

AN ANNOTATED CHECKLIST OF THE AMPHIBIANS OF SINGAPORE, WITH EMPHASIS ON MATERIAL IN THE ZOOLOGICAL REFERENCE COLLECTION

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ABSTRACT. - A list of 24 amphibian species known from Singapore is presented with reference to Singapore material from the Zoological Reference Collection, Department of Zoology, National University of Singapore. Notes on their taxonomy, ecology, biology and local distribution are appended where available.

INTRODUCTION

Of the approximately 96 species of amphibians thus far recorded from Peninsular Malaysia (Kiew, 1984), only 24 species have been reliably recorded from Singapore. There has apparently been no comprehensive listing of Singapore's amphibian fauna prior to a preliminary nominal checklist in Lim & Chou (1990). The present paper, which collates all known reports of amphibian species in Singapore, is intended to serve as a taxonomic base for future work on local amphibians. The Zoological Reference Collection (ZRC) of the Department of Zoology, National University of Singapore houses a good representation of the amphibian fauna of Singapore, and these specimens form the basis of the the material examined here.

Records of Singapore amphibians date back to Cantor (1847), Blanford (1881), Flower (1896), Butler (1904) and Swarder (1924, 1925). Their reports have been cited in Boulenger (1882a, 1882b, 1912), Kampen (1923), Hanitsch (1908, 1912), Bourret (1942), and Smith (1930), and later, in Taylor (1960, 1962) and Inger (1966). Berry (1964, 1965), Sit (1968), Ting (1970), Lee & Chen (1970) and Elliot (1968) dealt on the general biology of some Singapore anurans. Singapore is the type locality of *Ichthyophis singaporensis* Taylor (1960), *Leptobra-chium nigrops* Berry & Hendrickson (1963) and *Rana malesiana* Kiew (1984).

Native amphibian species can be satisfactorily identified by referring to several technical monographs, and also to several local guide books and keys aimed at students and the interested layman. Berry (1975) compiled the only comprehensive popular guide that describes all species known from Peninsular Malaysia and Singapore. It is currently still useful despite presently outdated information. A new edition which takes into account recent developments and changes, with colour photographs, additions of new species and descriptions of larval stages

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would enhance the value of the book. Harrison's (1985) guide to the vertebrate (excluding birds) fauna of the Bukit Timah Nature Reserve suffers from errors in correlating text with illustrations. A picture of the American Bullfrog (*Rana catesbeiana*) is used for text describing *Rana macrodon* (presently *Rana malesiana* and *Rana blythii*) (p. 129); and for *Rana erythraea*, a picture instead, of *Rana chalconota* (p. 128). In the first reprint (Harrison, 1990), the picture of "*Rana macrodon*" was substituted with yet another picture of *Rana catesbeiana* (p. 129), and the name for the picture of *Rana chalconota* has been changed to *Rana hosei*, a species not hitherto recorded from Singapore, yet claimed to be "... (v)ery common" (p. 128).

The amphibian fauna of Singapore has not been well-documented. Recent studies (eg. Lim, 1989a, 1989b) have added two more species, viz. *Rana paramacrodon* and *Bufo quadriporcatus*, and further surveys, especially in the forest areas may reveal additional new records for the island. Knowledge of the general biology, ecology and ethology of many species are still in the discovery stages, e.g. the recent find of *Kalophrynus pleurostigma* spawning in pitcher plant cups (Lim & Ng, 1991).

The majority of Singapore amphibians appear to be strict forest taxa. The rapid urbanisation of Singapore island has drastically reduced the areas of tropical rainforest (Wee & Corlett, 1986) which could lead to the extinction of most of the forest taxa in the near future. Currently, all amphibians confined to forests (about 16 species, indicated with "*" beside the name) should be recognised as locally endangered. Three key areas for the conservation of locally endangered amphibians have been identified; i.e. the Bukit Timah Nature Reserve, the Sime Road forest and the Nee Soon Swamp-forest (Fig. 1). The first site holds the last substantial but severely degraded stand of primary rainforest in Singapore, and records of three species viz., *Pelophryne brevipes*, *Nyctixalus pictus* and *Kalophrynus pleurostigma* appear to be restricted there. The Sime Road forest and the Nee Soon Swamp-forest are both within the boundaries of the Central Catchment Area; the first consisting mainly of secondary forest vegetation, while the second, of peat swamp and secondary forest vegetation. Singapore records of *Rana paramacrodon* and *Rhacophorus bimaculatus* are only from Nee Soon.

Frog legs are an esteemed delicacy in many Chinese restaurants in Singapore, and the American Bullfrog, *Rana catesbeiana* is locally cultivated for this purpose. Some large native species are occasionally collected for food, viz., *Rana cancrivora*, *Rana blythii* and possibly *Rana malesiana*. There have, however, been no published attempts to culture the indigenous species. The newly metamorphosed larvae of *Rana cancrivora* are raised in ponds in large quantities to be sold as live food for aquarium fishes. *Bufo melanostictus* is locally abundant, and commonly used as laboratory animals for school dissection classes (see Harrison & Tham, 1973: 254). The Horned Toad, *Megophrys nasuta* is sometimes sold as pets in aquarium shops, and stocks seem to have been imported from neighbouring areas. The American Bullfrog, *Rana catesbeiana* has been released into the wilds of Singapore by merit-making Buddhists on Vesak Day (see Anon, 1989b:21 as *R. castabeiana*; Lim, 1989c: 66 as *R. catasbeiana*), but does not seem to have become feral. The other amphibians appear to have negligible or no commercial value.

In presentation, each species is listed along with synonyms where Singapore specimens have been mentioned. Nomenclature follows largely that used by Frost (1985) except for a few species. In addition, the names used in Berry (1975) and Dubois (1986) are listed in the synonymy, for the former compiled a comprehensive (in her time) identification guide to the

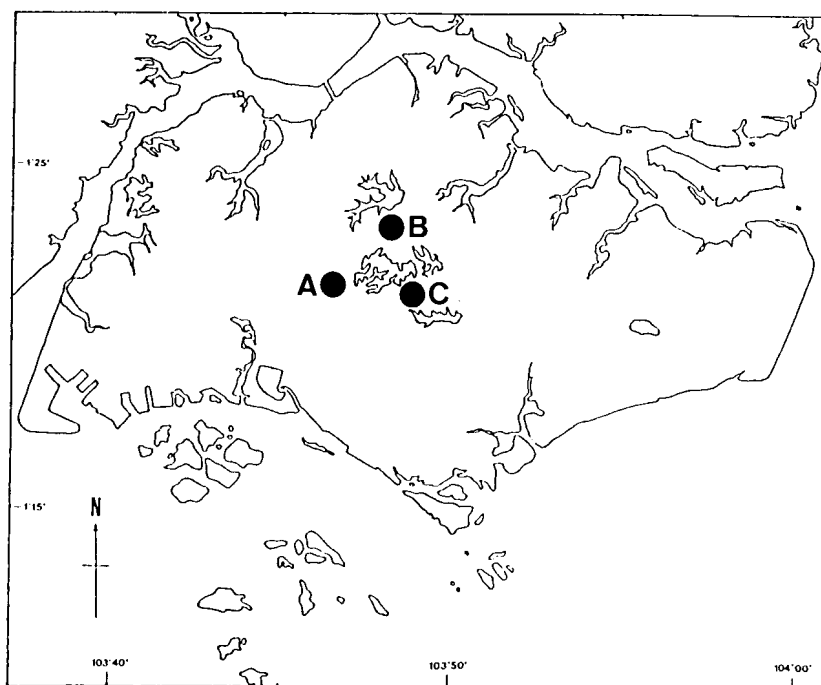


Fig. 1. Map of Singapore island indicating the three key areas for locally endangered amphibians. A. Bukit Timah Nature Reserve; B. Nee Soon Swamp-forest; C. Sime Road forest.

amphibians of Peninsular Malaysia (which is equally useful in Singapore), and the latter attempted to revise certain groups of anurans, mainly ranids. As Dubois' revision is not complete, the names he used will not be followed here. The present paper deals mainly with the adult stage as a large part of the larvae collection in the ZRC has not been properly identified nor catalogued. Remarks on the current status, local distribution, and notes on ecology, biology and taxonomy will be appended where available.

SYSTEMATIC SECTION

Order GYMNOPIHONA

Family Ichthyophiidae

1. *Ichthyophis* cf. *paucisulcus* Taylor, 1960 *

Ichthyophis paucisulcus Taylor, 1960. *Univ. Kansas Sci. Bull.*, 40: 103-107, figs. 34, 35. [Siantar, Sumatra]

Ichthyophis glutinosus - Hanitsch, 1908: 49; Hanitsch, 1912: 19; Berry, 1975: 30-31, fig. 13.

Ichthyophis [sic] *paucisulcus* - Ng, Chou & Yang, 1988: 36-37.

Ichthyophis ? *paucisulcus* - Anon, 1989a: 4.

Ichthyophis cf. *paucisulcus* - Lim & Chou, 1990: 56.

Ichthyophis paucisulcus - Ng, 1989: 13.

Material examined. - 1 spec., ZRC.1.1360, Bukit Timah Nature Reserve, Jungle Fall Valley, leg. P. K. L. Ng, 29.iii.1984. — 1 spec., ZRC.1.1703, Bukit Timah Nature Reserve, Jungle Fall Valley, leg. P. K. L. Ng, 14.ii.1989.

Remarks. - The presence of this yellow-striped caecilian in Singapore was first recorded by Hanitsch in 1904 (see Ng *et al.*, 1988). It was not recorded again until March 1984 and February 1989 (Ng *et al.*, 1988; Ng, 1989). Dr. Robert Inger has examined the 1989 specimen and found that it fits Taylor's (1960) description of *I. paucisulcus*, a species affiliated to *I. glutinosus* and hitherto known only from Sumatra. Ng (1989) and the present authors chose to refer the second recent specimen, also yellow-striped as *I. paucisulcus* although it is generally felt that Taylor's new caecilian species have not been well-defined (see Inger, 1966: 353-354). On 17 July, 1990, the first author observed a caecilian (about 10 cm), brown, with a dull-yellow band in a small, shallow, leaf-littered stream in the Nee Soon Swamp-forest. It was not collected but constitutes a record of *I. cf. paucisulcus* from a new locality in Singapore.

2. *Ichthyophis cf. singaporensis* Taylor, 1960 *

Ichthyophis singaporensis Taylor, 1960. *Univ. Kansas Sci. Bull.*, 40: 55-58, figs. 5,6. [Singapore]

Ichthyophis glutinosus - Cantor, 1847: 1058-1059.

Ichthyophis monochrous - Boulenger, 1882a: 91, pl. IV, fig. 1; Flower, 1896: 914; Butler, 1904: 402; Hanitsch, 1908: 49; Boulenger, 1912: 286; Kampen, 1923: 3-4; Bourret, 1942: 138-139, fig. 15; Berry, 1975: 31.

Ichthyophis [sic] *singaporensis* - Ng, Chou & Yang, 1988: 36-37.

Ichthyophis singaporensis - Ng, 1989: 13; Lim & Chou, 1990: 56.

Material examined. - None.

Remarks. - The description of this purportedly endemic species is based on a poorly preserved specimen collected in Singapore by Cantor (1847), which was recognised by various authors as *I. monochrous* prior to Taylor's publication. This appears to be the only record of a uniformly dark-coloured caecilian from Singapore.

Order ANURA

Family Pelobatidae

3. *Leptobrachium nigrops* Berry & Hendrickson, 1963 *

Leptobrachium nigrops Berry & Hendrickson, 1963. *Copeia*, 1963: 644, figs. 1-2 [Nee Soon, Singapore].

Leptobrachium hasseltii (part) - Flower, 1896: 913; Butler, 1904: 397-398; Hanitsch, 1912: 19.

Megalophrys hasseltii (part) - Boulenger, 1912: 282-283.

Megalophrys hasseltii (part) - Kampen, 1923: 13-15.

Megophrys hasseltii hasseltii (part) - Bourret, 1942: 211-213, fig. 47, 48.

Leptobrachium nigrops - Berry, 1963: 163-167; Berry, 1964: 227-243; Inger, 1966: 37-39; Berry, 1975: 35-36, fig. 17; Anon, 1988a: 6; 1988d: 77; Lim, 1989c: 65; Lim, 1989a: 56; Lim & Chou, 1990: 56.

Megophrys hasseltii - Johnson, 1964: 29.

Material examined. - 1 spec., ZRC.1.154, Mandai Rd; leg. P.M. de Fontaine, 10.iv.1910. — 5 spec., ZRC.1.1260-1264, Nee Soon; leg. C. F. Lim, 9.xii.1974. — 1 spec., ZRC.1.1521, Bukit Timah Nature Reserve, Jungle Fall Valley; leg. K. Lim, 22.xi.1986. — 1 spec., ZRC.1.1766, Sime Rd forest; leg. K. Lim & Y. H. Koo, 24.xii.1989. — 4 spec., ZRC.1.1769-1772, Nee Soon Swamp-forest; leg. K. Lim, P. Yap & P. K. L. Ng, 28.xii.1989. — 1 spec., ZRC.1.1784, Nee Soon Swamp-forest; leg. K. Yong & K. L. Yeo, 30.iii.1990. — 1 spec., ZRC.1.2760, Nee Soon Swamp-forest; leg. P. K. L. Ng & K. Yong, 3.iv.1990. — 1 spec., ZRC.1.2892, forest along north arm of Lower Peirce Reservoir; leg. K. Lim, 13. vii.1990. — 1 spec., ZRC.1.2913, Nee Soon Swamp-forest; leg. P. K. L. Ng & K. S. Boon, 29.ix.1990.

Remarks. - This terrestrial species, often found in the forest leaf litter is currently known from the Central Catchment Area (Sime Road forest, Nee Soon Swamp-forest) and from the Bukit Timah Nature Reserve (Anon, 1988a, 1988d; Berry, 1964, 1975: 36) where it appears to be not uncommon.

4. *Megophrys nasuta* (Schlegel, 1858) *

Ceratophryne nasuta Schlegel, 1858. *Handl. Dierk.*, 2: 57, pl. 4, fig. 72. [Sumatra].

Megalophrys nasuta - Flower, 1896: 913; Butler, 1904: 399; Hanitsch, 1908: 48; Boulenger, 1912: 279-280, fig. 77; Hanitsch, 1912: 19; Kampen, 1923: 10-13, fig. 2.

Megophrys nasuta - Bourret, 1942: 195-197, fig. 38; Johnson, 1964: 29,55; Anon, 1988c: 51; 1988d: 77; 1989c: 41; Lim, 1989c: 65; Lim & Chou, 1990: 56.

Megophrys aceras - Johnson, 1964: 29,55.

Megophrys monticola nasuta - Inger, 1966: 39-46, figs. 11, 12, tables 5,6; Berry, 1975: 40-41, fig. 21.

Material examined. - 1 spec., ZRC.1.1267, Bukit Timah Nature Reserve, wireless station; 28.xii.1977. — 1 spec., ZRC.1.1553, Bukit Timah Nature Reserve, Jungle Fall Valley; leg. P. K. L. Ng, 12.xi.1988. — 1 spec., ZRC.1.2930, Nee Soon Swamp-forest; leg. K. Lim, 30.x.1990.

Remarks. - Johnson (1964: 29) suggested the presence of *Megophrys aceras* from Singapore, but suspected that it "... may merely be a form of the same species (which is *M. nasuta*)". His record of *M. aceras* has not been confirmed by photographs nor specimens. Grandison (1972: 63) listed several key characters to separate *M. aceras* from *M. nasuta*, and one of these is the presence of the rostral appendage in *M. nasuta*, and its absence in *M. aceras*. However, identification based on rostral appendage alone is not reliable, as shown by Inger (1966: 41), who found individual variation in the length of the rostral appendage in a series of six males from Bukit Timah, one of which has no rostral appendage; and also by the possibility of appendage loss due to injury. The horned toad is present in the Central Catchment Area (Sime Road forest, Nee Soon Swamp-forest) and the Bukit Timah Nature Reserve, where its "... loud, short honk" (Dring, 1979: 184) may often be heard. Its funnel-mouthed tadpole occurs in small shallow streams among leaf-litter.

The authors have observed defensive "startle" behaviour in a *Megophrys nasuta* from the Bukit Timah Nature Reserve, which was held captive in a vivarium for several weeks in 1989. Attempts at hand capture usually initiated such responses; the animal propped itself on its four limbs and lunged its body forwards and downwards at the offensive subject (usually human hands) with eyes closed and mouth widely opened; simultaneously emitting a loud cry

reminiscent of a human infant's wail, after which it may remain in the forward-hunched position for several seconds.

Family Bufonidae

5. *Bufo melanostictus* Schneider, 1799

Bufo melanostictus - Schneider, 1799. *Hist. Amph.*, 1: 216 ["Ex India orientalis"]

Bufo melanostictus - Flower, 1896: 911-912; Hanitsch, 1908: 48; Hanitsch, 1912: 19; Swarder, 1924: 20;

Berry, 1963: 163-167; Berry, 1964: 227-243; Inger, 1966: 70-74, table 10; Chuang, 1973: 4; Harrison & Tham, 1973: 254; Berry, 1975: 49-50, fig. 29; Sit, 1968; Lim & Chou, 1990: 56.

Bufo melanosticta - Johnson, 1964: 55; 1973: 117.

Material examined. - 5 spec., ZRC.1.70-74, Pulau Ayer Merbau, leg. F. N. Chasen, 11.v.1921. — 1 spec., ZRC.1.75, Pulau Ubin, 7.iii.1921 — 1 spec., ZRC.1.76, Pulau Ubin, 29.v.1921 — 3 spec., ZRC.1.77-79, Pulau Marabau, 7.v.1923. — 1 spec., ZRC.1.80, Pulau Marabau, 8.v.1923 — 1 spec., ZRC.1.1176, Ayer Rajah Campus, leg. H. P. Wang, 9.iii.1976. — 1 spec., ZRC.1.1177, Bt. Timah, Hindhede Drive, leg. H. K. Lua, 3.iv.1976. 1 spec., ZRC.1.1178, Ayer Rajah Campus, leg. H. K. Lua, 10.ix.1976 — 1 spec., ZRC.1.1179, Ayer Rajah Campus, leg. H. K. Lua, 16.ix.1976. — 2 spec., ZRC.1.1180-1181, Jurong Campus, leg. H. H. Goh, 25.ii.1981. — 1 spec., ZRC.1.1367, Botanic Gardens, leg. C. F. Lim, ii.1970. — 1 spec., ZRC.1.1368, Bt. Timah Hill, leg. C. F. Lim, 10.x.1973. — 7 spec., ZRC.1.1369-1375, Bt. Timah Campus, leg. Chatra M., 17.xii.1974. — 1 spec., ZRC.1.1577, Bt. Timah, Hindhede Drive, leg. H.K. Lua, 18.i.1989. 1 spec., ZRC.1.2818, Changi Point, leg. A.Y. H., 14.xi.1982. 1 spec., ZRC.1.2895, Lower Peirce Reservoir, north arm, leg. P. K. L. Ng, 11.viii.1990.

Remarks. - This very common anuran is virtually ubiquitous in Singapore, associating mainly with human habitations. It has, however, been found outside Fern Valley on Bukit Timah Hill as well as in an open clearing in the Nee Soon Swamp-forest, both forested areas. The author has observed it in canals close to sea at East Coast Park, and the tadpoles are tolerant of seawater (D. H. Murphy, pers. comm.). A small specimen (ZRC.1.2895) from Lower Peirce Reservoir, has reddish warts on the dorsum.

6. *Bufo quadriporcatus* Boulenger, 1887 *

Bufo quadriporcatus Boulenger, 1887. *Ann. Mag. Nat. Hist.*, 5(19): 347, pl. 10, fig. 4 [Malacca, Peninsular Malaysia].

Bufo quadriporcatus - Berry, 1975: 52, fig. 31; Lim, 1989b, pl. 2c, d; Lim, 1989c: 66; Lim & Chou, 1990: 56.

Material examined. - 4 spec., ZRC.1.2909-2912, Nee Soon Swamp-forest, leg. K. Lim, 29.ix.1990.

Remarks. - Lim (1989b) noted the presence of this species in Singapore for the first time based on a series of good photographs taken in the Sime Road forest. This has been confirmed

by four male specimens (snout-vent lengths 39 mm to 46 mm) obtained recently in the Nee Soon Swamp-forest. They were collected by tracing their calls, which were heard at the edges of and from inside the swamp, usually from under leaf-litter. One specimen was found calling in a shallow puddle of water on a laterite track, suggesting that it probably breeds in small bodies of water. They were obtained in the afternoon, ca. 2.30 pm. after rain. Two gravid females collected from the northeastern foothill of Gunung Pantii in Kota Tinggi, Johor, were also from freshwater swamp-forest. One of them (ZRC.1.2900) was observed sitting on a broad leaf, about 20 cm off the ground. *B. quadriporcatus* occurs sympatrically with *Rana paramacrodon* in both Johor and Singapore. All specimens of *B. quadriporcatus* observed or collected from Singapore have been rust-coloured above, and pale grey on the underside in life. The two females from Johor were both dark brown.

7. *Pelophryne brevipes* (Peters, 1867) *

Hylaplesia brevipes Peters, 1867, *Monatsber. Akad. Wiss. Berlin*, 1867: 34 [Zamboanga, Mindanao, Philippines].

Nectophryne guentheri - Flower, 1896: 910; Butler, 1904: 394; Boulenger, 1912: 268; Hanitsch, 1912: 18; Kampen, 1923: 68-69; Bourret, 1942: 158-159, fig. 20.

Pelophryne brevipes - Inger, 1966: 85-87; Grandison, 1972: 54; Berry, 1975: 55-56, fig. 34; Lim, 1990; Lim & Chou, 1990: 56.

Material examined. - 1 spec., ZRC.1.1760, Bukit Timah Nature Reserve, Fern Valley, leg. D. H. Murphy, 27.xi.1989.

Remarks. - A small and cryptic, poorly-known species which appears to be locally restricted to the Bukit Timah Nature Reserve. Recent examples have been recorded by Lim (1990).

Family Ranidae

8. *Occidozyga laevis* (Günther, 1858) *

Oxyglossus laevis Günther, 1858. *Cat. Batr. Sal. Brit. Mus.*, p. 7, pl. 1, fig. A [Philippine Islands].

Phrynoglossus laevis - Taylor, 1962: 353-358, figs. 26, 27; Dubois, 1986: 59

Ooeidozyga laevis laevis - Inger, 1966: 240-243, table 31.

Ooeidozyga laevis - Berry, 1975: 59-60, fig. 37.

Occidozyga laevis - Anon, 1988d:78; 1989a:4; Lim, 1989c: 66; Lim, 1989a: 56; Lim & Chou, 1990: 56.

Material examined. - 5 spec., ZRC.1.1290-1294, Bt. Timah Hill; leg. C. F. Lim, 29.x.1974. — 1 spec., ZRC.1.1554, Nee Soon Swamp-forest; leg. P. K. L. Ng & H. P. Ng, 29.xi.1988. — 2 spec., ZRC.1.1565-1566, Nee Soon Swamp-forest; leg. P. K. L. Ng & K. Lim, 17.xii.1988. — 2 spec., ZRC.1.1569-1570, Nee Soon Swamp-forest; leg. K. Lim, 31.xii.1988. — 1 spec., ZRC.1.1655, Nee Soon; leg. C. F. Lim, 27.x.1974. — 1 spec., ZRC.1.1775, Nee Soon Swamp-forest; leg. K. Lim, P. Yap & P. K. L. Ng, 28.xii.1989. — 1 spec., ZRC.1.1776, Nee Soon Swamp-forest; leg. P. K. L. Ng & K. Lim, 31.xii.1989. — 2 spec., ZRC.1.1777-1778, Nee Soon Swamp-forest; leg. P. K. L. Ng & K. Lim, 17.xii.1989. — 2 spec., ZRC.1.2761-2762, Nee Soon Swamp-forest; leg. P.K.L. Ng & K. Yong, 3.iv.1990. — 1 spec., ZRC.1.2993, Nee Soon Swamp-forest; leg. F. L. Tan, 8.iii.1991.

Remarks. - Taylor (1962: 357-358) examined a specimen from Singapore and found some characters which may be different from the Thai examples. He remarked that “...(l)arger collections may show that the Singapore specimen discussed merits specific recognition if the characters are constant” (pg. 358). Inger (1966: 240) also examined Singapore specimens, but did not indicate that they may be different from others found Southeast Asia. Recent observations and collections have shown that *Occidozyga laevis* is not uncommon in streams in the Nee Soon Swamp-forest. There are also records from the Bukit Timah Nature Reserve, and also from trackside puddles in Sime Road forest (Anon, 1988d, 1989a). Some specimens from the Nee Soon Swamp-forest have a white snout, while some others possess a white or orange vertebral stripe.

9. *Rana baramica* Boettger, 1901 *

Rana baramica Boettger, 1901. *Abh. Senck. Naturf. Ges.*, 25: 391 [Baram River, Sarawak, Borneo].
Rana glandulosa - Flower, 1896: 905; Butler, 1904: 200; Boulenger, 1912: 236-237; Kampen, 1923: 194-195.
Rana (Hylarana) glandulosa (part) - Bourret, 1942: 362-364, fig. 114.
Rana baramica - Inger, 1966: 160-162, table 20; Berry, 1975: 61-62, fig. 39; Lim & Chou, 1990: 56

Material examined. - 3 spec., ZRC.1.1400-1402, Nee Soon; leg. C. F. Lim, 9.xii.1974. — 1 spec., ZRC.1.1540, Sime Rd. forest; leg. D. H. Murphy, 27.ii.1975. — 1 spec., ZRC.1.2929, Nee Soon Swamp-forest; leg. K. Lim & P. K. L. Ng, 23.xi.1990.

Remarks. - Recent records are from Sime Road and the Nee Soon Swamp-forest. Its characteristic call, a “loud ‘yip yip yip’ ...” (Dring, 1979: 197) is often heard at dusk from the second locality, but the frogs are very difficult to locate. Obtained on Bukit Timah in the past. A rarely seen and poorly known species in Singapore.

10. *Rana blythii* Boulenger, 1920 *

Rana macrodon var. *blythii* Boulenger, 1920. *Rec. Indian Mus.*, 20: 43. [Burma, Annam, Siam, Malay Peninsula, Sumatra, Borneo, Philippines].
Rana macrodon (part) - Boulenger, 1882b: 24-25; Flower, 1896: 898-901; Hanitsch, 1908: 47; Boulenger, 1912: 233-234; Smedley, 1931: 59-62; Bourret, 1942: 255-260; Johnson, 1964: 28; Berry, 1975: 77-79, fig. 52.
Rana blythii - Inger, 1966: 162-175, figs. 31,32,33, tables 21, 22; Grandison, 1972: 64.
Rana blythii - Frost, 1985: 483; Anon, 1989c: 41; Lim, 1989c: 66; Lim & Chou, 1990: 56
Limnonectes (Limnonectes) blythii - Dubois, 1986: 63

Material examined. - 1 spec., ZRC.1.355; leg. N. Smedley. — 1 spec., ZRC.1.356; leg. M. W. F. Tweedie. — 8 spec., ZRC.1.1462-1469, Bt. Timah Hill; leg. C. F. Lim, 29.x.1974. — 1 spec., ZRC.1.1759, Sime Rd. forest; leg. K. Lim, 27.x.1989. — 1 spec., ZRC.1.1768, Sime Rd. forest, leg. K. Lim & P. K. L. Ng, 24.xii.1989. — 1 spec., ZRC.1.2931, Nee Soon Swamp-forest, leg. P. K. L. Ng, 1.i.1991. — 1 spec., ZRC.1.2988, Nee Soon Swamp-forest, leg. P. K. L. Ng & K. Lim, 8.iii.1991.

Remarks. - This species, reputedly the largest (over 100 mm in snout-vent length) anuran in the Malay Peninsula, has commercial food value. It was previously regarded as conspecific with *Rana malesiana* (both collectively known as varieties of *Rana macrodon*) (see Kiew, 1984a). Currently present on Bukit Timah, and in the Central Catchment Area (Sime Road Forest and Nee Soon Swamp-forest) where it occurs sympatrically with *R. malesiana*.

11. *Rana cancrivora* Gravenhorst, 1829

Rana cancrivora Gravenhorst, 1829. *Delic. Mus. Zool. Vratisl.*, 1: 41 [Java]

Rana tigrina - Swarder, 1924: 20.

Rana cancrivora - Swarder, 1925; Taylor, 1962: 377-379, fig. 34; Berry, 1975: 62-63, fig. 40; Anon, 1988a: 6; 1988b: 28; 1988c: 51; 1988d: 78; Lim & Chou, 1990: 56.

Rana cancrivora cancrivora - Bourret, 1942: 245-249, fig. 58, 59; Inger, 1966: 175-176.

Limnodynastes (Hoplobatrachus) cancrivorus - Dubois, 1986: 60.

Material examined. - 2 spec., ZRC.1.1311-1312, Woodlands. — 5 spec., ZRC.1.1403-1407; leg. C.F. Lim, 28.ii.1970. — 2 spec., ZRC.1.1408-1409, Jalan Bongkok Kechil; leg. C. F. Lim, 28.x.1974. 8 spec., ZRC.1.1410-1417, Thomson Rd.; leg. Chatra M. & C. F. Lim, 17.xii.1974. — 1 spec., ZRC.1.1513, East Coast Park; leg. K. Lim, xii.1987. — 1 spec., ZRC.1.1765, Cluny Rd., in suburban monsoon drain; leg. K. Lim, 24.iii.1990. — 1 spec., ZRC.1.2764, Bt. Timah, Institute of Education field; leg. K. Yong, 4.iv.1990. 1 spec., ZRC.1.2767, in mangroves; 31.x.1977. — 1 spec., ZRC.1.2893, Sg. Buloh fish ponds; leg. J. Smith, 12.vii.1990. — 1 spec., ZRC.1.2894, Lower Peirce Reservoir, north arm; leg. P. K. L. Ng, 11.viii.1990. — 1 spec., ZRC.1.2915, Sg. Buloh prawn ponds; leg. K. Lim, 4.xi.1990. — 1 spec., ZRC.1.2916, Sg. Buloh fish ponds; leg. H.K. Lua, 7.xi.1990. — 1 spec., ZRC.1.2932, Pasir Laba, along forest stream; leg. P. G. Lee & N. Kang, 26.xii.1990.

Remarks. - This frog was first reported from Singapore by Swarder (1924) as *R. tigrina*, and subsequently corrected to the said species (Swarder, 1925). It is known to be highly tolerant of saltwater, and has been regularly found in the mangroves (see Taylor, 1962: 379). In Singapore, it is widespread along the coast, but can be found inland where it inhabits fields and canals. Newly metamorphosed frogs of this species are often reared for sale as live food for predatory pet fish. It is similar to *Rana limnocharis*, but has much more extensive webbing on its feet, a broader head, and grows to a larger size.

12. *Rana chalconota* (Schlegel, 1837) *

Hyla chalconota (part) Schlegel, 1837. *Abbild. Amph.*, p. 23, pl. 50, fig. 3 [Java].

Rana labialis - Flower, 1896: 903-904; Butler, 1904: 199; Boulenger, 1912: 242-243; Hanitsch, 1912: 18; Kampen, 1923: 220-221.

Rana (Hylarana) chalconota - Bourret, 1942: 366-369, fig. 116, 117.

Rana chalconota - Johnson, 1964: 28; Berry, 1975: 63-64, fig. 41; Anon, 1988a: 6; 1988b: 28; 1988d: 78; Lim, 1989a: 56; Lim & Chou, 1990: 56.

Material examined. - 1 spec., ZRC.1.496. — 1 spec., ZRC.1.497, Botanic Gardens; 18.iv.1988. — 1 spec., ZRC.1.1515, Bt. Timah Nature Reserve, Jungle Fall Valley; leg. K. Lim, 22.xi.1986. — 1 spec., ZRC.1.1519, Bt. Timah Nature Reserve, Jungle Fall Valley; leg. K. Lim, 22.xi.1986. — 1 spec., ZRC.1.1528, Bt. Timah, Hindhede Drive; leg. H. K. Lua, 24.iv.1988. — 1 spec., ZRC.1.1529, Bt. Timah, Hindhede Drive, leg. H.K. Lua, 2.v.1988. — 1 spec., ZRC.1.1560, Bt. Timah, Hindhede Drive; leg. H.K. Lua, 4.ix.1988. — 1 spec., ZRC.1.1572, Bt. Timah, Hindhede Drive; leg. H. K. Lua, 3.i.1989. 1 spec., ZRC.1.1781, Bt. Timah Nature Reserve; leg. P. K. L. Ng, ii.1987.

Remarks. - This frog occurs around water-bodies in the Bukit Timah Nature Reserve and the Central Catchment Area. Tadpoles identified to this species have been found in a stream flowing through a small patch of forest at Pasir Laba military exercise area.

13. *Rana erythraea* (Schlegel, 1837)

Hyla erythraea Schlegel, 1837. *Abbild. Amph.*, p. 27, pl. 9, fig. 3 [Java].

Rana erythraea - Flower, 1896: 902-903; Butler, 1904: 198; Hanitsch, 1908: 47; Boulenger, 1912: 241-242; Hanitsch, 1912: 18; Kampen, 1923: 222-223; Johnson, 1964: 28; Inger, 1966: 183-184; Berry, 1975: 66-67, fig. 43; Anon, 1988a: 6; 1988d: 78; 1989a: 5; Lim, 1989a: 56; Lim & Chou, 1990: 56.

Rana erythraeus - Johnson & Tham, 1973: 254.

Material examined. - 1 spec., ZRC.1.558; leg. 1895. — 1 spec., ZRC.1.559, Botanic Gardens; iii.1913. — 20 spec., ZRC.1.560-579, Botanic Gardens; 5.iii.1913. — 2 spec., ZRC.1.580-581, Pasir Panjang; 7.viii.1931. — 1 spec., ZRC.1.1323, Bt. Timah Rifle Range; leg. H.P. Wang, 7.iii.1976. — 3 spec., ZRC.1.1421-1423, Jurong, 11th ml.; leg. C.F. Lim, 28.ii.1970. — 2 spec., ZRC.1.1424-1425, Jln Bongkok Kechil; leg. C. F. Lim, 28.x.1974. — 12 spec., ZRC.1.1426-1437, Peirce Reservoir; leg. C.F. Lim, 9.xii.1974. — 1 spec., ZRC.1.1660, Nee Soon Swamp-forest; leg. K. Lim, xii.1988. — 1 spec., ZRC.1.2817, Bt. Timah, Singapore University pond; leg. C. F. Lim, 1974.

Remarks. - A common species in rural areas and gardens where it is usually found at the edges of ponds and streams. It also occurs in the forests of Sime Road and Nee Soon where it co-exists with other forest species. However in these localities, it appears to be restricted to clearings. The first author has observed one individual in a brackish water canal draining into Sungei Khatib Bongsu at Yishun. Johnson & Tham (1973: 254) regard this to be the most common species of frog in Singapore.

14. *Rana limnocharis* Boie, in Weigmann, 1835

Rana limnocharis Boie, in Weigmann, 1835. *Nova Acta Acad. Leop. Carol.*, 17: 255 [Java]

Rana limnocharis - Flower, 1896: 901-902; Hanitsch, 1908: 47; Hanitsch, 1912: 18; Berry, 1963: 163-167; Berry, 1964: 227-243; Johnson, 1964: 28; Lee & Chen, 1970; Johnson, 1973: 117; Berry, 1975: 73-74, fig. 49; Anon, 1988a: 6; 1988d: 78; 1989a: 5; Lim & Chou, 1990: 56.

Rana limnocharis limnocharis - Inger, 1966: 205-206; Grandison, 1972: 66.

Limnonectes (Fejervarya) limnocharis - Dubois, 1986: 61

Material examined. - 1 spec., ZRC.1.692, Fort Canning; 9.iii.1896. — 1 spec., ZRC.1.1330, Kent Ridge; leg. H. P. Wang & H. K. Lua, 30.x.1975. — 4 spec., ZRC.1.1458-1461, Peirce Reservoir; leg. C.F. Lim, 9.xii.1974. — 1 spec., ZRC.1.1767, Sime Rd. forest; leg. K. Lim & P. K. L. Ng, 24.xii.1989. — 1 spec., ZRC.1.1785, Nee Soon Swamp-forest; leg. K. Lim, 30.iii.1990.

Remarks. - A common and widespread frog in built-up areas, especially in fields. It also penetrates clearings in secondary forest. Butler (1904: 197) said that this was the only amphibian which he has found in brackish water in tidal creeks and ditches. The authors have not encountered this species associating with brackish water, and it is likely that Butler could have confused it with a similar species, *Rana cancrivora*.

15. *Rana malesiana* Kiew, 1984 *

Rana malesiana Kiew, 1984. *Malay. Nat. Journ.*, 37: 153, pl. 1, figs. 1, 2 [Bt. Timah, Singapore].

Rana macrodon - Blanford, 1881: 225-226, pl.XXI, fig. 4; Butler, 1904: 196; Hanitsch, 1912: 18; Anon, 1988a: 6.

Rana macrodon (part) - Boulenger, 1882b: 24-25; Flower, 1896: 898-9011, pl. XLVI; Hanitsch, 1908: 47; Boulenger, 1912: 233-234; Kampen, 1923: 174-176; Smedley, 1931: 59-62; Bourret, 1942: 255-260, fig. 63-64; Johnson, 1964: 28; Berry, 1975: 77-79, fig. 52.

Limnonectes (Limnonectes) malesianus - Dubois, 1986: 63.

Rana malesiana - Anon, 1988d: 78; 1989c: 41; Lim, 1989a: 56; Lim & Chou, 1990: 56.

Material examined. - 1 spec., ZRC.1.707, Bt. Timah; xi.1933. -1 spec., ZRC.1.715, Economic Gardens; 3.x.1921 — 1 spec., ZRC.1.735. — 7 spec., ZRC.1.1335-1341, Bt. Timah Hill stream; leg. C. F. Lim, 29.x.1974. — 1 spec., ZRC.1.1514, Bt. Timah Nature Reserve, Jungle Fall Valley; leg. K. Lim, 3.x.1987. — 2 spec., ZRC.1.1551-1552, Bt. Timah Nature Reserve, Jungle Fall Valley; leg. P.K.L. Ng, 12.xi.1988 — 1 spec., ZRC.1.1574, Nee Soon Swamp-forest; leg. J. Fox, xii.1988. — 1 spec., ZRC.1.1638, Bukit Timah Nature Reserve, near Jungle Fall Valley; leg. P. K. L. Ng, ii.1987. — 2 spec., ZRC.1.1657-1658, Bukit Timah Nature Reserve; leg. C. F. Lim, 29.x.1974. — 1 spec., ZRC.1.1758, Bt. Timah Nature Reserve, Rock Path stream; leg. P.K.L. Ng, 26.viii.1989. — 1 spec., ZRC.1.1780, Bukit Timah Nature Reserve; leg. D. H. Murphy, 15.vi.1969. — 1 spec., ZRC.1.1786, Nee Soon Swamp-forest; leg. K. Yong & K. Lim, 30.iii.1990. — 1 spec., ZRC.1.1788, Sime Rd. Forest; leg. K. Lim, 17.iv.1990. — 1 spec., ZRC.1.1789, Bt. Timah Nature Reserve, south-west boundary, in stream; leg. K. Lim & K. Yong, 8.iv.1990. — 2 spec., ZRC.1.2933-2934, Pasir Laba (military exercise area), along forest stream; leg. P. G. Lee & N. Kang, 26.xii.1990. — 1 spec., ZRC.1.3004, Nee Soon Swamp-forest, leg. W. Denzer & K. Lim, 9.iv.1991.

Remarks. - This is the so-called "Singapore variety" of *Rana macrodon* of Smedley (1931) and other authors. Kiew (1984) has, however described it as a new species. In Singapore, recent observations have shown it to be fairly common on Bukit Timah Hill where it occurs sympatrically with *Rana blythii*. It is also found in the Nee Soon Swamp-forest, as well as in a small patch of secondary forest in the Pasir Laba military exercise area.

16. *Rana paramacrodon* Inger, 1966 *

Rana paramacrodon Inger, 1966. *Fieldiana: Zool.*, 52: 228, fig. 47 [Sungei Tawan, a small tributary of the Kalabakan River, Tawau District, Sabah, Borneo].

Rana paramacrodon - Berry, 1975: 83-85, fig. 57; Lim, 1989c: 66; Lim & Chou, 1990: 56.

Limnonectes (Limnonectes) paramacrodon - Dubois, 1986: 63.

Rana paramacrodon paramacrodon - Lim, 1989a: 51-57, fig. 1, pl. 1, table 1.

Material examined. - 1 spec., ZRC.1.1489, Nee Soon; leg. C. F. Lim, 17.xii.1974. — 1 spec., ZRC.1.1555; leg. P. K. L. Ng & H. P. Ng, 29.xi.1988. — 1 spec., ZRC.1.1557; leg. K. Lim & H. C. Ho, 25.xi.1988. — 2 spec., ZRC.1.1563-1564; leg. P. K. L. Ng & K. Lim, 17.xii.1988 — 1 spec., ZRC.1.1567; leg. P. K. L. Ng, K. Lim & H. K. Lua, 31.xii.1988. — 2 spec., ZRC.1.1773-1774; leg. K. Lim, P. Yap & P. K. L. Ng, 28.xii.1989. — 1 spec., ZRC.1.2763; leg. P. K. L. Ng & K. Yong, 30.iv.1990. — 1 spec., ZRC.1.2917; leg. K. Lim, 30.x.1990. — 4 spec., ZRC.1.2984-2987, leg. P. K. L. Ng & K. Lim, 8.iii.1991. — 2 spec., ZRC.1.2991-2992, leg. P. K. L. Ng, 8.iii.1991. All specimens collected from Nee Soon Swamp-forest.

Remarks. - Lim (1989a) records this species for the first time in Singapore. It has so far only been observed in the Nee Soon Swamp-forest. Details of its habitat and biology can be found in Lim (1989a).

17. *Rana plicatella* Stoliczka, 1873 *

Rana plicatella Stoliczka, 1873. *Journ. Asiat. Soc. Bengal*, 42: 116, [Penang or Province Wellesley, Peninsular Malaysia].

Rana plicatella - Butler, 1904: 196-197; Boulenger, 1912: 231-232; Bourret, 1942: 270-272, fig. 70; Taylor, 1962: 401-405, figs. 43,44; Berry, 1975: 85-86, fig. 58; Anon, 1988a: 6; 1989c: 41; Lim & Chou, 1990: 56.

Limnonectes (Bourretia) plicatellus - Dubois, 1986: 62

Material examined. - 1 spec., ZRC.1.1516, Bt. Timah Nature Reserve, Jungle Fall Valley; leg. K. Lim, 3.x.1987. — 1 spec., ZRC.1.1517, Bt. Timah Nature Reserve; leg. K. Lim, 22.xi.1986. — 4 spec., ZRC.1.1536-1539, Bt. Timah Hill; leg. C. F. Lim, 5.viii.1974. — 1 spec., ZRC.1.2928, Nee Soon Swamp-forest; leg. K. Lim & J. Koh, 23.xi.1990.

Remarks. - Recorded from the Bukit Timah Nature Reserve and the Nee Soon Swamp-forest where it lives along small streams, and does not appear to be common. Also recorded from the Nee Soon Swamp-forest. Males possess a horny protruberance on top of the head. A related species, *Rana doriae* Boulenger, 1887, appears to have been erroneously recorded for Singapore. Boulenger (1912: 231) states that *R. doriae* has been collected "... on the top of Bukit Timah, Singapore by Mr. A. L. Butler". This information is supposed to have been cited from Butler (1904), "... on page 196". Upon reference to Butler's paper however, page 196 failed to produce a similar statement. Apart from Boulenger's questionable citation, there appears to be no other record of *R. doriae* from Singapore.

Family Rhacophoridae

18. *Nyctixalus pictus* (Peters, 1871) *

Ixalus pictus Peters, 1871. Monatsber. Akad. Wiss. Berlin, 1871: 580 [Sarawak].
Ixalus pictus - Butler, 1904: 203-204; Boulenger, 1912: 255; Flower, 1896: 908.
Philautus pictus - Kampen, 1923: 269-270; Bourret, 1942: 455; Berry, 1975: 94-95, fig. 64.
Hazelia picta - Taylor, 1962: 506-509, fig. 79.
Philautus pictus pictus - Inger, 1966: 349-352.
Nyctixalus pictus - Lim & Chou, 1990: 56

Material examined. - 1 spec., ZRC.1.1534, Bt. Timah Nature Reserve; leg. D. H. Murphy, 1980.

Remarks. - So far recorded only from the Bukit Timah Nature Reserve, where it has been observed in tree holes (W. Denzer, pers. comm.).

19. *Polypedates leucomystax* (Boie, in Gravenhorst, 1829)

Hyla leucomystax Boie, in Gravenhorst, 1829. *Delic. Mus. Zool. Vratistav.*, 1: 26 [Java].
Polypedates leucomystax - Cantor, 1847: 1063; Anon, 1988a: 6; 1988d: 77; Lim, 1989a: 56; Lim & Chou, 1990: 57.
Rhacophorus maculatus var. *quadrilineata* - Boulenger, 1882b: 83-85.
Rhacophorus leucomystax - Flower, 1896: 905-906; Hanitsch, 1908: 48; Hanitsch, 1912: 18; Berry, 1964: 227-243; Johnson, 1964: 28; Berry, 1965: 163-167; Ting, 1970; Chuang, 1973: 4; Johnson, 1973: 117; Murphy, 1973: 65; Berry, 1975: 101-102, fig. 70.
Rhacophorus leucomystax var. *sexvirgata* - Kampen, 1923: 246-250, fig. 27.
Rhacophorus leucomystax leucomystax - Bourret, 1942: 425-430, fig. 114, 115; Grandison, 1972: 72-73.
Rhacophorus (Rhacophorus) leucomystax leucomystax - Dubois, 1986: 80-81

Material examined. - 1 spec., ZRC.1.903; 20.ix.1897. — 1 spec., ZRC.1.1346, Ayer Rajah Campus; leg. H.P. Wang, 28.iv.1976. 1 spec., ZRC.1.1347, Bt. Timah, Hindhede Drive; leg. H.K. Lua, iv.1981. — 8 spec., ZRC.1.1490-1497, Bt. Timah Campus; 17.xii.1974. — 1 spec., ZRC.1.1498, Jurong, 11th ml.; leg. C.F. Lim, 28.ii.1970. — 2 spec., ZRC.1.1524-1525, Bt. Timah, Hindhede Drive; leg. H. K. Lua, 4.vi.1986. — 1 spec., ZRC.1.1527, Bt. Timah, Hindhede Drive; leg. H. K. Lua, 17.iv.1988. — 1 spec., ZRC.1.1531, Bt. Timah, Hindhede Drive; leg. H. K. Lua, 10.v.1988. — 1 spec., ZRC.1.1532, Bt. Timah, Hindhede Drive; leg. H. K. Lua, 30.v.1988. — 1 spec., ZRC.1.1533, Bt. Timah, Hindhede Drive; leg. H. K. Lua, 6.vi.1988. 1 spec., ZRC.1.1558, Bt. Timah, Hindhede Drive; leg. H. K. Lua, 20.ix.1988. — 1 spec., ZRC.1.1559, Bt. Timah, Hindhede Drive, leg. H.K. Lua, 11.ix.1988. — 1 spec., ZRC.1.1561, Bt. Timah, Hindhede Drive; leg. H. K. Lua, 7.xii.1988. — 1 spec., ZRC.1.1575, Bt. Timah, Hindhede Drive; leg. H. K. Lua, 13.i.1989. 4 spec., ZRC.1.1664-1667, Dover Rd.; leg. C. F. Lim, 7.xii.1974. — 1 spec., ZRC.1.1787, Nee Soon Swamp-forest; leg. K. Yong & K. Lim, 30.iii.1990. — 1 spec., ZRC.1.2758, Bt. Timah, Hindhede Drive; leg. H.K. Lua, 1989. — 4 spec., ZRC.1.2775-2778; viii.1988.

Remarks. - A common and widespread frog both in built-up areas, and in the forest.

20. *Rhacophorus bimaculatus* (Peters, 1867) *

Leptomantis bimaculatus Peters, 1867. *Monatsber. Akad. Wiss. Berlin*, 1867: 32 [Upper Agusan Valley, Mindanao, Philippines].

Philautus bimaculatus - Inger, 1966: 344-346; Berry, 1975: 92-93, fig. 63.

Leptomantis bimaculatus - Frost, 1985:

Rhacophorus (Leptomantis) bimaculatus - Dubois, 1986: 76

Rhacophorus bimaculatus - Lim & Chou, 1990: 57

Material examined. - 1 spec. (in Field Museum of Natural History, Chicago, Illinois, U.S.A.) from Nee Soon examined by R. F. Inger.

Remarks. - The single record from Singapore (listed in Inger, 1966: 44) was presumably obtained by J. R. Hendrickson from Nee Soon "in swamp forest" (undated, but possibly in the 1950-60s), and presently housed at the Field Museum of Natural History, Chicago (R. F. Inger, *in litt.*).

Family Microhylidae

21. *Kalophrynus pleurostigma pleurostigma* Tschudi, 1838 *

Kalophrynus pleurostigma Tschudi, 1838. *Classif. Batr.*: 86 [Sumatra]

Calophrynus pleurostigma - Flower, 1896: 908; Boulenger, 1912: 258; Kampen, 1923: 102-104, fig. 12; Murphy, 1973: 59.

Kalophrynus pleurostigma pleurostigma - Parker, 1934: 97-98; Bourret, 1942: 496-498, fig. 180; Berry, 1975: 112-113, fig. 79; Lim & Ng, in prep.

Kalophrynus pleurostigma - Lim & Chou, 1990: 57.

Material examined. - 1 spec., ZRC.1.1705, Bt. Timah Nature Reserve, Rock Path; leg. Y. H. Koo, 11.viii.1989. — 2 spec., ZRC.1.1763-1764, Bt. Timah Nature Reserve; leg. D. H. Murphy, 24.xi.1966. — 1 spec., ZRC.1.2935, Bt. Timah Nature Reserve, nr. entrance; leg. R. Subharaj, 11.i.1991.

Remarks. - A secretive forest species with records only from the Bukit Timah Nature Reserve. This species has recently been found spawning, and the tadpoles developing in the cups of a pitcher plant *Nepenthes ampullaria* (Lim & Ng, 1991).

22. *Kaloula pulchra* Gray, 1831

Kaloula pulchra Gray, 1831. *Zool. Misc.*, 1: 38 ["China"]

Callula pulchra - Flower, 1896: 908-910; Butler, 1904: 390-392; Hanitsch, 1908: 48; Boulenger, 1912: 264; Hanitsch, 1912: 18.

Kaloula pulchra pulchra - Parker, 1934: 84-86.

Kaloula pulchra - Berry, 1964: 227-243; Berry, 1965: 163-167; Berry, 1975: 114-116, fig. 81; Lim & Chou, 1990: 57.

Caloula pulchra - Johnson, 1964: 28.

Material examined. - 1 spec., ZRC.1.124; 14.iii.1904. — 1 spec., ZRC.1.1378, Botanic Gardens; leg. C. F. Lim, ii.1970. — 1 spec., ZRC.1.1379, Dover Rd.; leg. C. F. Lim, 7.xii.1974. — 2 spec., ZRC.1.1211-1212, Ayer Rajah Campus; leg. H. P. Wang, 24.iii.1976. — 1 spec., ZRC.1.1213, Jurong Campus; leg. H. H. Goh, 7.iv.1980. — 4 spec., ZRC.1.1214-1217, Jurong Campus; leg. H. H. Goh, 8.iv.1981. — 1 spec., ZRC.1.1578, Bt. Timah, Hindhede Drive; leg. H.K. Lua, 18.i.1989. — 2 spec., ZRC.1.2773-2774, Commonwealth Drive Park; leg. A. Y. H., 7.ix.1981.

Remarks. - This species seems to have been introduced by man (see Flower, 1896: 908). It is presently common in built-up areas and even near mangrove swamps as well as in the forest on Bukit Timah Hill.

23. *Microhyla butleri* Boulenger, 1900

Microhyla butleri Boulenger, 1900. *Ann. Mag. Nat. Hist.*, 7(6): 188 [Larut Hills at 4000 ft, Perak, Peninsular Malaysia]

Microhyla butleri - Berry, 1964: 227-243; Berry, 1965: 163-167; Grandison, 1972: 59; Berry, 1975: 120-121, fig. 85; Anon, 1989a:5; Lim & Chou, 1990: 57.

Microhyla (part) - Johnson, 1964: 29.

Material examined. - 1 spec., ZRC.1.1520, Jurong, Hong Kah Lane; leg. B. S. Ang, x.1986. — 6 spec., ZRC.1.1639-1644, Dover Rd.; leg. C. F. Lim, 7.xii.1974. — 1 spec., ZRC.1.2898, Sime Rd. forest; leg. R. Subharaj & M. Chong, 8.ix.1990.

Remarks. - A relatively common but secretive frog of open, built-up areas. Its tadpoles are commonly seen in roadside pools and puddles or water tanks in rural and suburban areas.

24. *Microhyla heymonsi* Vogt, 1911

Microhyla heymonsi Vogt, 1911. *Sitzungsber. Ges. Naturforsch. Freunde Berlin*, 1911: 181 [Kosempo, Taiwan].

Microhyla heymonsii - Berry, 1964: 227-243; Berry, 1965: 163-167; Grandison, 1972: 60; Anon, 1988d:77; 1989a:5.

Microhyla (part) - Johnson, 1964: 29.

Microhyla heymonsi - Berry, 1975: 121-122, fig. 86; Lim, 1989c: 66; Lim & Chou, 1990: 57.

Material examined. - 1 spec., ZRC.1.1259, Bt. Timah, Hindhede Drive; leg. H. K. Lua, 22.vi.1978. — 1 spec., ZRC.1.1556, Bt. Timah, Hindhede Drive; leg. H. K. Lua, 8.xii.1988. — 1 spec., ZRC.1.1571, Botanic Gardens; leg. J. Fox, xii.1988. — 1 spec., ZRC.1.1576, Bt. Timah, Hindhede Drive; leg. H.K. Lua, 25.xii.1988.

Remarks. - Like *M. butleri*, *M. heymonsi* is common but rarely seen. It is widely distributed in various habitats ranging from built-up areas to forest clearings, and can easily be detected by its characteristic call, a "... k-r-r-i-c-k, k-r-r-i-c-k repeated at regular intervals" (Grandison, 1972: 60).

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LITERATURE CITED

- Anon, 1988a. Recent reports - amphibians. *The Pangolin*, Malayan Nature Society Singapore Branch, 1(1): 6.
- Anon, 1988b. Recent reports - amphibians. *The Pangolin*, Malayan Nature Society Singapore Branch, 1(2): 28.
- Anon, 1988c. Recent reports - amphibians. *The Pangolin*, Malayan Nature Society Singapore Branch, 1(3): 51.
- Anon, 1988d. Recent reports - amphibians. *The Pangolin*, Malayan Nature Society Singapore Branch, 1(4): 77-78.
- Anon, 1989a. Recent reports - amphibians. *The Pangolin*, Malayan Nature Society Singapore Branch, 2(1): 4-5.
- Anon, 1989b. Recent reports - amphibians. *The Pangolin*, Malayan Nature Society Singapore Branch, 2(2): 21.
- Anon, 1989c. Recent reports - amphibians. *The Pangolin*, Malayan Nature Society Singapore Branch, 2(3): 41.
- Berry, P. Y., 1964. The breeding patterns of seven species of Singapore Anura. *J. Anim. Ecol.*, **33**: 227-243.
- Berry, P. Y., 1965. The diet of some Singapore Anura (Amphibia). *Proc. Zool. Soc. Lond.*, **144**: 163-174, 1 text fig.
- Berry, P. Y., 1975. *The Amphibian Fauna of Peninsular Malaysia*. Tropical Press, Kuala Lumpur, x+130 pp., 91 figs.
- Berry, P. Y. & J. R. Hendrickson, 1963. *Leptobrachium nigrops*, a new pelobatid frog from the Malay Peninsula, with remarks on the genus *Leptobrachium* in Southeast Asia. *Copeia*, **4**: 643-648, 4 figs.

- Blanford, W. T., 1881. On a collection of reptiles and frogs chiefly from Singapore. *Proc. Zool. Soc. Lond.*, **15**: 215-226, Pls. 20, 21.
- Boulenger, G. A., 1882a. *Catalogue of the Batrachia Gradientia s. Caudata and Batrachia Apoda in the collection of the British Museum*. Second edition. Taylor & Francis, London. vi + 127 pp., 9 Pls.
- Boulenger, G. A., 1882b. *Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum*. Second edition. Taylor & Francis, London. xvi + 503 pp., 30 Pls.
- Boulenger, G. A., 1912. *A Vertebrate Fauna of the Malay Peninsula from the Isthmus of Kra to Singapore including the adjacent islands. Reptilia and Batrachia*. Taylor & Francis, London. xiii + 294 pp., 79 Figs.
- Bourret, R., 1941. Les batraciens de l'Indochine. *Mém. Insti. Oceanogr. Indochine*, 6, x + 517 pp., 4 Pl., 196 Figs.
- Butler, A. L., 1904. A list of the batrachians known to inhabit the Malay Peninsula, with some remarks on their habits, distribution and &c. *J. Bombay Nat. Hist. Soc.*, **15**: 193-205, 387-402.
- Cantor, T. E., 1847. Catalogue of reptiles inhabiting the Malayan Peninsula and islands. *J. Asiatic Soc. Bengal*, **XVI**(7): 607-1078, Pl. XX, XL.
- Chuang, S. H., 1973. Introduction. In: Chuang S. H. (Ed.), *Animal Life and Nature in Singapore*, Singapore University Press, pp. 1-6.
- Dring, J. C. M., 1979. Amphibians and reptiles from northern Trengannu, Malaysia, with descriptions of two new geckos: *Cnemaspis* and *Cyrtodactylus*. *Bull. Brit. Mus. Nat. Hist. (Zool.)*, **34**(5): 181-241, 1 Pl. 17 Figs.
- Dubois, A., 1986. Miscellanea taxonomica batrachologia (I). *Alytes*, Paris, **5**(1-2): 7-95.
- Elliot, A. B., 1968. Water uptake in a tropical amphibian. *J. Singapore Natn. Acad. Sci.*, **2**(3): 64
- Flower, S. S., 1896. Notes on a collection of reptiles and batrachians made in the Malay Peninsula in 1895-96; with a list of species recorded from that region. *Proc. Zool. Soc. Lond.*, **56**: 856-914, Pls. 44-46.
- Frost, D. R. (Ed.), 1985. *Amphibian species of the World, a taxonomic and geographic reference*. Allen Press Inc. and the Association of Systematics Collection, Lawrence, Kansas, U.S.A., 732 pp.
- Grandison, A.G.C., 1972. The Gunung Benom Expedition 1967, 5. Reptiles and amphibians of Gunung Benom with a description of a new species of *Macrocalamus*. *Bull. Brit. Mus. (Nat. Hist.) Zool.*, **23**(4): 43-101, 4 text figs.
- Hanitsch, R., 1908. *Guide to the Zoological Collections of the Raffles Museum*, Singapore. Straits Times Press, Ltd., 112 pp.
- Hanitsch, R., 1912. *A list of the birds, reptiles and amphibians in the Raffles Museum, Singapore*. Straits Settlements Government Printing House, Singapore, 19 pp.

- Harrison, B., 1985 (first reprint 1990). Mammals, reptiles and amphibians. In: Sharp, I. (Ed.). *A Guide to the Bukit Timah Nature Reserve*, Singapore Science Centre, p. 108-132.
- Harrison J. L. & A. K. Tham, 1973. The exploitation of animals, In: Chuang, S. H. (Ed.), *Animal Life and Nature in Singapore*, Singapore University Press, pp. 251-259.
- Inger, R. F., 1966. The systematics and zoogeography of the amphibia of Borneo. *Fieldiana (Zool.)*, **52**: 1-402, 71 Figs.
- Johnson, D. S., 1964. *An introduction to the Natural History of Singapore*. Rayirath (Ray) Books, Kuala Lumpur, 106 pp.
- Johnson, D. S., 1973. Freshwater Life. In : *Animal Life and Nature in Singapore*. Ed. S. H. Chuang, Singapore University Press, pp. 103-127.
- Kampen, P. N., van, 1923. *The Amphibia of the Indo-Australian Archipelago*. E. J. Brill, Leiden, x + 304 pp., 29 Figs.
- Kiew, B. H., 1984a. *Rana malesiana*, a new frog from the Sunda Region. *Malay Nat. J.*, **37**: 153-161, 1 Pl., 2 Figs.
- Kiew, B. H., 1984b. Conservation status of the Malaysian Fauna. III. Amphibians. *Malay Nat. J.*, Kuala Lumpur, **37**(4): 6-10.
- Lee, S. H. & T. W. Chen, 1970. Artificial breeding and early development of the tadpoles of *Rana limnocharis* Boie. *J. Singapore Nat. Acad. Sci.*, **2**(2): 59
- Lim, K. K. P., 1989a. First record of the swamp-forest frog *Rana paramacrodon paramacrodon* Inger, 1966 (Amphibia: Anura: Ranidae) from Singapore, with notes on its taxonomy, ecology and biology. *Raffles Bull. Zool.*, **37**(1&2): 51-57.
- Lim, K. K. P., 1989b. *Bufo quadriporcatus* Boulenger, 1887, a toad new to Singapore Island. *Raffles Bull. Zool.*, **37**(1&2): 170-171.
- Lim, K.K.P., 1989c. Recent reports: amphibians. *The Pangolin*, Malayan Nature Society Singapore Branch, **2**(4): 65-66.
- Lim, K. K. P., 1990. Two recent records of the toad, *Pelophryne brevipes* (Peters, 1867) (Anura: Bufonidae) from Singapore. *Raffles Bull. Zool.*, **38**(1): 25-26.
- Lim, K. K. P. & L. M. Chou, 1990. The herpetofauna of Singapore. In: Chou, L.M. & P. K. L. Ng (Eds.), *Essays in Zoology*. Department of Zoology, National University of Singapore, pg. 49-59.
- Lim, K. K. P. & P. K. L. Ng, 1991. Nepenthophilous larvae and breeding habits of the sticky frog, *Kalophrynus pleurostigma* Tschudi (Amphibia: Microhylidae). *Raffles Bull. Zool.*, **39** (1): 209-214.
- Murphy, D. H., 1973. Animals in the Forest Ecosystem. In : *Animal Life and Nature in Singapore*. Ed. S. H. Chuang, Singapore University Press, pp 53-73.

Ng, P. K. L., Chou, L. M. & C. M. Yang, 1988. Caecilians in Singapore! *The Pangolin*. Malayan Nature Society Singapore Branch, 1(2): 36-37.

Ng, P. K. L., 1989. A third record of the caecilian, *Ichthyophis paucisulcus* from Singapore. *The Pangolin*, Malayan Nature Society Singapore Branch, 2(1): 13-14.

Sit, K. H., 1968. Mineral corticoid induced ovulation and development in the toad *Bufo melanostictus* Schneider. *J. Singapore Nat. Acad. Sci.*, 2(4): 65

Smedley, N. A., 1931. Notes on the Giant Frog, *Rana macrodon*. *Bull. Raffles Mus.*, 5: 59-62.

Smith, M. A., 1930. The Reptilia and Amphibia of the Malay Peninsula. *Bull. Raffles Mus.*, 3: 1-149.

Sworder, G. H., 1924. On a few reptiles and batrachians from the Singapore islands. *Singapore Nat.*, 1(3): 15-20.

Sworder, G. H., 1925. The frog, *Rana tigrina* and its allies. *Singapore Nat.*, 1(5): 99.

Taylor, E. H., 1960. On the caecilian species *Ichthyophis glutinosus* and *Ichthyophis monchrous*, with description of related species. *Univ. Kansas Sci. Bull.*, 40(4): 37-120.

Taylor, E. H., 1962. The amphibian fauna of Thailand. *Univ. Kansas Sci. Bull.*, 43(8): 265-599, 107 Figs.

Ting, M. C., 1970. Table of the early development of *Rhacophorus leucomystax* Boie. *J. Singapore Nat. Acad. Sci.*, 2(2): 38.