



<http://dx.doi.org/10.11646/zootaxa.3811.3.9>

<http://zoobank.org/urn:lsid:zoobank.org:pub:A449DA92-EA8B-4D8B-A538-C2845B33033F>

The breeding behavior of *Glyphoglossus molossus* and the tadpoles of *Glyphoglossus molossus* and *Calluella guttulata* (Microhylidae)

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Abstract

The breeding behavior of *Glyphoglossus molossus* is described from still and video images taken in Cambodia. These large, burrowing frogs follow the general theme of microhylids that deposit aquatic eggs: explosive breeding in ephemeral water and performing multiple amplexic dips to oviposit surface films of pigmented eggs. A portion of a clutch is released with each dip, a dip lasts for about 6 s, 200-300 eggs are released per dip, and about 5 s pass between dips. The ova have a dark black animal pole and yellow vegetal pole. Expanded datasets on the morphology of the tadpoles of *Glyphoglossus* from Vietnam and *Calluella* from Myanmar are presented.

Key words: Microhylidae, breeding, oviposition, tadpole

Introduction

There are rotund, short-legged frogs in several families (Nomura *et al.* 2009) that spend the majority of their time underground but emerge with seasonal rains to breed. Microhylid frogs that lay aquatic eggs commonly behave in this way, and the tadpoles are suspension feeders with depressed bodies, a reduced oral apparatus without keratinized mouthparts, lateral eyes, and a midventral spiracle. The nonbreeding biologies of burrowing frogs are poorly known, but *Nasikabatrachus* (Zachariah *et al.* 2012) and *Rhinophrynus* are known to remain active underground, and at least juvenile *Glyphoglossus* forage above ground (A. Lathrop and G. Zug, personal communications) during the rainy season. Various other burrowers aestivate while encased in epidermal cocoons. Other than *Otophryne* (Otophryninae, South America) and *Scaphiophryne* (Scaphiophryninae, Madagascar), each of which have different keratinized structures on the jaw cartilages, microhylid tadpoles lack keratinized mouthparts, and except in one case (i.e., *Otophryne*), have a midventral spiracle. *Glyphoglossus molossus*, which ranges from northern Myanmar through most of Thailand, Laos, and southern Vietnam at 200-600 m elevation (Frost 2013), is a large, globose frog with an oddly truncate snout. The tadpole is morphologically a typical microhylid (e.g., Inthara *et al.* 2005) but has a unique coloration. Aran *et al.* (2012) and Inthara *et al.* (2005) both presented photographs of a tadpole and mouthparts, and the former included drawings of the buccopharyngeal papillae. Savage (1952) presented sketches of the mouthparts and buccopharyngeal anatomy of the tadpoles of *Calluella* and *Glyphoglossus*. We describe the breeding behavior of *Glyphoglossus* based on still and video images, and new data are added for the tadpoles of *Glyphoglossus* and *Calluella*.

Material and methods

On 28 April 2011, W. K. Fletcher and D. Baylis (<http://www.wildsidephotography.ca>) were on a photographic project with WWF-Cambodia in the dry deciduous forest of the Phnom Prich Wildlife Sanctuary, 35 km NNW of Sen Monorom, Mondulkiri, Cambodia. At 1610 h it was 33.0°C, and a heavy rain at the end of the dry season

them. Some hylids make ovipositional dips similar to those described here, but the females of other hylids and some ranids (e.g., part of the *Lithobates catesbeianus* group; Aronson 1943a–b) that produce surface films of eggs arch the middles of their backs downwards sufficiently to position their vents above the water while lying almost horizontal at the surface. Soonthornvipat and Soonthornvipat (2010) noted that the fertilized eggs of *G. molossus* are 4.5"0.8 mm in diameter and that embryos hatched at 5.0"0.17 mm total length about 25 h after fertilization at 22–26EC. External gills are present, 5-day old tadpoles were 9.1"0.02 mm in length, hind limbs were obvious after 12 days, and metamorphosis occurred after 33 days

The vane of the ventral fin adjacent to the body of these microhylids is an uncommon trait that also occurs in *Xenopus* (Pipidae) and some phyllomedusine hylids that feed while stationary in midwater. The vane was not noticed when the *Glyphoglossus* tadpoles were collected and is not visible in the photograph of a live tadpole. Increased opacity in preservative and eventual staining revealed this odd morphology. The *Glyphoglossus* tadpoles were collected near the bottom in about 1 m of muddy water. In the net they did not flip around like most tadpoles do, and when placed in water they swam quite feebly. Microhylid tadpoles typically hold rather stationary positions in midwater or at the surface while they suspension feed, and the tail lobe may help retard roll and yaw of these long-tailed tadpoles.

In tadpoles that have a medial vent, the vent tube typically exits the abdominal cavity and extends posteriorly parallel with the ventral fin. In microhylids, it is not uncommon for the vent to exit the body cavity more dorsally; the vent tube extends ventrally in the anterior margin of the ventral fin and then empties by a ventrally facing aperture. The tadpoles of *Calluella guttulata* that were first examined shortly after they were preserved had the black tail margins similar to that of *C. yunnanensis*. Tadpoles of *Calluella smithi* (Haas and Das 2012) are similar in shape to those of *C. guttulata*, but lack the dark tail pigmentation.

Crabs of various sorts are common in aquatic habitats, including tree holes, throughout the Old World tropics. Predation on frogs (Andrade *et al.* 2012, Grapsidae; Gutsche and Elefandt 2007, Potamonautidae; Pike *et al.* 2013, Grapsidae; this paper), eggs, and tadpoles is probably more common than realized.

There remains a lot to be learned about the morphology and particularly the behavioral ecology of microhylid tadpoles. For example, tadpoles of *Glyphoglossus* from Thailand (USNM 206392-206394) are larger at a given stage than the specimens we examined, and the gut, with a wider, flatter gut coil, is filled with soil. The tadpoles we collected were never far off the bottom in relatively deep, turbid water, and *Glyphoglossus* tadpoles may feed differently than most other microhylids that are assumed to be midwater suspension feeders.

Acknowledgments.—D. Baylis and W. K. Fletcher graciously permitted us to examine their images, videos (<http://www.youtube.com/user/WildsidePhotography/search?query=Glyphoglossus+molossus>) and notes on the breeding biology of this poorly known frog. They wish to thank the Cambodian Ministry of Environment and WWF-Cambodia for making their visit possible and specifically to Channa Phan and Rohit Singh for their field assistance. Comments and the loan of materials were made by A. Lathrop and R. Murphy (ROM) and G. Zug (USNM). Rafael Lemaitre (USNM) and Peter Ng (National University of Singapore) tried to identify the crabs from photographs, and Leong Tze Ming (National University of Singapore) helped track down elusive references.

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