



Death Feigning Behaviour of Several Frog Species from Kedah, Peninsular Malaysia

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Two individuals of ranid species, *Hylarana picturata* and *Hylarana laterimaculata*, were collected from Sungai Sedim Recreational Forest. A single individual of dicroglossid species, *Occidozyga laevis* and two individuals of *Polypedates leucomystax*, were captured from Ulu Paip and Bukit Hijau Recreational Forest respectively. When approached and handled for photography, the first two species leaped in very erratic patterns for approximately 10-15 minutes, before becoming exhausted and exhibiting death feigning posture. However, the third species only made a single leap before displayed a death feigning behaviour. The latter species also showed thanatosis behaviour, but in a very different body posture. The first specimen of *P. leucomystax* flexed its head ventrally, while the second specimen stretched its hindlimbs laterally.

Keywords: Amphibia; defensive mechanism; death feigning; stream; Peninsular Malaysia.

1. INTRODUCTION

The Spotted Stream Frog or *H. picturata* is a medium-sized frog, with snout-vent length (SVL)

of males and females reaching 33-47 and 48-69 mm, respectively [1]. It can be determined by orange spots on a blackish dorsal surface, with finger and toe tips dilated into small disks and

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interrupted or uninterrupted orange line extending from snout to dorsolateral fold. This species inhabits small forest streams and forest floors of primary lowland rainforests and secondary growth [2]. The Lesser Swamp Frog or *H. laterimaculata* is a medium-sized frog, with a total length between 38 and 67 mm. This species can be recognized by small, low, and rounded glandular warts on its back, scattered oval glands on both sides and dark spots scattered on back and side regions [2]. It can be encountered in primary rainforest. A small semi-aquatic frog, *O. laevis* or Common Puddle Frog, has a total length of 20 to 40 mm. It can be recognized by having a broadly rounded tongue, short fingers with blunt tips and toe tips dilated into small oval disks. This microglossid usually inhabits still and shallow pools in undisturbed forests or clearing areas [2]. The Four Lined Tree Frog or *P. leucomystax* is a moderate to large size frog, with snout-vent length reaching at 50 mm in males and 80 mm in females [1]. This tree frog is characterized by its rounded snout, finger tips expanded into large round disks, a distinct supratympanic fold and often possessing four longitudinal dorsal stripes [2]. *Polypedates leucomystax* occupies many habitat types, but is most frequently encountered around human habitations in urban and rural areas [2,3,1,4].

Amphibians are exposed to a great variety of predators, parasites, and diseases. Due their abundance in nature, small to moderate size and soft skin, they become a common prey for a various types of predators, including fishes, snakes, birds, mammals, and some arthropods [5]. From time to time, amphibians have evolved various morphological, physiological and behavioural features, which provide varying degrees of protection from a potential predator [5]. Currently, at least 30 defensive behaviours have been recorded in the anuran families [6]. Each mechanism may employ a different synergistic tactics to enhance their survival chances [7,8]. The commonest defensive strategy in anuran is to flee and followed by remain motionless [6]. Active escape or fleeing is a widespread defensive behaviour and might be used by all anuran species. It may either be quick and erratic or slower but directed and vigorous [6]. Anurans are also known to feign death to avoid or minimize the risk of predation. This type of behaviour is mostly displayed by non-toxic species [8]. While demonstrated this behaviour, the animal adopted a posture like being dead, which deflect an attack from a potential predator [8].

Previously, report on defensive behaviour has been recorded in several frog species from Peninsular Malaysia, including *Microhyla berdmorei* [9], *Leptobrachium hendricksoni* [10] and *Hylarana nigrovittata* [11]. To add more knowledge and understanding on frog defensive mechanism, herein we documented a death feigning behaviour displayed by *H. picturata*, *H. laterimaculata*, *O. laevis* and *P. leucomystax* from Kedah, Peninsular Malaysia. The latter species exhibited death feigning mechanism in a very different body posture.

2. MATERIALS AND METHODS

Between 2013 and 2014, several frog species were collected from various locations in Kedah, Peninsular Malaysia. Two individuals of ranid species, *Hylarana picturata* and *Hylarana laterimaculata*, were collected from Sungai Sedim Recreational Forest (SSRF) (5°25'N, 100°46'E; elevation < 200 m asl) in March and June 2013. A single individual of microglossid species, *Occidozyga laevis* and two individuals of *Polypedates leucomystax*, were captured from Ulu Paip Recreational Forest (UPRF) (5°23'N, 100°39'E; < 150 m asl) and Bukit Hijau Recreational Forest (BHRF) (5°30'N, 100°46'E; < 150 m asl) in December 2013 and January 2014 respectively (Fig. 1). The specimens were collected at night, between 2000 and 2300 hours, via active searching. The search was carried out along the river banks, forest streams, rock pools, forest pools and temporary puddles of the sampling sites.

Hylarana picturata was collected near a small forest stream at SSRF. The width of a stream was about 0.5-1.5 m and surrounded by lowland dipterocarp forest. It was composed of granite rocks, possessed a gravel-sandy bottom and had slow to moderate current flow. The Lesser Swamp Frog, *H. laterimaculata*, was captured at the edge of the forest pool at SSRF. This moderate-sized pool was approximately 2.5 m in length, 1.5 m in width and 5-25 cm in depth. Leaf litters, twigs and rotten branches were accumulated at the bottom of the pool. The pool consists of cloudy water, having a silty bed, and surrounded by low vegetation and lowland dipterocarp forest. *Occidozyga laevis* was observed near a small temporary puddle at UPRF. This muddy water puddle was about 50 cm in length, 30 cm in width and 2-10 cm in depth, filled with dead leaves, and having a silty bottom. The puddle was only filled with water after heavy rainfall, and will drying up within a

week. Finally, two specimens of *P. leucomystax* were collected near an artificial fish pond at BHRF. The moderate-sized cement pond consisted of clear water, together with fishes (*Oreochromis mossambicus*), aquatic plants (*Hydrilla verticillata* and *Eichhornia crassipes*) and dead leaves. Other sympatric species, including *H. erythraea* and *F. limnocharis*, were also observed around the pond.

Frogs were captured either by hand or fish nets, aided by head lamps and torch lights by 3-4 field party members. The collected specimens were placed into specimen plastic bags and brought to the laboratory for further inspections. Snout-vent length (SVL), head width (HW), and mass (W) of the specimens were measured using a digital calliper and electronic balance. SVL was measured from the tip of the snout to vent region, HW is measured at the widest region of the head and W is the weight of the specimens. Identification of frog species followed Berry [2] based on their morphological characteristics, while taxonomic nomenclatures followed Frost [12]. Air temperature and humidity value were recorded using a Thermo-Hydro meter.

To observe defensive mechanism, the specimens were stimulated by touching or gently hitting it with hands, sticks or blunt forceps. These procedures were saved and did not injured or harmful the specimens. The antipredator behaviours exhibited by *H. picturata*, *H. laterimaculata*, and *P. leucomystax* were documented in the laboratory, while for *O. laevis*, it was recorded at the sampling site. Observation of the behaviours were documented and photographed by using Olympus digital camera, model SP800UZ with 30X optical zoom. After measurement and photographing of their defensive postures, the specimens were released back to their natural environments.

3. RESULTS

An adult male of *Hylarana picturata* (SVL=48 mm, HW=16 mm, W=7 g) (Fig. 2) was observed while actively calling among leaf litters on the wet forest floor, approximately 1 m from a small forest stream. Air temperature and humidity values for the sampling site were 23°C and 65%, respectively. The specimen was captured and brought back to the laboratory for further inspections. When relocating the specimen from the vivarium to the substrates, it leaped away in various irregular directions in order to escape. After approximately 10 minutes, the frog

discontinued leaping and maintained a motionless posture. When approached, it suddenly turned its venter up to exhibit a death feigning behaviour (Fig. 3). While in this condition, several characteristics were noted: ventral surface up, exposed white and pale yellow spots on greyish background, immobilization, both eyes partially opened, forelimbs raised upward, exposed palmar surfaces, hindlimbs halfly stretched, and exposed grey thigh surfaces. Additionally, no odorous or distress calls were emitted by the frog. After nearly 2 minutes, the frog resumed a normal posture and started to leap again.

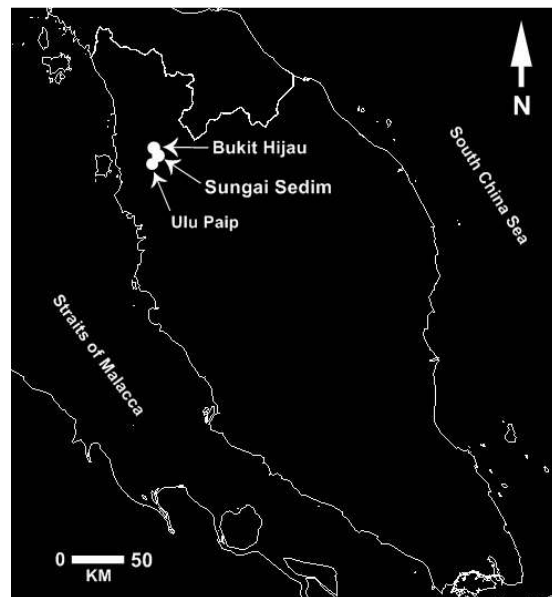


Fig. 1. Sampling locations in Kedah, Peninsular Malaysia

An adult male *H. laterimaculata* (SVL=52 mm, HW=16 mm, W=8 g) (Fig. 4) was collected perched on branches of low vegetation (< 1 m above ground) at the edge of the forest pool, beside the forest trail. Other frog species, including *P. leucomystax* and *O. laevis*, were also sighted around this pool. When handling the specimen for photography, it leaped in very erratic patterns for nearly 15 minutes, in an attempt to flee. Later, the specimen was recaptured and placed it on the substrates, but rapidly turned up its body and displayed thanatosis behaviour (Fig. 5). Several features were recorded: venter-up, exposed dark brown throat, displayed white belly with dark spots or blotches, stay motionless, both eyes half-opened, front legs raised upward, exposed palmar surfaces, rear legs held close to body,

exposed granular glands on thigh surfaces, and apparent plantar surfaces. Within this period, no odorous or distress calls were emitted by the frog. One and a half minutes later, the frog returned to normal posture and leaped again.



Fig. 2. An adult *H. picturata* from Sungai Sedim, Kedah



Fig. 3. Death feigning behaviour displayed by *H. picturata*

Beside thanatosis, this specimen also showed a body raising behaviour (Fig. 6), and several characteristics were documented: body elevated approximately 45°, snout facing up, forelimbs erected in straight position, palmar surfaces touching the substrates, hindlimbs expanding out laterally, hindlimbs not meeting substrates except for the plantar surfaces, and inguinal area raised-up. This type of behaviour was displayed by the frog after gently hitting it with a blunt forcep. It retained in this position for about 2 minutes before leaped again.



Fig. 4. An adult *H. laterimaculata* from Sungai Sedim, Kedah



Fig. 5. Death feigning behaviour exhibited by *H. laterimaculata*

The third species, a male *O. laevis* (SVL=34 mm, HW=7 mm, W=1 g) (Fig. 7) was observed near a small temporary puddle, beside the roadside, along the way to Ulu Paip. While trying to capture it, the frog made a single jump and hiding beneath dead leaves. After the leaves were removed, surprisingly the frog did not leap but turned their body upside down displaying death feigning posture (Fig. 8). While in this position several characteristics were recorded: ventral surface turned up, exposed yellow-grey throat, showed yellow-white belly, both eyes partially opened, forelimbs raised upward, exposed palmar surfaces, right hindlimb held close to body, left hindlimb stretched out, and displayed plantar surfaces. The frog was in this stationary position for approximately 2.5 minutes before resuming normal posture and leaping away.



Fig. 6. Body raising behaviour showed by *H. laterimaculata*



Fig. 7. An adult *O. laevis* from Ulu Paip, Kedah



Fig. 8. Thanatosis behaviour displayed by *O. laevis*

Finally, a male *P. leucomystax* (SVL=50 mm, HW=17 mm, W=9 g) (Fig. 9) was captured, perched on leaves of low vegetation (< 1 m

above ground) near an artificial fish pond at Bukit Hijau, Kedah. The air temperature and humidity values of the site were 24°C and 68%, respectively. Upon capture, the specimen was actively calling, and another two individuals were also observed nearby. The captured tree frog was brought to the laboratory for further inspections. When approached for photography, the specimen fled by leaping in various directions for approximately 10 minutes. After recaptured and placed it on leaves, the specimen rapidly turned its ventral surface up, showing thanatosis behaviour. However, their body posture was slightly different, as the frog arched its head ventrally (Fig. 10). Several other characteristics were also recognized: Body upside down, exposed dark brown throat, displayed whitish belly, body slightly arched up, head facing up (approx. 45°), both eyes fully opened, forelimbs raised upward and showed palmar surfaces, hindlimbs adpressed to the body, displayed plantar surfaces and webbing. The specimen was in this immobilized position for about three minutes before returning to normal posture.



Fig. 9. An adult *P. leucomystax* from Bukit Hijau, Kedah

Another male individual of *P. leucomystax* (SVL=48 mm, HW=17 mm, W=8 g) was collected, perched on the creeping plants (< 0.5 m above ground), approximately 2 m from the first specimen. When handling the specimen, it displayed a death feigning behaviour, but in a very different body posture, as their hindlimbs stretching out laterally (Fig. 11). Several other features were also recorded: body in inverted position, exposed ventral surface, both eyes fully opened, forelimbs raised upward, both thighs adpressed to the body, tibia and tarsus stretched out, plantar surfaces not exposed, and hindlimbs displaying a weaving pattern. The specimen was

in this motionless position for nearly three minutes. In addition, this specimen also emitted a distress call when we grasped it very tightly, but no recording was made. Table 1 summarizes the defensive behaviours displayed by all the observed specimens.



Fig. 10. Thanatosis posture (head flexed ventrally) exhibited by *P. leucomystax*



Fig. 11. Thanatosis posture (hindlimbs laterally stretched out) exhibited by *P. leucomystax*

4. DISCUSSION

When approached or handled, all the observed specimens fled in order to escape. It showed that fleeing is the primary defensive mechanism produced by the frogs to avoid danger or when in threatened situation. According to Toledo et al. [6], fleeing or active escape is the widespread behaviour that may be used by all anuran species. Besides fleeing in any direction, the frog

may also move backward, climb, walk, jumping into the water, entering into a burrow or gliding [13]. Fleeing may be accompanied with cloacal discharge, defensive calls and flash colours [6]. In our observations, all the specimens leaped in erratic patterns and in various angles when in a danger situation, except for *O. laevis* that only made a single leaped. As for *O. laevis*, the single leaped may be influenced by hiding beneath the leaves. There were no cloacal discharges or distress calls emitted by the observed specimens, except for individual number two of *P. leucomystax* which produced a distress call.

In the laboratory, *H. picturata*, *H. laterimaculata* and *P. leucomystax* were leaped in various directions in inconsistent patterns, for approximately 10-15 minutes before being fatigued. When the specimens were exhausted and cannot escape anymore, they perform another defensive mechanism such as death feigning. In this study, we proposed death feigning as a secondary defensive mechanism, since it was only exhibited by the above species when they were in fatigued condition and could not flee anymore. Toledo et al. [8] also noted that this type of behaviour is displayed after a short series of jumps by the frog, in response to a potential predator. Thanatosis may appear under a wide range of situations and may interact synergistically with other behaviours, including odoriferous secretions and aposematic coloration [8]. However, in this study, no such synergistically behaviours mentioned above were displayed. According to Toledo et al. [8], while displaying this behaviour, a frog remains motionless even when touched, generally keeps its eyes open or closed. These characteristics were recognized in all observed specimens.

Body raising posture is another defensive strategy displayed by *H. laterimaculata*. We suggest this mode of behaviour is a secondary defensive mechanism, since it was exhibited by the frog after leaping for nearly 10 minutes, followed by gentle hitting with a blunt forceps. While in this position, the frog inflated its lung, elevated their body and appeared larger than usual, which might be scared the potential predator. Duellman and Trueb [5] also reported that some amphibian species might present a larger image to the predator, or confuse the predator by changing the characteristic shape of the body.

Table 1. Defensive behaviours displayed by several frog species from Kedah, Peninsular Malaysia

Species	Sampling locations	Date	Defensive behaviours
<i>H. picturata</i>	Forest stream, Sungai Sedim	Mar 13	fleeing, death feigning (laboratory observation)
<i>H. laterimaculata</i>	Forest pool, Sungai Sedim	Jun 13	fleeing, death feigning, body raising (laboratory observation)
<i>O. laevis</i>	Temporary puddle, Ulu Paip	Dec 13	fleeing, hiding, death feigning (field observation)
<i>P. leucomystax</i> (1)	Artificial pond, Bukit Hijau	Jan 14	fleeing, death feigning [head flexed ventrally (laboratory observation)]
<i>P. leucomystax</i> (2)	Artificial pond, Bukit Hijau	Jan 14	fleeing, death feigning [hindlimbs stretched out laterally (laboratory observation)]

In this study, we also recognized a death feigning behaviour exhibited by *P. leucomystax*, but in a very different body posture. Both specimens exposed their ventral surfaces up and stayed immobilized for nearly 3 minutes. At the same time, the first specimen arched its head ventrally and the second specimen stretching out their hindlimbs laterally, similar to a weaving pattern. These body posture patterns had not been previously recorded. This finding indicated that a death feigning posture might be divided into several subdivisions depending on the pattern of body parts, especially their hindlimbs. Thus, more research is needed to explore and study this kind of behaviour.

5. CONCLUSION

Finally, this researched has explored the characteristics of death feigning behaviours exhibited by four different frog species from Peninsular Malaysia.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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