

Climbing a giant tree trunk like cruising on the ground: observations on the climbing behaviour of five roughneck monitors, *Varanus rudicollis* (Gray, 1845), in Sabah, Borneo

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Tropical rainforests are captivating to researchers due to their biodiversity, complex vertical structures, and the unique adaptations of the species that inhabit them. The dense canopy of towering trees creates a three-dimensional environment that offers reptiles more sunlight, food, and shelter, as well as protection from terrestrial predators. The vertical trunk of a tree serves as a pathway from the ground to the canopy, particularly in the case of large trees. Some studies suggest that the dominance of large trees (primarily species from the family Dipterocarpaceae) in Asian rainforests is a driver of arboreal and gliding morphologies in a variety of Southeast Asian vertebrate lineages (Emmons and Gentry, 1983; Corlett, 2007; Singh and Sharma, 2009; Heinicke et al., 2012; Chaitanya et al., 2023). Due to their lifestyle, arboreal reptiles are typically recorded less frequently in inventory, ecology, or conservation research than ground-dwelling species (Henderson et al., 2016), and as a result, their natural histories often remain poorly understood and their conservation status uncertain.

Varanidae is a reptile taxon that currently contains 88 described species (Uetz et al., 2026). Of the five habit types (semi-aquatic, terrestrial, saxicolous, semi-arboreal, and arboreal), arboreality appears to be the second most common lifestyle habit used by varanids (Pianka, 1995; Bedford and Christian, 1996; Thompson et al., 1996a, b; Bennett, 2014; Law et al., 2016; Eidenmüller et al., 2017). Arboreality likely resulted in evolutionary adaptations in monitors to overcome the challenges of neural and arterial blood stress associated

with vertical movement, as is known in squamates (Lillywhite and Donald, 1994). Such adaptations include the length of the digits, narrow bodies, and relatively long and/or prehensile tails, with a coarse texture to facilitate clinging to the tree trunk when the lizards ascend or descend a tree trunk (Emmons and Gentry, 1983; Bedford and Christian, 1996; Pavón-Vázquez et al., 2022).

The rough-necked monitor (*Varanus rudicollis*) occurs naturally in southern Thailand, Myanmar, the Malay Peninsula, Bangka, Riau, Borneo, and Sumatra (Lauprasert and Thirakhupt, 2001; Bennett, 2004; Grismer, 2011; Koch et al., 2013; Auliya and Koch, 2020). It is a rare monitor species (Lauprasert and Thirakhupt, 2001; Phimmachak et al., 2021) that appears to occur at low densities. *Varanus rudicollis* is listed as data deficient (DD) on the IUCN Red List and as a CITES Appendix II species due to threats such as human disturbance, deforestation, and the commercial pet trade (Auliya and Koch, 2020; Pernetta, 2009; Phimmachak et al., 2021).

There is currently limited information on the natural history (Bennett, 2004) and habitat requirements of *V. rudicollis*. De Rooij (1915) briefly stated that *V. rudicollis* can be found on trees in the jungle and classified it as an arboreal species, as did Pianka (1995). Lauprasert and Thirakhupt (2001) reported that it is usually found in high-humidity habitats like dense evergreen forests at higher elevations or lowland coffee plantations surrounded by tropical rainforests in Southern Thailand. Grismer (2011) listed *V. rudicollis* as occurring in mangrove swamps, peat swamps, and hill dipterocarp forests up to 1200 m in Peninsular Malaysia. Bennett (2004) indicated that it is a shy creature found in dense habitats, often avoiding human settlements, with tree hollows being the preferred shelter sites. However, Auliya and Koch (2020) noted that more *in situ* information was still needed on the biology of *V. rudicollis*.

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Varanus rudicollis attains a total length of about 1 m, with a maximum recorded total length of 146 cm (Bennett, 2004). Despite its relatively large size, this species has a generalist diet consisting of a variety of small prey. It primarily feeds on terrestrial arthropods, including ants, termites, stick insects, cockroaches, grasshoppers, spiders, scorpions, and occasionally small mammals, frogs, frog eggs, fish, and crabs (Losos and Greene, 1988; Cota et al., 2008; Das, 2010; Grismer, 2011).

Since 2015, five occasional observations have been made on *V. rudicollis* at the Rainforest Discovery Centre (RDC), Sepilok, Sabah, and nearby native rainforests. On two occasions, monitors were accidentally disturbed while walking along the remote forest trail at RDC during our ecological field observation exercise. The first recorded case was observed around 15:00 h on 6 September 2015 along the Kabilit trail while returning from the border of Kabili-Sepilok Forest Reserve (Fig. 1). The second record was documented

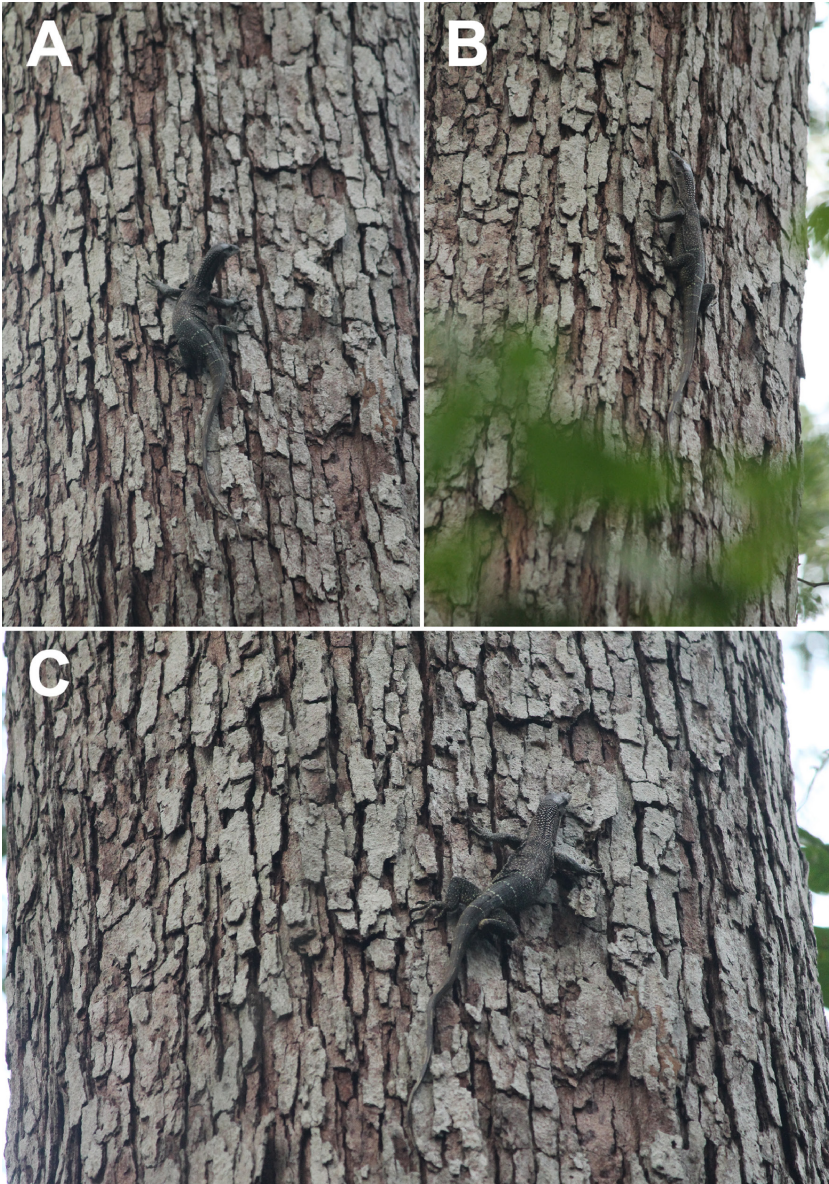


Figure 1. *Varanus rudicollis* fleeing up a large tree after it had been disturbed. First, the lizard raised its head to observe us (A) and then began to climb up the trunk towards the canopy (B, C). Photos by Xi Yu Yu.

at approximately 10:50 h on 13 February 2023 (Fig. 2), along the Pitta Path, which is also located on the border of the Kabili-Sepilok Forest Reserve. According to the Sabah Forestry Department classifications, this area is a lowland dipterocarp forest and belongs to Class VI or Virgin Jungle Forest Reserve (Salam and Busrah, 2020). In both instances, the lizards immediately fled up a giant dipterocarp tree towards the canopy. The escape responses of both *V. rudicollis* align with the

description of Lim (1958). Based on the morphology of the bark in both instances, the tree was identified as *Shorea* sp., both with a diameter at breast height (DBH) of more than 1 m. The lizards climbed with their bodies pressed against the trunks as opposed to lifted off the substrate when walking on the ground. The tail, however, was held in a similar posture, irrespective of whether the lizard was walking along the ground or climbing a tree.

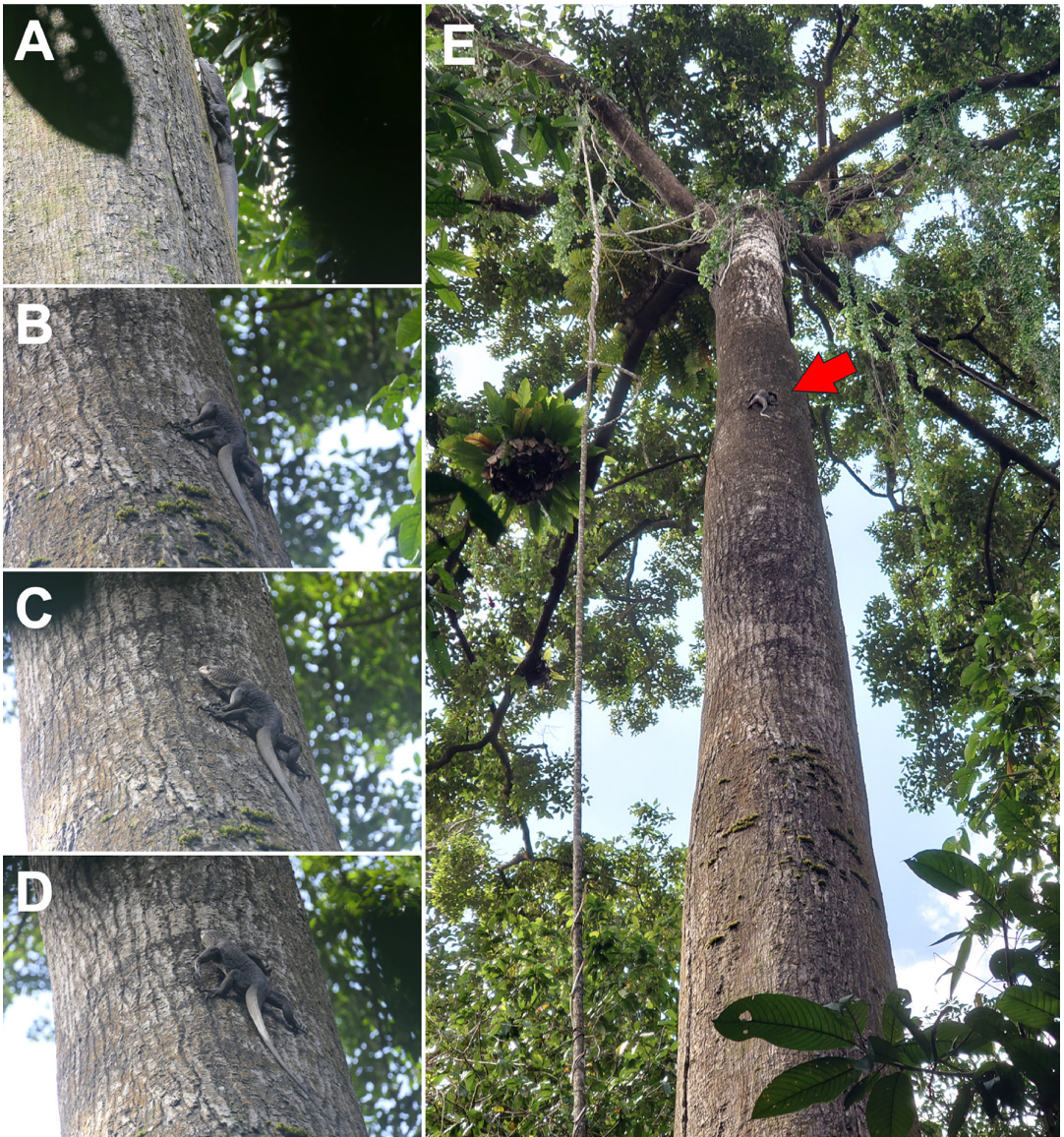


Figure 2. An adult *Varanus rudicollis* climbing up the trunk of a *Shorea* sp. tree (A–D) towards the canopy (E), with a red arrow indicating its location. Photos by Jean-Jay Mao.

On 22 September 2023, the first author made a third observation at the Bornean Sun Bear Conservation Centre (BSBCC), which is situated about 2 km from the RDC within the same lowland forest reserve (Salam and Busrah, 2020). This sighting consisted of a small monitor searching for food inside a cavity of a *Shorea* sp. (Fig. 3A). Incidentally, on 28 June 2024, he made another observation on the same tree, this time of an adult monitor clinging to the bark of the tree while basking (Fig. 3B). Furthermore, a local eco-tour guide, Adrian Migiú, reported an observation at the RDC on 9 March 2025 at around 14:30 h of two *V. rudicollis* mating, roughly 6 m above the ground on an 11 m tall *Shorea* cf. *parvifolia*. As in previous observations, the lizards clung to the tree with their claws, and they remained in this posture for about 5 min, after which the observer then left.

It should be noted that the five observations were made on four large dipterocarp trees, with similar trunks and bark texture, which may offer better grip for climbing the trees. Grismer (2011) noted that the congener *V. nebulosus* is often observed basking on trees or looking into tree holes and cavities. They have been frequently seen climbing as high as 20–30 m. Additionally, Grismer (2011) points out that these lizards spend a considerable amount of time digging in the ground in search of prey. More empirical studies and observations are needed to better understand the patterns of tree utilization by these lizards. Research conducted by Bennett and Lim (1995) and Lauprasert and Thirakhupt (2001) has indicated that the clearance of primary and secondary forests contributes to the decline of forest-dwelling species like *V. rudicollis*. Therefore, it is crucial to conduct further empirical studies on the habitat requirements of this species to inform conservation status and management plans.

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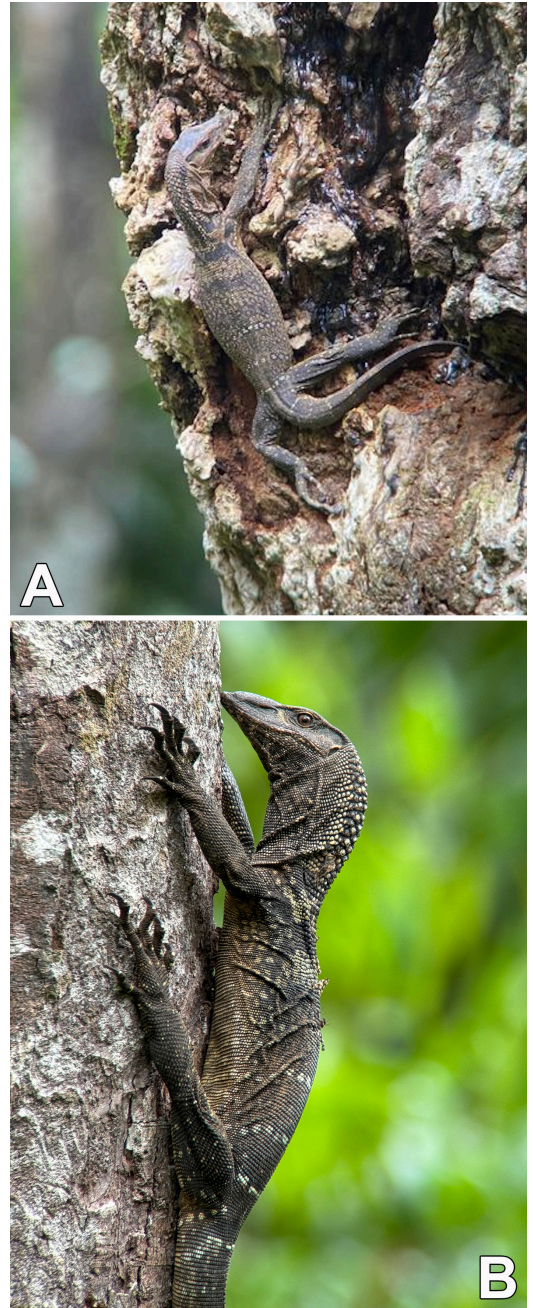


Figure 3. (A) An immature *Varanus rudicollis* at the Bornean Sun Bear Conservation Centre outdoor enclosure, searching for food in a cavity of a tall *Shorea* sp. tree. (B) An adult *V. rudicollis* at the Bornean Sun Bear Conservation Centre clinging to a tree trunk. Photos by Siew Te Wong.

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