

ENDOTROPHIC TADPOLES OF THE SAINT ANDREW'S CROSS TOADLET, *PELOPHRYNE SIGNATA* (AMPHIBIA: ANURA: BUFONIDAE) IN SINGAPORE

T. M. Leong* and S. C. Teo

Central Nature Reserves, National Parks Board,

601 Island Club Road, Singapore 578775, Republic of Singapore

(*Corresponding author: leong_tzi_ming@nparks.gov.sg, banjarana@gmail.com)

INTRODUCTION

Singapore is home to 24 species of native anurans, of which 18 species are largely confined to the remnant forests within the protected Central Nature Reserves. This includes the Saint Andrew's Cross toadlet, *Pelophryne signata* (Boulenger, 1894), which has only been recorded from a single locality at the Bukit Timah Nature Reserve (BTNR), in the heart of Singapore Island. The last confirmed sightings of the adults of this species were some 18 years ago (Lim, 1990), when two individuals were reported. Despite subsequent attempts to document the breeding behaviour and tadpoles of this particular species locally (Leong & Chou, 1999), no successful observations were obtained till recently. Another vernacular name for this diminutive species is the "lowland dwarf toad", as referred to by Inger & Stuebing (2005). In Singapore, earlier references to this toadlet used the name "*Pelophryne brevipes*" instead (e.g., Lim & Lim, 1992; Teo & Rajathurai, 1997; Leong, 2004b). According to Frost (2008), *Pelophryne signata* was earlier synonymised under *Pelophryne brevipes* in 1966 by Robert F. Inger, but subsequently revalidated in 1985 by himself! The type locality of true *Pelophryne brevipes* (Peters, 1867) is actually Zamboanga, Mindanao (the Philippines) and its current recognised distribution is confined to the islands of Mindanao and Basilan. The geographic distribution for true *Pelophryne signata* includes Peninsular Malaysia, Borneo, and the Natuna Islands (Indonesia).



Fig. 1. Adult male *Pelophryne signata* (family Bufonidae) perched on a leaf of a shrub at the Bukit Timah Nature Reserve. Its snout-vent length was ca. 15 mm. Photographed in-situ on 22 Jun.2008.

OBSERVATIONS AND DISCUSSION

While conducting an amphibian survey at the BTNR on the night of 22 Jun.2008, an adult *Pelophryne signata* was encountered crawling on a leaf of a shrub at waist-level. It was merely 15 cm away from a tree hole that was found to have tadpoles in an earlier survey on the night of 20 Jun.2008. While the toadlet was being observed, it suddenly raised the front of its body and inflated its vocal sac to issue a series of high-pitched, insect-like, buzz calls. This male (snout-vent length ca. 15 mm) was then photographed in-situ (Fig. 1). The small tree hole was first investigated by the second author, who noticed the wriggling motion of tadpoles inside. The phytothelm was around 1.5 m from the forest floor, with a rim diameter of ca. 3 cm and a depth of ca. 2 cm (Fig. 2). The level of water was half full at the time, and found to contain 13 individual larvae (Stage 32, according to Gosner, 1960). These tadpoles were photographed in-situ (Fig. 3) and were initially suspected to belong to those of *Pelophryne signata*. Their identities were subsequently confirmed, as they agreed closely with the early larval descriptions by Inger (1960).

When we returned to this site on the afternoon of 24 Jun.2008, the tree hole was found to be full of water to the brim and to our disappointment, only five tadpoles remained. This sudden surge in water volume was owed to heavy rains the day before, which may possibly have caused an overflow that flushed out some tadpoles. It was immediately decided to remove the remaining tadpoles for ex-situ rearing to prevent further mortality in the event of continued heavy rains. The tadpoles were reared in a small glass tank (8 × 8 × 2 cm), filled with clean water from an adjacent forest stream.

In captivity, the detailed morphology, behaviour and development of the tadpoles could be closely documented and photographed (Figs. 4 and 5). Each tadpole is overall greyish, with translucent tail fins. Its tail muscle is whitish and tapered towards the posterior. The tail tip is broadly rounded. Ventrally, the tadpole is largely translucent, with its major internal organs visible from below. The quantity of yolk remained relatively abundant throughout its developmental stages and declines at a slow rate. The spiracular opening is noticeable from below and is situated on the left side of its body. Its anal tube is also distinct and located medially between the hindlimbs. At its anterior, the simplified oral disc has an almost circular shape, with no observable marginal papillae. A single labial tooth row is present on the anterior labium, with none on the posterior labium. Hence, its Labial Tooth Row Formula (LTRF) would be 1/0. Its jaw sheaths (anterior and posterior) are also distinct, but weakly keratinised along their margins.



Fig. 2. Phytothelm of tree hole selected as a larval microhabitat for *Pelophryne signata*. This tree hole was situated around 1.5 m from the forest floor, with a rim diameter of ca. 3 cm. The depth of water was ca. 2 cm.



Fig. 3. In-situ photograph of the early tadpoles (Gosner stage 32) of *Pelophryne signata* within the confines of the small tree hole (as in Fig. 2). Their hind limb buds are already noticeable at this stage. The yolk in each tadpole is still abundant.

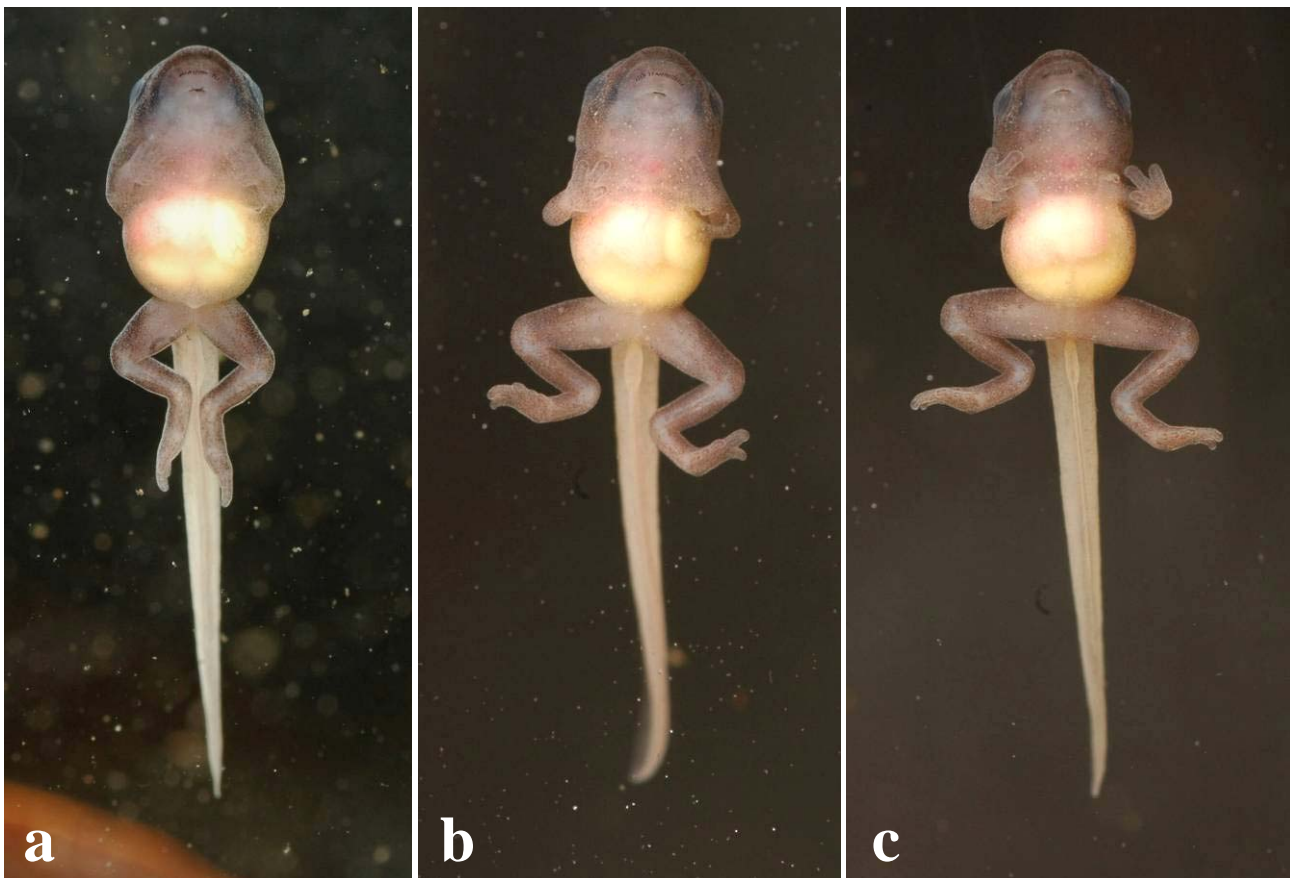


Fig. 4. Ventral perspectives of the live tadpole at: a, Stage 40: forelimbs still internal; b, transition from Stages 41–42: forelimbs beginning to emerge; c, Stage 42: both forelimbs freshly emerged. Note circular oral disc with single row of labial teeth on the anterior labium. At this advanced stage, the abdominal yolk is still not depleted. The total lengths (including tail) of the larvae were 12–13 mm and their body lengths were 4–5 mm.



Fig. 5. Lateral perspectives of live *Pelophryne signata* tadpoles at: a, Stage 40: forelimbs visible but still internal; b, Stage 42: forelimbs emerged, tail not resorbed as yet.

The tadpoles spent much of their time remaining motionless and were never observed to actively forage for food or scrape on the detritus for additional nutrition. The copious amount of yolk provided for them was apparently more than sufficient to see them through to complete metamorphosis in a relatively short time (approximately two weeks). Though uncommon among anurans, such a strategy of endotrophic larval development, accompanied by the progressive reduction of mouthparts, is also witnessed in certain frogs in the Southeast Asian region, e.g., *Limnonectes laticeps* (Boulenger, 1882) (family Ranidae) in Peninsular Malaysia (Leong, 2004a). In addition to *Pelophryne signata*, the larvae of other species in this genus have been described, e.g., that of *Pelophryne misera* (Mocquard, 1890) from the highlands of northern Borneo (Malkmus et al., 2002).

In Singapore, other species of frogs that are known to be phytothelm breeders include one microhylid, *Kalophrynus pleurostigma* Tschudi, 1838, and two rhacophorids (treefrogs), *Nyctixalus pictus* (Peters, 1871), and *Theloderma horridum* (Boulenger, 1903) (Leong & Chou, 1999). While *Kalophrynus pleurostigma* is not an obligate phytothelm breeder, its nutritional mode is largely endotrophic, but the larvae are known to ingest detritus at the later stages. As a consequence of their arboreal habits, the two treefrogs are predominantly phytothelm-dependant for their reproduction. However, the tadpoles of both species are clearly non-endotrophic, and possess typical larval mouthparts to feed on any available organic matter in their respective treeholes. The size of the tadpoles is much larger, reaching 40 mm in total length. Their developmental period is also much more prolonged than those of the endotrophs, often exceeding a month for metamorphosis to be complete.

By 29 Jun.2008, the *Pelophryne signata* tadpoles had attained Gosner stage 40 (Figs. 4a and 5a) and by 2 Jul.2008, their fore-limbs had already erupted (Figs. 4c and 5b). At this point, the water level in their holding tank was reduced drastically to allow them to emerge onto a solid surface when necessary. Unfortunately, complete tail resorption did not occur and the individuals were observed to become progressively sluggish. Eventually, all the larvae did not survive and

appeared to have succumbed to an aquatic fungus that was focused around the axillary region. This may be a particularly vulnerable spot, especially after the eruption of the fore-limbs. All deceased larvae were subsequently preserved in alcohol and deposited at the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research (ZRC.1.12425–12429, total lengths: 12–13 mm, body lengths: 4–5 mm). A single adult specimen of *Pelophryne signata* from BTNR presently serves as a voucher specimen for Singapore, collected by Dennis H. Murphy on 27 Nov. 1989 from the trunk of a tree, more than 1 m above the forest floor (ZRC.1.1760, snout-vent length 14 mm).

Despite the unsuccessful attempt to raise and release the larvae of *Pelophryne signata*, this nevertheless serves to be the very first documented record of its larvae within Singapore. Elsewhere, their tadpoles have been encountered from Sarawak, Borneo (e.g., Denzer, 1994). For Singapore, future surveys need to be conducted to ascertain the existing population size/distribution of this highly localised species and monitor all potential phytohelms in the vicinity as important breeding sites. In addition, artificial receptacles, in the form of plastic tubes/containers may be deployed to collect rainwater and serve as extra oviposition alternatives. Nationally, this toadlet is currently regarded as critically endangered (Lim & Leong, 2008) and is deserving of practical measures that will ensure its long term survival within our Nature Reserves.

ACKNOWLEDGEMENTS

We are grateful to Mishak Shunari (Bukit Timah Nature Reserve, National Parks Board) for his enthusiastic assistance with the extrication and attempted salvage of the tadpoles from the tree hole. We thank Tan Heok Hui (Raffles Museum of Biodiversity Research) for the loan of the custom-made photo tank, which enabled us to photograph the toadlet tadpoles. We thank Kelvin K. P. Lim (Raffles Museum of Biodiversity Research) for permission to refer to relevant anuran specimens in the herpetology collection. The enthusiastic and encouraging comments of an anonymous reviewer were much appreciated.

LITERATURE CITED

- Denzer, W., 1994. Tree hole breeding in the toad *Pelophryne brevipes* (Peters, 1867). *Amphibia-Reptilia*, **15**(2): 224–226.
- Frost, D. R., 2008. Amphibian species of the World: an online reference. Version 5.2 (15 July, 2008). American Museum of Natural History, New York, U.S.A. <http://research.amnh.org/herpetology/amphibia/index.php>. (Accessed 8 Dec. 2008).
- Gosner, K. L., 1960. A simplified table for staging anuran embryos and larvae with notes on identification. *Herpetologica*, **16**: 183–190.
- Inger, R. F., 1960. Notes on toads of the genus *Pelophryne*. *Fieldiana (Zoology)*, **39**(39): 415–418.
- Inger, R. F. & R. B. Stuebing, 2005. *A Field Guide to the Frogs of Borneo. Second Edition*. Natural History Publications (Borneo), Kota Kinabalu. vii + 201 pp.
- Leong, T. M., 2004a. Larval descriptions of some poorly known tadpoles from Peninsular Malaysia. *Raffles Bulletin of Zoology*, **52**(2): 609–620.
- Leong, T. M., 2004b. The status of amphibian populations in Singapore, with emphasis on forest-dependent species. In: Wilkinson, J. W. (Ed.), *Collected DAPTF Working Group Reports: Ten Years on*. Declining Amphibian Populations Task Force (DAPTF), The Open University, Milton Keynes, U.K. Pp. 25–31.
- Leong, T. M. & L. M. Chou, 1999. Larval diversity and development in the Singapore Anura (Amphibia). *Raffles Bulletin of Zoology*, **47**(1): 81–137.
- Lim, K. K. P., 1990. Two recent records of the toad, *Pelophryne brevipes* (Peters, 1867) (Anura: Bufonidae) from Singapore. *Raffles Bulletin of Zoology*, **38**(1): 25–26.
- Lim, K. K. P. & F. L. K. Lim, 1992. *A Guide to the Amphibians & Reptiles of Singapore*. Singapore Science Centre, Singapore. 160 pp.
- Lim, K. K.P. & T. M. Leong, 2008. Amphibians. In: Davison, G. W. H., P. K. L. Ng & H. C. Ho (eds.). *The Singapore Red Data Book – Threatened Plants & Animals of Singapore. 2nd Edition*. Nature Society (Singapore), Singapore. Pp. 155–159.
- Malkmus, R., U. Manthey, G. Vogel, P. Hoffmann & J. Kosuch, 2002. *Amphibians & Reptiles of Mount Kinabalu (North Borneo)*. A. R. G. Gantner Verlag K. G., Ruggell, Liechtenstein. 424 pp.
- Teo, R. C. H. & S. Rajathurai, 1997. Mammals, reptiles and amphibians in the Nature Reserves of Singapore—diversity, abundance and distribution. *Gardens' Bulletin Singapore*, **49**(2): 353–425.