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The lizard genus *Luperosaurus*: taxonomy, history, and conservation prospects for some of the world's rarest lizards

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Eight species are recognized in the southeast Asian gekkonine genus *Luperosaurus*. The Philippine species (*L. cumingi*, *L. macgregori*, *L. palawanensis*, and *L. joloensis*) constitute half of the content of the genus and are some of the most poorly known species of lizards in the world. Each species is known from fewer than eight specimens, and most are represented by fewer than two specimens or a single holotype. The history of the discovery, systematics, and the relationships of the species are discussed. The paucity of museum specimens, lack of associated ecological data, and the older age of many of the available specimens conspire to prevent a realistic understanding of much of the natural history of these

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elusive Philippine endemics. So little is known about *Luperosaurus* species that we are compelled to recommend increased faunal survey efforts in the remaining higher forest canopies in spite of the fact that we suspect the Philippine species are severely threatened by deforestation. Although we support conservation programs that prevent excessive harvesting and exploitation of other well-known species of Philippine reptiles (i.e., sea turtles and endangered species of monitor lizards), *Luperosaurus* species are so poorly known that to restrict scientists' access to Philippine populations would be premature, counterproductive, and misdirected.

Taxonomic history

Gray (1845) erected the gekkonine lizard genus *Luperosaurus* to accommodate *L. cumingi*, an unusual species he named from the first specimen collected in the Philippines by H. Cuming [Fig. 1 (Gray 1845, Brown and Alcalá 1978)]. Thorough discussion of the specific morphological characteristics that distinguish *Luperosaurus* from its relatives have been provided by Gray (1845), Taylor (1918, 1922), Brown, (1964), Kluge (1968), Brown and Alcalá (1978), Russell (1972, 1979), Ota *et al.* (1996) and Brown *et al.* (in press). As Brown (1964), Brown and Alcalá (1978), Russell (1972, 1979), and Brown *et al.* (in press) have noted, different species of *Luperosaurus* are similar in appearance to, and have been taxonomically confused with, members of the gekkonine genera *Pseudogekko*, *Lepidodactylus*, and *Gekko*. Attempts to reliably diagnose the genus from these and other gekkonine genera (Brown and Alcalá 1978, Russell 1979, Ota *et al.* 1996, Brown *et al.*, in press) primarily have relied the combination of strong digital webbing, the presence of cutaneous expansions on the posterior surfaces of the limbs, small to moderate body size, small size of dorsal tubercles (if present), reduced or absent anterior chin scales, the lack of enlarged scales under the tail, and a few skeletal characters (vomeres fused, nasals paired) that have been surveyed in only a few species.

The two original specimens of *L. cumingi* were accompanied only by the locality data "The Philippines" Brown and Alcalá (1978) report several specimens from Negros Island and referred a single specimen to this species from Luzon Island. Three other specimens have been collected since the publication of that review. Two of these were collected in Negros Island; one by P. Heideman (Lake Balinsasayao, 1000 meters above sea level) and another by E. Rickart, L. Heaney, and R. Utzurrum (Camp Lookout, 500 m.). The third specimen was collected by W. Auffenberg in Bicol, Luzon Island, bringing the total number of specimens known for this species to nine.

The next *Luperosaurus* species to be described was *L. macgregori* (Stejneger, 1908). This species description was based on two immature individuals from Calayon Island (in the Babuyan Islands, north of Luzon). No other specimens of this species

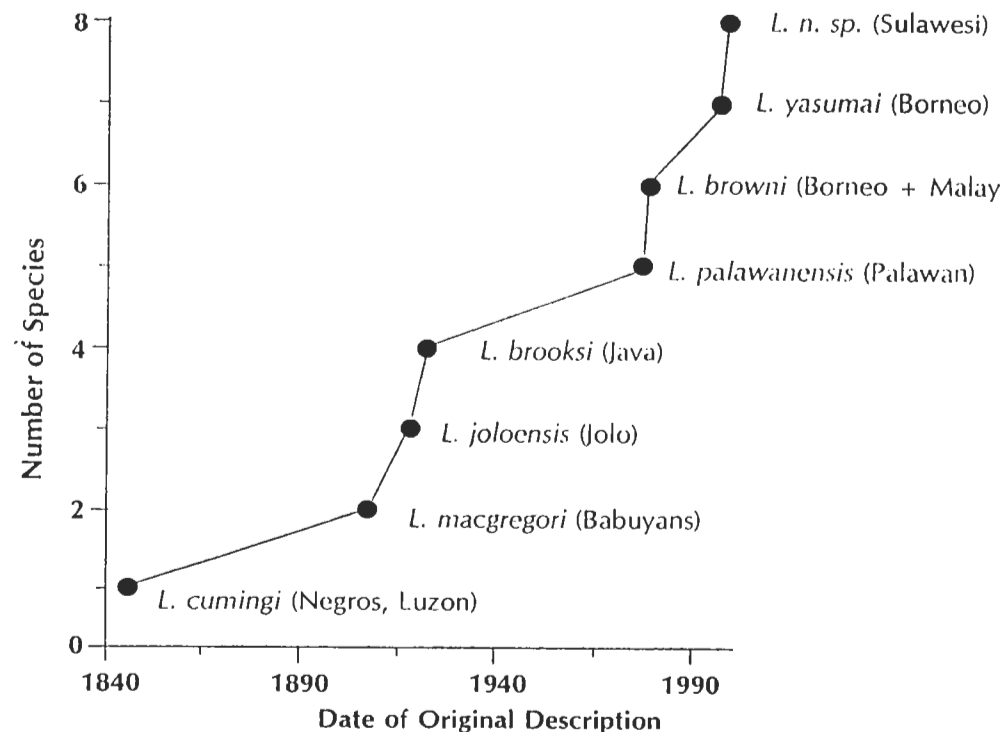


Fig. 1. Patterns of activity in taxonomic research involving *Luperosaurus* species are evident in the relationship between history (year of original description) and the cumulative total of currently recognized *Luperosaurus* species. This graph indicates that the greatest periods of activity in research related to *Luperosaurus* taxonomy were in the early (1909-1922) and late 1900s (1978-present day). Excluded from consideration are *L. amissus* (now considered a synonym of *Gekko hokouensis*), *L. serraticaudus* (a synonym of *L. browni*) and *L. compressicorpus* (now recognized as a *Pseudogekko*). *Luperosaurus brooksi* originally was described as a species of *Gekko*.

have been available until very recently when R. Crombie (USNM) collected four more individuals from Barit Island (a satellite of Fuga Island). This more recent material is significant because until Crombie's collection, no adults species had been collected. Until recently, the absence of adult specimens has prevented scientists from adequately defining or comparing this species to its congeners (Stejneger 1908, Brown and Alcalá 1978, Ota *et al.* 1996) therefore, an understanding of its phylogenetics affinities has been lacking (Ota *et al.* 1996; Brown *et al.*, in press).

Taylor (1918, 1922a) described *L. joloensis* on the basis of two specimens (an adult and a juvenile) from Jolo Island in the Sulu Archipelago. The reportedly adult

specimen was destroyed during the WWII bombing of the Bureau of Science in Manila but only the poorly preserved paratype and an additional specimen (from Mindanao) were available at the time of Brown and Alcalá's (1978) review. No further material representing this species has been uncovered. In fact, some recent survey work in the Sulus (Gaulke 1994, 1995, 1996) suggests several other endemic forest species of amphibians and reptiles that may be extinct. Further collection representing this species are badly needed. This is because a precise understanding of the diagnostic characteristics for this species is troubled by disagreement between Taylor's published descriptions, the existing paratype from Jolo, and the non-type Mindanao specimens referred to this species (Brown *et al.*, in press). As Brown *et al.* (in press) demonstrate, the paucity of available specimens and the poor state of present material allow the following possibilities: (1) an undescribed species of *Luperosaurus* may inhabit southwestern Mindanao; (2) a population of *L. yasumai* (known from Borneo) may be present in southwestern Mindanao; (3) the Mindanao population may, in fact, be *L. joloensis*, a species of poorly understood morphological variability.

The last Philippine *Luperosaurus* species to be discovered was first collected in Palawan Island in 1961. Brown and Alcalá (1978) described *L. palawanensis* on the basis of two specimens from Thumb Peak (Fig. 2). No further material representing this species has been collected since the time of its discovery.

Finally, Brown and Alcalá (1978) referred two *Luperosaurus* specimens from Polillo Island to *L. macgregori* (Fig. 2). These specimens were collected by Taylor in 1920 (Taylor 1922a) and presumably removed from eggs by the collector (i.e., not naturally hatched). Their small size and state of preservation prevent the confident assignment of these specimens to any known species. Brown and Alcalá (1978:113) tentatively assigned them to *L. macgregori*, but it seems unreasonable that they would be conspecific with material from the Babuyans. Although Polillo Island is land-bridge to Luzon (Heaney 1985) this unique island harbours apparent endemic species of amphibians [e.g., *Platymantis polillensis* (Taylor 1922b, Inger 1954, Alcalá and Brown 1988)] and reptiles [e.g., *Pseudogekko smaragdina* (Taylor 1922a)], some of which have been recently rediscovered in the watershed region (V. Yngente, J.C. Gonzalez and R.I. Crombie, pers. comm.). We hope that by drawing attention to uncertain status of the Polillo *Luperosaurus* specimens, we can stimulate local efforts to survey Polillo forest canopy for this probable undescribed species.

There are four non-Philippine species of *Luperosaurus* currently recognized (Welch *et al.* 1990, Ota *et al.* 1996, Brown *et al.*, in press). *Luperosaurus brooksi* is a Javanese species (Figs. 1, 2) that is known from a single specimen. This species was first described as a species of *Cekko* but was transferred to *Luperosaurus* at the suggestion of W. C. Brown (Brown and Alcalá 1978, Russell 1979). *Luperosaurus*

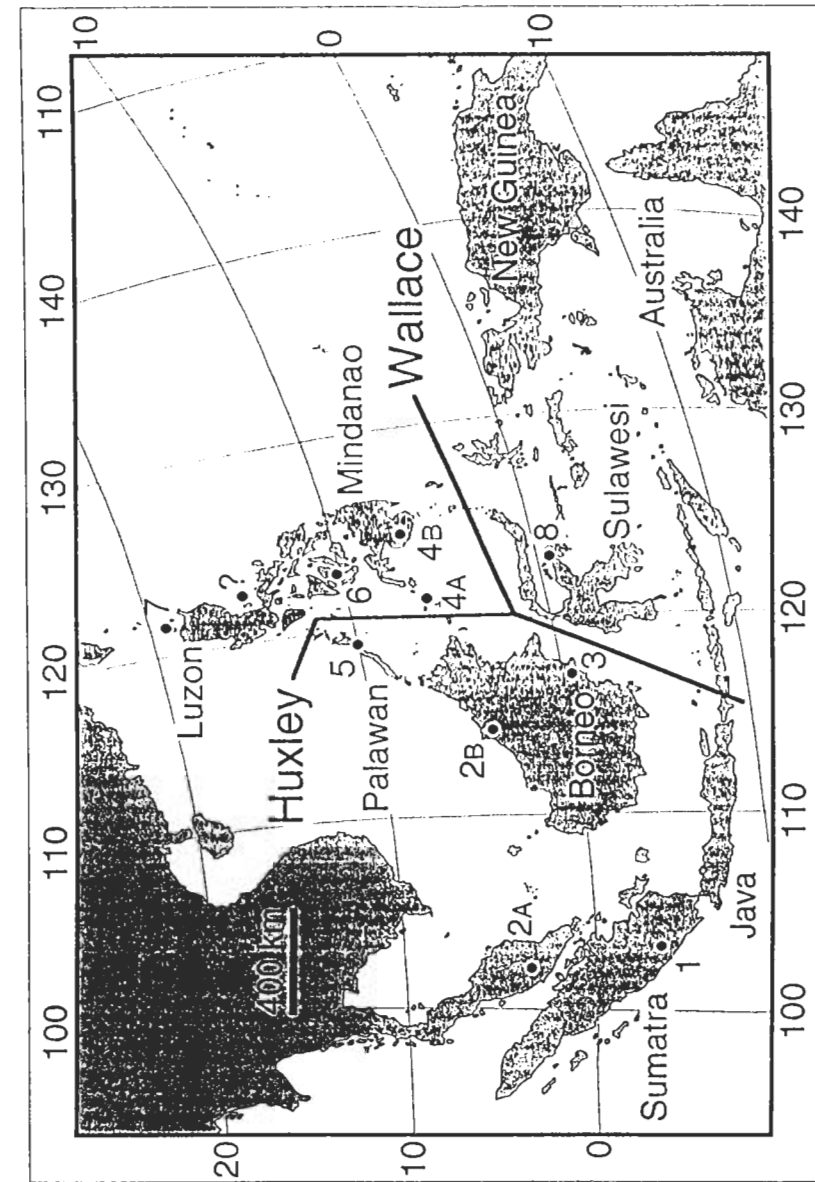


Fig. 2. The geographic distribution of *Luperosaurus* species spans the Oriental-Australian faunal zone interface and centers on Wallace's Line. Species include (1) *L. brooksi* (Sumatra Is., Indonesia), (2) *L. browni* [(A) peninsular Malaysia and (B) Sarawak, Malaysian Borneo], (3) *L. yasumai* (Kaltimantan, Indonesian Borneo), (4) *L. joloensis* (A) Jolo and (B) Mindanao islands, Philippines], (5) *L. palawanensis* (Palawan Is., Philippines), (6) *L. cumingi* (Negros and Luzon Is., Philippines), (7) *L. macgregori* (Calayan and Barit (near Fuga) Is., Philippines), (8) *L. n. sp.* (Mt. Tompotika, Propinsi Sulawesi Tengah). The uncertain taxonomic status of the Polillo population is indicated by a question mark (?). Wallace's Line (corresponding to the eastern edge of the Sunda Shelf) runs between Borneo and Sulawesi and (as modified by Huxley) extends north to divide Palawan from the remainder of the (oceanic northern) Philippines.

yasumai (Borneo) and another containing *L. brooksi*, *L. browni* and possibly the new species from Sulawesi (Brown *et al.*, in press).

These results suggest that all the Philippine species possessed a single ancestor that invaded the Philippine archipelago at an unknown time in the past. These results also suggest that the Bornean endemic *L. yasumai* is derived from a lineage that dispersed back into Borneo from the Philippines subsequent to the initial invasion of the Philippines (possibly down the Mindanao-Sulus island arc, as suggested by its sister relationship with *L. joloensis*). The analysis also suggests that the Sunda Shelf species (*L. browni* and *L. brooksi*) share a common ancestor, and that the new species from Sulawesi is either a member of this same clade or possibly falls basal to the remaining *Luperosaurus* (Brown *et al.*, in press).

Microhabitat and Ecological Preferences

Only the circumstances of collection for a few specimens give us any indication of the microhabitats of members of the genus *Luperosaurus*. The collection of *L. cumingi* eggs from leaves of forest trees for years constituted the only available habitat data suggesting this species' presumed microhabitat preference: the forest canopy. The recent collection of an additional specimen from first growth forest confirms the earlier report of Brown and Alcala (1978) that this appears to be a canopy species. The specimen collected by E. Rickart and colleagues on Negros was taken from a mist net about 2 meters above the ground, at the edge of second growth forest. No habitat data are associated with the original collection of *L. macgregori*, but recent collections of this species reveal that it was collected in a small regenerated sapling forest (trees no higher than 4 m) and that specimens were perched at the ends of small branches at night (R. Crombie, pers. comm.).

Taylor collected the type series of *L. joloensis* on an exposed tree trunk in a heavily forested area near Siet Lake in Jolo (Taylor 1971). The only known specimens of *L. palawanensis* (Brown and Alcala 1978) were collected from axils of arboreal ferns in original forest more than 15 meters above the forest floor (300 meters above sea level). The only specimen *Luperosaurus yasumai* was collected on a forest path in the morning, while specimens of *L. browni* have been collected on the base of a tree trunk (0.3 meters from the ground) in the early afternoon in Borneo (Ota *et al.* 1996) and 2.0 meters from the ground on 0.8 meter diameter trees at night in the Malaysian peninsula (Russell 1979). The new species *L. iskandari* (Brown *et al.*, in press) was collected in the morning, crawling out of a fast mountain stream near sea level in original forest in eastern Sulawesi (Indonesia).

As discussed by Brown *et al.* (in press), it is presumed that the circumstances of collection of the new species do not accurately reflect the habitat preferences of this

species, rather than the specimen was probably dislodge from the forest canopy during a heavy storm that hit the area the previous night (Brown *et al.*, in press). Similarly, the presumed canopy specialist *Ptychozoon intermedium* (the endemic Philippine parachute gecko) was recently rediscovered by R. E. Fernandez on the lower portions of mahogany trunks (*Swietenia macrophylla*) in a forest fragment in S. Mindanao (Brown *et al.* 1997) on a night following a strong storm. We suspect that the captured individuals were driven down the trunks by the harsh weather but usually restrict their movements to the highest portions of the same trees. The same might be true for *Luperosaurus* species seldomly collected low on tree trunks (i.e., *L. browni*, *L. joloensis*) or on the ground (*L. yasumai*, *L. n. sp.*); we find it highly unlikely that *L. yasumai* is a terrestrial species. No ecological data are available for *L. brooksi*.

Conclusions

The enigmatic gekkonid genus *Luperosaurus* has been surrounded by taxonomic confusion and uncertainty since its original description. Attempts to properly diagnose the genus, delineate its content, establish its phylogenetic position, and even determine its systematic affinities have all been troubled by the paucity of available specimens (Brown and Alcala 1978, Russell 1979, Ota *et al.* 1996; Brown *et al.*, in press). Fewer than 20 specimens are available for study, and the fact that most of these have been designated as types prevents dissection or osteological study. The older, poorly preserved state of many of these specimens prevents even a sufficient study of much of their external morphology.

At least half of the species included in this genus are Philippine endemics; unfortunately, these primarily are represented by older and often poorly preserved specimens, many of which are immature individuals or are hatchlings, and some of uncertain localities. Thus, the Philippine species are among the most poorly understood members of the genus.

All species of *Luperosaurus* (with the possible exception of *L. macgregori*) appear to be forest obligates. These species have only been captured within first growth forest, either high in the canopy or in circumstances which suggest that the specimens fell from the forest canopy to the location in which they were captured. We suspect that the few specimens (i.e., *L. browni*, *L. joloensis*) that have been captured low on forest tree trunks more frequently prefer higher canopy microhabitats. This might explain why, despite thorough searches of the lower portions of tree trunks, none or only a few specimens have been taken. If *Luperosaurus* species do prefer canopy microhabitats, this fact would in part explain why these animals are so poorly represented in museum collections and so seldomly observed by biologists.

prevented because our current level of knowledge of their natural history is so underdeveloped. We strongly suspect that additional *Luperosaurus* species exist (or at one time existed) in the Philippines and that with additional intensive sampling of canopy habitats, new Philippine endemics will be discovered in the near future (W. C. Brown, pers. comm.). One risk of highly restrictive conservation efforts aimed at limiting scientific collecting is that scientists may be prevented from identifying undescribed species and, thus, an underestimation of biodiversity will result (Goodman and Lanyon 1994, Savage 1995, Stuebing 1998). Because a realistic understanding of the faunal biodiversity of a given area is a prerequisite for enacting successful site-specific conservation strategies, we can think of no benefit that would be served by purposefully underestimating Philippine biodiversity in this manner.

We therefore, strongly recommend that immediate biodiversity survey efforts be directed towards the remaining Philippine rainforest canopy in an effort to identify and study *Luperosaurus* species and their preferred habitats. To sample herpetological communities, we suggest the use of standard herpetological collecting and specimen preservation techniques (Pisani 1973, Simmons 1987, Heyer *et al.* 1994), centered on elevational transects (Custodio 1986, Auffenberg and Auffenberg 1988, Rickart 1993, Ruedas *et al.* 1994, as modified by Brown *et al.* 1995, 1996). We furthermore suggest that canopy faunas may be sampled by adhesive trapping methods ("sticky traps" placed in the forest canopy) and intensive sampling of arboreal microhabitats such as aerial ferns (*Asplenium* spp.), pandans and screwpines (*Pandanus* spp. and *Freycinnetia* spp.), tree ferns (*Cyathea* spp.) and epiphytes such as orchids. Collection of active *Luperosaurus* specimens may require that investigators climb trees during day and night, or (where applicable) conduct surveys from canopy walkways and utilize other canopy access techniques (Lowmann and Nadkarni 1995).

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