Oral Structure and Diet of Larval Berdmore’s Narrow-mouthed Frogs, *Microhyla berdmorei* (Blyth 1856), in Mizoram, India

H.T. Lalremsanga and Lal Muansanga

Developmental Biology and Herpetology Laboratory, Mizoram University, Aizawl 796004, Mizoram, India (munapunte16@gmail.com)

The most conspicuous characters that differentiate larval frogs in the family Microhylidae from those in other families are the absence of keratinized jaw sheaths and labial teeth and a single, midventral spiracle (Orton 1953, 1957). Understanding morphology, especially that of the oral disc, is crucial to comprehending the feeding ecology of tadpoles and...
therefore likely is the foremost factor in interpreting most, perhaps all, aspects of their biology (Altig and McDiarmid 1999). External morphological characters and especially internal oral features of tadpoles are very important in the systematics of anuran amphibians (e.g., Wassersug 1980; Chou and Lin 1997; Li et al. 2011). Nevertheless, only scant information is available on the oral structure and even the morphology of tadpoles.

Berdmore’s Narrow-mouthed Frog (Microhyla berdmorei) occurs in northeastern India, Bangladesh, China, Myanmar, Thailand, Malaysia, Laos, Vietnam, Cambodia, and Indonesia (Frost 2021). Kundu et al. (2021) described genetic diversity within the species. Inthara et al. (2005) provided a brief description of larval morphology and oral features, and Lalremsanga and Hooroo (2012) addressed the remodeling of intestines during development. Herein we present detailed information on oral morphology with respect to diet during larval development in M. berdmorei.

We collected tadpoles of Microhyla berdmorei in February–May 2019 from a natural pond inside the estate of the Zoram Poultry Development Society Hatchery Farm at Tuvmat, Aizawl, Mizoram (23°74.30’11.10”N, 92°68.00’12.37”E; elev. 964 m asl) and fixed larvae of each stage (Gosner 1960) in a solution comprising 4% buffered formalin and 70% ethanol in equal volume. We examined mouthparts with a light microscope (CETI Star 24) and a scanning electron microscope (JSM-35 CF). For the latter, preserved samples were washed with double distilled water, fixed in 2.5% glutaraldehyde solution (prepared in 0.1M Na-cacodylate buffer) for 1 h and post-fixed in 1% buffered osmium tetroxide (0.1M Na-cacodylate buffer) for 1 h at 4 °C while maintaining the pH of the fixative and buffer at 7.4. Samples were then dehydrated through ascending acetone grades and dried in tetramethylsilane as in Dey et al. (1989) before applying a thin conductive coating of gold using a JFC 2600 (Jeol) ion sputter. We then examined the coated samples at an accelerating voltage of 5 kV and a working distance of 1100 (Jeol) ion sputter. We then examined the coated samples at an accelerating voltage of 5 kV and a working distance of 1100 (Jeol) ion sputter.

Samples were then dehydrated through ascending acetone grades and dried in tetramethylsilane as in Dey et al. (1989) before applying a thin conductive coating of gold using a JFC 2600 (Jeol) ion sputter. We then examined the coated samples at an accelerating voltage of 5 kV and a working distance of 1100 (Jeol) ion sputter. We then examined the coated samples at an accelerating voltage of 5 kV and a working distance of 1100 (Jeol) ion sputter. We then examined the coated samples at an accelerating voltage of 5 kV and a working distance of 1100 (Jeol) ion sputter.

Larval Microhyla berdmorei lack keratinized jaws and labial teeth and have a terminally-oriented (as opposed to antero-ventrally oriented; i.e., umbelliform) mouth known as a semicircular labial flap. A U-shaped medial notch protrudes from the mouth between the two semicircular labial flaps (Figs. 1A & B). Infracircular papillae are reduced and lingual papilla are absent. As tadpoles from stage 42 onward ceased to feed, mouthparts gradually changed into the adult configuration (Figs. 1C & D).

Gut contents at stage 25 consist of phytoplankton (Diatoma, Fragilaria, Navicula, Stauroeis, Synedra, and Tabellaria [Bacillariophyceae]; Cladophora, Closterium, Cosmarium, Spirogyra, Staurastrum, and Ulothrix [Chlorophyceae]; Oscillatoria [Cyanophyceae]; Acella and Cryptomonas [Cryptophyceae]) and a zooplankton (Lecane). During hindlimb bud development (stages 26–30), gut contents included phytoplankton (Cymbella, Melosira, and Pinnularia [Bacillariophyceae]; Mougeotia, Oedogonium, and Synedra [Chlorophyceae]; Anabaena and Nostoc [Cyanophyceae]; and Euglena [Euglenophyceae]) and a zooplankton (Euglypha). Guts of larvae at stages 31–41 contained only Phacus (Phacaceae). After the emergence of forelimbs at stages 42–45 and coinciding with a cessation of feeding, the larval oral apparatus began to degenerate. From stage 46 onward, froglets fed on various small invertebrates.

Tadpoles at stages 30–40 have relatively stable external morphological characters (Gosner 1960). The absence of jaw sheaths and keratodonts in larval Microhyla berdmorei agrees with observations of Rao (1933), who reported the total absence of teeth in the tadpoles of Kaloula and Microhyla; Das and Coe (1994), who noted the absence of denticles in Microhyla rubra, M. ornata, and Uperodon systoma; and Inthara et al. (2005), who examined Kaloula pulchra, Microhyla ornata, M. butleri, M. pulchra, Micryletta ornata, and Glyphoglossus molosus. The umbelliform disc of the Microhyla berdmorei tadpole has a large, infolded semicircular structure at each corner of the mouth that appears to be derived from the lower labium, as in larval Microhyla heymonsi (Altig and McDiarmid 1999) and M. ornata (Khan and Mufti 1994). Altig and McDiarmid (1999) reported that an umbelliform or upturned oral disc appears as a convergent trait in tadpoles of some arthroleptids, dendrobatids, hylids, mantelline rhacophorids, megophryids, and microhyline microhylids. Most umbelliform tadpoles occur in backwaters of lotic systems. Tooth rows and jaw sheaths are reduced to absent in these forms, and large ridge-like papillae that project radially from the mouth are common. The absence of keratodonts excludes surface-rasping in some species and, conversely, the presence of robust rostrodonts and multiple tooth rows signals food removal by surface rasping (Candioti et al. 2004).

Larval gut contents consisted mainly of Bacillariophyceae, followed by Chlorophyceae, Cryptophyceae, zooplankton, Euglenophyceae, detritus, and Cyanophyceae. Among food items, Chlorophyceae, Cladophora, and Mougeotia predominated. Khan and Mufti (1994) noted that sympatric species of tadpoles differ not only in oral disc morphology but also in exploiting different components of the common food base available in the pond ecosystem. For example, in contrast to the sympatric Indo-Burmese Stream Frog (Sylvirana lacrima) tadpoles that mainly consume Chlorophyceae, larval Microhyla berdmorei fed more frequently on Bacillariophyceae (Lalremsanga 2011). Also, as suggested by Lalremsanga et al. (2017), the reduction in the size of infralabial papillae and the absence of lingual papillae might imply that these structures...
are not important in retaining some larger particles in the buccal cavity. This has been observed in Microhyla butleri, M. heymonsii, M. ornata, and M. stejnegeri (Chou and Lin 1997); Dermatonatus muelleri and Elachistocleis bicolor (Echeverria and Lavilla 2000); and Kaloula rugifera and K. borealis (Zhou et al. 2011).

Acknowledgements

We thank Mr. Liandawla (Principal Chief Conservator of Forests), Government of Mizoram, for issuing a permit (No.A.33011/2/99-CWLW/225) to collect herpetofauna in Mizoram, and the Defence Research Development Organisation (DRDO), Ministry of Defence (No. DFTM/07/3606/NESTC/ABR/M/P-01), and the Department of Biotechnology (DBT), Ministry of Science and Technology (No. DBT-NER/AAB/64/2017), Government of India, New Delhi, for financial support.

Literature Cited


