

Observations on nocturnal activities of the Dumeril's Monitor, *Varanus dumerilii* Schlegel, 1839, in Borneo, Malaysia

Zichen Qiao^{1,*}, Yuchen Hu², Law Ingg Thong³, and Law Ing Sind³

Monitor lizards (Squamata: Varanidae) comprise a group of medium to large-sized lizards distributed across Sub-Saharan Africa to Asia, Australia and Pacific islands (Pianka et al., 2004; Auliya and Koch, 2020). There are over eighty extant species of monitor lizards (Auliya and Koch, 2020; Brennan et al., 2021; Uetz et al., 2025). Despite extensive variation in morphology and natural history, all species are currently placed under the single genus *Varanus*, which can be further classified into 11 subgenera (Auliya and Koch, 2020; Brennan et al., 2021). All monitor species are considered primarily diurnal as they engage essential activities such as feeding and mating during daytime hours (Pianka et al., 2004). Anatomical studies on the Desert Monitor (*V. griseus*) and Savanna Monitor (*V. exanthematicus*) revealed that these two species rely on the presence cone cells on their retina for great daytime vision, whereas the absence of rod cells indicated that these lizards have limited visual capabilities in low-light environments (Bhattacharjee, 1992; Röhl and Horn, 1999). The general morphological conservativeness among monitor lizards led Röhl and Horn (1999) to further conclude that all monitors possess eye structures specialised for daytime vision as discovered in *V. griseus*, on the absence of evidence from other species, particularly species from other subgenera.

Interestingly, crepuscular and nocturnal activities have been documented in several monitor species, including the Asian Water Monitor *V. salvator* (Uyeda et al., 2013), Yellow-spotted Monitor *V. panoptes* (Trembath,

2000), Black Palmed Monitor *V. glebopalma* (Rhind et al., 2013), and Dumeril's Monitor *V. dumerilii* (Cota and Chan-Ard, 2008; Yong et al., 2008; Lui, 2022). Among these, *V. dumerilii* (Schlegel, 1839) has been featured in multiple reports of nocturnal behaviour (Cota and Chan-Ard, 2008; Yong et al., 2008; Lui, 2022). This rare species inhabits mangroves, swamp forest, and other forested habitats of Southeast Asia, where it predares upon a broad range of small prey items, including crabs, insects and small rodents (Bennett and Liat, 1995; Pianka et al., 2004; Cota and Chan-Ard, 2008). The shy and cryptic nature of *V. dumerilii* makes it difficult to detect during field surveys, leading to a limited understanding of its natural history (Bennett and Liat, 1995; Cota and Chan-Ard, 2008). Consequently, the species is classified as “Data Deficient” on the IUCN Red List, and its actual conservation status remains unclear, necessitating further research to assess its conservation status (Iskandar et al., 2021).

Although *V. dumerilii* is considered primarily diurnal like other monitor species (Pianka et al., 2004; Cota and Chan-Ard, 2008), three independent natural history publications from Singapore and Thailand suggest that this species does occasionally engage in nocturnal activities (Cota and Chan-Ard, 2008; Yong et al., 2008; Lui, 2022). Building on these observations, we report two additional cases of nocturnal behaviour in *V. dumerilii* from Sarawak and Sabah in Malaysian Borneo.

On 15 August 2024 at 21:55 h (sunset at 18:48 h), under a cloudy weather condition and an air temperature of 25 °C, Ing Sind Law (ISL), Ingg Thong Law (ITL) and several other herpetologists encountered an adult *V. dumerilii* (around one metre in total length, Fig. 1A) in a lowland dipterocarp forest while walking along a road at Bau, Sarawak (approximately 1.4166°N, 110.1500°E, specific location withheld due to poaching and disturbance concerns) during a recreational herpetological survey. When encountered, the monitor appeared to be foraging near the roots of a large *Ficus* tree besides a stream inhabited by large freshwater

¹ Adaptive Biototoxicology Lab, School of the Environment, University of Queensland, St. Lucia, Brisbane, Queensland 4072, Australia.

² Independent researcher, Dongxiao Street, Luohu District, Shenzhen, Guangdong 518019, China.

³ Herpetological Society of Singapore, 12J Sime Road, Singapore 288296, Republic of Singapore.

* Corresponding author. E-mail: zcqherpetology@gmail.com

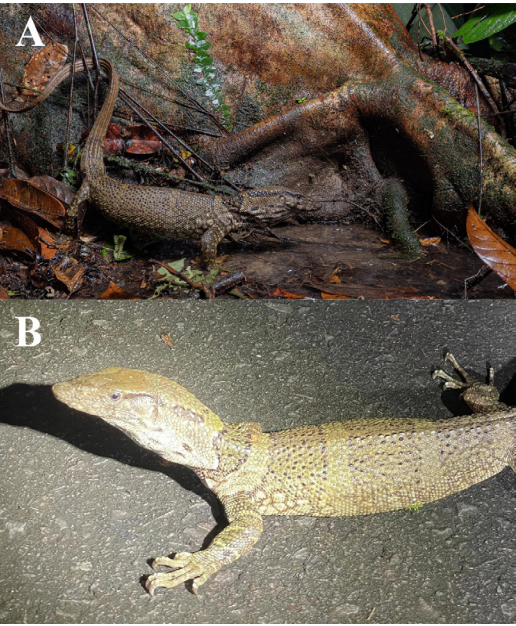


Figure 1. (A) Adult *Varanus dumerilii* foraging at night under a *Ficus* tree near Bau, Sarawak, Malaysia. (B) Adult *Varanus dumerilii* encountered moved onto the road near Gomantong Caves, Sabah, Malaysia. Photos by Ingg Thong Law (A) and Yuchen Hu (B).

crabs (likely *Parathelphusa* sp.), which are potential prey item of *V. dumerilii* (Krebs, 1979; Pianka et al., 2004; Cota and Chan-Ard, 2008). This encounter lasted approximately ten minutes, during which ISL, ITL, and their peers observed and photographed the lizard from a distance. Throughout the observation, the monitor moved slowly along the roadside, frequently flicking its tongue. Eventually, it retreated into dense vegetation, likely disturbed by the observers’ head torchlight.

On 20 January 2025 at 22:15 h (sunset at 19:26 h), under an overcast weather condition and an air temperature

of 28 °C, Yuchen Hu (YCH) came across an adult *V. dumerilii* (around one metre in total length, Fig. 1B) in a lowland peat swamp forest while driving on a road near Gomantong Caves, Sabah, Malaysia (approximately 5.5166°N, 118.0666°E). The monitor was initially observed climbing down a tree beside the road. When exposed to the vehicle’s headlights, it leapt from the tree onto the road, where it remained motionless for about a minute. As YCH exited the vehicle and approached the monitor to check out the situation, it moved off the road and retreated into the roadside forested habitat, from where it eventually climbed a tree and disappeared. The total duration of the encounter was five minutes, during the observation, the monitor frequently flicked its tongue and walked slowly. The surrounding peat swamp forest contained abundant water sources, and YCH observed numerous nocturnally active *Parathelphusa valida* crabs throughout the habitat, including individuals spotted on the road.

Based on literature records and our observations, we summarised key information regarding the nocturnal behaviours of *V. dumerilii* and the localities where these observations were made (Table 1; Fig. 2). Existing reports indicate that *V. dumerilii* engages in nocturnal activity across much of its range, including Thailand,

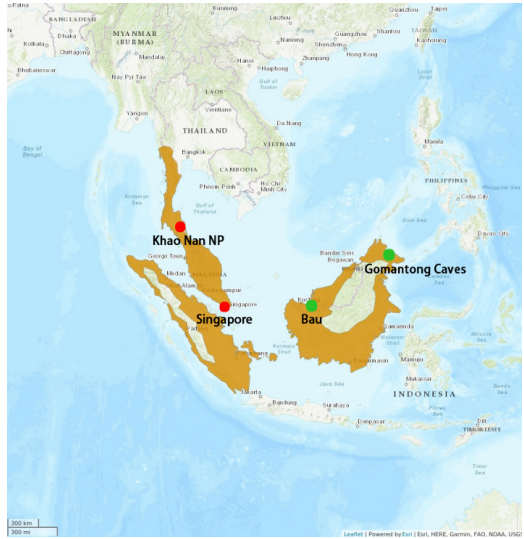


Figure 2. Distribution range of *Varanus dumerilii*. Red dots indicate localities where nocturnal behaviours of *V. dumerilii* have been previously reported (Cota and Chan-Ard, 2008; Yong et al., 2008; Lui, 2022). Green dots mark sites where nocturnal activities were documented in this study. Map adapted from the IUCN Red List (Iskandar et al., 2021).

Table 1. Key information of extant published sightings on nocturnal behaviours of *Varanus dumerilii*, based on literature records and observations reported in this study.

Locality	Date	Time	Age class	Behaviour	Reference
Singapore	18 Jan 2008	22:45	Adult	Presumably foraging	Yong et al., 2008
Thailand	23 Oct 2006	19:30	Adult	Moving	Cota and Chan-Ard, 2008
Singapore	14 Oct 2022	19:30	Adult	Moving	Lui, 2022
Malaysia	15 Aug 2024	21:55	Adult	Presumably foraging	This paper
Malaysia	20 Jan 2025	22:15	Adult	Moving	This paper

Singapore, and Malaysia (Fig. 2) (Cota and Chan-Ard, 2008; Yong et al., 2008; Lui, 2022). Observations have been recorded at various times of the year (January, August, and October), with presumed foraging behaviours noted as late as 22:45 h (Cota and Chan-Ard, 2008; Yong et al., 2008; Lui, 2022). Our observations suggest that nocturnal activity in *V. dumerilii* may be more common than previously recognised and is likely widespread across the species' range, rather than restricted to specific local populations (Pianka et al., 2004; Cota and Chan-Ard, 2008). Nevertheless, despite these findings, significant gaps remain in our understanding of the behavioural ecology of this poorly known species.

In comparison to partly sympatric monitor species, the Asian Water Monitor (*V. salvator*), the Clouded Monitor (*V. nebulosus*), and the Roughneck Monitor (*V. rudicollis*), which are dietary generalists and exhibit little (only in *V. salvator*) to no nocturnal activities (Pianka et al., 2004; Uyeda et al., 2013), *V. dumerilii* is a specialised crab feeder that has evolved a broad skull structure to facilitate crab eating (Krebs, 1979; Pianka et al., 2004; Cota and Chan-Ard, 2008). As most freshwater crabs are primarily nocturnal by hiding in the shelter during the day and actively foraging after dark (Cota and Chan-Ard, 2008; Yeo et al., 2008), Cota and Chan-Ard (2008) hypothesised that *V. dumerilii* may exploit these peak activity times of crabs, despite a reduced visibility under low-light conditions. In this way, it can also reduce inter-specific competition against larger sympatric monitor species that are more strictly diurnal (Pianka et al., 2004). Both our observation from Malaysia and previous reports from Singapore consistently show the presence of water sources such as streams, lakes, and swamps, with freshwater crabs either sighted or reported as abundant near these habitats (Yong et al., 2008; Cai et al., 2016; Lui, 2022), which are in line with observations by Cota and Chan-Ard (2008). However, as direct observations of *V. dumerilii* preying on crabs at night have yet to be documented, the current evidence is insufficient to definitively attribute these nocturnal activities to foraging behaviour. Therefore, we strongly recommend field researchers to extensively deploy video cameras in suitable *V. dumerilii* habitats (e.g., Yong et al., 2008), to increase the likelihood of capturing actual evidence of nocturnal feeding. Moreover, radiotracking, a method previously employed to study the ecology and behaviour of monitor lizards (Sweet, 1999; Sweet, 2018), could also be utilised to monitor the circadian rhythms of *V. dumerilii*. These recommended future studies will

not only significantly enhance our knowledge on this highly secretive and cryptic species but also contribute to its conservation given the current "Data Deficient" status (Iskandar et al., 2021).

It is noteworthy that all five *V. dumerilii* reported to engage in nocturnal activities were adult specimens with total lengths around one metre (Cota and Chan-Ard, 2008; Yong et al., 2008; Lui, 2022; this study). At present, there is no evidence on whether juveniles of this species also exhibit nocturnal behaviours. Unlike large adults armoured with rough body scales, juveniles of some monitor species, including the enormous Komodo Dragon (*V. komodoensis*), are shy and secretive due to vulnerability to predation and cannibalism, which drive them to occupy a different ecological niche to adults (Pianka et al., 2004; Imansyah et al., 2008). *V. dumerilii* has been reported to undergo a similar ontogenetic behavioural shift with juveniles observed to spend significantly more time hiding under the substrate than adults during the day, which is distinctive even among monitor lizards (Cota and Krebs, 2015). Due to their cryptic nature and the potential risks associated with foraging under presumably poor vision, we propose that nocturnal activity is unlikely, if ever, practiced by juvenile *V. dumerilii*. Krebs (1979) reported that the skull structure of juvenile *V. dumerilii* is similarly broad as in adults, which is a trait hypothesised to facilitate crab feeding. Considering that juveniles frequently hide during daytime when nocturnal crabs are also hiding (Yeo et al., 2008; Cota and Krebs, 2015), it would be interesting to investigate their feeding strategy in the wild under the hypothesis that they rarely, if ever, engage in nocturnal activity.

Although *V. dumerilii* has been proposed to trade off poor vision at night for more abundant crab prey (Cota and Chan-Ard, 2008), the specific details of this strategy remain unexamined. In both of our observations, nocturnally active *V. dumerilii* frequently displayed tongue-flicking behaviours. Therefore, when active in the dark with limited visibility, we hypothesise that highly developed olfactory system described in Pianka et al., (2004) and Dakrory (2011) is the dominant system exploited by monitor lizards for sensing. To further examine this hypothesis, we recommend future studies to assess the efficacy of olfactory-dominated sensing in nocturnal locomotion of monitor lizards. To date, there are also no published studies on eye structure and visual system of *V. dumerilii*. The only similar studies on monitor lizards have focused on two African/Middle East species (*V. griseus* and *V. exanthematicus*)

(Bhattacharjee, 1992; Röhl and Horn, 1999). Despite the proposal that different monitor species possess similar cone-only eye structure with highly limited night vision (Röhl and Horn, 1999; Cota and Chan-Ard, 2008; Rhind et al., 2013), we encourage future research to explore the visual capabilities of more monitor species, particularly *V. dumerilii* and *V. glebopalma* which have been featured in multiple reports of nocturnal activity (Cota and Chan-Ard, 2008; Rhind et al., 2013). Such studies could clarify whether intrageneric variation in eye structure exists within the genus *Varanus* and significantly enhance our understanding of the unusual nocturnal behaviours exhibited by these lizards.

Acknowledgments. We sincerely thank Dr. Juan Lei for his extraordinarily valuable feedback to this paper. We thank Masila Jripin (Economic Planning Unit Sarawak) for clarifying that a single, serendipitous observation does not fall under the SORAS permitting requirement.

References

- Auliya, M., Koch, A. (2020): Visual identification guide to the monitor lizard species of the world (Genus *Varanus*). Guidance for the Identification of monitor Lizards with current distribution data as well as short explanations on reproductive characteristics and captive breeding to support CITES authorities. Bonn, Germany, Bundesamt für Naturschutz..
- Bennett, D., Liat, L. (1995): A note on the distribution of *Varanus dumerilii* and *V. rudicollis* in Peninsular Malaysia. *Malayan Nature Journal* **49**: 113–116.
- Bhattacharjee, J. (1992): Organization of the retinal photoreceptors in the Savannah monitor lizard (*Varanus exanthematicus*). *Experimental Eye Research* **55**: 243.
- Brennan, I.G., Lemmon, A.R., Lemmon, E.M., Portik, D.M., Weijola, V., Welton, L., Donnellan, S.C., Keogh, J.S. (2021): Phylogenomics of monitor lizards and the role of competition in dictating body size disparity. *Systematic Biology* **70**(1): 120–132.
- Cai, Y., Li, T., Lim, W., Tok, C., Woo, C.M. (2016): Biodiversity assessment of freshwater shrimps and crabs in the Nee Soon swamp forest, Singapore. In: *A Global Overview of the Conservation of Freshwater Decapod Crustaceans*, p. 373–418. Kawai, T., Cumberlidge, N., Eds., Cham, Switzerland, Springer Cham.
- Cota, M., Chan-Ard, T. (2008): Geographical distribution, instinctive feeding behavior and report of nocturnal activity of *Varanus dumerilii* in Thailand. *Biawak* **2**(4): 152–158.
- Cota, M., Krebs, U. (2015): Do the hatchlings of Dumeril's monitor (*Varanus dumerilii*) Schlegel, 1839 display Batesian mimicry? A conspicuous phenomenon and its presumptive evidence. *Proceedings of the 2015 Interdisciplinary World Conference on Monitor Lizards*.
- Dakrory, A. (2011): Innervation of the olfactory apparatus of *Varanus niloticus* (Squamata– Lacertilia–Varanidae). *Journal of American Science* **7**(9): 118–125.
- Imansyah, M.J., Jessop, T.S., Ciofi, C., Akbar, Z. (2008): Ontogenetic differences in the spatial ecology of immature Komodo dragons. *Journal of Zoology* **274**(2): 107–115.
- Iskandar, D., Wogan, G., Panitvong, N., Grismer, L., Quah, E., Cota, M., et al. (2021): *Varanus dumerilii*. The IUCN Red List of Threatened Species **2021**: e.T83777732A83777736.
- Krebs, U. (1979): Der Dumeril-Waran (*Varanus dumerilii*), ein spezialistischer Krabbenfresser? *Salamandra* **15**(3): 146–157.
- Lui, E.Y.L. (2022): Biodiversity Record: Unusual behaviour of a Dumeril's monitor at Upper Seletar. *Nature in Singapore* **15**: e2022151.
- Pianka, E.R., King, D.R., King, R.A. (2004): *Varanoid Lizards of the World*. Bloomington, Indiana, USA, Indiana University Press.
- Rhind, D., Doody, J., Ellis, R., Ricketts, A., Scott, G., Clulow, S., McHenry, C. (2013): *Varanus glebopalma* (black-palmed monitor) nocturnal activity and foraging. *Herpetological Review* **44**: 687–688.
- Röhl, B., Horn, H. (1999): The structure of the eye of the monitor lizard *Varanus griseus caspius* (Reptilia, Varanidae). *Advances in Monitor Research II. Mertensiella* **29**: 306.
- Sweet, S.S. (1999): Spatial ecology of *Varanus glauerti* and *V. glebopalma* in northern Australia. *Mertensiella* **11**: 317–366.
- Sweet, S.S. (2018): Comparative spatial ecology of two small monitors in northern Australia. *Mertensiella* **16**: 378–402.
- Trembath, D. (2000): Nocturnal activity by Gould's Monitor (*Varanus gouldii*) at Town Common Environmental Park, Townsville QLD. *Herpetofauna* **30**: 52.
- Uetz, P., Freed, P., Aguilar, R., Reyes, F., Hošek, J. (2024): The Reptile Database. Available at: <http://www.reptile-database.org>. Accessed on 30 June 2025.
- Uyeda, L., Iskandar, E., Wirsing, A., Kyes, R. (2013): Nocturnal activity of *Varanus salvator* on Tinjil Island, Indonesia. *Biawak* **7**: 25–30.
- Yeo, D.C., Ng, P.K., Cumberlidge, N., Magalhaes, C., Daniels, S.R., Campos, M.R. (2008): Global diversity of crabs (Crustacea: Decapoda: Brachyura) in freshwater. In: *Freshwater animal diversity assessment*, p. 275–286. Balian, E.V., Lévêque, C., Segers, H., Martens, K., Eds., Dordrecht, Netherlands, Springer.
- Yong, D.L., Fam, S., Ng, J. (2008): Rediscovery of Dumeril's monitor, *Varanus dumerilii* (Varanidae) in Singapore. *Nature in Singapore* **1**: 21.