



Defensive Behavior of Banded Bullfrogs, *Kaloula pulchra* Gray 1831 (Anura: Microhylidae) from Kedah, Peninsular Malaysia

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Photographs by the author.

Anurans are subjected to a diverse suite of potential predators and exhibit a wide spectrum of defensive strategies (Williams et al. 2000; Wells 2007; Toledo et al. 2010). At least 30 anti-predator behaviors have been described in anurans (Duellman and Trueb 1986; Toledo et al. 2011) and different defensive strategies or combinations thereof can be employed during different phases of predation (localization, identification, approach, subjugation, ingestion, and digestion) (Toledo et al. 2011).

The Banded Bullfrog (*Kaloula pulchra*) (Fig. 1) is a burrowing species native to Bangladesh, Cambodia, China, Hong Kong, India, Indonesia, Laos, Macao, Malaysia, Myanmar, Singapore, Thailand, and Vietnam at elevations from sea level to 750 m asl (Kuangyang et al. 2004). In Peninsular Malaysia, this species is abundant in cities, towns, and villages, but is not known to occur in natural or undisturbed forests (Berry 1975; Ibrahim et al. 2008). Herein I

describe defensive behaviors exhibited by Banded Bullfrogs when subjected to simulated threats.



Fig. 1. An adult male Banded Bullfrog (*Kaloula pulchra*) from Kedah, Peninsular Malaysia.

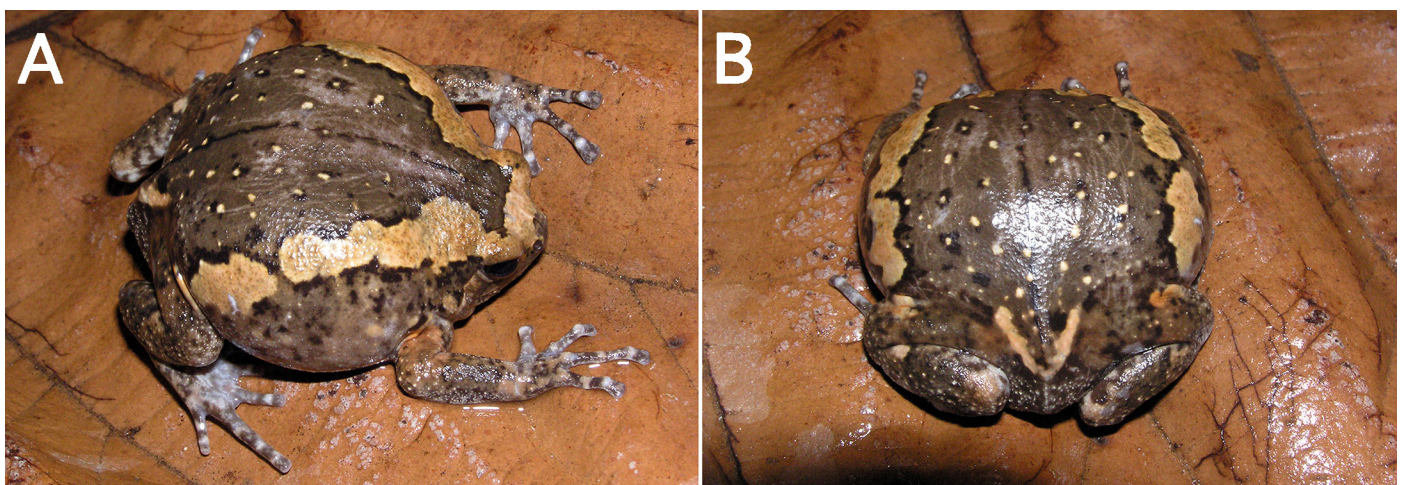


Fig. 2. Inflation (A) and deimatic behavior (B) of an adult male Banded Bullfrog (*Kaloula pulchra*).



Fig. 3. Crouching by an adult male Banded Bullfrog (*Kaloula pulchra*).

I collected four adult male Banded Bullfrogs by hand while searching between 2100 and 2200 h along cement drains, ditches, roadside pools, rain puddles, and open areas near human habitations at Kulim Hi-Tech Park, Kulim, Kedah, Peninsular Malaysia (5°24'N, 100°34'E; elev. 56 m asl). I took the frogs to the laboratory, where I subjected them to simulated threats and photographed their responses before releasing them in suitable habitat.

Frog 1 and 2 were collected while actively calling from a clogged cement drain in October 2015 after a heavy rainfall. When struck gently with blunt forceps, frog 1 (SVL = 57 mm; HW = 24 mm; W = 27 g) displayed inflation (puffing up its body) (Fig. 2A) combined with deimatic behavior (Fig. 2B). These behaviors are used by an animal that lacks strong defenses to startle or distract a predator by exposing aposematic coloration or creating the illusion of similarity to a dangerous animal (Hodl and Amezcuita 2001; Toledo and Haddad 2009). Its body was inflated like a balloon and slightly arched with the dorsal pattern exposed, belly rigid and slightly elevated, head face-down and tucked into the body, fore- and hindlimbs extended, eyes open, and mouth closed. The frog held this position for approximately 2 min before resuming a normal posture. When stimulated again, it inflated

low V-shaped mark and the yellow spots on the posterior end of the dorsal surface.

Frog 2 (SVL = 57 mm; HW = 24 mm; W = 27 g) crouched (Fig. 3) and inflated itself when stimulated. During handling, the frog slowly crawled under leaves in an attempt to hide. When the leaves were removed, the frog remained motionless in a crouched position during which the venter was flattened and in contact with the substrate. The dorsum was slightly arched, head tucked tightly into the body, hindlimbs held close, snout down, eyes open, and mouth closed. The frog held this position for nearly 1.5 min before resuming its normal posture. When stimulated again, the frog inflated its body and remained in that position for approximately 3 min.

Frog 3 (SVL = 52 mm; HW = 24 mm; W = 25 g), collected while calling from a shallow roadside pool after a shower in November 2015, exhibited a flattened body (Fig. 4A), diving, camouflage (Fig. 4B), inflation, and unusual crawling behavior (Fig. 4C) when threatened. During the attempt to capture this frog, it dived into the water, stirred up the sediment in an effort at camouflage, and remained motionless at the bottom of the pool for nearly 10 min. After emerging from the water, it hid under some leaves. When the leaves were removed, the frog remained immobile with its body flattened and remained in this position for at least 2 min before crawling back under the leaves. When I subsequently touched the frog, it rapidly inflated its elevated body and crawled away slowly for nearly 2 min before hiding in some grass.

Frog 4 (SVL = 60 mm; HW = 25 mm; W = 28 g), collected in January 2016 while hiding under a flowerpot behind my house, exhibited inflation and deimatic behavior while exuding presumably noxious or otherwise unpleasant skin secretions (Fig. 5). The frog maintained this position for nearly 2.5 min before resuming an ordinary posture.

Kaloula pulchra is a stocky, slow moving frog incapable of escaping rapidly and would become easy prey for a wide range

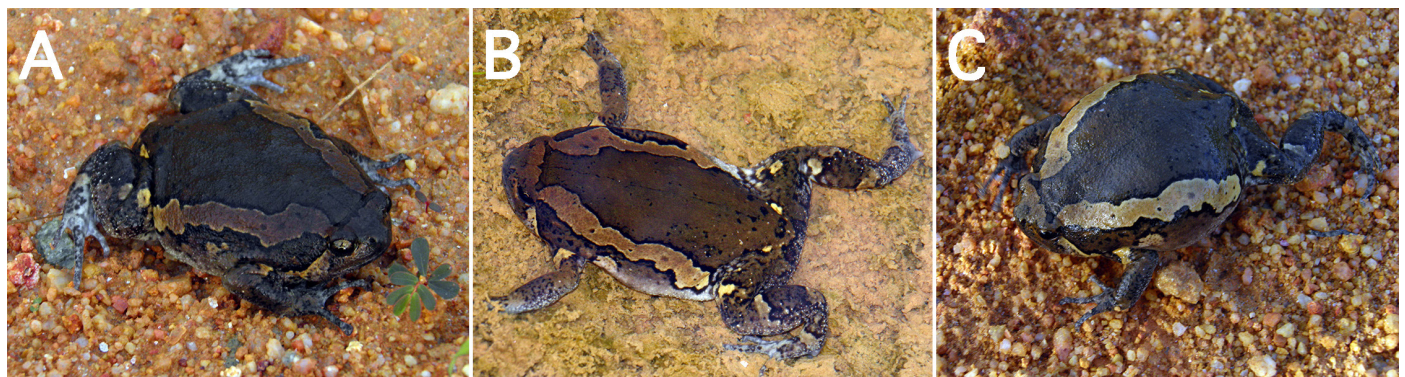


Fig. 4. An adult male Banded Bullfrog (*Kaloula pulchra*) with a flattened body (A), employing camouflage (B), and exhibiting unusual crawling behavior (C).

its body even further and elevated its posterior, exposing a yel-



Fig. 5. An adult male Banded Bullfrog (*Kaloula pulchra*) exhibiting inflation and deimatic behavior while exuding presumably noxious skin secretions.

of predators without employing alternative defensive strategies. All four of the males examined inflated their bodies when disturbed, suggesting that this behavior is used frequently by these frogs. The increase in size alone might discourage potential predators (Williams et al. 2000), but this strategy, which can be employed on the ground or on vegetation, while floating in water, or while being seized by a predator, is often accompanied by other behaviors (Toledo et al. 2011). In this study, frogs combined inflation with crouching, deimatic behavior, and exuding skin secretions, in one case, even while engaged in crawling toward cover. Crouching, exhibited by frog 2, typically is performed synergistically with chin-tucking, inflation, and exuding skin secretions (Toledo et al. 2011). Anuran skin secretions, which I saw only in frog 4, fall into four categories, odoriferous (Smith et al. 2004), adhesive, noxious, or slippery (Toledo et al. 2011), and often accompany other defensive behaviors. That of *K. pulchra* is known to be adhesive (Evans and Brodie 1994) and might have other properties as well.

Acknowledgements

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