



Cat Geckos (*Aeluroscalabotes felinus*) are most commonly found in shrubs and low trees in the vicinity of streams. Although this is the most ancient of all living gecko lineages, these lizards bear a number of highly specialized features to accommodate their arboreal lifestyle.

Slender Toes in Southern Malaysia

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Geckos are one of the largest and most distinctive groups of lizards in the world and, in some regions, are among the most conspicuous elements of the ecosystem. Well over 800 currently recognized species of geckos are distributed worldwide, with the highest concentration occurring in tropical and subtropical regions. Most geckos are nocturnal, thin-skinned, large-headed with bulging, lidless eyes boasting extravagantly sculpted pupillary margins, and adept climbers. In fact, this latter characteristic, accompanied by its myriad of digital specializations, is the iconic trademark of geckos and a key feature of their overall success and diversity. The vast majority of geckos have varying degrees of digital specializations involving the modification of the scales beneath their toes. These enhance their ability to gain purchase on a wide range of substrates, be they vertical or inverted, rough or smooth. The most common specialization comes in the form of “toe pads.” The scales on the underside of

the digits (subdigital lamellae) have become transversely expanded to increase their overall surface area and are adorned with microscopic structures that enhance adhesion to almost any substrate. Toe pads may occur along the entire length of the digit, as in the majority of species, including the familiar Tokay Gecko (*Gekko gecko*) and the Common House Gecko (*Hemidactylus frenatus*), or they may involve only the terminal scales at the tips of the digits as in the many species of New World Leaf-toed Geckos (*Phyllodactylus* spp.). Still others have digits on which expanded scales occur only at the base and the remainder of the digit is slender and unmodified. In all of these digits, the claw may or may not be present.

In the ancient, tropical lowlands of southern peninsular Malaysia and the associated islands of the Seribu Archipelago, which is cradled along its eastern shore, geckos are not only the most diverse group of lizards, but among the most conspicuous



Many of the Bent-toed Geckos (*Cyrtodactylus* spp.) have only recently been discovered and named; the article formally describing *C. aurensis*, which is endemic to Aur Island, was published in 2005.



Another Bent-toed Gecko (*Cyrtodactylus quadrivirgatus*) is common and ranges widely across southeastern Asia.



Smaller (65–75 mm SVL) species of Bent-toed Geckos (*Cyrtodactylus* spp.), such as *C. sworderi*, are most frequently encountered when precariously perched at the end of a small twig or on the surface of a leaf.

nocturnal elements in these rainforest ecosystems. Although a number of the species have “typical” gekkonid fingers and toes, on which the toe pads extend along the length of the entire digit, the most speciose groups have a different type of digit — one where the digits are kinked or bent along their length, and the subdigital scales for the most part remain unmodified or are only slightly expanded at the base of the digit. This bend or inflection, which can occur in geckos with toe pads as well, results from modifications in the shapes of the phalanges (the bones in the digits) and the way they articulate with one another, resulting in yet another adaptation for climbing. The padless geckos with bent fingers and toes in this part of the world are the Cat Gecko (*Aeluroscalabotes felinus*), the Bent-toed Geckos (*Cyrtodactylus* spp.), and the Rock Geckos (*Cnemaspis* spp.).

Aeluroscalabotes felinus is a slow moving, catatonic species most commonly found in shrubs and low trees in the vicinity of streams. The species’ distribution extends from southern Thailand south through peninsular Malaysia and Singapore to Borneo. Although this is the most ancient of all living gecko lineages (Grismer, 1988), it bears a number of highly specialized features to accommodate its arboreal lifestyle. These include more forwardly directed eyes, a prehensile tail, and, of course, bent, padless digits. Additionally, digits one and two are nearly parallel in arrangement and they oppose digits four and five,

which also are parallel to one another, thus providing *A. felinus* with a chameleon-like grasp of the substrates on which it climbs.

The Bent-toed Geckos, genus *Cyrtodactylus*, comprise one of the largest groups of geckos in the world. This genus contains at least 90 species and ranges across all of Asia and into the South Pacific. It also is one of the fastest growing groups, with over 15 new species being discovered and described within the last five years. One-third of those came from southern peninsular Malaysia and the Seribuat Archipelago: *C. aurensis*, endemic to Aur Island (Grismer 2005); *C. semenanjungensis*, endemic to southern peninsular Malaysia (Grismer and Leong 2005); *C. seribuatensis*, endemic to seven islands in the Seribuat Archipelago (Youmans and Grismer 2005); *C. sworderi*, endemic to southern peninsular Malaysia and just recently rediscovered and redescribed (Grismer et al. 2006); and *C. tiomanensis*, endemic to Tioman Island (Das and Lim 2001). In addition to these species, the more common and widely distributed *C. consobrinus* and *C. quadrivirgatus* also occur in the region.

The Bent-toed Geckos are notorious for their climbing abilities, and each species seems content to spend the majority of its time in one type of microhabitat. For the smaller (65–75 mm SVL) *Cyrtodactylus quadrivirgatus*, *C. semenanjungensis*, and *C. sworderi*, this microhabitat usually consists of branches and leaves of the small trees in which they forage, and these species are most frequently encountered while they are precariously perched at the end of some small twig or on the surface of a leaf. The larger species (120–135 mm SVL), such as *C. consobrinus*, *C. tiomanensis*, and, to some extent, *C. aurensis*, spend most of their time on tree trunks and boulders. The former two species are commonly seen as high as 15 m above the forest floor on the sides of trees, whereas *C. aurensis* is a bit more discriminating in that it is almost exclusively found on relatively small boulders that are partially concealed by overhanging vegetation.

The most specialized species of all the Bent-toed Geckos in southern Malaysia is the newly discovered and described *Cyrtodactylus seribuatensis* of the Seribuat Archipelago. This remarkable endemic is restricted to the periphery of seven tiny islands, where it makes its living in the harsh, ever-changing interface between land and sea known as the intertidal zone. This is one of the most extreme environments in which a terrestrial vertebrate may choose to live and, not surprisingly, few species successfully exploit this microhabitat. Making a living here means an individual must gauge its activities around a daily cycle of advancing and receding tides, which is further complicated by the fact that each episode dramatically alters the habitat. Additionally, food can be scarce and what is available is usually hypersaline because of its marine origin. The handful of lizards known to live in intertidal areas and feed exclusively (or nearly so) from such a salty menu have evolved some extraordinary anatomical and physiological adaptations for eliminating the excess salt they ingest (e.g., Dunson 1976, Grismer 1994, Hazard et al. 1998). Although our studies of *C. seribuatensis* have just begun, stomach content analyses and field observations confirm it is eating intertidal invertebrates — but we do not yet know how it deals with the excess salt load. During the day, these lizards remain hidden beneath surface debris such as coconut husks, palm fronds, and pieces of driftwood that accumulate on the beach. At night, they emerge to search for food,

and lizards can be seen moving about, hopping from rock to rock, and foraging in the cobble at the water's edge.

The Rock Geckos (*Cnemaspis* spp.) of southern Malaysia are a curious, somewhat cartoonish looking group of lizards that, as their common name would suggest, spend the vast majority of their time on rocks — in this case, boulders. This is a relatively large group of nearly 50 species dispersed to areas as distant as eastern Africa and India, although their highest diversity is in Indochina and southeastern Asia. The digits of Rock Geckos lack all traces of toe pads and, for the most part, appear completely unmodified — save for that same old bend, which, as in *Cyrtodactylus*, is an adaptation to its bouldering lifestyle. This, however, is not the only specialization in this group. The digits are also very long, which is functionally complementary to their very long limbs and tails and flattened heads and bodies. All of this serves to bring the lizard's center of gravity close to the substrate, which any good rock-climber will tell you, is essential to keep from falling. So, the flattened body with the long, splayed, limbs and elongate digits is the perfect morphology for moving about on vertical and inverted flat surfaces. Attendant with this lifestyle and microhabitat preference, however, is the fact that many potential predators will be coming from "above." As such, these lizards have evolved flattened heads with widened snouts, making them somewhat duck-like in appearance, and their eyes have moved inward toward the center of the head and have rotated slightly upward, enabling them to see "up" without having to raise their heads too far off the substrate. *Cnemaspis* steps even further out of the typical gecko mold in that it does not have the weird looking eyes and elaborate pupils of most species, but instead has simple, round pupils, which, surprisingly, is in line with its other gecko-mold-breaking characteristic — it is diurnal.

Four species of *Cnemaspis* occur in southern Malaysia, three of which are some of the largest members of the group (90–100 mm SVL) and endemic to their own island in the Seribuat Archipelago: *C. baueri*, an endemic of Aur Island (Das and Grismer 2003), *C. limi*, an endemic of Tioman and Tulai islands (Das and Grismer 2003), and *C. pemanggilensis*, which is endemic to Pemanggil Island (Grismer and Das 2005). A fourth and somewhat smaller species (*C. kendallii*) is widespread throughout Malaysia. During the day, *C. baueri*, *C. limi*, and *C. pemanggilensis* can be observed moving about in their boulder microhabitat — but only in dark, shady areas where one boulder leans against another or in the deep recesses of large cracks. This would lead one to think that these species are nocturnal. However, at night they are hard to find unless you go deep into the cave-like boulder piles looking for them. *Cnemaspis kendallii*, on the other hand, is commonly seen foraging on rocks and the trunks of large trees, darting to and fro in the green filtered sunlight beneath the canopy. In fact, this species is so obvious at times, it has evolved an anti-predator defensive display during which it curls its tail high above its back, showing off the bright-yellow underside while wagging it slowly back and forth. At night, *C. kendallii* turns a ghostly white and can be found sleeping on rocks and the trunks of trees, or even clinging to the undersides of leaves as much as 20 m above the forest floor.

Unfortunately, some of these bent-toed denizens of Malaysia are in danger of losing major tracts of their habitat.

Much of the lowland forest of southern peninsular Malaysia, to which *Cyrtodactylus sworderi* and *C. semenanjungensis* are endemic, is being converted into oil palm plantations (think of this the next time you order popcorn at the movies, the yellow coloration of which comes from palm oil). Although our data



Larger species (120–135 mm SVL) of Bent-toed Geckos (*Cyrtodactylus* spp.), such as *C. tiomanensis*, spend most of their time on tree trunks and are commonly seen as high as 15 m above the forest floor.



Cyrtodactylus seribuatensis of the Seribuat Archipelago is the most specialized of all Bent-toed Geckos. This newly discovered species makes its living in harsh, ever-changing intertidal zones.



The Rock Geckos, such as *Cnemaspis limi*, are a curious, somewhat cartoonish looking group of lizards that, as their common name would suggest, spend the vast majority of their time on boulders.



Because many potential predators come from “above,” Rock Geckos, such as *Cnemaspis baueri*, have evolved flattened heads with widened snouts, making them somewhat duck-like in appearance, and eyes that are rotated slightly upward, enabling them to see “up” without having to raise their heads too far.



At night, *Cnemaspis kendallii* turns a ghostly white and can be found clinging to the undersides of leaves as much as 20 m above the forest floor.

on the natural history of these two species comes only from anecdotal observations made during the collection of the type series, these geckos are clearly lowland rainforest specialists. In nearby mountainous regions, where we have been conducting field research, we have not yet found these species and believe the habitat there is inappropriate. Nor is this habitat appropriate for the oil palm industry, which is rapidly replacing the extremely diverse flora and fauna of the lowland rainforests with a single species of palm. This will not only affect the species of *Cyrtodactylus*, but every other species in the region. Currently, these isolated mountain ranges amid a sea of oil palms are all

that is left of the native rainforest in some areas. If not for the existence of the Endau-Rompin National Forest in this general area, which thus far has resisted habitat conversion and has been host to a number of scientific expeditions (see Wood et al. 2006 for summary), our knowledge of the natural history of this portion of southern peninsular Malaysia would be all but lost.

Equally bleak is the future of the islands on which endemic *Cnemaspis baueri*, *C. limi*, and *C. pemanggilensis* enjoy the safety of their shaded, rocky retreats. These are rapidly becoming popular tourist get-aways, with all the accoutrements of a growing tourism infrastructure — and they are beginning to make inroads into the forest. In fact, the villagers on Tioman Island and many of Malaysia’s leading scientists and naturalist are struggling right now to halt the construction of a marina and a large airport along a portion of virgin, unspoiled coastline (Grismer 2005). Currently, none the species are listed on the IUCN Red List, although the endemic, insular species would clearly qualify (see http://www.redlist.org/info/categories_criteria.html).

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The **Geckophile Gathering 2006** will be held on 9–11 June 2006 in Austin, Texas (<http://www.gathering.geckosunlimited.com/>). If you are a geckophile, you shouldn’t miss this exciting event. Some of the best-known gecko enthusiasts from around the world will speak. All proceeds from the charity banquet will be donated to the **International Reptile Conservation Foundation**.

The Herpetological Community

The geckos of southern Malaysia occur in one of the most biologically diverse and complex terrestrial ecosystems in the world. Lowland rainforests are renowned for their diversity, but, in southern Malaysia, and especially on Tioman Island where 13 species of geckos make their home, the diversity is even more astounding. Tioman is the largest island in the Seribuat Archipelago and is characterized by steep-sided mountainous terrain reaching 1038 m. It supports lowland rainforest on its alluvial foothills and hill forest above 300 m. The coastline and low-lying periphery are dominated by mangrove and coastal forests. Exposed granitic outcroppings consisting of large boulders define much of the island's rugged topography, and its hillsides are cut by a number of boulder-strewn, fast-flowing streams in both open and closed canopy forest. This environmental diversity supports nearly 100 species of amphibians and reptiles on this small island. These range from tree-hole nesting and stream-dwelling frogs such as the White-spotted Treefrog (*Nyctixalus pictus*) and the Spotted Stream Frog (*Rana picturata*), respectively, to strange looking lizards such as the Chameleon Anglehead Lizard (*Gonocephalus chamaeleontinus*). At least 44 species of snakes live on Tioman Island, with adaptive types ranging from tiny blind snakes in the family Typhlopidae to King Cobras (*Ophiophagus hannah*), Red-headed Kraits (*Bungarus flaviceps*), and Reticulate

Pythons (*Python reticulatus*). Geckos are an intricate part of this diverse ecosystem and function as both predators and prey for many species.



Chameleon Anglehead Lizard (*Gonocephalus chamaeleontinus*).



White-spotted Treefrog (*Nyctixalus pictus*).



King Cobra (*Ophiophagus hannah*).



Spotted Stream Frog (*Rana picturata*).



Reticulate Python (*Python reticulatus*).