

## 6. The Amphibians

By J. R. HENDRICKSON

### INTRODUCTION

IT APPEARS that previous zoological collectors on Pulau Tioman have paid little attention to the amphibians. This is apparently the first faunistic account dealing with the amphibians of the island; so far as can be determined, all species except *Rana macrodon* (reported by Smedley, 1931) are here recorded from Tioman for the first time.

The collections reported on here were made by Hendrickson from 26th May to 5th June, 1958 (during the course of a visit made primarily to survey sea turtle nesting beaches) and the University of Malaya party in March and April, 1962. The 1958 collections were made at Kampong Tekek and Kampong Juara, and along the trail which runs across the island to connect the two villages. The 1962 party explored more fully and penetrated much difficult terrain beyond this area; all of the frogs collected from above 1,500 feet elevation were taken by the later expedition.

Twelve species, one described as new, are represented in the present collections. No doubt further exploration will demonstrate the existence of other species of amphibians, unrecorded here. However, I believe that the main body of the amphibian fauna is now known and that a fair faunistic summary can be made. Further new records will probably be confined mainly to small, relatively inconspicuous species which are closely tied to restricted niches in the forested interior of the island. I would, for instance, expect further intensive work in the island streams to produce a caecilian.

One major service which future expeditions can perform is to give special attention to investigation of the abundance and distribution of *Bufo parvus* and *Rhacophorus leucomystax* on the island. Both these species are characteristically abundant and conspicuous wherever they occur on the adjacent Malayan mainland, yet our present collections contain only a single specimen of each. If they exist at all as breeding populations, many specimens should have been found. It is quite anomalous to have each species represented by a single individual after such intensive collecting as was done on the 1962 visit. I believe that, should future expeditions fail to find more of these two amphibians, they should be dropped from the faunal list and our two individuals considered as chance introductions, without opportunity to breed.

No amphibians were found on Pulau Tulai. There is no permanent fresh-water on that island (see Bullock and Medway, this *Bulletin*, p. 7).

### SPECIES LIST<sup>16</sup>

*Megophrys monticola nasuta* (Schlegel).

Nose-horned Frog.

Four specimens were collected, including 2 adult females, 1 adult male, and 1 immature individual. One of the adult females contained ova about 3 mm. in diameter; the gonads of the other appeared to be inactive.

16. Established common names do not exist for most Malayan frogs. For the sake of consistency, an attempt has been made here to suggest English names for most species; these should not be considered as necessarily having wide acceptance and usage.

Comparison with specimens from Singapore, Selangor and various parts of Pahang (including the Rompin area, about 50-60 airline miles from Tioman) revealed no particular differences between Tioman and mainland forms. I follow Inger (1954) in considering *nasuta* Schlegel as a subspecies of *monticola* Kuhl and van Hasselt.

All four of these specimens were collected in wooded portions of the island, the male at an elevation of about 200 feet behind Kampong Mokut, one large female on the cross-island trail behind Kampong Tekek at an elevation of about 900 feet, and the other large female and the immature individual on the slopes of Gunung Kajang, at about 2,500 feet. This species was commonly heard calling along the Sungei Ayer Besar near Camp II.

**Bufo parvus** Boulenger.

Forest Ground Toad.

A single specimen of this (usually) common little forest toad was taken at Kampong Juara on 26th March, 1962. It is an adult female (No. 5092) with many large ova; snout-vent length, 45.7 mm. When compared with specimens from Selangor, Pahang and Kelantan it shows no remarkable differences except for possibly having slightly higher, sharper spines on its tubercles.

When the writer visited Tioman for eleven days in 1958, he did not see or hear a single *Bufo*. The 6 persons in the main party on the 1962 expedition did considerable collecting for 43 days, covering many parts of the island, and they did a great deal of searching for amphibians. One might have expected one or more species of *Bufo* to be quite common, yet only this single specimen was taken and no larvae were recorded. This must remain a mystery for the present — one is tempted to suggest that we may have collected an individual recently introduced from the mainland.

**Pelophryne signata** (Boulenger).

Dwarf Toad. (Plate 9).

Eight specimens, all females, of this interesting little toad were collected.

Barbour (1938) lists eight species of *Pelophryne*. Of these, my specimens fit best the descriptions of *signata* from Borneo (Boulenger, 1894) and *brevipes* from the Philippines (see Inger, 1954 and 1960a). Both of these species have a more or less cruciform dorsal pattern and venters spotted with black, and both are of comparable small size to the Tioman specimens (Boulenger's report on the two known specimens of *signata* gives 15 mm. snout-vent length; Inger records a mean of about 17.1 mm. for *brevipes*). The sizes of the eight Tioman specimens are as follows:

No. 5306 (immature)	10.3 mm. snout-vent length
No. 5222 (immature)	11.3 mm. snout-vent length
No. 5223 (subadult female)	16.0 mm. snout-vent length
No. 5221 (subadult female)	16.1 mm. snout-vent length
No. 5224 (adult female, ova = 0.8 mm.) <sup>17</sup>	18.6 mm. snout-vent length
No. 5178 (adult female, ova = 0.9 mm.) <sup>17</sup>	18.9 mm. snout-vent length
No. 5115 (adult female, ova = 1.0 mm.) <sup>17</sup>	20.0 mm. snout-vent length
No. 5116 (adult female, ova = 1.5 mm.) <sup>17</sup>	20.3 mm. snout-vent length

The Tioman specimens have the tympanum bare and very distinct,  $\frac{2}{3}$  to  $\frac{3}{4}$  the diameter of the eye, as described for *signata* (Boulenger, 1894). It is not covered with skin and obscure, slightly less than  $\frac{1}{2}$  the diameter of the eye as described for *brevipes* (Inger, 1954). The hands are less extensively webbed (particularly on the medial side of the second finger) than Inger's (1954) figure of *brevipes*. In this they

17. All frogs possessing enlarged eggs had these in one ovary only, the other ovary appearing inactive.

appear to match Boulenger's original figure of *signata* (*Proc. Zool. Soc. London*, 1894, pl. 40, fig. 1). It should be mentioned that, while Boulenger states in the original description that the tibiotarsal articulation reaches the tip of the snout, it extends only to the front of the eye in these specimens.

The colour and pattern of these little toads is sufficiently striking to warrant an attempt at description: Dark blackish brown dorsally with a variably contrasting large "X" pattern formed by lighter bands which run from each upper eyelid back across the body to the inguinal region of the opposite side, the point of intersection of these bands being a short distance behind the level of insertion of the forelimbs. At the point of intersection of the "X" and also over the coccyx are two fairly extensive spots of guanistic overlay. When the "X" pattern is dark and relatively inconspicuous, the large guanistic spots are very intense and contrasting; when the "X" is a contrasting light tan (as on all the smaller specimens), the guanistic spots are suppressed. The dark ground colour is intensified to a contrasting black on the edges of whichever light pattern is dominant. There is a dark interorbital bar and variably-expressed dark median line from the snout tip back to this. The tops of many of the tubercles on the dorsal surface are a bright carmine, particularly in the dark areas, producing further colourful contrast. The limbs are blotchily barred with darker colour. There is a fairly sharp line of demarcation between dorsal dark ground colour and ventral chrome yellow, irregularly blotched with black; this line runs from just below the center of the tympanum (which is uniform brown) back to the hind limb base. There are irregular black blotches on the yellow venter (heavier in the larger specimens) tending to increase to a marbling of black on the throat and decreasing to a faint speckling on the ventral thighs.

Plate 9 shows five specimens arranged to show the variation in dorsal pattern.

All the specimens were taken in forest on the higher parts of the island: five along the trail crossing the island from Tekek to Juara — minimum elevation 900 feet, two at Ulu Lalang above 2,400 feet, and one on Gunung Kajang above 2,900 feet. All were collected during the daytime, by insect collectors. They were sitting on the ground or a few inches up off the ground in the herb layer of the forest vegetation. They were not found in any particular relation to water; in this they conform with other observations on the ecology of the genus, which is apparently a highly adapted general forest type, able to breed in very small, inconspicuous bodies of entrapped rain water (Inger, 1960a).

**Ansonia tiomanica** sp. nov.

Slender Toad. (Plate 10).

Two specimens, an adult male (No. 5129) and an adult female with eggs (No. 5128), are described here as syntypes. Both were collected by Bullock and Medway from a cave at an elevation of about 2,400 feet, Ulu Lalang, Pulau Tioman, Pahang, Malaya, on 5th April, 1962. The types are deposited in the Bishop Museum, Honolulu.

*Diagnosis*<sup>18</sup>: A medium-sized species (female 36.3 mm. and male 31.2 mm. in snout-vent length); tympanum clearly visible externally; finger tips broadened into small spatulate disks; first finger not reaching to disk of second finger; no interorbital ridges or conspicuously enlarged tubercles in interorbital space; at least two phalanges of third and fifth toes free of web; no tarsal ridge; uniform dark blackish brown with scattering of small, irregular yellow dots.

*Further description*: Habitus slender, with long legs, the tibiotarsal articulation reaching the front of the eye and the tarso-metatarsal articulation extending well out beyond the snout. Snout about as long as the eye, constricted in front

18. In describing this new species I have attempted to follow the form of presentation used by Inger (1960b) in his review of the genus *Ansonia*.

of the eyes and sloping in profile, truncate and projecting; canthus rostralis distinct, sharp; lores vertical, faintly concave; interorbital space at narrowest point about  $1\frac{1}{4}$  times upper eyelid; tympanum diameter slightly less than  $\frac{1}{2}$  that of eye.

Fingers long and slender, with tips expanded into bluntly rounded, spatulate disks which, on at least fingers 3 and 4, are twice as wide as the narrowest portion of the digits which bear them. Inconspicuous web at base of fingers, not reaching beyond distal ends of basal phalanges. Length of first finger (measured from median edge of palmar tubercle) about equal to diameter of eye in male, slightly greater than diameter of eye in female. First finger not reaching disk of second, which in turn does not extend as far as the base of the disk of the fourth finger. Subarticular tubercles feeble; a distinct, rounded outer palmar tubercle (fig. 5A).

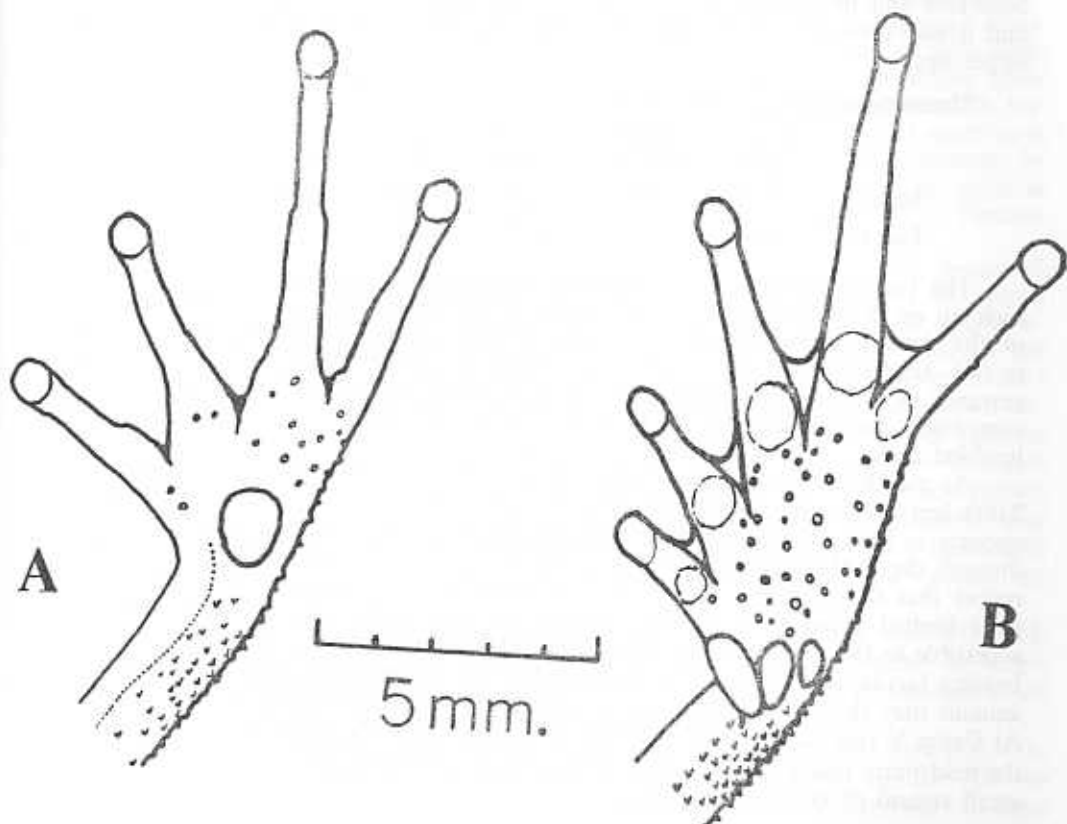


Figure 5. *Ansonia tiomanica*. A, male, palmer surface of left hand; B, female, palmer surface of left foot.

Toes with very slightly expanded disks (not as large as disks on fingers); third toe shorter than fifth (not reaching level of base of fifth toe disk in male, reaching this level in female); reduced web on foot, extending narrowly out along sides of toes but leaving at least two phalanges free on third and fifth toes, three phalanges free on fourth toe. Subarticular tubercles weak to nearly absent; outer metatarsal tubercle oval, well-demarcated and moderately high; inner metatarsal tubercle large, very flat, tending to be divided into an inner, more flattened tubercle and a central, oval, slightly higher tubercle which almost touches the medial edge of the outer tubercle. No sign of a tarsal ridge (fig. 5B).

Densely covered dorsally with heterogeneous rough tubercles, lower and smoother on head, more spinose on back, smaller-sized on limbs, grading to granular texture on ventral surfaces.

Male (which has large, lobulated testes) with longitudinal slit on right side opening into vocal sac; no noticeable nuptial pad and no particular distinctive tubercles or asperities under mandible. The larger of the ova carried by the female were about 1.5 mm. in diameter; all ova were unpigmented (Plate 10).

Colour (in alcohol) uniform dark blackish brown grading to grey ventrally, with sparse scattering of round dots (single tubercles) and small irregular spots (groups of tubercles) of yellowish white (reported by the collectors as canary yellow in life), tending to form ill-defined narrow bands of contrasting colour on both fore and hind limbs; one or more conspicuous light dots at jaw commissure and a tiny area of light colour under each eye (not extending down to edge of upper lip).

Measurements (in millimeters):

	Snout-vent	Head Length	Head Width	Tibia	Foot	Eye
Male	31.2	8.3	8.5	12.8	10.4	3.1
Female	36.3	9.4	9.2	15.8	12.3	3.6

The two specimens were both collected from the cave known as Gua Sinah, high up on the slopes of the island in the Ulu Lalang area. The deeper portions of the cave were inhabited by *Collocalia maxima* (see Medway, this *Bulletin*, p. 43). One of the toads was found sitting on a rock under the overhanging entrance to the cave, the other was found a short distance back in the cavern (not completely dark at this spot); a third individual was seen, but escaped among the jumbled rocks.

As mentioned in the Introduction, there is practically no surface water above 2,000 feet on the island and the only running water is subterranean. Gua Sinah appears to be a drainage channel following interstices between large boulders, cut through the packing clays but not involving much erosion of rock. The collectors report that the cave was damp, but that they reached no running water during their limited exploration. It may be that running water occurs at some points accessible to the toads and that suitable habitat exists underground for the sucker-bearing larvae of this genus, at least during the rainier portion of the year. The animals may thus have become more or less obligate cave inhabitants on Tioman. At Camp V (see Bullock and Medway, this *Bulletin*, p. 7), the only suitable water the field party could find was deep in a cave, in total darkness, where there was a small stream of fast-flowing water.

***Rana cancrivora cancrivora* Gravenhorst.**

Crab-eating Frog.

Seven specimens: adult male (No. 5100) from Kampong Lalang; three sub-adult females from Kampong Tekek; three immature specimens from about  $\frac{1}{2}$  mile south of Kampong Tekek. All were collected in or near standing or very slow-moving water in stream meanders near sea level.

The Tioman specimens conform with descriptions of the species *cancrivora* (Boulenger, 1920; Smith, 1930 (key); Inger, 1954). They resemble two specimens in my collection from Chon Buri, Thailand but differ from all my Malayan and Singapore specimens in their smaller size, as indicated by the adult male (and not contra-indicated by the three sub-adult females). Smith (1930) described southern

Thai frogs from the vicinity of Patani as a new subspecies, *Rana cancrivora raja*, on the basis of their larger size. He cites snout-vent lengths of 60 mm. (male) and 73 mm. (female) for Bangkok specimens of his "forma typica" (= *cancrivora cancrivora*) as against 87 mm. (male) and 120 mm. (female) for *cancrivora raja*<sup>19</sup>. The adult male from Tioman measures only 61 mm. from snout to vent, whereas among some 15 adult males from Selangor and Singapore, none measure less than 71 mm. It seems probable that Smith's 87 mm. male and 120 mm. female *cancrivora raja* were his largest specimens; my largest specimens (from Selangor) measure 81 mm. (male) and 118 mm. (female).

Size alone seems an unsatisfactory criterion for separating off subspecies; I agree fully with other workers who feel that the two subspecies "look different" as well but, like them, I have failed to turn up any good physical character other than size to separate *raja* from *cancrivora*. There is a great deal of individual variation in these frogs. All my Tioman specimens and the two specimens from Chon Buri have distinctly narrower skin flaps on the outer side of the 5th toe than do any of my peninsular specimens. Comparison of larger series of *cancrivora cancrivora* with *cancrivora raja* might validate this as a distinctive difference. In my *cancrivora raja* from Malaya and Singapore this flap at its broadest point is wider than the penultimate phalanx of the 5th toe (not so with the 7 Tioman and 2 Chon Buri specimens).

Aside from the physical characters so useful when working with preserved animals, it appears there is a marked physiological difference between *cancrivora* and *raja*. The northern, smaller subspecies has long been known to show a remarkable tolerance to salt water (Inger, 1954, gives a short summary of some of the earlier reports). Recent work by Gordon, Schmidt-Nielsen and Kelley (1961) has demonstrated that, by means of a physiological uraemia in some ways comparable to that found in elasmobranch fishes, *cancrivora cancrivora* can tolerate up to 80 per cent sea water—3 times the salt concentration which can be borne by other frogs. This tolerance was observed with starved frogs in the laboratory, and the authors point out that feeding individuals under natural conditions may have even greater salt tolerance than they observed. Larvae tested at the same time tolerated a remarkable 3.9 per cent salinity (about 120 per cent of normal sea water concentration).

At the time the above work was going on in South Vietnam and Thailand, I attempted a few crude tests on *cancrivora raja* purchased in the market in Singapore: some survived 25 per cent sea water for two days, but none of these survived 50 per cent sea water when transferred to it.

The Tioman specimens reported on here were all found in semi-brackish, swampy situations close to the sea (see Bullock, this *Bulletin*, p. 4). All the *cancrivora raja* I have collected in the Peninsula have been in freshwater swamps beyond tidal influence. I have never seen one in a mangrove swamp, as *cancrivora cancrivora* has been reported.

The salt tolerance of the Tioman *cancrivora* should be tested. This could be a factor in explaining the existence of this "Thai" subspecies on the island, while subspecies *raja* holds sway on the mainland. It is interesting to speculate on a vast Sundaland population of *cancrivora* being subjected to salt water invasion during the Pleistocene, with strong selection pressure for salt tolerance, and successful adaptation occurring and persisting to the present in areas as far apart as Thailand and Java, with a minor pocket at Pulau Tioman.

19. Inger (pers comm.) reports that specimens of *cancrivora* from Borneo range from 51.0 to 70.9 mm. snout-vent in males and 52.9 to 82.0 mm. snout-vent in females, roughly comparing in size with northern (coastal) Thai, Tioman, and Java specimens.

**Rana blythii** (Boulenger).<sup>20</sup>

Malayan Giant Frog.

44 specimens from Tioman are at hand, 19 adult males, 13 adult females, and 12 immatures and juveniles of various sizes. The ten largest males (measured to the nearest 0.5 mm.) average 108.4 mm. in snout-vent length (min. 96 mm., max. 117.5 mm.); the ten largest females average 86.1 mm. (min. 81.0 mm., max. 95.0 mm.). They conform to Boulenger's (1920) description of his "variety *blythii*" in shape of head, size of eye, and generally greyish olive colouration. Six of the females have large unpigmented ova from 2.1 mm. to 2.5 mm. in diameter; one of these (No. 5175) has the ova in oviducal sacs, with full jelly coats, immediately ready for laying.

Comparison with other specimens from many parts of Malaya, including the Rompin area of Pahang (50-60 airline miles from Tioman) fails to reveal any distinctive differences on the part of the Tioman specimens. None are as large as the largest mainland specimens, but they are not significantly smaller than the mass of breeding individuals obtained from the same localities. Note might be made here of a suspected distinctiveness in the call of *blythii* from Pulau Tioman. When I visited the island in 1958 I thought that I had identified the call of Singapore *blythii* as a muffled, fairly musical grunt. Although I was never able to actually see an individual as it called, I had repeatedly located large *blythii* as a result of tracing this particular sound. On Tioman I was able to observe individuals in the act of calling; there, the call sounds remarkably like the imitation of flatulence which can be made by expressing air in a short burst through tightly compressed lips.

Inger (pers. comm.) points out that *blythii* of the Malay Peninsula and Borneo differs from *macrodon* and from Philippine taxa (*acanthi*, *magna*, *macrocephala*, and *visayanus*) in that *blythii* lacks vocal sacs and has eggs without a densely pigmented dark hemisphere. I have no quarrel with this, but wish to add a word of caution to anyone opening Malayan *blythii* for a quick look at the ova as an aid to identification. The ova of *blythii* are not formed of contrasting dark and light hemispheres, but neither are they completely pigment free as are the ova of, say, *Staurois larutensis* or *Rhacophorus leucomystax*. When a little less than 1 mm. in diameter they gain considerable pigment and become dark grey *all over*; as they grow further, this pigment is diffused and they become progressively lighter in colour, although they never become as pale as the pigment-free eggs of the above species. If a female opened for inspection happens to have no large eggs, but has a developing size class of ova which have reached the most heavily pigmented stage, their dark grey contrasts with the white of the many tiny ova to produce an impression of speckling which at first glance might be mistaken for the characteristic appearance of an ovary with black-and-white eggs.

*Rana blythii* is a forest frog, inhabiting the vicinity of moving water for the most part. It is definitely the dominant amphibian on Tioman, living mainly in forest near upland streams, but also following these down onto the edges of the coastal plain. At night, individuals sit at the edge of the water, or back on a raised bank as much as ten feet or more from the water, seizing any moving object of the appropriate size class. Mainland individuals have been found with frogs, rats and snakes in their stomachs, in addition to invertebrates.

As noted in the introductory remarks, this frog has been recorded from Tioman by Smedley (1931).

20. Inger (in litt.) establishes *blythii* as a full-standing species. I agree with this and therefore, with Inger's permission, use the name here rather than "*macrodon* Dumeril & Bibron" or "*macrodon* var. *blythii* Boulenger".

**Rana (Discodeles/Platymantis) sp.**

Two male specimens, 34.0 and 20.8 mm. in snout-vent length, collected at about 1,000 feet on the cross-island trail and at 2,500–3,000 feet in Ulu Lalang. These frogs are unidentifiable to species by any literature or specimens available to me. They have disks on the fingers with circummarginal grooves separating dorsal and ventral surfaces. They lack any intercalary cartilages between ultimate and penultimate phalanges. The outer metatarsals are partially bound together by heavy skin. The omosternum is distinctly forked at the base and has a bony style. There are small, but strong, vomerine teeth.

Boulenger (1918a, 1918b and 1920), while recognising close affinities, kept the genera *Cornufer* and *Platymantis* separate from *Rana* on the basis of large disks with a ventral transverse groove in the former and reduced webbing on the foot in the latter. He recognised a subgenus *Discodeles* of *Rana* which shares with *Cornufer* and *Platymantis* all the characters listed in the preceding paragraph, but which differs from them in having no ventral transverse grooves on the disks and in having strongly webbed feet. *Discodeles* also has a large, retractile papilla in the middle of the tongue which the others lack. Van Kampen (1923) recognised *Cornufer* as generically distinct on the basis of its highly differentiated digital pads (adhesive portion demarcated by the ventral transverse groove); he treated both *Discodeles* and *Platymantis* as subgenera of *Rana*. Smith (1930) states that he has "taken full advantage" of Boulenger's 1920 monograph, but classes as *Discodeles* two species (*tasanae* and *tenasserimensis*) which conform to *Platymantis* in having reduced webs and no tongue papillae; he gives no discussion of this; he did not deal with *Cornufer* or *Platymantis* species in this work. Noble (1931) viewed *Discodeles*, *Platymantis* and *Cornufer* each as full genera separate from *Rana*. Inger (1954) did not deal with species of *Discodeles*, but combined *Platymantis* and *Cornufer* species into the single genus *Cornufer*, separate from *Rana*.

The specimens concerned here (No. 5117 and 5176) differ from *Discodeles* in having reduced webbing on the feet and no tongue papillae. They differ from *tasanae* and *tenasserimensis* (*Discodeles* of Smith, 1930) in vomerine teeth, size of disks, webbing of foot, colouration and other characters. They differ from the *Cornufer* of Boulenger, Van Kampen and Noble in having only small digital disks and in lacking any transverse ventral grooves on these; and they differ from Inger's concept of *Cornufer* in having the outer metatarsals less fully bound together (groove separating fourth and fifth metatarsals ends about  $\frac{1}{2}$  way back dorsally, about  $\frac{2}{3}$  of the way back ventrally) : they also lack the supernumerary subarticular tubercle on the fourth finger which Inger describes for Philippine species of *Cornufer*. They most nearly conform with *Platymantis* of Boulenger (derived from and with affinities to species of his subgenus *Discodeles*) or with Smith's *Discodeles* as exemplified by *tasanae* and *tenasserimensis*.

The interesting feature of this record is that, aside from *Rana tasanae* Smith from South Thailand near the Kra Isthmus and *Rana tenasserimensis* Sclater from Southern Burma and the northern part of the Malay Peninsula, this is the only other record known of a frog of this facies intermediate between the *Discodeles* species of South India and the species of *Discodeles* and *Platymantis* of the Philippines, Melanesia, and New Guinea.



The specimens are of superficially unremarkable appearance, dark blackish brown dorsally, grading to grey-brown on the limbs; one has a contrasting dirty-white mid-dorsal stripe with a fine dark line down its center, the smaller specimen lacks this; the limbs bear partial bars of black; ventrally the colour is off-white with sparse, very fine brown speckling on the throat. The smaller specimen was found on the cross-island trail between Camp II and Juara; the larger was found on the forest floor high up on the slopes of the island at Ulu Lalang, far from any known surface water (frogs of this group are known or suspected to be terrestrial breeders, passing the larval stage in the egg membranes). Neither specimen has vocal sac openings, or any sign of nuptial pads.

***Rana erythraea*** (Schlegel).

39 specimens : 4 females (3 with large eggs), 20 males, and 15 immatures and juveniles. Comparison with specimens from Singapore, South Pahang, Selangor and other parts of Malaya revealed no particular differences on the part of the Tioman individuals.

All the specimens were taken in or near water on the coastal plain, where the water of debouching streams is either slow-moving or impounded and stagnant. Most of the specimens were collected south of Kampong Tekek, where a bar across the mouth of a stream impounds its outflow into a stagnant pool which has its only outlet by way of seepage through the sand of the beach front (see Bullock, this *Bulletin*, p. 4). This area is relatively open and sunlit; there was an extensive mat of freshwater algae.

This is the commonest rice field frog in most parts of Malaya. On Tioman there is no wet rice cultivation and no indication that there ever has been such; *Rana erythraea* lives in the nearest approach to a rice field habitat which is available to it on Tioman.

***Rana hosii*** Boulenger.

Hose's Cataract Frog.

The 1962 expedition took none of this species; I collected four adult females near the site of Camp II in May, 1958:

No. 3018 — 89.0 mm. snout-vent length (swollen oviducts, but no large ova).

No. 3019 — 88.9 mm. snout-vent length (1.9 mm., unpigmented ova).

No. 3042 — 90.2 mm. snout-vent length (1.8 mm., unpigmented ova).

No. 3043 — 93.0 mm. snout-vent length (swollen oviducts, but no large ova).

When compared with available large females from Selangor and central Pahang, the Tioman specimens showed no distinctive differences.

It is assumed that the two ovigerous females from Tioman were almost ready to breed and the other two with swollen oviducts had just laid their eggs. *Rana hosii* from Pahang in my collection have loose abdominal eggs which measure approximately 2 mm. in diameter.

*Rana hosii* is an inhabitant of the vicinity of fast-flowing upland forest streams. It looks superficially like a giant form of *Rana chalconota* and the two species are often found in association, but *hosii* is most commonly found at night sitting on rocks very near the faster water, while *chalconota* is usually perched on nearby vegetation. The more completely webbed feet of *hosii* are probably an adaptation for fast water and its tadpole (apparently unknown) may well be equipped with a sucker; the unpigmented eggs indicate some special site of deposit. (The rather ordinary-looking larvae of *chalconota* hatch from the usual sort of eggs with black and white hemispheres, laid in relatively quiet pockets of clear water along streams).

**Rana chalconota** (Schlegel).

Malayan Bush Peeper.

Forty-two specimens are available, most taken during the recent visit in 1962. The collection includes 19 females (11 with large eggs) and 23 males. Comparison with specimens from Singapore, Johore, South Pahang, Selangor and other parts of Malaya reveals no distinctive differences on the part of the Tioman individuals.

This is a frog of forest streams, frequenting mainly the plant growth on stream margins. On Tioman it is found mainly on the higher ground where the forest is less disturbed, although it follows the stream courses down to the coastal plain and a number of specimens in this collection were taken at low elevations. In some respects it is the upland ecological counterpart of *Rana erythraea*, preferring more shaded surroundings and moving, clear water, although it appears to do well in swampy situations where these exist in the forest.

**Rhacophorus leucomystax** (Boie, in Gravenhorst, 1829)<sup>21</sup>. Common Tree Frog.

A single mature female (No. 5093) from Kampong Tekek; snout-vent length 68.6 mm., with 2 mm. diameter eggs. When compared with 3 comparable-sized female specimens from Rompin, Pahang (50-60 airline miles from Tioman) and 3 from Singapore, no striking differences were noted. The skin over the frontoparietal and part of the squamosal area is fused to the skull in all 7 specimens; it is not fused to the nasal bones in any of them. The Tioman specimen agrees with Rompin females in having a heavier skin fold over the tympanum than do the Singapore females. It shows the common dorsal pattern of four primary and two subsidiary longitudinal stripes; in this it matches the Singapore animals, but differs from the three available large females from Rompin, which are plain with a few small dark blotches dorsally. However, several smaller Rompin specimens show this striped pattern, which appears to be more uncommon in that particular population than in most *leucomystax* in other parts of the Peninsula. No particular taxonomic importance is assigned to this matter of dorsal pattern, spotted frogs having been taken in amplexus with striped frogs and, on one occasion, a large number of progeny having been reared from this union. It is believed that the character is genetically controlled, but not an indicator of genetic isolation; Church (in litt.) discusses the inheritance of pattern in this species.

*Rhacophorus leucomystax* is very much a follower of man in South-east Asia; in the present case the specimen was taken in a rural village environment. It is one of the commonest frogs of the Malayan area, and is certainly the commonest around human habitations. It is almost invariably the first frog brought in by local children when a collecting party moves into an area and announces that the scientists are interested in seeing any animals which they can catch. Yet only this one specimen was taken (by a University collector) on Tioman in a collecting campaign which included well over 100 man-hours of work with lights at night and which should on the mainland have produced a large number of *Rhacophorus leucomystax*. In 1958 the writer spent considerable time night-lighting in and around Kampong Tekek, and never saw a single specimen of this species; neither were any heard croaking during his visit (the calls of these frogs were usually ubiquitous elsewhere).

21. I follow Inger (1954) in attributing the name *leucomystax* to Boie, whose manuscript on the herpetology of Java was never published, but whose specimens, with his manuscript names, were sent to other museums and reported on by other workers. Gravenhorst (1829) makes it clear that *leucomystax* was one of Boie's new species.

Is this by chance an example of an introduced individual (see account of *Bufo parvus*) or are there factors on Tioman which induce rarity in this otherwise abundant species? It must be admitted that no frog in Malaya seems more likely to be transported by man than *Rhacophorus leucomystax*, which lives most abundantly immediately around human habitations, often dwelling within houses and breeding in domestic water containers and impoundments. It resists dessication well when tightly folded in its resting posture, and would be quite likely to insert itself into bundles of materials which were made up for transport. It is possible that this frog is rather frequently brought to Tioman from the mainland and that, despite frequent introductions, it has never been able to establish itself successfully. The principal areas of human habitation in which introduced frogs would have to "start" are on sandy beach areas where there is little standing water except the brackish swamps behind the beach front. Although suitable breeding sites and larval habitats exist, they may be beyond the reach of frogs put ashore at the village sites.

***Philautus petersi* (Boulenger).**

Mountain Tree Frog.

*Ixalus petersi* Boulenger, 1900, Proc. Zool. Soc. London, 1900 : 185, pl. 17, fig. 3.

*Philautus petersi* M. A. Smith, 1925, Journ. Sarawak Mus., 3 : 10; idem., 1930, Bull. Raffles Mus., 3 : 116.

*Ixalus larutensis* Boulenger, 1900, Ann. Mag. Nat. Hist., (7) 6 : 187; idem., 1903, Fascic. Malay., Zool. 1 : 139, pl. 5, fig. 3 & 4; idem., 1912, Vert. Fauna Malay Pen., Rept. & Batr. : 253.

*Ixalus castanomerus* Boulenger, 1905, Journ. Fed. Malay States Mus. 1 : 39, pl. 4, fig. 1; idem., 1912, Vert. Fauna Malay Pen., Rept. & Batr. : 254.

A single adult male (No. 5314) taken near Camp V, 2,500 feet, Ulu Lalang.

This identification is made with some diffidence; as Smith (1930) and Inger (1954) point out, the *Philautus* group badly needs revision and it is extremely difficult to be confident of identifications made by reference to many of the published descriptions. I have not had access to any of the type specimens but, after study of Boulenger's descriptions and figures of *petersi*, *castanomerus* and *larutensis* and acceptance of Smith's (1930) lumping of all these into *petersi*, I find that my specimen agrees well with the enlarged scope of *petersi*. I also note that Inger (1954, p. 403) notes, after examination of the types of *petersi*, that they have the skin along the outer edge of the fifth metatarsal crenulated and that the snout of *petersi* usually bears a dermal projection. My specimen has the tarsal skin faintly but unmistakably crenulated; it also shows a small fold of skin across the snout between the nostrils which I would ordinarily have dismissed as a wrinkle acquired during preservation due to pressure of some sort on the nose in a crowded preserving jar.

The specimen measures 21.9 mm. in snout-vent length; it has well-formed, but not large, testes. The bilateral openings to the vocal sacs are clear. There are clearly-raised, non-pigmented, non-spinose nuptial pads on the medio-dorsal aspects of the bases of the first fingers.

This individual was found sitting on a palm leaf, (*Licuala* sp.) off the ground and was located by its distinctive call. Calls were frequently heard in the forest above 2,500 feet, but nowhere below this elevation.

## DISCUSSION

The amphibian fauna of Pulau Tioman appears to be peculiarly unbalanced, with a number of conspicuous gaps in species representation as compared with the adjacent Malayan mainland. The complete absence of microhylids in our collections is noteworthy; so is the absence of any members of the widespread and hardy genus *Bufo* except for the solitary, enigmatic specimen of *Bufo parvus* collected. The whole group of rhacophorids, so populous and widespread over South-east Asia, is represented in our collections by a single specimen of *Rhacophorus leucomystax*, believed to be an introduced individual without meaning for the species.

I believe that the composition of the present fauna can be satisfactorily explained in its special context by the same Pleistocene history postulated in the accompanying paper on reptiles. By virtue of the permeable skin of the adults and, most particularly, by virtue of the strict requirements of the aquatic larvae of many species, the amphibian fauna of an island such as Tioman might be expected to show rather clearly the influence of physiography and climate, both present and past.

Of the 12 species of amphibians collected on Tioman, only four are bound closely to slow-moving or standing water (*many* of the "absentee species" mentioned above are so-bound). The remaining eight Tioman species are either adapted for life in or near fast-flowing upland streams or are more or less independent of any larger water bodies by virtue of some special adaptation. *Bufo parvus*, *Rhacophorus leucomystax*, *Rana erythraea*, and *Rana cancrivora cancrivora* all have larvae requiring quiet water habitats which are very limited on Tioman (and may have been even more limited in the past). I believe that the first three of these are introduced species, brought accidentally to the island by human agency (it seems possible that the *Bufo* and *Rhacophorus* are not successful immigrants). The fourth species, *Rana cancrivora cancrivora*, is the one lowland frog which I believe to have survived on the island from ancient times, finding suitable brackish habitat here and there along the coastline as the sea level went up and down.

The remaining eight species I believe to be all relicts, surviving on the island since it was isolated by rising Pleistocene seas. Four of these are probably independent of permanent surface streams and would appear to have been particularly well adapted to survive the postulated times of crisis when a raised sea level forced terrestrial life up to the higher portions of the island where the terrain was steep, rocky, and excessively well-drained. *Pelophryne signata* probably breeds in tiny, hidden pockets of entrapped rain water among the leaves of the forest floor. The two specimens of *Ansonia tiomanicus* were found in a cave, which was also a major drainage channel and probably provided a suitable underground habitat for the (presumably) sucker-bearing larvae. The *Discodeles/Platymantis* group of frogs are thought to produce terrestrial eggs and to have no free larval stage. *Philautus petersi* belongs to a group which largely occurs at higher altitudes, commonly in rocky mountain-top situations; it probably breeds in entrapped water in tree holes or leaf axils.

The last four species are all characteristic of upland stream courses, where the water usually flows clear over rocky beds (closely comparable with the Sungei Ayer Besar on Tioman). *Rana chalconota* can also be found in wooded, swampy areas, but it is most dependably found in the brush fringe of small, moderately fast brooks. Its larvae live in the quieter pools where there are accumulated leaves but little or no silt. I have never found *Rana hosii* away from moving water and rocks; its larva is apparently not definitely known, but is suspected to be a sucker-bearing tadpole inhabiting fast water. *Megophrys monticola nasuta* is a

true forest frog and wanders far from water; it returns to streams to breed, and its larvae live best in very shallow trickles of clear water. *Rana blythii* is the common dominant frog of Malayan upland forest streams; its larva and method of reproduction are unknown. It has been suggested to me by Malayan aborigines that the adult constructs a small pool for reproductive purposes. The adult frogs are important in the aboriginal diet and the people claim that they make a conscious effort at conservation by taking care not to step in or otherwise disturb the "nurseries" from which more eatable frogs may someday come. The fact that *blythii* eggs are unpigmented is not inconsistent with a habit of placing the eggs in some special, more or less concealed, place.

It seems to me that the amphibian fauna of Tioman fits very neatly into the historical picture which was postulated in the discussion of the reptile fauna. By their ecology the nine species considered here as relicts seem particularly well-fitted to have survived times of stress which would have eliminated many other species. I venture to predict that any further species discovered on Tioman will either show comparable special features of their life cycle or their appearance will correlate suspiciously with some particular new human activity.

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