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Front cover image. Varanus salvator macromaculatus, Bangkok, J.B.Owens

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Predation and Feeding Behaviour of *Varanus salvator macromaculatus* on the Asian swamp eel (*Fluta alba*) in Lumpini Park, Bangkok, Thailand

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Introduction

The Asian water monitor (*Varanus salvator*), is second only to the Komodo dragon (*Varanus komodoensis*) in being the largest lizard species in the world (Shine *et al*., 1996; Kulablong and Mahaprom, 2015). The Southeast Asian water monitor (*V. s. macromaculatus*), a subspecies within the *V. salvator* complex, has a wide distribution throughout mainland Southeast Asia, including offshore islands such as Sumatra and Borneo (Koch *et al*., 2007). *Varanus* species have a high degree of cranial kinetic functionality, although not to the same degree that can be observed in snakes; which allows monitors to quickly ingest large prey items whole (Stanner, 2010). This adaptation is highly advantageous, as the amount of time required to consume food items is reduced. Therefore energy expenditure is also reduced and, in turn, the vulnerability period to potential predators during prey consumption (Stanner, 2010).

Due to the evident habituation to humans observed in the local population of *V. s. macromaculatus* in Lumpini Park, Bangkok, Thailand, there is greater potential to observe and record unique behaviours.

Individuals within the park typically behave indifferently to human presence at a distance of a few metres away; however, they will quickly flee or retaliate upon approach (Stanner, 2010). Here, we describe a predation event from a juvenile/subadult *V. s. macromaculatus* on an Asian Swamp Eel (*Fluta alba; synonym of *Monopterus alba*). Although these monitor lizards predating *F. alba* has been documented (Stanner, 2010), details of the capture, the actions used to subdue the prey item and subsequent ingestion is poorly documented; with the exception of a recent observation by Cota and Sommerlad (2013). Furthermore, there are no current recordings from Lumpini Park within the available literature.

Observation and Discussion

At 1349 h on 24 August 2016, a *V. s. macromaculatus* was observed actively foraging for prey items along a large pond in Lumpini Park, Bangkok, Thailand (13° 43' 50.11'' N; 100° 32' 19.77'' E; 4 m ASL).

Figure 1. *Varanus salvator macromaculatus* upon capturing a *Fluta alba*. The monitor can be observed carrying the eel away from the water's edge as the eel begins to wrap its body around the head and neck of the monitor lizard.

Figure 2. Prey manipulation before ingestion by *Varanus salvator macromaculatus.*

Figure 3. The use of lateral head movements by *Varanus salvator macromaculatus* and the ground in order to manipulate *Fluta alba*.

Figure 4. The use of rapid biting and lateral head movements in order to incapacitate and re-position the *Fluta alba*, ready for consumption by *Varanus salvator macromaculatus*.

Figure 5. Initial stages of ingestion of *Fluta alba* by *Varanus salvator macromaculatus*

V. salvator species rely heavily on both olfactory and optic cues during active foraging (Gaulke, 1992). Water monitors use visual cues to identify suitable shelter sites for prey items and will subsequently investigate the shelter with use of the nares and tongue (Gaulke, 1992). In this observation, once the swamp eel had been detected along the pond's edge, the monitor began to dig into the shelter site with the use of its snout, until capture. The eel was quickly grasped in between the jaws of the monitor lizard by the same means described in Cota and Sommerlad (2013), which consisted of a sudden jerk forward of the head whilst elongating the neck. The eel was struck on the lateral portion of its head with the posterior portion of the eel's body free to

Figure 6. The use of the ground to assist with the rapid ingestion of the *Fluta alba* by *Varanus salvator macromaculatus*.

Figure 7. Lateral body and head movements, including the thrusting forward of the head during the pharyngeal compression stage of ingestion by *Varanus salvator macromaculatus*.

move. The monitor lizard immediately began to move away from the water side, with the eel still clutched between its jaws (Figure 1); and moved approximately 50-70cm away from the water's edge. Through the evidence from this observation, and the observation by Cota and Sommerlad (2013),it is evident that *V. s.* macromaculatus takes *F. alba* to an adequate distance away from the water's edge in order to prevent the prey item from escaping (Figure 1). It is typical behaviour of species within the *V. salvator* complex to maintain hold of small and agile prey items with the mouth, in order to prevent prey escaping (Gaulke, 1992). This is reinforced in this observation where the eel did not leave the mouth of the monitor lizard from capture and throughout ingestion.

Upon capture, the eel had wrapped the posterior portion of its body around the neck and head of the monitor (Figure 1), as also observed in Cota and Sommerlad (2013); it can be postulated that this is done as a last-resort defence mechanism by *F. alba*.

However, the eel was quickly thrown off by sudden head jerks at an approximate 45 degree angle forward from the monitor lizard (Figure 2). The *V. s. macromaculatus* began to manipulate the eel within its mouth, using the ground to aid in maintaining grip and position of the eel (Figure 3).

Once a tight hold had been established on the lateral portion of the eel's head, the monitor proceeded with rapid biting and banging of the eel's head on the ground in order to completely incapacitate the eel (Figure 4). Once the eel ceased moving (presumably dead), the monitor immediately began to reposition the eel so that the anterior portion of the head faced towards the throat of the monitor (Figure 4). To do this, the monitor used quick head jerks to begin the repositioning before using the ground to completely shift the eel around. The monitor took exactly 62 seconds to swallow the eel whole; using head, throat, entire body movements and the ground as aid in the process (Figure 5 - 6). Subsequent behaviours included rapid tongue flicking following the ingestion, maintaining position on the level ground.

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The use of roadside gabions as refugia by reptiles in Kota Kinabalu, Sabah, Malaysia

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On the evening of 10 September 2016 at approximately 23:00, an Asian water monitor (*Varanus salvator*) was observed to be sheltering from the rain inside a gabion in Kota Kinabalu, Malaysia (Figure 1). The monitor lizard was spotted during a short excursion to make a preliminary count of the amphibian species in the nearby area. There had been persistent rain throughout the day and it is believed that the monitor was sheltering from this downpour whilst trying to maintain a reasonable internal body temperature. The area where the monitor was discovered is an edge habitat, to the west is the city of Kota Kinabalu and to the east is an area of tropical woodland. Usually burrows are used for thermoregulation (Shine *et al*., 1996) but these are likely less common in urban areas compared with semi-natural and natural areas.

Figure 1. Varanus salvator as seen from within a roadside gabion.

Gabions are used for the support of embankments and consist of a wirework frame filled with rocks and broken concrete. These can then be used in the construction of roads or as a method of coastal defence. The gabion in which the monitor was seen sheltering in was part of a small complex which aids in supporting a local embankment close to a car park and local buildings, including a hotel. Interestingly the gabion was also occupied by a number of invertebrate species such as cockroaches, orthopterans and mantids. Unfortunately none of the invertebrates were identified past order level. Geckos of the species *Hemidactylus garnotii* and *H. frenatus* were also found seeking refuge in or around the gabion. As a plentiful food source was available, perhaps the geckos were using this man-made habitat feature as a place to hunt for food.

When the monitor lizard was initially spotted, it was assumed to be dead. Earlier in the week a smaller juvenile was found at the roadside nearby after being struck by a car. Urban environments post a number of risks to wildlife such as reptiles

Figure 2. A roadside gabion in Kota Kinabalu.

(Koenig *et* al., 2002) that are only going to increase as settlements encroach wild habitats. As well as sheltering from the rain, this shows evidence of seeking refuge from the traffic or the disturbance of people. Urban environments may be dangerous to large lizard such *V. salvator* but they also offer opportunities for the lizards to scavenge food scraps left by humans (Kulabtong & Mahaprom, 2014).

At first all that was visible was the monitor's tail but after a few brief moments of shining a torch through the crevices to see if the rest of the lizard was hidden, the tail disappeared and the body of the lizard came into view. The monitor had been disturbed by the bright light of the torch and had awoken, it then hissed for a only a couple of seconds before manoeuvring between the rocks within the gabion and moving deeper inside. This was likely to find somewhere new to hide. During this time that the lizard's size became apparent, the lizard had a snout to vent length (SVL) of somewhere between 30 and 40 cm. Telling the true length of the animal was difficult as it was contorted in order to fit in such a tight gap. Once the monitor moved out of view all care was taken not to disturb the animal any further and so we moved on. The uses of gabions in semi-urban environments are likely to benefit local species of herpetofauna as shown in this case as they provide both a refuge and plentiful hunting opportunities to smaller individuals/species.

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Ex-situ maintenance and breeding of Hernandez's Helmeted Basilisk *Corytophanes hernandesii* (Weigmann, 1831)

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Species description and captive maintenance

Hernandez's Helmeted Basilisk *Corytophanes hernandesii* (Weigmann, 1831) is a small arboreal, diurnal iguanid species occurring in tropical and subtropical, wet and dry forests in Mexico, Guatemala, Belize and Honduras, up to around 1400m elevation (Wilson *et al.*, 2010). Unfortunately, a major threat to this species, like many tropical species in the 21st Century, is deforestation (Wilson *et al.*, 2001). However, as the species is currently considered locally common and widely distributed throughout its range, it is listed as Least Concern with a stable population trend by the IUCN Red List (Ariano-Sánchez, 2013). The pressure of wild collection is comparably low in comparison to many other reptile species (Ariano-Sánchez, 2013). *Corytophanes hernandesii* is rarely kept or reproduced in captivity, though once established, individuals are not difficult to maintain in a captive environment.

All species within the genus *Corytophanes* are laterally flattened lizards with a large

Figure 1. Captive adult male (left) and captive female (right) *C. hernandesii* exhibiting a normal resting colouration. Parents of the juveniles in this article.

Figure 2. Captive adult male (left, centre) and captive adult female (right) *C. hernandesii* showing different colour variations initiated for intraspecific signalling.

bony helmet that differs in morphology between species. Colouration is highly variable within species, even at the same locality, however general trends in colour, pattern and the differences in helmet morphology allow differentiation between species. *Corytophanes hernandesii* reaches up to 100mm snout-vent length (SVL), with a tail approximately 250% of SVL, exhibiting various shades of brown on the dorsum at rest, with pale undersides (Figure 1). In the captive environment, it was observed that both males and females can change dorsal colouration to yellow, orange, red, green-white, light blue and black; this appears to be dependent on intraspecific signalling, such as during courtship (Figure 2, pers. obs.). There is slight sexual colour dimorphism present in *C. hernandesii*, whereas this is not the case in other *Corytophanes* species; this does not appear to have been reported previously. Black gular striping is present in females and when fecund, develop a cross band on the top of the head between the eyes (Figure 3, pers. obs.). From around 5-6 months of age, it is possible to visually determine sex of individuals; males have a larger helmet than the females and have obvious hemipenal bulges present below the vent (Figure 4, pers. obs.).

Figure 3. Gravid, captive female *C. hernandesii* displaying cross banding on top of the head; only present in fecund females.

Exo-terra style enclosures of 90x45x60cm have been used successfully by the author to house breeding pairs or trios of this species, ensuring one male per enclosure is maintained to avoid male-male aggression. Furnishings include multiple perch choices in the form of branches, foliage from *Ficus* sp., *Tradescantia*, *Calathea*, *Begonia* and *Anthurium*, and Expanded Insulation Corkboard (Tŷ-Mawr Lime Ltd.) lining the walls. A mix of soil, sand, perlite and Oak *Quercus* mulch is provided as a substrate with several invertebrate species used to manage waste build up. Species include

Springtails *Collembola*, Woodlice *Oniscus*, *Folsomia*, Earthworms *Dendrobaena* and Beetles *Zoophobas*. Arcadia T5 lighting produces suitable UV-B levels in the enclosure; intensity varies dependent on perch location. This is supplemented by provision of LED lighting for plant growth and general broad spectrum natural lighting. The enclosure is sprayed 1-4 times daily (dependent on season, using equal time between sprays; 2 times daily- sprays every 12 hours, 3 times daily- every 8 hours, etc. to maintain constant ambient relative humidity) with an automatic misting system and heated by a single overhead, thermostatically-controlled heat source (50w ceramic heater) situated at one end. Relative humidity levels are maintained at 60-90% and ambient temperature varies from 24-35^{o}C throughout the year (dependent on season). These parameters are taken from data collected in the natural habitat of *C. hernandesii* by the author (El Pet**én**, Northern Guatamala, data unpubl.).

In the wild, *Corytophanes* are a prey species and rely on camouflage on branches and the forest floor to avoid predation. The dorsal pattern has evolved to mimic dead leaves, and therefore staying motionless for long periods increases the likelihood of survival. Furthermore, *Corytophanes* have evolved a preference for surprisingly large prey items, thus reducing feeding frequency and movement, allowing them to stay motionless for extended periods (Andrews, 1979). It was observed that invertebrates similar or equal to the SVL of captive *Corytophanes* are easily overpowered and consumed, and this can provide enough nutrition to last up to a week between individual feeding events. In captive juveniles, this behaviour is demonstrated to the extreme whereby only large prey is consumed and smaller prey items that would usually be deemed suitable for a lizard of that size are almost totally ignored (Pers. obs.).

Breeding notes

Figure 4. Captive juvenile pair of *C. hernandesii* at 6 months of age. Male (left) showing larger head crest and slight pattern differences to female (right).

Breeding behaviour, both in the wild and captivity, occurs from March-June and appears aggressive, but females usually remain uninjured. Following several 'head bobs', colour variation and chasing, the male bites and holds the females crest to manoeuvre and copulate (Pers. obs.). This behaviour in the captive environment was repeated several times in the days following to ensure reproductive success. Eggs are laid between 10-12 weeks following successful mating. The individuals in this article laid clutches of 3-7 eggs, though anecdotal evidence suggests up to 11 eggs are possible (Villalba, pers. comm). Clutch size appears dependent on the size and age of the female. Eggs are comparatively large for a lizard of this size, measuring on average 25mm in length. The largest of clutches occupy almost the entire volume of the torso which prevents food intake when heavily gravid (within 2-3 weeks before egg deposition) (Pers. obs.). Juveniles hatched after 90 days incubation at approximately 26^{o}C, producing both sexes at this temperature at a 1.1 ratio. Information from future breeding efforts are valued as so far, only a small sample size is available (10 fertile eggs, 2 successful hatchlings). Eggs appear very sensitive to water content of incubation media and care should be made to ensure water content does not change during incubation. Unsuccessful eggs failed due to water content increasing in media. The two hatchings from the following clutch appeared healthy and these were maintained in media with constant water content. Hatchlings were maintained in identical conditions to adult individuals with 100% success, and at the time of writing are 6 months of age. Finally, it is expected that this species shows temperature-dependent sex determination but more research and breeding effort is required to conclude this.

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Caudal Luring by a Captive Common Boa (*Boa sp.*)

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Introduction

Caudal luring is a predatory behaviour whereby a snake undulates or waves the distal portion of its tail, producing a deceptive signal and aggressively mimicking an invertebrate. The intention is to attract prey to the snake (Heatwole & Davison 1976; Nelson et al. 2010). Caudal luring has been recorded in snakes from the families Boidae, Colubridae, Elapidae, Pythonidae, and Viperidae (Heatwole & Davison 1976; Murphy et al. 1978; Radcliffe & Chiszar 1980; Chiszar et al. 1990; Leal & Thomas 1994; Rabatsky & Farrell 1996; Tiebout III 1997; Reiserer 2002; Reiserer & Schuett 2008). Among species in the genus *Boa*, captive sub adult Argentine boas (*Boa constrictor occidentalis* PHILLIPI 1873) have been observed caudal luring, primarily when rodent prey disappears from view (Radcliffe & Chiszar 1980). Here I describe an instance of caudal behaviour in a *Boa sp.* in a captive habitat.

Observation

At 1722 h on 14 March 2017, a captive female common boa (*Boa sp.*) measuring 98 cm snout-vent length (SVL) was observed demonstrating caudal behaviour. The individual was three years and one month old, amelanistic, and of unknown lineage. Owing to the ambiguous heritage of boas in captivity, and in the light of recent species delineations by Reynolds et al. (2014), the species has been left unknown. The specimen had last eaten a weaned domesticated rat (*Rattus norvegicus* BERKENHOUT 1769), 21 days previously and had not been offered food in the interim. She had sloughed the previous night and appeared to be actively foraging within the vivarium. As I approached the vivarium, the snake began slowly flicking and waving its tail at intervals of approximately one second, producing waves moving posteriorly from just below the vent, and coming to rest between motions. During this period the tail of the snake was slapping against a faux rock hide and some artificial foliage, producing noise audible at a distance of two metres. This behaviour continued for six minutes. Throughout the observation the snake's head was at the opposite end of the vivarium, approximately 75 cm from the tail, and no tongue flicks were observed.

Discussion

There is uncertainty surrounding the function of some caudal behaviours employed by snakes. *Boa constrictor* generally uses short strikes of <10 cm to attack prey (Cock Buning, 1983; Cundall and Deufel, 1999), and the common boa described here can certainly strike much further, up to approximately one third of SVL (pers. obs). Usually, the snake's head is within strike range of the tail when snakes exhibit caudal luring (Murphy et al. 1978; Chiszar et al. 1990; Sazima 1991). Here, the head of the specimen was 75 cm from the tail, likely outside of strike range. This contrasts to numerous instances of caudal luring in other species (Heatwole & Davison 1976; Murphy et al. 1978; Chiszar et al. 1990; Leal & Thomas 1994; Rabatsky & Farrell 1996; Tiebout III 1997; Reiserer 2002; Reiserer & Schuett 2008). Mullin (1999) recorded a behaviour in the yellow ratsnake (*Pantherophis obsoletus* UTIGER et al 2002), referred to as caudal distraction. After detecting prey nearby, the snake began loudly slapping the tail against the substrate, despite the tail being outside of strike range. A behaviour distinct from the defensive tail vibration employed by ratsnakes. Mullin (1999) postulated that this may serve as a distraction, as opposed to a lure, to divert attention away from the head of the snake prior to a strike. A similar behaviour was noted in the horned adder (*Bitis caudalis* FITZSIMONS & BRAIN 1958), another species which displays caudal luring (Reiserer 2002). Moving snakes undulated the tail in the air as they moved, seemingly to distract attention away from the head, both in the presence and absence of prey.

As with *B. caudalis*, the purpose of the behaviour documented here is unclear. To better understand the cognitive interplay between the snake and its prey, the tail movement of common boas should be compared to the movement of their prey species (Reiserer & Schuett 2008). This would aid in elucidating the exact function of the behaviour as either distraction or aggressive mimicry. This note represents the first published record of this behaviour in an individual over two years old from the genus *Boa*.

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