in some of these specimens, but the essential characters are present. As is true of many delicate organisms, the tadpoles of *Rhinophrynus* seem to be profoundly affected by variations in the method of fixation and subsequent treatment.

A Guerrero larva from Taylor's series and a Veracruz larva of nearly the same body length (16 mm. and 15.5 mm.) were examined comparatively. Some caution must be used in comparing tadpoles of dissimilar states of preservation, but allowing for such differences in condition as skin texture, transparency, and tissue shrinkage, the two larvae are unlike in several respects. The most obvious divergence is in the barbels; the Guerrero larva has only a small chin barbel. In the Veracruz larva the head and body are relatively narrower, the axial musculature is relatively broader, and the eyes are distinctly larger.

These differences seem sufficient to indicate that when specimens of adult *Rhinophrynus* are collected in Guerrero they may be found to be a distinct form. Taylor has suggested (in correspondence) that *Rhinophrynus rostratus* Brocchi may prove to be valid.

The Guerrero larva in the list of specimens elsewhere in this paper, U.M.M.Z. No. 80447, was collected by Taylor at "Km. 436 (So.) No. of Acapulco." Unfortunately, it is in poor condition. Most of the skin is missing from the head, and it is not certain whether any of the remaining shreds represent barbels.

U.M.M.Z. No. 90645 includes several recently hatched *Rhino-*

phrynus larvae about 5.5 mm. in total length. They are in a rather poor state of preservation, but certain characters are evident: head small and narrow, with a prominent bulge anterior to the eyes; eyes dark but still poorly differentiated; mouth a shallow depression, not fully formed; adhesive organ a single transverse bar; external gills rudimentary, apparently just forming; operculum not yet developed; tail about as long as head and body, fins quite well developed. Larvae of 9.5–11.0 mm. total length agree with the fully developed tadpoles except that the smaller larvae have disproportionately shorter barbels.

NOTES ON MORPHOLOGY

Certain structures of morphological and systematic importance have been studied by dissection. In addition, frontal sections were prepared of the head region of two larvae from Jalapa, Veraacruz. The larvae measured ± 35 mm. in total length.

In the structure of the larval jaw cartilages (Pl. I, Figs. 3–4), *Rhinophrynus* resembles *Xenopus*² and differs markedly from higher tadpoles. The lower jaw consists of long Meckel's cartilages which extend obliquely forward and are continuous with the cartilage of the symphyseal region of the jaw. The slightly smaller size of the cartilage cells at the symphysis and the tendency of the tissue to fold, when sectioned, at a point on each side a short distance from the symphysis suggest that in an earlier stage of development one or two separate centers of chondrification may be present here, representing the lower labial (infrarostral) cartilage, which is of paired origin in higher tadpoles.

The articular surface of the quadrate is a short projection immediately anterior to the low processus muscularis. The posterior ramus of the quadrate is separated from the chondrocranium by a narrow subocular fenestra and extends backward to the otic region.

The upper jaw consists of a thin plate of cartilage which is

²I am indebted to the American Museum of Natural History for the tadpoles of *Xenopus mülleri* used in this study.

incompletely separated from the tips of the cornu trabeculae and the nasal septum.

Histological examination of the barbels reveals that each consists of a tubular extension of the skin with a connective tissue core bearing capillaries and melanophores. The barbels contain no cartilage and probably no muscle fibers.

Although there are no true lips, the labial fold at the sides of the lower jaw in both *Rhinophrynus* and *Xenopus* may be the forerunner of the expanded lower lip which is present in most higher tadpoles.

In the branchial basket the rows of gill rakers are extensively developed, but there are no respiratory filaments bordering the gill clefts, such as occur in most tadpoles. The problem of the method of respiratory exchange in larval *Rhinophrynus* is beyond the scope of this paper, although it may be appropriate to point out that there is a controversial literature on this question in connection with the tadpole of *Xenopus*.

One feature of the hyoid apparatus is of particular interest. This is the small biconcave disk of cartilage between (and articulating with) the lateral tip of the hyoid and the quadrate, behind and slightly below the processus muscularis. It is present in Taylor's Guerrero tadpoles as well as in University of Michigan specimens from the various localities listed. The bulk of the ceratohyoangularis muscle originates on the ceratohyal (hyoid) and on this intercalated element, suggesting that the latter may be of hyoidean origin. The homologies of this structure are uncertain; it may be a new development, or it may represent the symplectic part of the hyomandibular. Preliminary search of the literature and examination of specimens has not yet revealed this cartilage in the tadpoles of other genera. The presence of a separate lateral element in the larval hyoid apparatus of *Rhinophrynus* may be associated with the peculiar condition of the adult hyoid of this genus, in which the basal and distal parts of the hyalia are completely separated (Walker, 1938: 6-7).

The tongue is rudimentary in all the larvae examined, but

its forward direction and free anterior edge seem evident in the sections.

The larval jaw and hyoid muscles have been compared with those of *Xenopus mülleri*. The intermandibularis and interhyoideus are similar to their counterparts in this pipid, though differing in proportions, due partly to differences in the shape of the ceratohyal. In *Rhinophrynus* the intermandibularis is broader and more fan-shaped and the interhyoideus is relatively narrower than these are in *Xenopus*. In *Rhinophrynus* there does not appear to be a suspensorio-hyoideus distinct from the orbitohyoideus, nor do suspensorio-angularis and quadratoangularis seem to be differentiated from the ceratohyoangularis. There is a single muscle, the adductor mandibulae posterior longus, originating along the posterior ramus of the quadrate and inserting on Meckel's cartilage. Pterygoideus and adductor mandibulae posterior longus profundus are not sharply differentiated. In *Xenopus mülleri* this muscle mass resembles that of *Rhinophrynus*, but is differentiated distally with separate insertions of pterygoideus (with a long transparent tendon), adductor mandibulae posterior longus superficialis, and adductor mandibulae posterior longus profundus.

Three small muscles originate on the anterior face of the processus muscularis, the outermost inserting in connective tissue at the tip of the upper labial cartilage, and the other two inserting on Meckel's cartilage, where they appear to be fused with the adductor mandibulae posterior longus. The exact homologies of these three small muscles are uncertain. Two of them are lateral to the nerve V_3 and hence would together correspond to the adductor mandibulae externus of Luther's terminology (1914: 73). The outermost, however, agrees in function with the adductor mandibulae subexternus of *Rana* and other higher tadpoles and is so labeled in my figure (Pl. I, Fig. 6). The small muscle mediad to V_3 is probably the adductor mandibulae articularis.

In *Xenopus mülleri* a long slip from the adductor mandibulae posterior longus passes down the barbel ("tentacular")

cartilage. In this tadpole the muscle which is apparently the adductor mandibulae subexternus inserts on Meckel's cartilage, as in the adult, instead of on the upper labial cartilage. The function of support of the tip of the latter cartilage is performed by the proximal part of the barbel cartilage, which extends from the base of the processus muscularis to the tip of the upper labial cartilage and then bends outward, the remainder of its length being contained in the barbel.

The tadpole of the Brazilian pipid, *Hemipipa carvalhoi*, was described and figured by Carvalho (1939). Externally, it closely resembles the tadpole of *Xenopus*, differing in lacking the pair of long maxillary barbels of the latter genus. It is probable that its internal structure is also comparable. Tadpoles of *Hymenochirus* and *Pseudhymenochirus*, African pipids allied to *Xenopus*, apparently have not yet been described, but they are not expected to differ significantly from *Xenopus*.

A noteworthy feature of metamorphosis in *Xenopus* and *Hemipipa* is the emergence of the forelegs relatively early in development and at points above and independent of the spiracles. Whether this is also true of *Rhinophrynus* is not yet known.

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PLATE I

The Tadpole of *Rhinophrynus dorsalis*

FIG. 1. Lateral view; total length 38 mm.

FIG. 2. Mouthparts.

FIGS. 3-5. Frontal sections through jaw region.

FIG. 6. Diagram of side of head with parts of orbitohyoideus and ceratohyoangularis muscles cut away to reveal underlying cartilages.

AMA, M. adductor mandibulae articularis; AMP, M. adductor mandibulae posterior longus; AMS, M. adductor mandibulae subexternus; B, barbel; CA, M. ceratohyoangularis; CH, ceratohyal; CT, cornu trabeculae; IH, M. interhyoideus; IM, M. intermandibularis; MC, Meckel's cartilage; NS, nasal septum; OH, M. orbitohyoideus; Q, quadrate cartilage; UL, upper labial cartilage; X, symplectic (?) cartilage.



