

5. The Reptiles

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INTRODUCTION

EARLIER ZOOLOGICAL expeditions to Pulau Tioman have laid much stress on mammals and birds, but have resulted in few published accounts of the cold-blooded vertebrates occurring on the island. Smith (1930) records 12 species of lizards from Tioman, largely as a result of collections made in 1927 by Smedley of the Raffles Museum (now Singapore National Museum); Boulenger (1912) records one species of soft-shelled turtle; de Haas (1949) records one snake. I can find no other published records of reptiles from Tioman, and none whatever from Tulai.

The collections discussed below were made by Hendrickson in 1958, and by the University of Malaya party in 1962. Nine of the twelve lizards recorded by Smith are represented, as is the turtle recorded by Boulenger and the snake recorded by de Haas. The three lizard species recorded by Smith and not found by us are: "*Lygosoma*" (now *Leiolepisma*) *vittigerum* (Boulenger), *Mabuya longicaudata* (Hallowell), and *Goniocephalus harveyi* Boulenger. There is some room for doubt regarding each of these¹³. Six species of lizards and seven snakes, all represented by specimens now in the Zoology Department, University of Malaya, are here added to the list of reptiles known from Pulau Tioman. Several other species which were not collected, but are probably present, are mentioned below.

There are apparently no resident crocodylians on the islands. None of the islanders who were interviewed made any claim to ever having seen a crocodile there. Although there is no good reason why the Estuarine Crocodile, *Crocodylus porosus* Schneider, might not reach the island from time to time, the amount of available coastal swamp land is extremely limited and such areas enjoy little isolation from the human population.

The truly marine reptiles have not been given serious consideration in this report. There are an unknown number of species of sea snakes in the waters around the island and four species of sea turtles nest on the island beaches (investigation of these was the principal goal of the 1958 visit by Hendrickson). The Green Sea Turtle, *Chelonia mydas* Linn., nests on Tioman in the greatest numbers; smaller numbers of the Pacific Ridley, *Lepidochelys olivacea* (Esch.) visit the beaches; the islanders report sporadic nestings of the Leathery Turtle, *Dermochelys coriacea* (Linn.) and the Hawksbill, *Chelonia imbricata* (Linn.). There are apparently no terrestrial species on the island and the only non-marine chelonian found was the Soft-shelled Turtle, *Dogania subplana* (see discussion).

13. (a) *Leiolepisma vittigerum*: Smith (1930) states, "There is a specimen . . . from Pulau Tioman in the Raffles Museum." Despite a careful search of the collections now in the Museum, I have been unable to locate this specimen.

(b) *Mabuya longicaudata*: See text discussion of *M. multifasciata*; the only specimen of *longicaudata* now in the Singapore National Museum is from Thailand.

(c) *Goniocephalus harveyi*: There is one half-grown specimen of *G. chamaeliontinus* mislabelled "*Goniocephalus harveyi*" (sic) in the Singapore National Museum (see text discussion of *chamaeliontinus*).

In addition to the 15 species of lizards collected and reported on here, mention should be made of two more which may well be added to the faunal list at some future date. The rocky coast of Tioman provides an extensive suitable habitat for one of the characteristic seashore skinks, such as *Emoia atrocostata*, and in 1958 I noted "small, black skinks" on the intertidal rocks when circumnavigating the island in a boat; the absence of this or a comparable species in our collections may be due to nothing more than insufficient collecting with a gun on the rocky portions of the coast. Secondly, I find it difficult to believe in the absence of *Varanus salvator*; this excellent swimmer, commonly found foraging on both rocky and sandy coasts, occurs almost ubiquitously on many small islands more isolated than Tioman. The locale and actions of a large varanid seen on Pulau Tulai (see below) fit this species. We collected no specimens, however, and I did not see any *Varanus* on the coast when circumnavigating the island in 1958.

Snakes, are, in general, much less conspicuous than lizards and our present list of eight species is probably far from complete¹⁴. Two species which were not collected but should eventually be added to the Tioman faunal list are the cobras, *Naja naja* (Linn.) and *Naja hannah* (Cantor). The islanders are uniformly familiar with both of these very distinctive and dangerous snakes, and all reports agree as to the presence of both on the island. During the 1962 expedition there were two meetings with Hamadryads, once by a party of two when rather full notes were taken. On one occasion during my 1958 visit I had a brief glimpse of the rear half of a jet black snake as it disappeared into a dense tangle of roots and debris; I believe this was a *Naja naja*.

On one occasion a party of three saw a small burrowing snake when they were digging out a rat's nest at the base of a palm in the forested uplands. This was described as 4"-5" long, slim, and all black; it was assumed at the time to be a *Typhlops braminus*.

Only four species of lizards (no snakes or chelonians) were collected on Pulau Tulai—two skinks (*Mabuya multifasciata* and *Lygosoma scotophilum*) and two geckoes (*Cnemaspis kendalli* and *Cnemaspis* sp.). One member of the 1962 party reports seeing *Calotes cristatellus* and a large *Varanus*. The *Varanus* was seen on the rocky beach and ran into hiding among the rocks (see preceding discussion of *Varanus salvator*). This reduced fauna is in accord with the small size and depleted flora of the island (see description in Bullock and Medway, this *Bulletin*, p. 5).

Where possible, all the specimens collected have been compared with both published descriptions and specimens from the mainland of Malaya and Singapore. Where differences have been noted, these are described, but no new names have been added to the already confused taxonomy of South-East Asian reptiles. It is felt that the specimens available for comparison do not provide adequate coverage of the known museum material and that the literature should be searched more fully than is possible at this time. Almost certainly there are several definable new taxa represented in the Tioman collections, and I hope it will be possible to give these adequate treatment at some future date.

14. E. R. Alfred reports that *Maticora intestinalis* (Laur.) has been collected on Tioman since this ms. was first submitted.

SPECIES LIST

Dogania subplana (Geoffroy). Soft-shelled Turtle.

One specimen with a carapace about 20 cm. long was taken in the Sungei Ayer Besar near Camp II, Pulau Tioman, at about 1,000 feet elevation (see fig. 2). A smaller individual was taken in the lower reaches of the same stream near Kampong Tekek and others were seen at various points along this stream. The villagers at Kampong Juara say it is common there.

This species appears to be remarkable among Soft-shelled Turtles for its ability to invade the upper reaches of small hill streams. Downstream from Camp II where the 20 cm. specimen was found, the Sungei Ayer Besar descends the steep slopes of the island in repeated slides and falls as much as 10 to 30 feet high. I have found this same species in similar situations on the mainland, near the top of Kedah Peak and on Fraser's Hill, Pahang. It apparently occurs at all points on Tioman where there is sufficient surface water.

Boulenger (1912) records *Dogania subplana* from Pulau Tioman.

Varanus nebulosus (Gray). Clouded Monitor Lizard.

Four specimens (two adults and two juveniles) were collected on Pulau Tioman—all from Kampong Tekek and vicinity. A number of other individuals were seen at various points around the island on the coastal plain. This is a great tree climber, and our two adults were both shot out of the tops of coconut palms. We have only one sight record of *Varanus* from the interior uplands; although I see no reason why it may not occur there, it is likely that this lizard is more common near the cultivated areas where it finds a more plentiful supply of rats, nestling birds, and edible refuse. I have never seen this species prowling the intertidal rocks as does *Varanus salvator*.

This is apparently the first time that *Varanus nebulosus* has been reported from Pulau Tioman. The sight record of *Varanus* on Pulau Tulai (above) cannot be designated as to species; it may have been a *V. salvator*.

Cnemaspis kendalli (Gray). Slender-toed Forest Gecko.

Five specimens from Pulau Tioman and one (No. 5270) from Pulau Tulai are tentatively assigned to this species. They compare well with four specimens in my collections from the Malayan mainland. Of the six island specimens, one (No. 5276) is an adult female with two developing ova about 2.9 mm. in diameter; the remainder are males, apparently all adult although with testes of different sizes. The two smallest individuals are 51 mm. and the largest measures 53 mm. in snout-vent length.

In scalation these geckoes conform well with published descriptions of *kendalli* and differ from descriptions of other South-East Asian species (see following account of "*Cnemaspis* sp."). Boulenger (1912) gives 80 mm. as the snout-vent length of *kendalli*, but there seems to be room for doubt concerning this; Inger (pers. comm.) reports that the two type specimens of *kendalli* in the British Museum measure 56.1 and 60.9 mm. from snout to vent. Smith (1930) speaks of strongly expressed canthal ridges in *kendalli*, whereas in the present specimens the canthal ridges are very weakly expressed. No clear distinctions based on colour and pattern have been possible.

The state of our knowledge of the genus *Cnemaspis* is still very imperfect. Underwood's (1954) excellent review of the geckoes reserves the genus for further study and his following note in *Nature* (Underwood, 1955) goes no further than to definitely place the genus in his subfamily Gekkoninae. The following descriptive notes on the Tioman and Tulai animals should be considered along with the tentative species identification:

Digits slender, clawed, not dilated, with the two distal phalanges compressed and forming an angle with the basal portion. Underside of both basal and raised portions of digits with a row of transverse plates. Body moderately depressed and tail subcircular in section. Pupil round; brille of eye completely surrounded by a ridge of skin, least prominent postero-ventrally (somewhat more strongly expressed in these specimens than in the "*Cnemaspis* sp." to be described later). Forehead slightly concave; canthal ridges very faintly expressed. 11/12 upper and 10/11 lower enlarged labials. Ventral scales smooth; no preanal or femoral pores. Ventral side of tail with median series of large, keeled, semi-erect scales.

This smaller species differs markedly in ecology from the larger "*Cnemaspis* sp." taken on the same two islands, in that it frequents trees and dead wood rather than rock surfaces. So far as I can determine, all six of the present specimens were found well up off the ground in trees and were collected by shooting. The species appears to occur mainly in upland forests, but probably is limited more by its preferred tree habitat than by altitudinal factors. Smith (1930) records *Cnemaspis kendalli* from Pulau Tioman; whether the record stems from collection of these animals or the more conspicuous "*Cnemaspis* sp." cannot be determined.

Cnemaspis sp.

Gecko

Twelve specimens from Pulau Tioman (8 males and 4 females) averaging 80.1 mm. in snout-vent length (min. 73 mm., max. 86 mm.), and one male from Pulau Tulai measuring 75.5 mm.

Boulenger (1912) records two species of "*Gonatodes*" (now *Cnemaspis* for Old-World species) from the Malay Peninsula: *kendalli*, which he describes as large with a snout-vent length of 80 mm. (but see earlier mention of measurements of type specimens in British Museum) and *affinis*, with a snout-vent length of 47 mm. Smith (1925) adds another small (42 mm. snout-vent length) species *siamensis* to the fauna of the Malay Peninsula and describes a large (75 mm. snout-vent length) species *nigridius* from Sarawak. The only other *Cnemaspis* species known to me from the general area is *C. boulengeri*, described by Strauch (1887) from Pulau Condore, South China Sea (= *Gonatodes glaucus* of Smith, 1921).

The Tioman and Tulai specimens are of the order of size of *kendalli* (Gray) as given by Boulenger, of *nigridius* (Smith), and of *boulengeri* Strauch. They are close to twice the size of *affinis* (Stoliczka) and *siamensis* (Smith) and they differ from each of these small species in a number of scale characters as well. They differ from *nigridius* and *boulengeri* in having neither femoral pores nor enlarged femoral scales, as well as showing other important differences in scalation. Unlike the descriptions of *kendalli* (and the smaller *Cnemaspis* from Tioman and Tulai which have been tentatively identified as *kendalli*), the present specimens have a median row of ventral caudal scales which lie flat, are not pointed, and have no keels.

The most that can be done at present is to describe the specimens at hand without assigning a species name to them:

Digits slender, clawed, not dilated; the two distal phalanges compressed, forming an angle with the basal portion, a row of transverse plates along the undersurface of both basal and raised portions. Body moderately depressed; tail subcircular in section, with ventral scales enlarged and in a median linear series on

at least the terminal $\frac{2}{3}$ of the tail in specimens with unregenerated tails (ventral scales irregularly arranged and not conspicuously enlarged at ventral tail base). Pupil round; brille of eye completely surrounded by a ridge of skin, this least prominent postero-ventrally. Forehead concave, snout rounded at the tip, its length almost twice the diameter of the eye; ear vertically oval, its distance from the eye about $1\frac{1}{2}$ times the eye diameter. Rostral quadrangular, entering the nostrils, deeply cleft in the midline; 10/13 upper and 10/11 lower enlarged labials; mental very large, broader than rostral, subtriangular, with one or two pairs of accompanying enlarged chin shields and — usually — a median unpaired shield behind the mental. Pointed, granular scales on the snout larger than those on the occiput; dorsum with small, granular scales intermixed with larger, conical, pointed tubercles, white in colour and arranged rather haphazardly in longitudinal rows. Ventral scales smooth, cycloid, not larger than the dorsal tubercles; no enlarged preanal or femoral scales and no preanal or femoral pores. Scales on ventral side of thigh smaller than on pubic area, tending to become granular; scales on ventral side of tibia larger than those on thigh, each with a small, clear keel; at distal extremity of tibia a variable group of as many as 6 to 8 enlarged scales from two to three times the size of their neighbours, arranged in an elongate group rather than in a single line (ref. *boulengeri*), extending as much as $\frac{1}{5}$ of the distance up the tibia.

Colour (in alcohol) variable gray, symmetrically blotched with both darker and lighter areas, but not usually much conspicuous contrast. Principal series of median dark blotches begins anteriorly with a dark crescent leading from each eye around to the nape, with an unpaired dark blotch between these in the midline. Following this, a pair of slanting dark bars in front of the shoulders. The mid-dorsal dark markings continue posteriorly with three pairs of elongate dark blotches on the trunk, a pair of subcircular dark blotches over the sacrum, and a similar postsacral pair. There may be a matching secondary series of smaller dark blotches lateral to the three large markings on the trunk. Lighter areas tend to form narrow, irregular cross bands immediately posterior to each set of dorsal dark markings. The venter is variably dusky, always with the mid-ventral area of the trunk and the ventral surface of the thighs lighter.

The single specimen (No. 5271) from Pulau Tulai is conspicuously lighter in colour than any of the Tioman specimens. It follows the pattern of pigment distribution described above, but it is so light in ground colour that the "lighter" blotches are barely detectable. On this specimen the larger tubercles on the dorsal skin are very much less developed than on any of the Tioman specimens and the digits appear to be shorter; the first fingers of this 75.5 mm. specimen measure about 6.2 and 6.3 mm. (from junction of first and second fingers to tip of claw of first finger), while the first fingers of a 73 mm. Tioman specimen measure about 6.8 and 6.9 mm.

One of the Tioman females had no enlarged ova; two had each a pair of developing, spherical ova, 5.2 mm. and 6.9 mm. in diameter. The fourth female contained one large, shelled egg which measured approximately 12.6 mm. in diameter.

This species is more a frequenter of rock surfaces than of trees. All seven specimens which I collected in 1958 were found at night clinging to the undersides of large boulders where these were piled up off the ground; two of the 1962 specimens from the slopes of Gunung Kajang bear the notation "on rock". The species apparently occurs through nearly the entire altitudinal range of the island, wherever it finds its preferred rock-face habitat; it seems to be much more common within the upland forest than on the sea coast.

Hemidactylus frenatus Dumeril & Bibron.

House Gecko.

One specimen (No. 5286) was taken in the Rest House at Kampong Tekek. This is an adult female, measuring 50 mm. snout-vent length; it contains two oviducal eggs, each over 5 mm. in average diameter. It conforms well with published descriptions and with specimens from other parts of Malaya.

This is the commonest house gecko of the Malay Peninsula and I have never failed to find it wherever there are human habitations, from city office buildings to remote kampongs and on boats. I have also collected it in the forest, but rarely. The presence of a single specimen in the Tioman collections should not be taken as any sign of its rarity on the island—I have full confidence that it occurs in virtually every dwelling place on the island. I doubt, however, that it occurs in any numbers in the upland forest of Tioman.

There is little point in debating whether this species has been introduced to the island by man, or formed part of the fauna before man arrived on the island. In this part of the world it is almost as consistent a companion of human societies as are cockroaches and lice over most of the world; if it was not present on the island earlier it would dependably have been one of the very first human introductions.

This is apparently the first time the species has been recorded from Tioman.

Gehyra mutilata (Weigmann).

House Gecko.

Two specimens: No. 5269, an adult male 51 mm. in snout-vent length from the Rest House at Kampong Tekek, and No. 5264, an adult female (no large ova) 49 mm. in snout-vent length, from a dwelling in Kampong Mokut.

These specimens agree well with Boulenger's (1912) description (less well with the description in Smith (1935) which covers a wider geographic range and gives higher counts for labials, subdigital lamellae, and preanal and femoral pores)

Although both the specimens from Tioman were collected in houses, this species also inhabits trees and rock faces. While a very likely prospect for introduction by man, it is less completely tied to human habitation and easier to visualize as a natural inhabitant of the island before the advent of man.

This is apparently the first time the species has been recorded from Pulau Tioman.

Draco melanopogon Boulenger.

Flying Lizard.

Seventeen specimens from Pulau Tioman, all but one collected along the trail crossing the island between Kampong Tekek and Kampong Juara, mostly around 1,000 feet above sea level. One individual was taken on the slopes of Gunong Kajang at 2,700 feet. There are ten adult males and one half-grown male; the remaining six individuals are adult females, four of them with large eggs.

The Tioman specimens correspond with descriptions in Boulenger (1912) and Taylor (1958), aside from being slightly larger and having somewhat larger heads. In this they appear to differ also from mainland specimens, but measurements of the small sample available did not show differences which fully met tests of statistical significance.

The four gravid females each contained two elongate shelled eggs. These were all about the same size and averaged 14 mm. along the axis by 6.5 mm. in greatest diameter. Ten individuals randomly selected from among the gravid females in a large Selangor collection and opened for inspection also each had two eggs. One Tioman female had an egg partially extruded into the cloaca (ready to lay?),

the remaining oviducal egg in this individual was dissected out for examination and found to measure 15.7 mm. along the long axis by 7.6 mm. in diameter. The eggs were all distinctly pointed at each end. Figure 4 compares the eggs of *melanopogon* with those of *Draco volans* (see discussion of that species).



Figure 4. Eggs of *Draco* species.

This is a true forest animal, and I did not record it from the vicinity of villages; all our specimens were collected in undisturbed forest. In this restriction it conforms well with the habits of the species on the mainland, where it is usually the commonest species of *Draco* in undisturbed areas. A large collection of over 400 *Draco* made from primary forest near Kuala Lumpur by a resident tribe of aborigines was more than 80% *melanopogon* (see also discussion of *Draco volans*).

Smith (1930) records this species from Pulau Tioman.

Draco volans Linnaeus.

Flying Lizard.

Five individuals, all from Kampong Tekek, Pulau Tioman. Three were adult males and two were adult females (one gravid).

The specimens all conform well with Boulenger's (1912) description and with the mainland specimens available.

The gravid female in this Tioman collection had four large eggs (about 12.5 mm. x 7.5 mm. diameter). Flower (1896) also records four eggs. Of some twenty gravid females and clutches of eggs I have examined in Singapore, most have had four and none have had less than three eggs. It is interesting to note this normal number of four eggs in contrast to the usual two eggs of *Draco melanopogon* (see discussion under that species). The eggs of *volans* also differ markedly in shape from *melanopogon* eggs, the former being smoothly rounded at the ends instead of pointed (fig. 4); my notes give measurements of 13.7 mm. in long diameter by 7.6 mm. in short diameter for *volans* eggs freshly laid, and 14 mm. x 7.8 mm. for an egg the day before it hatched.

This is a species of open plantations and parkland more than of true forest. On Tioman it is probably restricted to the developed areas around villages on the coastal plain. Boulenger (1912) says, "specially abundant in coconut plantations on the islands near the East Coast of the Peninsula". In Singapore it is particularly abundant in the older residential areas which have a park-like environment with scattered trees planted in the gardens. In Selangor I have collected the species in a city park, but a collection of over 400 *Draco* made from nearby primary forest by a resident tribe of aborigines, and including eight different species, had no *Draco volans*.

Smith (1930) records this species from Pulau Tioman.

Aphaniotis fusca Peters.

Earless Agama.

Thirteen specimens from Pulau Tioman, five adult males and eight adult females. All but one were taken in undisturbed forest along the trail crossing the island between Kampong Tekek and Kampong Juara.

The Tioman individuals compare well with Boulenger's (1912) description and with available examples from the mainland. The males show slightly greater development of the feeble gular sac than do my mainland specimens.

Aphaniotis fusca appears to lay only one egg at a time, as a rule. Each of the females collected had one or more enlarged ova, as follows:

- 2 had single, spherical ova about 7 mm. in diameter.
- 4 had single, elongate ova over 12 mm. long.
- 1 had an elongate ovum about 12 mm. long and another flattened (degenerating?) ovum about 6 mm. in diameter by about 3 mm. thick.
- 1 had two large, shelled eggs which appeared to be ready for laying; one of these, dissected out, measured 15.9 mm. long by 7.3 mm. in diameter. The eggs were smoothly rounded on the ends, as in *Draco volans* (fig. 4), but were more elongate.

One suspects that when two ova are formed and grow simultaneously, there is a tendency for one to be depressed and to degenerate after the ratio of total egg volume to body cavity size reaches a certain critical level.

This species is characteristic of undisturbed forest. It is not common anywhere on the mainland, so far as I am aware. I have four specimens collected on the Peninsula over a period of some eight years, yet I have no doubt that I could collect 20 or more individuals in one concentrated day on Pulau Tioman, where it may be continually encountered during a walk through the forested uplands. The reasons for its abundance on Tioman are not completely clear, but I am inclined to believe this is due to the absence of one or more critical predators.

Aphaniotis shares with *Draco melanopogon* a general foraging habitat on the stems of forest trees. There is apparently almost no overlap in diet between the two species (see Bullock, this *Bulletin* p. 93, on stomach contents), but there may be competition for space. The following appears in my field notes for 1st June, 1958 (vicinity of 1962 party's Camp II):

"One (*Aphaniotis*) was recognized only after it had been shot down, along with a *Draco*, from about thirty feet up on the trunk of a very large strangling fig (the two had appeared to be both *Draco*, engaged in some sort of social play; they were first seen about 18" apart)."

On two other occasions I saw *Draco melanopogon* and *Aphaniotis fusca* in close proximity on tree trunks and obviously engaging each other's attention. In each case the *Draco* was the more active of the two and appeared to be defending a territory; in each case the *Aphaniotis* appeared to give way.

Smith (1930) records this species from Pulau Tioman.

Goniocephalus chamaeleontinus (Laurenti).

Anglehead.

Eleven specimens from Pulau Tioman, all adult, 3 males and 8 females. All were collected in the forested uplands between Kampong Tekek and Kampong Juara, most along the trail leading across the island between the two villages.

The Tioman individuals agree quite well with Smith's (1930) description, written when he recorded the collection of a specimen from Pulau Tioman and added this species to the Malayan faunal list. I do not find the third finger to be shorter than the second as Smith says (the two are equal in length). The colour

in alcohol (and in life, as I recall it) has a definite bluish cast, particularly on the nuchal and dorsal crests. Smith says the species had previously been recorded from the Mentawi Islands, Sumatra, Java, and the Natunas; his record is the first from Malaya, and Tioman apparently remains the only Malayan locality where it is known to occur.

Seven of the females contained enlarged ova (the eighth had been shot at close range and had most of the abdomen destroyed). One had 6 ova, each about 10 mm. in diameter, three had 12 mm. diameter ova (4, 5 and 6 eggs respectively), and a fifth individual contained five ova, each about 15 mm. in diameter. The remaining two females had large, oblong eggs with shells—4 eggs, each measuring about 21 mm. by 12 mm. in one instance; 5 eggs, each measuring about 24 mm. by 12 mm. in the other. In the latter case, I assume the eggs were quite mature and ready for deposition.

This is a forest species, usually found sitting quite motionless on vines, tall saplings, and the smaller branches of large trees. I do not believe it occurs commonly on the coastal plain. Its apparent absence from the mainland fauna contrasts strongly with its relative abundance on Pulau Tioman.

Smith (1930) reports that *Goniocephalus harveyi* Boulenger "... has recently been obtained on Pulau Tioman." It is not clear whether Smith himself examined a specimen of *harveyi* from Tioman, or whether he merely recorded an identification made by someone else. Despite assiduous searching in both 1958 and 1962 which produced numbers of the other species of *Goniocephalus*, we failed to find *harveyi* on Pulau Tioman. In the Singapore National Museum is a half-grown (80 mm. snout-vent length) specimen of *G. chamaeleontinus* which bears the label: "*Gonyocephalus harveyi* (sic); Tioman Id., S. China Sea; vi, 1916; C.B.K." On these grounds I suggest that Smith's record is based on a mis-identified specimen and the species *harveyi* should be dropped from the Tioman faunal lists.

Goniocephalus grandis (Gray).

Anglehead.

Fifteen specimens from Pulau Tioman, including five males (one juvenile) and ten females (two sub-adult); all were collected from the upland forest between Kampong Tekek and Kampong Juara except for one individual which was taken on the forest edge of Kampong Tekek itself (elevation about 200 feet). Smith (1930) records the species from Tioman.

These animals are easy enough to identify with Boulenger's (1912) description when a series such as this is available. I would be very doubtful of my ability to identify a lone female specimen from this description. The sexual dimorphism in this species exceeds anything I have heretofore seen in agamid lizards, and warrants further description.

The males are conspicuous by their very high, sail-like nuchal and dorsal crests of joined scales. They are larger than the females, my four adult males averaging 148 mm. in snout-vent length (min. 145, max. 154 mm.) as compared with an average 125 mm. snout-vent length for my eight adult females (min. 120 mm., max. 133 mm.). Their colour (in alcohol) ranges from olive brown to metallic green and blue dorsally, with a scattering of round yellow to orange spots on the flanks. The colour grades to light greys and off-whites ventrally; there is a coarse vermiculation of blue-grey lines faintly visible on the throat. The tympanum is dark with a contrasting light spot where the extra-columella joins the membrane. The tail bears from ten to twelve dark (brown to black) cross bands which are wider than the intervening bands of contrasting lighter colour. The limbs are also cross-banded dorsally, the dark bands being from two to three times as wide as the intervening light spaces.

The females possess only the merest vestiges of the nuchal and dorsal crests which are so large in adult males; the juvenile male, 72 mm. in snout-vent length, already has a delicate, low dorsal crest which is better developed than in the adult females, where this structure is virtually non-existent. Both females and young are contrastingly marked with a complex pattern of stripes in dark brown and light tan or cream, giving a drastically different appearance from that of the adult males. The dorsal surface of the snout is mostly dark brown with a few lighter lines; on each upper eyelid are five light lines, the central one extending straight across the interorbital space to join its fellow of the opposite side to form a bar across the head; the two light lines anterior and the two posterior to this do not ordinarily meet across the interorbital space, but commonly join at their inner ends to form a "V" or "U" with its opening laterally; the anteriormost and posteriormost of these finger lines ordinarily delimit the upper lid. On the nape is a large, dark, triangular area with a central light spot; it includes practically all of the small, low nuchal crest and might be characterized as a dark chevron, beginning on each occiput and pointing backward; a contrasting light chevron (one end at each eye corner) separates this from a following heavy, dark chevron over the pectoral area (one end at the postero-ventral border of each eye). The pattern continues posteriorly with three dark chevrons on the trunk, one on the sacral region, and one post-sacral marking, then is carried on to the tail by the pattern of banding which was described for the male. The intervening light areas which separate the dark chevrons on the trunk and sacral areas contain central thin, dark lines. With progression posteriorly, there is a tendency for the outer ends of the chevron markings to be diverted backward, producing roughly an "M" shape in the last two or three when viewed from above and behind. The flanks and limbs show approximately the same pattern as on the adult males, but rendered in contrasting rich brown and light tan or cream rather than in the olive grey and yellow or orange shown by the males. The throat bears a number of thin, dark lines which join here and there to form a longitudinally-oriented reticulum, comparable to that shown in adult males, but clear and contrasting.

The juvenile male (No. 5243) has the full "female" colouration. It has identifiable testes, however, and (as stated above) the secondary sexual character of the dorsal crest has already begun to be expressed.

I have been able to compare the Tioman individuals with only two specimens from the mainland, a small male (115 mm. snout-vent length) from Johore and a larger male (145 mm. snout-vent length) from Selangor. Both of these have large testes and are fully mature. The Tioman males appear to have relatively shorter, higher nuchal crests than the mainland specimens. Both the Selangor and Johore specimens have 29 points (individual scale tips) in the nuchal crest; the Tioman males have 23, 24, 25, and 27 points. The basal portions of the nuchal crests are covered by ancillary series of enlarged scales, considerably larger than the ordinary scales on the dorsal surface of the neck; anteriorly these are arranged in somewhat confused fashion, but from about the middle of the crest on posteriorly they form regular rows. At the level of the tenth principal scale forward from the rear end of the nuchal crest, there are three series of these ancillary scales in the two mainland specimens, four series in the Tioman males. The Johore specimen has a relatively low crest which is probably not fully developed and therefore not suitable for comparison, but the Selangor animal can presumably be taken as fully developed; at the level of the tenth main scale forward from the rear of the crest, the distance from the scale point to the base of the crest is 17.6 mm. in the Selangor specimen, 18.9 mm., 20.1 mm., 20.8 mm., and 21.7 mm. in the Tioman males.

My mainland specimens are so badly faded that comparison of colour patterns is almost impossible. It can be noted, however, that both mainland animals show narrow dark and broad light bands on the limbs (the reverse of the pattern in the Tioman specimens — see above).

The two smallest Tioman females (99 mm. and 111 mm. snout-vent length) have no large ova, but each of the other eight females contains large ova as tabulated below (Table 1).

All the oviducal eggs had firm shells and appeared ready for deposition. They had evenly-rounded ends; the measurements given in Table 1 show the length along the long axis and the diameter at the midpoint.

TABLE 1

Ova in female *Goniocephalus grandis* from Tioman

Specimen	No. of ova	Size, etc.
5291	5	8 mm. (ovarian)
3006	3	11 mm. (ovarian)
5238	3	12 mm. (ovarian)
3061	2	12 mm. (ovarian)
3039	3	21 × 10 mm. (oviducal)
3060	3	22 × 10 mm. (oviducal)
5239	2	26 × 11 mm. (oviducal)
5290	4	22 × 11 mm. (oviducal)

This is a forest lizard, but it appears to be most common on Tioman in the vicinity of the boulder-strewn stream courses. It does not appear to occur on the coastal plain. So far as I can determine, all the males were found in trees, but many of the females were first seen moving on large boulders in stream beds. Following is an extract from my field notes (of 2nd June, 1958):

"One of the large specimens was collected from the trunk of a streamside tree, about 8 feet up on a 2' diameter trunk. All the others were shot on large boulders in the stream bed. In each case, my attention was drawn to the animals by their movement rather than purely on the basis of form (as is usually the case with most of the large *Goniocephalus*). These lizards are very long-legged and agile; they ran and jumped rapidly across the broken stream bed. All six, including the one taken on the tree, were found in portions of the stream bed filled with large boulders, (a person could not walk easily along, but had to clamber over boulders or jump from one to another). In all these places the tree cover was more sparse than in other stretches, and during the middle of the day it was drier and sunnier than along much of the rest of the course of the stream."

Members of the 1962 expedition report that on more than one occasion they disturbed females which escaped by diving into the water of the Sungei Ayer Besar and disappearing beneath the surface.

Goniocephalus armatus (Gray).

Horned Anglehead.

Three specimens from Pulau Tioman, an adult male (116 mm. snout-vent length) and two adult females (109 mm. and 120 mm. snout-vent length). These agree fairly well with Boulenger's (1912) description (of "*Acanthosaura armata*"). They differ from Smith's (1935) key and description in that they do have a perceptible small gular pouch (as do also my specimens from the nearby mainland). Both descriptions state that the gular scales are smaller than the ventrals, but this is not the case with the scales on the median portion of the gular sac in the three Tioman animals.

When compared with mainland specimens from Johore and Pahang, the Tioman animals appear to have heavier heads and relatively larger tympani, but Smith (1935) notes that there is considerable variation in head proportions in this species. The mainland specimens have virtually continuous nuchal and dorsal crests, whereas there is a clear, but very short, break between the two in all of the Tioman animals. Further, the mainland specimens conform with the published descriptions in having all the gular scales much smaller than the ventral scales (see above).

The larger of the two females from Tioman has 10 spherical ova which average about 10 mm. in diameter. The smaller female has 8 large, shelled oviducal eggs from 18 mm. long and averaging about 10 mm. in diameter. These appear to be ready for deposition.

This species is another inhabitant of the wooded uplands. All three of our specimens were taken along the trail which crosses the island between Kampong Tekek and Kampong Juara. They seem to prefer fairly dense undergrowth and apparently spend much of their time on the ground; one of our specimens was found under a dead log.

Smith (1930) records this species from Pulau Tioman.

Calotes cristatellus (Kuhl).

Variable Lizard.

Five specimens from Pulau Tioman, 4 adult males and 1 female with two eggs about 8 mm. in diameter. Three were collected at Kampong Tekek and one at Kampong Mokut; only one was taken in undisturbed forest, near Camp II. Medway contributed a sight record of this species from Pulau Tulai (above).

The Tioman animals agree well with the description in Boulenger (1912) and Smith (1935) and with specimens from various parts of the mainland. The account in Smith (1935) includes the statement: "Eggs oval, 30 by 11 mm. in size." This is not the case with the eggs I have seen in Singapore, Selangor, and Pahang, where the eggs are elongate and fusiform with "puckered", tapering tips (cf. Kopstein, 1938, plate XXVI, figures 65 & 66—photographs of the eggs of *Calotes jubatus* Dumeril & Bibron). An egg shell from which I hatched a young *Calotes cristatellus* in Singapore measures 40 mm. from tip to tip, by 9.7 mm. in diameter. Its axis is slightly curved.

Calotes cristatellus appears to be more of an inhabitant of dense, brushy vegetation than of undisturbed, high forest. It is particularly common around towns in hedges and shrubbery. On Pulau Tioman it appears to be much more common in the disturbed areas around human habitations (4 of our 5 specimens came from such areas) than in the relatively undisturbed uplands, where it is largely confined to stream courses, land slips, and similar sites where the vegetation is lower and more dense.

This species is common throughout the southern portion of the Malay Peninsula, but this is apparently the first record of its occurrence on Pulau Tioman.

Mabuya multifasciata (Kuhl).

Common Malayan Sun Lizard.

Eight specimens (four of each sex) from Pulau Tioman and two specimens (a male and a female) from Pulau Tulai. They agree in most particulars with descriptions in Boulenger (1912) and Smith (1935), and with mainland specimens of this species. No particular differences were noted between the Tioman and Tulai animals.

Two of the females had only small ova; one had 4 large, shelled oviducal eggs with well-developed embryos, and the remaining two females each contained 5 advanced embryos enclosed in transparent membranes and with depleted yolk sacs. These last embryos appeared about ready for birth.

This is an active, very abundant ground lizard, to be heard scuffling in the leaf litter in practically all forested parts of the island during the day (and, less commonly, the night). All our specimens were taken in the wooded uplands, mostly along the trail which crosses the island between Kampong Tekek and Kampong Juara. I did not record it as common in the vicinity of villages on the coastal plain, where *Dasia olivacea* (although much less abundant) appeared to more or less replace it.

Smith (1930) states that *Mabuya longicaudata* ". . . has been met with on Pulau Tioman." He does not record *Mabuya multifasciata* as present on the island, although we found it to be the most abundant ground lizard there. We did not collect any *Mabuya longicaudata*. I find it difficult to believe that the skinks accounting for Smith's record and our *multifasciata* skinks are not the same. It is perhaps worth noting that Smith says *longicaudata* has been "met with"; he does not say it has been "obtained", or that a specimen is in Raffles Museum "from Tioman", as he does for most of the other Tioman records in this 1930 account. This leaves the possibility that Smith's statement might have been based on a sight record only.

Two of our eight specimens from Tioman have narrow, longitudinal black lines dorsally, as Boulenger (1912) describes for "*siamensis*" (= *longicaudata*) and as Smith (1935) describes for *longicaudata*. On field sighting alone, this pattern might well be sufficient to cause identification as *longicaudata*; such a pattern is not recorded by either author for *multifasciata*. However, comparison of the Tioman specimens in hand with descriptions and with mainland specimens of both *multifasciata* and *longicaudata* reveals the following:

(1) The Tioman animals agree with *multifasciata* in having the tail about $1\frac{1}{2}$ times as long as the body rather than nearly or quite twice the body length, as in *longicaudata*.

(2) They all agree with *multifasciata* in having conspicuously tricarinate scales and 3 or 4 small lobules on the anterior edge of the ear opening (*longicaudata* usually has 2 keels on the dorsal scales and 3 or no keels on the lateral scales; it usually has no small lobules on the anterior edge of the ear opening).

(3) They agree with *multifasciata* in having 31 or 32 scale rows around the body (Smith, 1935, gives 30-34 rows for *multifasciata* and 26-30 for *longicaudata*).

(4) They agree with *multifasciata* in having 18 or 19 *obtusely keeled* lamellae under the fourth toe (Smith, 1935, says "17 to 23"), rather than with *longicaudata* which has 22 to 27 smooth lamellae under the fourth toe.

(5) All ten Tioman specimens have numbers of black-edged white spots on the flanks, as described by Smith (1935) for *multifasciata*; such spots are not obvious on *longicaudata*.

I feel quite definite about the identity of our Tioman specimens being *multifasciata*, and suggest that the record of *longicaudata* on the island should be considered as dubious until substantiated by further specimens collected there.

***Dasia olivacea* Gray.**

Tree Skink.

Five specimens, 3 males and 2 females, all from Kampong Tekek, Pulau Tioman. Both females are under 100 mm. in snout-vent length and have only small ova in the ovary.

The Tioman specimens agree well with the descriptions in Boulenger (1912) and Smith (1935). I have two mainland specimens for comparison, one from Rompin, Pahang (50-60 airline miles from Tioman), the other from the National Park in north-east Pahang. The Rompin specimen resembles the Tioman animals closely in colour and pattern, having a bright blue-green venter and lateral black dots with white flashes, arranged in transverse bars and tending to extend across the bronze-brown dorsal surface; the National Park specimen is a uniform dark olive-brown, shading to gray ventrally, and has only the very faintest hint of dark lateral dots.

This is a skink of semi-arboreal habits. It appears to occur mainly on the coastal plain of Tioman, where it largely replaces the upland *multifasciata*. *Dasia olivacea* appears to be much less abundant in its lowland habitat than is *Mabuya multifasciata* in the upland forest.

Smith (1935) says: "More than most skinks, *D. olivacea* appears to have a preference for small islands." Smith (1930) records this species from Pulau Tioman.

***Lygosoma scotophilum* Boulenger.**

Supple Rock Skink.

Six specimens, all males, from Pulau Tioman and one gravid female from Pulau Tulai. The female contains two large, shelled eggs in the left oviduct; these have been pierced by shot and are collapsed, but probably measured about 10 to 11 mm. long by about 5 to 6 mm. in diameter when intact. All individuals compare well with the description of this species in Boulenger (1912).

This is a small, rock-inhabiting species occurring quite commonly wherever there are large masses of bare rock, either on the sea coast or along stream courses in the uplands. Most of our specimens were collected along the course of the Sungei Ayer Besar in stretches of the stream bed jumbled with boulders the size of small houses. The animals were usually seen moving, gecko-like, over smooth, vertical or overhanging faces of the large, water-worn boulders, more often in the shade than in the sun. Their movements are quick and frequent, and they apparently have acute vision; small movements on the part of an observer some 20 feet away were usually sufficient to cause the lizards to flick out of sight into dark crevices in the rocks. Much of their foraging is apparently carried on deep down in debris-filled crevices between the boulders. Only about half of those shot could be retrieved, the others being lost when they fell into inaccessible crevices.

Smith (1930) has reported this species from Pulau Tioman.

THE SNAKES COLLECTED ON PULAU TIOMAN¹⁵

Snakes are, in general, much less conspicuous than lizards and our present collections from Tioman are less likely to include a meaningful representation of the ophidian fauna than is the case with the lizards. It is also much more difficult to define the habits and environmental preferences of most snakes, and no attempt has been made here to give our collections much ecological or zoogeographical meaning.

Except for a record of *Natrix chrysarga* (de Haas, 1949), I can find no published records of snakes from Tioman; apparently the other seven species listed here are recorded from the island for the first time. (Also, see my Introduction for discussion of cobra species on the island).

15. Common names taken from Tweedie, 1957.

Python reticulatus (Schneider). Reticulated Python.

One juvenile specimen taken at Kampong Tekek in 1962 and one 8 foot individual taken in 1958. The latter was found coiled up on a small beach at the back of a sea cave on a headland immediately north of Telok Dungun; its stomach contained a partly-digested mouse-deer (*Tragulus napu*). I believe the Reticulated Python to be quite common on Tioman, and to constitute one of the major predators on the island.

Natrix chrysarga (Schlegel). Speckle-bellied Keelback.

One specimen, collected in the forest behind Kampong Juara. This is a common snake with a wide range on the mainland. It is known to climb trees and bushes and to feed on lizards.

de Haas (1949) includes Pulau Tioman in the distribution of this species.

Oligodon purpurascens (Schlegel). Brown Kukri Snake.

One specimen, found in Ulu Lalang. It is more pale than mainland specimens in my collection, and the head pattern differs from that figured by Tweedie (1957) in that the longitudinal dark marking on the head does not join with the transverse bar between the eyes to form a "T" shape. This is a common snake on the mainland, usually found in wooded country.

Oligodon signatus (Gunther). Barred Kukri Snake.

One specimen was collected near Camp V, at about 2,700 feet elevation. Tweedie (1957) says this is a rare snake; he says there are a number of records from Singapore and reports one specimen taken in Malacca and another in Negri Sembilan.

Liopeltis tricolor (Schlegel).

One specimen, collected in the vicinity of Camp II (in 1958), when it fell from a tree branch about 20 feet overhead. The genus is poorly known, but considered to be a jungle group.

Calamaria vermiformis (Dumeril & Bibron). Variable Reed Snake.

One specimen, found on the trail between Kampong Tekek and Camp II at an elevation of about 500 feet. The colour pattern of this individual is that of the "lowland" form described by Tweedie (1957), except that it lacks the speckling or suffusion with black on the light portions of its venter which Tweedie describes for the specimens from under 3,000 feet elevation. In this it resembles another lowland specimen I have from Kelantan. On the mainland this snake is found mainly in foot-hill jungle.

Cerberus rhynchops (Schneider). Dog-faced Water Snake.

Two specimens, one from Kampong Tekek and one from Kampong Lalang. Perhaps the commonest Malayan water snake, this species is apparently abundant in the slow-moving and stagnant waters of the coastal plain on Tioman. It freely enters tidal waters.

Dryophis prasinus Boie. Grass-green Whip Snake.

Three specimens, all collected in the forest in the vicinity of Camp II. It is probable that this snake is plentiful on Tioman; the unusual abundance of small, arboreal lizards, which form the main food of *Dryophis*, would correlate with this.

DISCUSSION

Pulau Tioman is notable for the abundance of lizards found there, both in terms of the numbers of species and the numbers of individuals of many of the species. Particularly in the case of the arboreal agamids, the species biomass on Pulau Tioman appears to be many times greater than on the adjacent Malayan mainland. This can most readily be attributed to the paucity of mammalian and avian predators (see Medway, this *Bulletin*, on mammals and on birds), freeing the lizard populations from principal limiting factors which operate on the mainland allowing them to expand to new limits which are imposed by other factors such as competition for space or, possibly, food. Even the principal groups of lizard-eating snakes appear to be absent from the island; the Vine Snake, *Dryophis prasinus*, is the only important lizard predator among the snakes collected.

Each lizard species occupies approximately the same ecological niche as it does on the mainland and there are few obvious major lizard niches left unfilled on the island. *Varanus salvator* probably does occur on the island, although we did not collect a specimen; this would fill the role of the large-sized seashore scavenger. The apparent absence of any large species of the genus *Gecko* would indicate that there is a "vacancy" for a large-sized, nocturnal predator on the stems of the forest trees.

I attribute the absence of crocodylians to the lack of sufficient coastal swamp habitat on Tioman. This argument of insufficient habitat does not apply in the case of non-marine chelonians, where the existence of only a single species of Soft-shelled Turtle leaves a number of niches unfilled. It seems certain that a good habitat exists for several terrestrial tortoises and terrapins in the forested portions of the island, but they are apparently all absent. *Geomyda spinosa* occurs on the Natunas Islands, according to de Rooij (1915); it is difficult to understand why this common forest species and/or other species are absent from Pulau Tioman, so much less distinctly isolated than are the Natunas. In the absence of competition, *Dogania subplana* has taken over all the available freshwater habitat on the island; it was found not only in the small upland streams which are apparently typical for it, but also in the semi-stagnant waters of the coastal swamps—a habitat more likely to be inhabited by a *Trionyx* species on the adjacent mainland.

In the case of the snakes, it is difficult to be as confident of the adequacy of our sample of the fauna as in the case of lizards and chelonians. However, the evidence at hand indicates a depleted ophidian fauna. Four of the ten species listed are medium-to-small ground snakes; there are two water snakes—one a freshwater inhabitant and the other (*Cerberus rhynchops*) characteristically living in brackish to salt waters. *Python reticulatus* is probably one of the island's most important predators on small mammals (see Medway, this *Bulletin*, p. 27). The single arboreal snake, *Dryophis prasinus*, and two (uncollected) cobras complete the list. If all the large, active, terrestrial genera of colubrid snakes such as *Elaphe*, *Zaocys*, *Ptyas*, etc., are truly absent, one is prompted to wonder how the ophiphagous *Naja hannah* makes its living in the absence of the main items on its usual mainland diet.

As with the mammals and birds (see Medway), it is interesting to consider the reptile fauna in relation to the history of Tioman in general—to what extent they may be a relict collection isolated from the rest of ancient Sundaland by rising postglacial seas, and to what extent they may be more recent immigrants, whether by human agency or not.

Table 2 lists the 26 reptile species collected on Tioman and indicates the known distribution of each species. Eliminating the un-named species of *Cnemaspis*, the remaining 25 species all—without exception—occur also on one or more of the Sunda Islands. 24 occur on the Malay Peninsula as well (*Goniocephalus chamaeleontinus* gets no closer than Tioman), but only 15 of the 25 species occur on the mainland of Asia above the Malay Peninsula. This indicates a principal affinity of the Tioman fauna with the Sunda fauna rather than with the Indo-Chinese complex. I believe it argues for consideration of the Tioman fauna as principally a relict isolated *in situ* rather than a collection of immigrants across the water from the mainland.

TABLE 2

Tioman Reptile Species*—Distributional Data

Continental = occurs on the main continent of Asia above the Malay Peninsula.

Peninsular = occurs on the Malay Peninsula (Thai or Malayan portions).

Sunda = occurs on one or more islands of the archipelago related to ancient Sundaland (Borneo, Sumatra, Java, etc.)

			Continental	Peninsular	Sunda	
Chelonians						
<i>Dogania subplana</i>	...	...	x	x	x	? marine immigrant
Lizards						
<i>Varanus nebulosus</i>	...	...	x	x	x	
<i>Cnemaspis kendalli</i>	...	...	-	x	x	
<i>Cnemaspis</i> sp.	...	...	?-	x	?-	
<i>Hemidactylus frenatus</i>	...	...	x	x	x	? introduced by man
<i>Gehyra mutilata</i>	...	...	x	x	x	? introduced by man
<i>Draco melanopogon</i>	...	...	-	x	x	
<i>Draco volans</i>	...	...	-	x	x	
<i>Aphanotis fusca</i>	...	...	-	x	x	
<i>Calotes cristatellus</i>	...	...	x	x	x	
<i>Goniocephalus armatus</i>	...	...	x	x	x	
<i>Goniocephalus grandis</i>	...	...	-	x	x	
<i>Goniocephalus chamaeleontinus</i>	...	...	-	x	x	
<i>Mabuya multifasciata</i>	...	...	x	x	x	
<i>Lygosoma scotophilum</i>	...	...	-	x	x	
<i>Dasia olivacea</i>	...	...	x	x	x	
Snakes						
<i>Python reticulatus</i>	...	...	x	x	x	? marine immigrant
<i>Oligodon purpuracens</i>	...	...	x	x	x	
<i>Oligodon signatus</i>	...	...	-	x	x	
<i>Calamaria vermiformis</i>	...	...	-	x	x	
<i>Liopeltis tricolor</i>	...	...	-	x	x	
<i>Natrix chrysarga</i>	...	...	x	x	x	
<i>Cerberus rhynchops</i>	...	...	x	x	x	
<i>Dryophis prasinus</i>	...	...	x	x	x	
<i>Naja naja</i>	...	...	x	x	x	
<i>Naja hannah</i>	...	...	x	x	x	

*The three lizard species reported by Smith (1930), are omitted from this list to avoid confusion (see footnote 13, p. 53). The two cobra species (not collected) are included, but other "probables" such as *Varanus salvator* are omitted.

That at least some of the Tioman species are immigrants seems quite logical, and certain ones appear more likely than others to have been able to reach the island after its final isolation by rising seas. The large Pahang River, which drains a vast area in Malaya, debouches on the East Coast where the set of the currents is such as would carry vegetation-rafts southward toward Tioman. It is possible to believe in the likelihood of *Dogania subplana*, *Python reticulatus*, and *Cerberus rhynchops* successfully swimming the 24 miles from the mainland to Tioman (the distance might have been considerably less in earlier times). In my opinion, it is more probable than not that, even if the two house geckoes *Hemidactylus frenatus* and *Gehyra mutilata* were not already on Tioman, they would have arrived there in human baggage during the last 100 years. The skinks *Mabuya multifasciata* and *Dasia olivacea* are very widespread and appear to have a marked facility for island-hopping; I am quite prepared to believe that the coconut-plantation-inhabiting *Draco volans* was transported to Tioman by human agents—most probably as eggs carried with soil around the bases of plants which were dug up and brought to the island for transplanting. If the above turtle, 2 snakes, and 5 lizards are subtracted from the list of 25 species, the fauna score then becomes 100% shared with Sunda Islands, 94% shared with the Malay Peninsula, and only 47% shared with Asia above the Peninsula. Having granted the most probable immigrants after Tioman was isolated as an island, the remaining argument is strong for relict derivation.

In my mind's eye I visualize the Tioman mass as an isolated small mountain in a low, swampy Sundaland, grading from a poorly-drained base up through well-drained slopes to a virtually barren, excessively well-drained peak region consisting of little more than a colossal heap of boulders and supporting only meagre vegetation. Although its upper levels approached the required elevation above sea level, I do not believe Tioman supported many of the high-altitude species which existed—and have survived—in other, better-vegetation, high regions of Sundaland. During the fluctuation of sea level which took place during Pleistocene times, I visualize the resident fauna on the slopes of Tioman retreating uphill and returning down, losing some species during the periods of stress when the rising water level forced terrestrial species into the more limited space and more difficult living conditions which would exist on the upper, more rapidly-drained slopes. At some times the sea level was higher than it is now, as evidenced by fossil coral reef formations on the island today. (There seems to be no evidence of very recent uplift or subsidence of the land itself.)

During the periods of most extreme stress, the tropical rain forest as we know it in Malaya today must have virtually disappeared on Tioman except for relatively small, isolated pockets where soil and drainage were favourable for survival. Many plant species must have died out (see remarks on dipterocarps, etc., in Bullock and Medway, this *Bulletin*, p. 6) and many vertebrate species must have disappeared as their habitat altered. The terrestrial chelonians may have been forced out by disappearance of food in the form of fruits of tree species which did not survive and fungi which no longer had appropriate damp shade in the altered forest remnants. The insect-eating lizards, however, might have best survived these periods of trial, as indicated by their relatively abundant species representation on the island today.

Following the times of worst trial, conditions have presumably improved and a steady process of soil-building has gone on, so that today—with the most pressing predators removed and with considerable good habitat available—the surviving reptilian species have reached a high level of density.

It is interesting to contrast the Natunas Islands with Tioman. The former are very much more isolated and have a geographically very much stronger argument for relict derivation of their fauna than does Tioman. They differ in having a good deal more high ground capable of supporting good forest, and they presumably offered more abundant and more congenial refuge for relict species retreating uphill ahead of the rising Pleistocene waters. The number of species in the Natunas reptile fauna is probably about twice that of Tioman; 16 of the 25 listed Tioman species have been recorded from the Natunas, more may well occur there. There are 3 non-marine chelonians in addition to *Dogania subplana*, one (*Geomyda spinosa*) fully terrestrial forest species and two freshwater terrapins. The Natunas fauna has 6 *Draco* species as against Tioman's 2, and two lizard genera (*Japalura* and *Tachydromus*) which have not been found on Tioman.

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