REPTILES & AMPHIBIANS

Effects of Drought on the Larvae of the Short-legged Horned Toad, *Panophrys brachykolos* (Inger and Romer 1961) (Megophryidae), and the Lesser Spiny Frog, *Quasipaa exilispinosa* (Liu and Hu 1975) (Dicroglossidae), in Hong Kong

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Photographs by the author.

Drought is an important consequence of natural climatic processes that can have direct and severe effects on amphibian populations (Cayuela et al. 2016). Extreme weather and climate events, which include extreme floods and droughts, have increased during the last century (Walls et al. 2013). Adaptations of anurans to drought have been reported worldwide (Prather et al. 2001), but little is known of adaptations in larvae. In general, most anuran larvae rely on bodies of water as habitat in which to grow prior to metamorphosis (Wells 2010). With the exception of some species that evolved direct development without free-swimming larvae (Princy and Kannan 2018) and other species that adapted to a terrestrial environment with land-dwelling larvae (Tapley et al. 2011), most anuran larvae in Asia inhabit aquatic environments before undergoing metamorphosis.

The Short-legged Horned Toad (*Panophrys brachykolos*) (Fig. 1) is a medium-sized species with a snout-vent lengths (SVL) of 34–40 mm in males and 34–46 mm in females (Fei et al. 2012). The species is distributed throughout southern China, including Guangdong Province and Hong Kong, where it inhabits streams and seepages in secondary forest (Wang et al. 2020). Like all larvae of species in the genus *Panophrys*, those of *P. brachykolos* are surface microparticle filter feeders, which restricts them to aquatic habitats (Li et al. 2019). Currently, *P.*

Fig. 1. An adult male Short-legged Horned Toad (*Panophrys brachykolos*).

Fig. 2. An adult male Lesser Spiny Frog (*Quasipaa exilispinosa*).

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brachykolos is listed as Endangered (EN) by the IUCN Red List (Lau et al. 2004). The Lesser Spiny Frog (*Quasipaa exilispinosa*) (Fig. 2) is a medium-sized species with SVLs of 44–67 mm in males and 44–63 mm for females (Fei et al. 2012). During the breeding season, males develop short horny spines on their chests and fingers. This stream-breeding species is widely distributed in southern China. *Quasipaa exilispinosa* is listed as Least Concern (LC) on the IUCN Red List (IUCN SSC Amphibian Specialist Group 2020). Both species breed in lotic habitats (Lau 1998). Consequently, water shortages in larval habitats can be critical for the tadpoles. Herein I describe the response of the larvae of both species to drought in Hong Kong.

At 1630 h on 26 February 2018, during a rapid survey of Ngong Ping, Lantau Island, Hong Kong (22°15'24.3"N, 113°55'09.2"E; elev. 405 m asl), we found large numbers of larval *Panophrys brachykolos* and *Quasipaa exilispinosa* in a dried-out stream pool in which all surface water had disappeared. The tadpoles were surviving amidst moist leaf litter and sediments in the streambed (Fig. 3). During a previous survey in January 2018, the pool, then a shaded slow-flowing stream-side pool with a high degree of canopy cover, was being used as breeding habitat by both species.

Larvae of the two species were surviving in the dry pool by burrowing into moist leaf litter, silt, and gravel. We also observed an endemic Flat-headed Loach (*Oreonectes platycephalus*) in such refugia with the larval anurans. Similar behavior has been observed in stream insects that utilized different refuges during seasonal and supraseasonal droughts (Boulton and Lake 2008).

We paid another visit to the site at 1830 h on 28 February 2018, observed approximately the same number of tadpoles in the pool, and saw no evidence of unusual deaths. At 1730 h on 11 March 2018, after days of rainfall had refilled the pool, we revisited the site a second time. Males were calling in surrounding riparian habitat, larvae of both species were present in the pool (Fig. 4), and larval *P. brachykolos* were feeding by forming noticeable depressions at the water's surface and ingesting surface film.

Fig. 3. Larval Short-legged Horned Toads (*Panophrys brachykolos*) and Lesser Spiny Frogs (*Quasipaa exilispinosa*) in a dried-out stream pool at Ngong Ping, Lantau Island, Hong Kong.

Studies have revealed direct effects of drought on tadpole mortality due to the desiccation of breeding sites (Cayuela et al. 2016). Most anuran larvae must complete metamorphosis and move onto land before their larval aquatic habitats dry out. The larvae of some species can shorten the developmental period and begin metamorphosis when environmental cues indicate that the aquatic habitat will disappear (Wilbur and Collins 1973). However, at least these two species of stream-dwelling anuran larvae in Hong Kong are highly water-dependent during development and appear to rely on refuge use to survive droughts, behavior that had not been documented previously.

Fig. 4. A larval Short-legged Horned Toad (*Panophrys brachykolos*) feeding on surface film (left) and a larval Lesser Spiny Frog (*Quasipaa exilispinosa*) (right) in the pool after several days of rain.

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