State of Nature Conservation in Malaysia 2025, 447–454
doi: 10.62613/sonc2025.v2fnc10

CHAPTER 10

The herpetofauna of East Malaysia

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Abstract: The herpetofauna of the tropical island of Borneo, comprising the East Malaysian States of Sabah and Sarawak, together with Brunei Darussalam and the multiple provinces of Kalimantan, Indonesia, comprises 229 species of amphibians and 324 species of reptiles. These figures, current as of end of the year 2025, include invasive species from both groups (three and six, respectively). We review the known diversity of amphibians and reptiles of Borneo, and assess their conservation status particularly of the East Malaysian states. An analysis of species accretion pattern suggests that additional species are to be expected in the current and next several decades, particularly when new areas are explored, or if contemporary field, lab, and analytical technologies are employed. Of the known and sometimes familiar taxa, a large number remain unassessed for conservation status. In terms of on-the-ground protection and management, several endemic and therefore potentially threatened species occur exclusively in areas that are outside of the protected areas system. Gaps in present knowledge relevant to conservation of Borneo's amphibians and reptiles are summarised. These include oftentimes dated conservation assessments, starting with Red Listing, of species currently in the Not Evaluated or Data Deficient categories, identification of endemic and threatened populations that are outside of National Parks and Sanctuaries, particularly, the development of resources for emergency action for emerging threats, identification of unprotected areas harbouring microendemics, and enhancement of research efforts to understand causes of endangerment of the local species of amphibians and reptiles of Borneo.

INTRODUCTION

Borneo, one of four major islands of the Indo-Malayan Archipelago, is situated towards the eastern portion of the Sunda Shelf. It stretches between coordinates 04ºS to 07ºN and from 109 to 119ºE, and is the second largest tropical island in the world (after New Guinea), covering a land area of approximately 743,380 km^2. The seas around Borneo are shallow (< 200 m), except for the deep Makasar Strait (> 2,000 m). While the present chapter is an attempt to review the conservation status of the herpetofauna of East Malaysia, including Sarawak (124,450 km^2) and Sabah (73,620 km^2), one has to be mindful that a major part of the island falls in the Indonesian part of Kalimantan (539,460 km^2), and also, the Sultanate of Negara Brunei Darussalam (5,760 km^2). Nonetheless, numerous contacts, most recently over the Pleistocene glaciation phases, when sea levels fell between 120 – 200 m below current levels, facilitated movements of biota into and out of the island. At 4,101 m, Low's Peak in Mount Kinabalu, northern Sabah, is the highest point on the island (Malkmus *et al.* 2002). The Kinabalu Range itself comprises Tertiary sedimentary rocks, constituted of sandstone and shale. The highest mountain in Sarawak is Mount Murud, at 2,423 m asl. Cave systems on Borneo comprise isolated limestone outcrops located primarily in coastal Sarawak, north-western Sabah and south-eastern Kalimantan. A number of large rivers flow

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through Borneo, some forming important biogeographic limits. All of Sarawak's rivers drain into the South China Sea. The important rivers of Sabah include the Segama and the Kinabatangan. Kalimantan's great rivers include the Kapuas, Barito, Kahayan, Kayan, and Mahakam. Many of the coastal segments of rivers are broad and meandering, the Kapuas for example dropping only 50 m between Putussibau, ca. 900 km inland, and the sea.

Borneo lies within the tropics and the equator crosses the island approximately over the city of Pontianak in Kalimantan Barat. Consequently, the island is characterised by high, equitable temperature and heavy rainfall spread throughout the year. The relatively wetter periods are observed during the passage of the Northeast Monsoons (November to April), although the Southwest Monsoons (April to August) also bring rainfall to the area. Within Borneo, the western and central parts are wetter than the eastern ones. Daytime temperatures in most parts of the low-lying areas are 30 – 32ºC, and humidity is typically above 70%. On the other hand, temperatures in the highlands, such as Mount Kinabalu, can be low. Annual precipitation is typically 4,000 – 5,000 mm (Davies 2022).

The plant life of Borneo is characterised by high species diversity and endemism, especially in the highlands. The richest forests of south-east Asia are in north-western Borneo, encompassing the north-east portion of Sarawak, Brunei and the south-western lowlands of Sabah, an area that has been suggested to be a Pleistocene refugium (de Bruyn *et al.* 2014).

Nonetheless, rates of deforestation for timber in the lowlands are high in East Malaysia, translating to the near elimination of old growth dipterocarps forests outside of the protected areas. Secondary causes of forest loss include an enormous project of settling people from densely populated Indonesian islands of Java and Madura into Kalimantan, the opening up of forest land for settlement and plantations of oil palm and other crops, and forest fires. Most of Borneo's herpetofauna being linked to primary hill dipterocarp forests (exceptions being coastal and riparian assemblages), loss of forest cover may be considered the primary threat to the island's amphibians and reptiles (Inger and Tan 1996; Gaveau *et al.* 2019). Other factors more specific to poikilothermous groups include the change of thermal and hydric qualities of landscapes, as a result of climate change (Bickford *et al*. 2010; McAlpine *et al.* 2018; Davies 2022; Davies-Barnard *et al.* 2023).

CONSERVATION STATUS

Temporal aspects of discovery

Figure 1 shows the chronology of species descriptions of Bornean amphibians and reptiles. The earliest (pre-mid-1800s) records of reptiles and amphibians from Borneo do not have an explicit type locality and may have been obtained from other parts of south-east Asia (Das 2023). Explorations started around the mid-19th century with the arrival of European, chiefly British and Dutch, administrators, naturalists, and explorers. For amphibians, a major peak is evident during the late 1800s to early 1900s, corresponding to the activity of George Boulenger, Keeper of Zoology at the British Museum (Natural History) in London. Other peaks include the 1920s decade, when collections and descriptions were made by curators of the Sarawak Museum and others, and particularly, in the 1960s – 1970s, and 1990s to the first decade of the 2000s, primarily reflecting the work of Robert Inger, Curator of Amphibians and Reptiles of the Field Museum of Natural History, Chicago. The trend line for discovery of reptiles shows a somewhat similar pattern, with additional peaks of discovery in the 1830s – 1840s and 1860s – 1890s, with the publishing activities of John Gray and his successor at the British Museum (Natural History), Albert Günther, respectively.

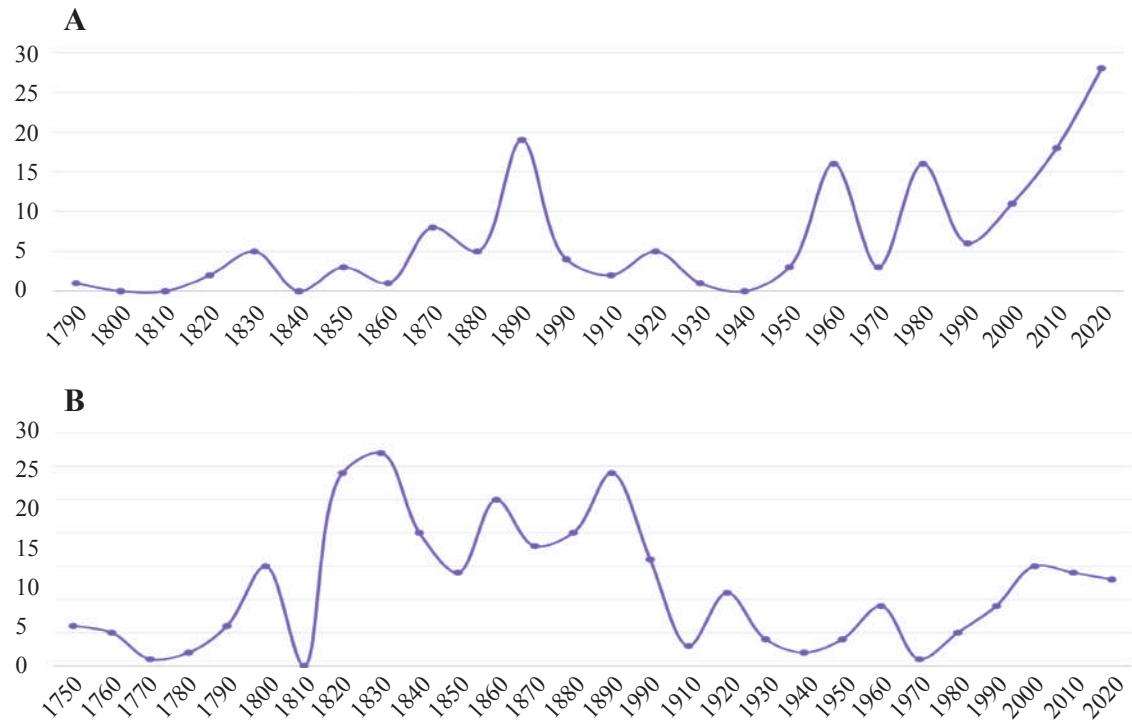

Figure 1. Description of **(A)** Bornean amphibian and **(B)** reptile species by decades.

For both taxonomic groups, cessation of studies during the War decades (World War I and II) are noticeable. Also obvious is the uptick in species discovery in the present decade, starting from the year 2020, where the first half of the decade produced nearly a third more species than the entire previous decade. The rapid increase in species can be explained by multiple, independent researchers, better access to once remote field sites, and contemporary analytical techniques, from field and lab tools to software, and above all, quicker communications and collaboration. The result has been the collection of 'all-new' species as well as the discovery of species complexes, the latter resulting in the naming of multiple species from what was once thought to be a single biological species (see for instance, Quah *et al*. 2019, 2020, 2021; Dehling *et al*. 2025).

Lineage diversity

By the end of 2025, a total of 229 species of amphibians and 324 species of reptiles had been recorded from Borneo (AmphibiaWeb 2025; Das 2025; Frost 2025; Uetz *et al.* 2025). These included invasive species, including three amphibians (*Aquarana catesbeiana*, *Hoplobatrachus chinensis*, and *Microhyla heymonsi*) and six reptiles (*Trachemys scripta*, *Pelodiscus sinensis*, *Calotes versicolor*, *Iguana iguana*, *Lycodon capucinus*, and *Naja kaouthia*) (Bauer and Das 2024; Quah *et al*. 2025).

As expected of a landmass that is continental with a recent history of land connection with the continent, higher level endemicity is low. The Lanthanotidae, unique to Borneo, is represented by a single species, *Lanthanotus borneensis*. Endemic genera too are rare for both amphibians (*Huia*, monotypic; *Sabahphrynus*, monotypic; *Sarawakiphrys*, monotypic; *Meristogenys*, 13 species) and reptiles (*Pelturagonia*, five species; *Complicitus*, monotypic, *Hypsicalotes*, monotypic) (Figure 2; AmphibiaWeb 2025; Frost 2025; Uetz *et al.* 2025).

Nonetheless, a number of lineages are more speciose on the island than elsewhere, for both amphibians (*Ansonia*, 16 species; *Pelophryne*, nine species; *Limnonectes*, 34 species; *Philautus*, 22 species) and reptiles (*Dibamus*, three species; *Cnemaspis*, 10 species; *Dasia*, five species; *Sphenomorphus*, 14 species; *Tropidophorus*, seven species; *Calamaria*, 21 species; *Asthenodipsas*, six species) (Figure 2; AmphibiaWeb 2025; Das 2025; Frost 2025; Quah and Grismer 2025; Uetz *et al.* 2025).

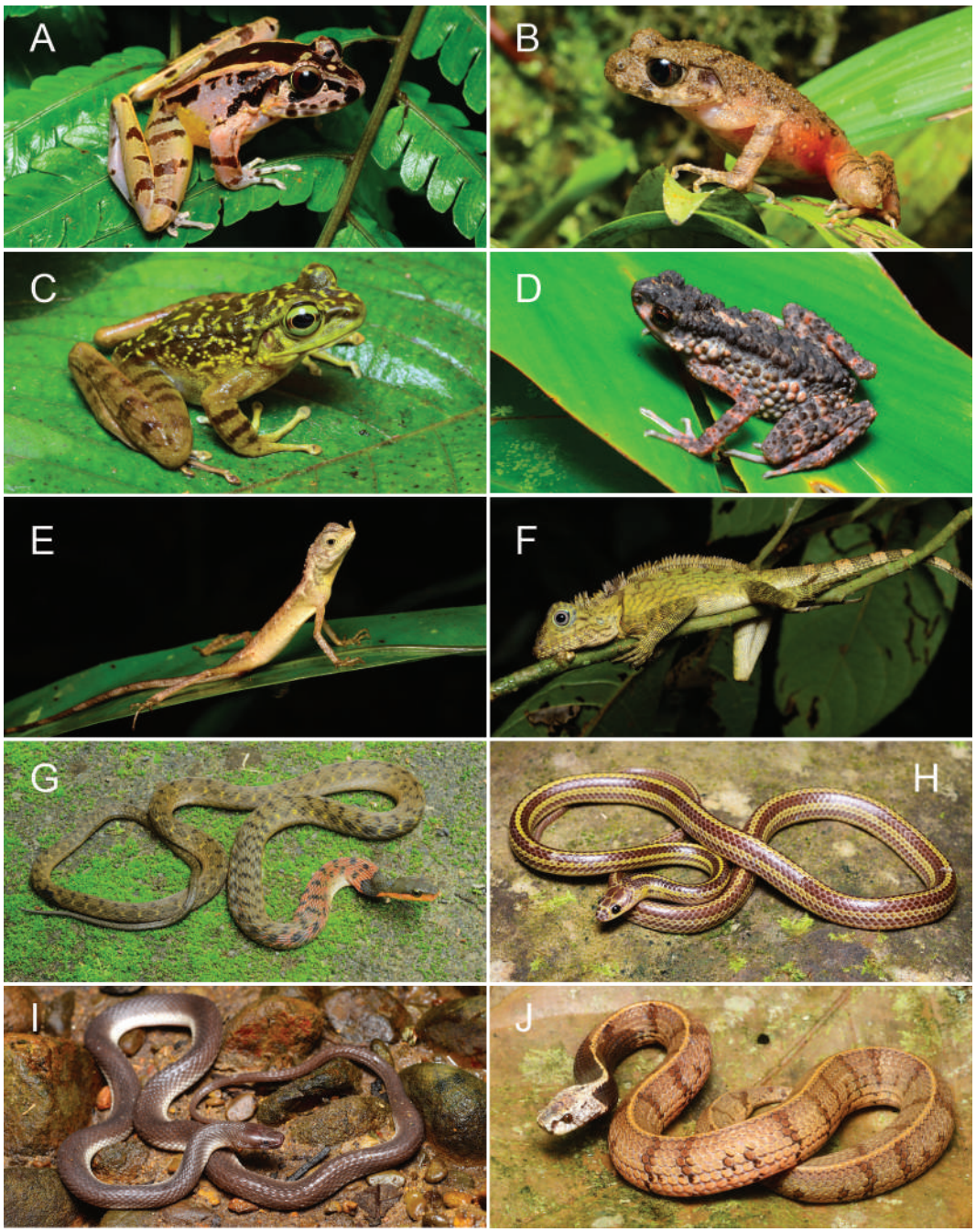

Figure 2. Representative species of amphibians and reptiles of Borneo. **A.** *Huia cavitympanum*, **B.** *Leptobrachella arayai*, **C.** *Meristogenys kinabaluensis*, **D.** *Ansonia spinulifer*, **E.** *Aphaniotis ornata*, **F.** *Gonocephalus borneensis*, **G.** *Rhabdophis murudensis*, **H.** *Dryocalamus tristrigatus*, **I.** *Hydrablabes typicus*, **J.** *Asthenodipsas borneensis*.

Conservation issues

We looked at the species recorded (until 31 December 2025) from Borneo, against those listed in the IUCN Red List of Threatened Species (version 2025.2; see www.iucnredlist.org), adopting the global threat categories therein. Species counts for amphibians and reptiles were considered separately. Figure 3 shows the distribution of species from these two groups under each of the threat categories.

Apart from the 34 (14.8%) amphibian species and 29 (9.0%) reptile species that are in the Not Evaluated (NE) categories, and 15 (6.6%) and 61 (18.8%) in the Data Deficient (DD) categories for the two groups, respectively, one sees slight and perhaps no significant difference in proportional representation in the threatened categories.

Of a smaller (229 species) fauna, six amphibians (2.6%) are Critically Endangered (CR), as against the larger (324 species) group comprising reptiles, whose equivalent figure is nine (2.8%). In the next highest threat category (Endangered, EN) are 13 (5.7%) amphibians and four (1.2%) reptiles. A total of nine (3.9%) amphibians are Vulnerable (VU), while the number of reptiles in this category is eight (2.5%). A total of 26 (11.4%) of amphibians and four (1.2%) reptiles are Near Threatened (NT). Finally, a majority of amphibians (126 species or 55.0%) and reptiles (209 species or 64.5%) are in the Least Concern (LC) category, that are currently not threatened, but may move to one of the threatened categories with one or more increased or novel threats in the future. Excluding the NE and DD categories, well over half of all recognised species are therefore in the threatened (Red Data List) species list of the IUCN.

The high number of species in the NE category (14.8% and 9.0% for amphibians and reptiles, respectively) is due to the recent discovery of many species, mostly in the current decade. On the other hand, the Red List assessment process itself is a lengthy, peer-reviewed activity, requiring considerable resources, volunteer effort, and coordination. Nonetheless, for a majority (> 95%) of all species enumerated, loss of forest cover, and for several CR species, unrepresented populations in the region's protected areas systems, are major drivers of extinction threat or endangerment.

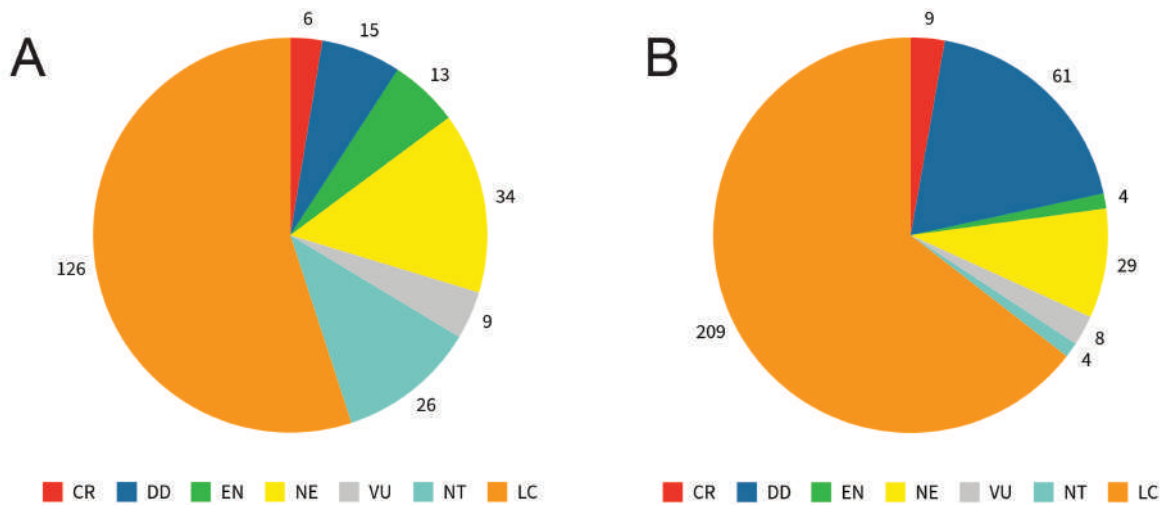

Figure 3. Conservation status of **(A)** amphibians and **(B)** reptiles of Borneo. Threat categories from the IUCN Red List of Threatened Species (version 2025.2).

KNOWLEDGE GAPS AND SUGGESTIONS FOR THE FUTURE

A priority is naturally to assess the conservation status of species that remain unassessed. These tend to be recently described taxa or those that are widespread. While the reasons for the absence from the threat categories of the former are obvious (IUCN Red List assessments and revisions take place about twice a decade, sometimes much longer), the shortage of time and expertise often place restrictions on the assessment teams. Examples include the Bornean species of *Cnemaspis*, a gekkonid lineage that tends to be specialist rock-dwelling microendemics, with over half of the known species described in the past half decade, and seven of these are in either the Data Deficient or Not Evaluated categories (Kurita *et al*. 2017, 2024; Nashriq *et al.* 2022). All are restricted to single, often spatially restricted sites of karst, and threatened with mining and other forms of quarrying. More resources therefore need to be freed up for conservation assessment activities, these perhaps moving at least partially online, as well as for follow-up action, such as emergency financial resources for species whose continued existence requires immediate intervention.

Another concern is the protection of species recognised as threatened that do not occur within any protected areas. For both jurisdictions (Sabah and Sarawak), legal instruments do not cover amphibians or all except the largest reptile species (such as marine and freshwater turtles, crocodilians, and large snakes) explicitly. Nonetheless, they are generally protected as components of the respective region's biological diversity. A cursory look at the IUCN Red List for East Malaysian species shows that several threatened species have populations entirely outside of the protected areas systems. Among amphibians, these include the Endangered *Ansonia latidisca*, *Limnonnectes cintalubang*, *Meristogenys penrissenensis*, and *Philautus erythtophthalmus*, and the Critically Endangered *Leptobrachium kantonishikawai*. The list is nearly equivalent for reptiles, and includes the Endangered *Tomistoma schlegelii* and *Siebenrockiella crassicollis*, and the Critically Endangered *Orlitia borneensis*, *Pelochelys cantorii*, and *Calamaria prakkei*, all species that find no space within parks and other protected areas of the two States. Studies have revealed there is value in protecting even secondary and non-forest habitats for the conservation of herpetofauna (Gillespie *et al.* 2012). Identification of sites with the known occurrence of multiple point endemics, therefore, is an urgent and immediate task, following taxon-focused surveys, using field methods, and where appropriate, emerging technologies such as the use of eDNA.

The utilisation of emerging technologies is also crucial for the management of threat -specific conservation action such as the monitoring of the spread of chytrid in amphibians (McLeod *et al.* 2020) and establishments of protocols for the detection of other emerging or future diseases. Similarly, technologies such as eDNA could also be deployed for the detection and management of invasive species. Concerted effort from all relevant stakeholders is key to curb the spread of invasive amphibians and reptiles in Borneo and presents an opportunity for citizen science and local conservation action.

Much remains to be learnt from the herpetofauna of East Malaysian Borneo. Areas for the expansion of fundamental research including the life histories of threatened species and physiological studies such as thermal tolerance, niche partitioning and habitat use, which are especially pertinent in the face of climate change. Past research has been dominated by faunistic studies, including inventories and systematics (Chan and Grismer 2021; Chan *et al.* 2022). While these are essential for understanding the diversity of local faunas in a given area, studies more directly pertaining to conservation have lagged behind. We recommend such research be given priority, not least because of the tendency of herpetofaunas to be microendemics but also as surrogates of poikilothermous vertebrates and a large component of the nation's biological diversity.

Acknowledgements: We thank our respective institutions, the Institute of Biodiversity and Environmental Conservation Universiti Malaysia Sarawak, and the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah, for support of our research, and Dato' Dr Dionysius Sharma and the Malaysian Nature Society for inviting us to write this chapter.

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