

Review

Anuran Inventory in Sabah—Past and Future

MASAFUMI MATSUI

*Graduate School of Human and Environmental Studies, Kyoto University,
Sakyo, Kyoto 606–8501, JAPAN*

Abstract: About 155 named species/subspecies of anurans, together with several caecilian species, reported from Borneo are considered to be valid, and at least 114 of these have been recorded from the state of Sabah, Malaysia. The general history of discovery of anuran fauna of Sabah from its beginning until now is outlined and the future of amphibian inventory in this state is discussed. From the curve of accumulated number of taxa, however, the number is expected to further increase and inventory will not be completed in the near future. In the past, accumulation of comparable materials led to the finding of several cryptic species. More recently, acoustic information greatly contributed to increment of records, and learning frog voices will prove a powerful tool to document local distribution as well as recognition of additional cryptic species. Another powerful method expected to contribute to compiling a more complete inventory is the biochemical method, such as analysis of mt DNA sequences. Applying these methods, a more intensive anuran inventory of Sabah should be made before the habitats of these animals are lost.

Key words: Borneo; Faunal survey; Frogs and toads; Inventory methods; Malaysia; Taxonomic history

INTRODUCTION

Among the various regions of Southeast Asia, the island of Borneo is the one where amphibian inventory has been made most intensively (see for instance, Inger et al., 1996; Das, 2003). From the entire island of Borneo, 138 species of anurans and several species of caecilians were reported some ten years ago (Inger et al., 1996). Of these, 99 species of frogs and toads were recorded from the Malaysian state of Sabah (former North Borneo).

On the other hand, Malkmus et al. (2002) listed 146 Bornean anurans (Fig. XI in p. 34, p. 46) or 147 (pp. 10, 62, 88, 115, 133, 175, plus 1 species of Bombinatoridae). Of these, 103 species are known from Sabah (Malkmus et al., 2002: Table 1–20 and pp. 10, 80, 116, 127, 136, 138, 176). However, this number includes neither two genera not found in Kinabalu (*Hoplobatrachus* and *Theloderma*, each contains one species in Borneo) nor two species (*Ansonia albomaculata* and *A. minuta*) whose records on Kinabalu are doubtful. Thus, the number of species occurring in Sabah would total 107, according to Malkmus et al. (2002).

Notwithstanding these slight differences in

Tel/Fax: +81–75–753–6846;
E-mail address: fumi@zoo.zool.kyoto-u.ac.jp

the numbers amongst authors, there is no doubt that the state of Sabah is endowed with a rich anuran fauna. In this mini-review, I carefully searched the literature and added my own data from recent trips to Sabah. As a result, six species were added to the fauna of Sabah most recently reported by Malkmus et al. (2002). In this mini-review, I outline the general history of anuran discovery in this state from the late 19th century until now (at the end of March 2006) and briefly discuss the future of amphibian inventories in Sabah.

HISTORY OF ANURAN INVENTORY IN SABAH

1850s

Although Günther (1858) included Borneo in the type localities of a ranid *Ixalus guttatus* Günther, 1858 [now *Staurois natator* (Günther, 1858)], and a rhacophorid, *Rhacophorus pardalis* Günther, 1858, no exact record from Sabah can be traced in this decade.

1880s

Boulenger (1887) described two new ranids, *Rana whiteheadi* Boulenger, 1887 [now *Meristogenys whiteheadi* (Boulenger, 1887)] and *Ixalus latopalmata* Boulenger, 1887 [now *Staurois latopalmatus* (Boulenger, 1887)] from Kinabalu.

Although Boulenger (1887) reported from Kinabalu a bufonid, *Bufo leptopus* Günther, 1872 [now *Ansonia leptopus* (Günther, 1872)] originally described from Matang, Sarawak, this record seems to be a misidentification of *Ansonia hanitschi* Inger, 1960 or *Ansonia longidigita* Inger, 1960. From Kinabalu, Boulenger (1887) also reported a rhacophorid, *Rhacophorus maculatus* Gray, 1832, but because this species, now moved to *Polypedates*, is considered to be restricted to South Asia (India, Nepal, Bangladesh and Sri Lanka), the record must be a misidentification of some other *Polypedates* species. Malkmus et al. (2002) associated this record to *Polypedates leucomystax* (Gravenhorst, 1829).

1890s

This decade is a very important period for the elucidation of anuran fauna in Sabah. Mocquard (1890) described four bufonids, *Bufo fuliginus* Mocquard, 1890 [now *Ansonia fuliginea* (Mocquard, 1890)] from north Borneo, *Bufo spinulifer* Mocquard, 1890 [now *Ansonia spinulifer* (Mocquard, 1890)] from Kinabalu, *Nectophryne maculata* Mocquard, 1890 [now *Pedostibes maculatus* (Mocquard, 1890)] from Kinabalu, and *Nectophryne misera* Mocquard, 1890 [now *Pelophryne misera* (Mocquard, 1890)] from North Borneo and three ranid species from Kinabalu.

All these ranids, however, are now usually considered invalid; *Rana decorata* Mocquard, 1890 and *Rana obsoleta* Mocquard, 1890, both from Kinabalu, were, respectively, synonymized by Boulenger (1891) with *Rana luctuosa* (Peters, 1871), originally described from Sarawak as *Limnodytes luctuosus* Peters, 1871, and *Rana signata* (Günther, 1872), originally described from Matang, Sarawak, as *Polypedates signatus* Günther, 1872. The remaining species, *Rana paradoxa* Mocquard, 1890 from Kinabalu, was synonymized by Boulenger (1891) with *Rana kuhlii* Tschudi, 1838 [now *Limnonectes kuhlii* (Tschudi, 1838)], originally described from Java, but like its relative *Rana conspicillata* Günther, 1872 [now *Limnonectes conspicillatus* (Günther, 1872)] from Matang, Sarawak, also synonymized with *L. kuhlii* by Boulenger (1882), it must be a valid species name (Matsui, unpublished data). He (Mocquard, 1890) further described a rhacophorid *Rhacophorus acutirostris* Mocquard, 1890 from Kinabalu, but because the name had been preoccupied, Ahl (1927) changed it to *Rhacophorus angulirostris* Ahl, 1927.

The species newly recorded in Sabah are as follows: Mocquard (1890) first reported four bufonids from Kinabalu: *Bufo leptopus* (see above), *Bufo biporcatus* Gravenhorst, 1829 originally described from Java, *Bufo asper* Gravenhorst, 1829 originally described from Java, and recorded from an unknown locality in Borneo by Boulenger (1882), and *Bufo*

penangensis Stoliczka, 1870 originally described from Penang. Of these records, however, *Bufo biporcatus* is now considered to be absent from Borneo, and the record must be a misidentification of *Bufo divergens* Peters, 1871 originally described from Sarawak. Similarly, *Bufo asper* might be *B. juxtasper* Inger, 1964, because no additional records of “true” *Bufo asper* are available from Kinabalu (Malkmus et al., 2002). *Bufo penangensis* [now *Ansonia penangensis* (Stoliczka, 1870)] is now known to be absent from Borneo, and the record must be other species of *Ansonia*. Malkmus et al. (2002) assigned this record to *Ansonia hanitschi*. Similarly, Inger (1966) identified *Bufo leptopus* recorded by Mocquard (1890) as *Ansonia longidigita* Inger, 1960, originally described from Kinabalu.

Mocquard (1890) also recorded two megophyids, *Megalophrys nasuta* (Schlegel, 1858) and *Leptobrachium gracile* (Günther, 1872) from Kinabalu. Of these, *Megalophrys nasuta* [now *Megophrys nasuta* (Schlegel, 1858)], originally described from Sumatra as *Ceratophryne nasuta* Schlegel, 1858, had already been recorded from an unspecified site in Borneo by Boulenger (1882), while *Leptobrachium gracile* [now *Leptolax gracilis* (Günther, 1872)] is known to be absent from Sabah (Inger et al., 1995). This record must be some other species of *Leptolax*, and as suggested by Malkmus et al. (2002), it may be a misidentification of *Leptolax arayai* Matsui, 1997 or an undescribed species (Matsui, unpublished). A ranid recorded from Kinabalu by Mocquard (1890), *Rana everetti* Boulenger, 1882, must refer to other species of *Rana*, because this nominal species is limited to the Philippines. Boulenger (1920) noted that the specimens from Celebes, which he had referred to *Rana everetti*, were inseparable from *Rana chalconota* (Schlegel, 1837) originally described as *Hyla chalconota* Schlegel, 1837 from Java. Thus, Mocquard’s (1890), *Rana everetti* may be also *Rana chalconota*.

Mocquard (1890) also recorded other ranids *Rana kuhli* Tschudi, 1838 from Kinabalu (see above), and *Rana gracilis* Wiegmann, 1834

from North Borneo. *Rana gracilis* in his record must be *Fejervarya limnocharis* (Gravenhorst, 1829), originally described from Java as *Rana limnocharis* Gravenhorst, 1829, and, although it is a very common species and recorded from Borneo by Flower (1899), the record from North Borneo (Kampen, 1923) was doubted by Inger (1966) and its occurrence in Sabah was not confirmed until Matsui et al. (1985) reported specimens (as *Rana limnocharis limnocharis*) from Kinabalu (see below). Mocquard (1890) confirmed the presence of a rhacophorid, *Rhacophorus leucomystax* (Gravenhorst, 1829) [now *Polypedates leucomystax* (Gravenhorst, 1829)], originally described as *Hyla leucomystax* Gravenhorst, 1829 from Java and recorded from Borneo by Boulenger (1882: see above), from Kinabalu. In addition, he reported from North Borneo another rhacophorid, *Rhacophorus cruciger* (Blyth, 1852) [now *Polypedates cruciger* Blyth, 1852], originally described from Ceylon (= Sri Lanka), but this record was later synonymized by Inger (1966) as *Rhacophorus colletti* Boulenger, 1890 [now *Polypedates colletti* (Boulenger, 1890)], originally described from Langkhat, Sumatra.

On the other hand, Boulenger described several species from Kinabalu as new to science: in 1893, a ranid, *Rana cavitympanum* Boulenger, 1893 [now *Huia cavitympanum* (Boulenger, 1893)] from Kinabalu; in 1896, a bufonid, *Nectophryne everetti* Boulenger, 1896 [now *Pedostibes everetti* (Boulenger, 1896)], two ranids, *Cornufer baluensis* Boulenger, 1896 [now *Ingerana baluensis* (Boulenger, 1896)] and *Oreobatrachus baluensis* Boulenger, 1896 [now *Occidozyga baluensis* (Boulenger, 1896)], and a rhacophorid, *Rhacophorus macroscelis* Boulenger, 1896 [now *Rhacophorus everetti macroscelis* Boulenger, 1896]; in 1899, a megophryid, *Leptobrachium baluensis* Boulenger, 1899 [now *Megophrys baluensis* (Boulenger, 1899)].

1900s

Boulenger (1900) described a rhacophorid, *Ixalus petersi* Boulenger, 1900 [now *Philau-*

tus petersi (Boulenger, 1900)], and included Kinabalu as one of the type localities. Hanitsch (1900) reported *Ixalus natator* Günther, 1859 (1858) [now *Staurois natator* (Günther, 1859)] originally described from the Philippines and recorded from Borneo by Günther (1858) as *Ixalus guttatus*, from Kinabalu.

1910s

Boulenger (1918) described a ranid *Staurois tuberilinguis* Boulenger, 1918, and included Kinabalu as one of the type localities.

1920s

As noted above for Mocquard (1890), Ahl (1927) proposed a substitute name, *Rhacophorus angulirostris* Ahl, 1927, for a rhacophorid *Rhacophorus acutirostris* Mocquard, 1890 from Kinabalu.

Boulenger (1920) published a monograph of *Rana*, and recorded five species new to Sabah: *Rana erythraea* (Schlegel, 1837) originally described from Java and Sumatra as *Hyla erythraea* Schlegel, 1837, and recorded from Borneo by Boulenger (1882), from Beaufort District (Padas); *Rana cancrivora* Gravenhorst, 1829 [now *Fejervarya cancrivora* (Gravenhorst, 1829)], originally described from Java, from Beaufort District (Padas); *Rana macrodon* Duméril and Bibron, 1841 [population from Sabah is now recognized as a distinct species *Limnonectes leporinus* (Anderson, 1923), originally described from Tumbang Maruwei, Kalimantan], already recorded from Sarawak by Boulenger (1882), from Sandakan; *Rana palawanensis* Boulenger, 1894 [now *Limnonectes palawanensis* (Boulenger, 1894)], originally described from Palawan, from Kinabalu; *Rana microdisca* Boettger, 1892 [the population from Sabah is now recognized as a distinct species *Limnonectes finchi* (Inger, 1966), originally described from Tawau District (Kalabakan)], from Sandakan.

Kampen (1923) listed Mt. Kappa, North Borneo as a locality of *Megalophrys hasseltii* Muller, 1839 [now *Leptobrachium hasseltii* Tschudi, 1838]. This seems to be the first published record of *Leptobrachium hasseltii*

from North Borneo, although the species has been reported by several workers from Borneo. However, *Leptobrachium hasseltii* is now limited to Java (Inger et al., 1995; Matsui et al., 1999), and forms occurring in Sabah are known to be a composite of three species (*Leptobrachium montanum* Fischer, 1885, *Leptobrachium abbotti* (Cochran, 1926), and *Leptobrachium gunungense* Malkmus, 1996).

1930s

Smith (1931) published an important paper on the Kinabalu fauna and described four new species of which, two, a megophryid, *Leptobrachella baluensis* Smith, 1931 from Kamborangah, and a rhacophorid, *Philautus amoenus* Smith, 1931 from Kamborangah, are now considered valid. The remaining two species, a bufonid, *Nectophryne altitudinis* Smith, 1931 from Pakka, and a rhacophorid, *Philautus spiculatus* from Kenokok, are now synonymized with *Ansonia fuliginea* Mocquard, 1890 and *Rhacophorus everetti* Boulenger, 1894, respectively (Inger, 1966).

Smith (1931) newly recorded one megophryiid, two microhylids, three ranids, and three rhacophorids from Kinabalu. Of these, *Megophrys monticola* Kuhl et Hasselt, 1822 from Lumu Lumu and Marei Parei, should be *M. kobayashii* Malkmus et Matsui, 1997, whose range includes Lumu Lumu, as suggested by Malkmus et al. (2002). Of the two microhylids, *Chaperina fusca* Mocquard, 1892 originally described from Sintang, Kalimantan, was recorded from Kiau. Another species, *Kalophrynus pleurostigma* Tschudi, 1838, originally described from Sumatra, and recorded from Borneo by Boulenger (1882), was collected from Kamborangah and Lumu Lumu, but, as suggested by Malkmus et al. (2002), this record should be now considered as that of *Kalophrynus baluensis* Kiew, 1984.

Of the three ranids, *Rana nicobariensis* (Stoliczka, 1870) from Kiau, was originally described from the Nicobar Islands as *Hylorana nicobariensis* Stoliczka, 1870, and recorded from Borneo by Kampen (1923). *Rana chalconota* (Schlegel, 1837) from Kiau

and Kabayau, originally described from Sarawak as *Hyla chalconota* Schlegel, 1837, should be treated as *Rana raniceps* (Peters, 1871), originally described from Sarawak as *Polypedates raniceps* Peters, 1871. *Rana jerboa* (Günther, 1872) from Kiau, Kenokok, Lumu Lumu, and Kamborangah, was originally described from Matang, Sarawak, as *Hylorana jerboa* Günther, 1872. It has now been moved to *Meristogenys* and is considered to be absent from Sabah. Therefore, this record must represent some other species of *Meristogenys*. Three rhacophorids recorded by Smith (1931) include *Rhacophorus pardalis* Günther, 1859 originally described from Borneo and Philippines, from Kabayau, *Philautus pictus* (Peters, 1871) [now *Nyctixalus pictus* (Peters, 1871)] originally described from Sarawak as *Ixalus pictus* Peters, 1871, from Lumu Lumu, and *Philautus mjobergi* Smith, 1925 originally described from Gunung Murud, Sarawak, from Marei Parei and Kamborangah.

1950s

Inger (1954) described a rhacophorid, *Rhacophorus baluensis* Inger, 1954 from Bundu Tuhan, Kinabalu.

Inger (1956) added many species to the fauna of Sabah. In the Bufonidae, *Ansonia leptopus* (Günther, 1872) originally described from Matang, Sarawak, was reported from Kinabatangan District (near the mouth of the Kretam Kechil River). As already noted above, *Bufo leptopus* was reported by Mocquard (1890) and Smith (1931) from Kinabalu, but these records may include *Ansonia hanitschi* and *Ansonia longidigita* (Inger, 1960). For microhylids, three species were listed: *Metaphrynella sundana* (Peters, 1867), originally described as *Calohyla sundana* Peters, 1867 from Pontianak, Kalimantan, from Sandakan District (Sapagaya), *Kalophrynus pleurostigma* Tschudi, 1838 (see above) from Kinabatangan District (near mouth of Kretam Kechil River) and Labuk District (near Beluran), and *Kaloula baleata* (Müller, 1836) originally described as *Bombinator baleatus* Müller, 1836 from Krawang, Java, and

recorded by Boulenger (1892) in Borneo, from Sandakan.

Additionally, Inger (1956) listed a ranid, *Ooeidozyga laevis* (Günther, 1859), originally described as *Oxyglossus laevis* Günther, 1859 from the Philippines and recorded by Smith (1925) from Sarawak, from Kinabatangan District (near mouth of Kretam Kechil River) and Sandakan District (Sandakan and Sapagaya), and two rhacophorids, *Rhacophorus appendiculatus* (Günther, 1859), originally described as *Polypedates appendiculatus* Günther, 1859 from the Philippines and reported from Sarawak by Boulenger (1892), from Sandakan, and *Rhacophorus ottilophus* Boulenger, 1893 [now *Polypedates ottilophus* (Boulenger, 1893)], originally described from Bongon, Sarawak, from Kinabatangan District (near the mouth of the Kretam Kecil River), Labuk District (Beluran), and Sandakan.

1960s

This is the most important decade for Bornean amphibian systematics because Inger (1966) compiled his comprehensive monograph "The Systematics and Zoogeography of Amphibia of Borneo". Prior to the publication of this monograph, Inger (1960) revised the bufonid genus *Ansonia*, and described *Ansonia hanitschi* Inger, 1960 from the Kadamaian River, Kinabalu, *Ansonia longidigita* Inger, 1960 from Kinabalu, and *Ansonia platysoma* Inger, 1960 from Bundu Tuhan, Kinabalu, as new species. Inger (1964) also described a bufonid, *Bufo juxtasper* Inger, 1964 from Kalabakan, Tawau District.

In the monograph, Inger (1966) described a bufonid, *Ansonia guibei* Inger, 1966 from Mesilau, Kinabalu, and three ranids, *Rana microdisca finchi* Inger, 1966 [now *Limnonectes finchi* (Inger, 1966)] from Kalabakan, Tawau, *Rana paramacrodon* Inger, 1966 [now *Limnonectes paramacrodon* (Inger, 1966)] from Kalabakan, Tawau, and *Amolops kinabaluensis* Inger, 1966 [now *Meristogenys kinabaluensis* (Inger, 1966)] from Kiau, Kinabalu.

Inger (1966) clarified the distribution of many species within Sabah. In bufonids, *Ansonia*

albomaculata Inger, 1960 originally described from Baleh River, Sarawak, was recorded from Kinabalu (Sg. Kipungit), *Bufo asper* Gravenhorst, 1829) (see above for Mocquard, 1890) from Kinabatangan District (Deramakot), Ranau, Sandakan, and Tawau District (Kalabakan), *Bufo quadriporcatus* Boulenger, 1887 originally described from Malacca and recorded from Sarawak by Boulenger (1892), from Sipitang, *Cacophryne borbonica* (Kuhl and van Hasselt, 1827) [now *Leptophryne borbonica* (Kuhl and van Hasselt, 1827)] originally described as *Hylaplesia borbonica* Kuhl and van Hasselt, 1827 from East Indies (Java) and recorded as *Bufo jerboa* from Sarawak by Simith (1925), from Kinabalu, and *Pedostibes hosei* (Boulenger, 1892) [now *Pedostibes hosii* (Boulenger, 1892)] originally described as *Nectophryne hosii* Boulenger, 1892 from Dulit, Sarawak, from Kinabatangan District (Deramakot, Dewhurst Bay), Lahad Datu District (Pangaruan River) and Tawau District (Kalabakan). Of these, occurrence in Sabah of *Ansonia albomaculata* was later rejected (Inger and Stuebing, 1997).

Three microhylids, *Kalophrynus subterrestris* Inger, 1966 originally described from Bintulu, Sarawak, and including paratypes from lower Segama, *Microhyla annectens* Boulenger, 1900 originally described from Larut, Malay Peninsula, from Kinabatangan District, and *Microhyla borneensis* Parker, 1928 originally described from Kidi District, Sarawak, from Kinabatangan District (Tegupi River), and Sepilok, were added, but, of these, *Microhyla annectens* is now considered to be absent from Sabah and other regions of Borneo.

Inger (1966) also recorded three ranids, *Rana baramica* Boettger, 1901 originally described from Baram River, Sarawak, from Sipitang, *Rana glandulosa* Boulenger 1882 originally described from Sarawak, from many localities of Sabah, and *Rana hosei* Boulenger, 1891 [now *Rana (Odorrana) hosii* Boulenger, 1891] originally described from Mt. Dulit, Sarawak, from Lahad Datu and Kinabalu (Sungei Mamut), and six rhacophorids, *Rhacophorus*

bimaculatus Peters, 1867 recorded as *Philautus* from Borno by Stejneger (1905), from Kinabatangan District (Deramakot) and Kinabalu (Lumu Lumu), *Rhacophorus dulitensis* Boulenger, 1892 originally described from Mt. Dulit, Sarawak, from Sandakan, *Rhacophorus nigropalmatus* Boulenger, 1895 originally described from the Akah River, Sarawak, from Kinabatangan Dist. (Deramakot) and Tawau District (Kalabakan), *Rhacophorus colletti* Boulenger, 1890 originally described from Sumatra, from Beaufort District (Lambidan), Labuk District (Paitan) and Sandakan, *Rhacophorus macrotis* Boulenger, 1891 originally described from the Baram River, Sarawak from Kinabatangan District (Deramakot), Labuk District (Beluran), Lahad Datu District (Lahad Datu and Silabukan valley), Ranau, Sandakan District (Sandakan and Sapagaya), and Tawau District (Kalabakan and Sebatik Island), and *Rhacophorus hosei* Boulenger, 1895 originally described as *Rhacophorus hosii* Boulenger, 1895 from the Patah River, Sarawak, from Ranau and Kinabatangan Districts. Of these, the population of *Rhacophorus bimaculatus* from Sabah is now treated as *Rhacophorus cyanopunctatus* Mantley et Steiof, 1998, originally described from Khao Sok, Thailand, *Rhacophorus colletti* and *Rhacophorus macrotis* are placed in *Polypedates*, and *Rhacophorus hosei* is now called *Philautus hosii*.

1970s

Matsui (1979) first reported the occurrence of a ranid, *Rana rugulosa* Wiegmann, 1834 [now *Hoplobatrachus chinensis* (Osbeck, 1765)] originally described from China, from Tuaran, and also confirmed a microhylid, *Kaloula pulchra* Gray, 1831 originally described from China and recorded from Borneo by Inger (1966), from Kota Kinabalu and Kinabalu Headquarters.

1980s

Dring (1984) described a megophryid, *Lepidobrachella parva* Dring, 1984 from Mulu, Sarawak, and included Deramakota in the

distribution range. Kiew (1984) described a microhylid, *Kalophrynus baluensis* Kiew, 1984 from Kamborangoh, Kinabalu, and Matsui (1986) described two ranids, *Amolops amoropalamus* Matsui, 1986 [now *Meristogenys amoropalamus* (Matsui, 1986)] from Crayan County, Kalimantan, including Kinabalu as a range of distribution, and *Amolops orphnocnemis* Matsui, 1986 [now *Meristogenys orphnocnemis* (Matsui, 1986)] from Bundu Tuhan, Kinabalu. Subsequently, Dring (1987) described a rhacophorid, *Philautus ingeri* Dring, 1987 from Mulu, Sarawak and included Kinabalu in the range of distribution. Inger (1989) described a microhylid, *Microhyla maculifera* Inger, 1989, from Danum Valley, Lahad Datu District, and two rhacophorids, *Philautus disgregus* Inger, 1989 from Danum Valley, Lahad Datu District, and *Philautus aurantium* Inger, 1989 from Mendolong, Sipitang District, as new species.

Inger (1985) recorded larvae of a megophryid, *Leptobrachium montanum* Fischer, 1885, originally described from Pramassan-Alai, Kalimantan, and long called *Leptobrachium haseltii* Tschudi, 1838 (see above), from Sandakan, Kinabatangan, Tawau, Tuaran, and Kinabalu, and Matsui et al. (1985) reported *Rana limnocharis limnocharis* Gravenhorst, 1829 from Kinabalu (see above for Mocquard, 1900). Inger and Stuebing (1989) published a handbook and recorded the following species from Sabah without locality data: a megophryid, *Megophrys edwardinae* Inger, 1989, originally described from Nanga Tekalit, Kapit District, Sarawak; a bufonid, *Pedostibes rugosus* Inger, 1958, originally described from Menuang, Sarawak; two microhylids, *Kalophrynus heterochirus* Boulenger, 1900, originally described as *Calophrynus* from somewhere in Borneo and *Microhyla berdmorei* (Blyth, 1856), originally described as *Engystoma berdmorei* Blyth, 1856 from Myanmar and recorded from Kalimantan in Inger (1966); a ranid, *Rana ingeri* Kiew, 1978 [now *Limnonectes ingeri* (Kiew, 1978)] originally described from Niah, Sarawak; six rhacophorids, *Philautus longicrus* (Boulenger, 1894) originally described as *Ixalus*

longicrus Boulenger, 1894 from Palawan and recorded from Mulu, Sarawak, by Dring (1987), *Philautus tectus* Dring 1987, originally described from Mulu, Sarawak, *Rhacophorus gauni* (Inger, 1966) originally described as *Philautus gauni* Inger, 1966 from Mengiong River, Sarawak, *Rhacophorus kajau* Dring, 1983 originally described from Mulu, Sarawak, *Rhacophorus reinwardti* (Schlegel, 1837) originally described as *Hyla reinwardti* Schlegel, 1837 from Java and recorded from Borneo by van Kampen (1923), and *Rhacophorus rufipes* Inger, 1966 originally described from Labang, Fourth Division, Sarawak.

1990s

In the 1990s, Inger and Stuebing (1991) and Malkmus (1992) described megophryids, *Leptobrachella palmata* Inger et Stuebing, 1991 from Labuk and Sugut District, and *Leptolalax pictus* Malkmus, 1992 from Kinabalu, respectively. Inger et al. (1995) described a rhacophorid, *Philautus bunitus* Inger, Stuebing et Tan, 1995 from Mt. Lumak, Sipitang District, and Malkmus (1996) described a megophryid, *Leptobrachium gunungense* Malkmus, 1996 from Kinabalu. Malkmus and Riede (1996a, b) described two rhacophorids, *Philautus saueri* Malkmus et Riede, 1996 from Pakka, Kinabalu, and *Philautus aurantium gunungensis* Malkmus et Riede, 1996 from Kinabalu. Finally, Matsui (1997), Inger et al. (1997), and Malkmus et Matsui (1997), respectively, described megophryids from Kinabalu, *Leptolalax arayai* Matsui, 1997, *Leptolalax maurus* Inger, Lakim, Biun et Yambun, 1997, and *Megophrys kobayashii* Malkmus et Matsui, 1997.

Inger and Stuebing (1992) reported from Kinabalu, a bufonid, *Ansonia minuta* Inger, 1960, originally described from Matang, Sarawak, and a rhacophorid, *Rhacophorus harrisoni* Inger and Haile, 1960, originally described from Baram River, Sarawak. They also recorded from Lumaku, a microhylid, *Microhyla petrigena* Inger et Frogner, 1979 originally described from Nanga Tekalit, Kapit District, Sarawak. Of these, the presence in Sabah of *Ansonia*

minuta was later denied by the same authors (Inger and Stuebing, 1997; but see below).

Inger et al. (1995) clarified taxonomic relationships of two megophryids, *Leptobrachium hasseltii* Tschudi, 1838 and *Leptolalax gracilis* (Günther, 1872), both long recorded from Sabah, with their relatives, and reported *Leptobrachium abbotti* (Cochran, 1926) originally described as *Megophrys abbotti* Cochran, 1926 from Balikpapan, Borneo, from Sabah, including Danum Valley, and *Leptolalax dringi* Dubois, 1987, originally described from Mulu, Sarawak, from Kota Marudu, Lahad Datu, Ranau, Kinabalu, Sipitang, Sandakan, Tambunan, Tawau and Tenom. They also noted an undescribed *Leptolalax* from Ranau, Sipitang, Tambunan, and Tenom, but part of the series on which species identification was based may include *Leptolalax pictus* Malkmus, 1992. Inger et al. (1995) also clarified the occurrence in Danum Valley of a rhacophorid, *Theloderma horridum* (Boulenger, 1903), originally described as *Ixalus horridus* Boulenger, 1903 from Pattani, Thailand. Inger et al. (1996) provided a list of anurans from Borneo and listed 99 species from Sabah, including a ranid, *Rana picturata* Boulenger, 1920, originally described from Borneo, and a microhylid, *Calluella smithi* (Barbour et Noble, 1916), originally described as *Calliglutus smithi* Barbour et Noble, 1916 from Limbang River, Sarawak.

In their new field guide, Inger and Stuebing [1997 (revised in 2005, but unchanged regarding frog fauna)] listed Kota Kinabalu, as a range of a bufonid, *Bufo melanostictus* Schneider, 1799, originally described from the East Indies, and recorded from Borneo by Boulenger (1882). They also listed Sabah in the range of distribution of another bufonid, *Pelophryne signata* (Boulenger, 1894), originally described as *Nectophryne signata* Boulenger, 1894 from Kalimantan, a ranid *Rana malesiana* Kiew, 1984 [now *Limnonectes malesianus* (Kiew, 1984)] originally described from Singapore, and a microhylid, *Microhyla perparva* Inger et Frogner, 1979 originally described from Bintulu District, Sarawak,

from Kinabalu.

2000s

In this century, a rhacophorid, *Philautus erythrophthalmus* Stuebing et Wong, 2000 and a bufonid, *Ansonia anotis* Inger, Tan et Yambun, 2001 have been described from Mt. Muruk Mio, Sipitang District by Stuebing and Wong (2000), and from Sayap, Kinabalu by Inger et al. (2001), respectively.

Inger et al. (2000) provided a list of frogs from three large parks in Sabah, and revived two bufonids, *Ansonia albomaculata* Inger, 1960 and *Ansonia minuta* Inger, 1960, in the fauna of Sabah.

Present study

Megophrys dringi Inger, Stuebing et Tan, 1995, originally described from Gunung Mulu, Sarawak, was confirmed to occur on Crocker range, and *Staurois parvus* Inger et Haile, 1960, originally described from the Akah River, Sarawak and once synonymized with *Staurois tuberilinguis* Boulenger, 1918 by Inger (1966), was shown to be a distinct species in our study (Matsui et al., in preparation).

TRENDS IN INVENTORY INCREMENT AND FUTURE PROBLEMS

According to the present review, 113 species and one subspecies have been recorded from Sabah, and 28 of these species are recorded only from this state within Borneo. Two of these 28 species are found also outside of Borneo, and, therefore, 26 species are considered to be endemic to Sabah (Table 1). Increment in number of species in Sabah as described above is shown in Fig. 1. As shown in this figure, one-third of the known taxa were listed by the 1950s, and half by the late 1960s. Thus, the remaining half has not been confirmed until the past three decades. As seen in the accumulated curve of species, the total number is expected to increase, and the time when the inventory will be complete cannot be estimated. In fact, we have at hand at least three more species (of *Leptolalax* and *Meris-*

TABLE 1. List of anurans recorded from Sabah, Borneo.

Species	First record in Sabah	Bornean distribution*
Bufonidae		
<i>Ansonia albomaculata</i> Inger, 1960	Inger, 1966	SB SW KL
<i>Ansonia anotis</i> Inger, Tan et Yambun, 2001	Inger et al., 2001	SB
<i>Ansonia fuliginea</i> (Mocquard, 1890)	Mocquard, 1890	SB
<i>Ansonia guibei</i> Inger, 1966	Inger, 1966	SB
<i>Ansonia guibei</i> Inger, 1960	Inger, 1960	SB SW
<i>Ansonia leptopus</i> (Günther, 1872)	Inger, 1956	SB SW KL
<i>Ansonia longidigita</i> Inger, 1960	Inger, 1960	SB SW
<i>Ansonia minuta</i> Inger, 1960	Inger et Stuebing, 1992	SB SW KL
<i>Ansonia platysoma</i> Inger, 1960	Inger, 1960	SB SW
<i>Ansonia spinulifer</i> (Mocquard, 1890)	Mocquard, 1890	SB SW
<i>Bufo asper</i> Gravenhorst, 1829	Inger, 1966	SB SW KL BN
<i>Bufo divergens</i> Peters, 1871	Mocquard, 1890	SB SW KL BN
<i>Bufo juxtasper</i> Inger, 1964	Inger, 1964	SB SW KL
<i>Bufo melanostictus</i> Schneider, 1799	Inger et Stuebing, 1997	SB SW KL
<i>Bufo quadriporcatus</i> Boulenger, 1887	Inger, 1966	SB SW KL
<i>Leptophryne borbonica</i> (Tschudi, 1827)	Inger, 1966	SB SW KL
<i>Pedostibes everetti</i> (Boulenger, 1896)	Boulenger, 1896	SB
<i>Pedostibes hosii</i> (Boulenger, 1892)	Inger, 1966	SB SW KL
<i>Pedostibes maculatus</i> (Mocquard, 1890)	Mocquard, 1890	SB
<i>Pedostibes rugosus</i> Inger, 1958	Inger et Stuebing, 1989	SB SW KL
<i>Pelophryne misera</i> (Mocquard, 1890)	Mocquard, 1890	SB
<i>Pelophryne signata</i> (Boulenger, 1894)	Inger et Stuebing, 1997	SB SW
Megophryidae		
<i>Leptobrachella baluensis</i> Smith, 1931	Smith, 1931	SB SW
<i>Leptobrachella palmata</i> Inger et Stuebing, 1991	Inger et Stuebing, 1991	SB
<i>Leptobrachella parva</i> Dring, 1984	Dring, 1984	SB SW
<i>Leptobrachium abbotti</i> (Cochran, 1926)	Inger et al., 1995	SB SW KL BN
<i>Leptobrachium gunungense</i> Malkmus, 1996	Malkmus, 1996	SB
<i>Leptobrachium montanum</i> Fischer, 1885	Inger, 1985	SB SW KL
<i>Leptolax arayai</i> Matsui, 1997	Matsui, 1997	SB
<i>Leptolax dringi</i> Dubois, 1987	Inger et al., 1995	SB SW
<i>Leptolax maurus</i> Inger, Lakim, Biun et Yambun, 1997	Inger et al., 1997	SB
<i>Leptolax pictus</i> Malkmus, 1992	Malkmus, 1992	SB
<i>Megophrys baluensis</i> (Boulenger, 1899)	Boulenger, 1899	SB
<i>Megophrys dringi</i> Inger, Stuebing et Tan, 1995	Matsui, this study	SW
<i>Megophrys edwardinae</i> Inger, 1989	Inger et Stuebing, 1989	SB SW
<i>Megophrys kobayashii</i> Malkmus et Matsui, 1997	Malkmus et Matsui, 1997	SB
<i>Megophrys nasuta</i> (Schlegel, 1858)	Mocquard, 1890	SB SW KL
Microhylidae		
<i>Calluella smithi</i> (Barbour et Noble, 1916)	Inger et al., 1996	SB SW
<i>Chaperina fusca</i> Mocquard, 1892	Smith, 1931	SB SW KL

TABLE 1. continued

<i>Kalophrynus baluensis</i> Kiew, 1984	Kiew, 1984	SB
<i>Kalophrynus heterochirus</i> Boulenger, 1900	Inger et Stuebing, 1989	SB SW KL
<i>Kalophrynus pleurostigma</i> Tschudi, 1838	Inger, 1956	SB SW KL
<i>Kalophrynus subterrestris</i> Inger, 1966	Inger, 1966	SB SW
<i>Kaloula baleata</i> (Müller, 1836)	Inger, 1956	SB SW KL
<i>Kaloula pulchra</i> Gray, 1831	Matsui, 1979	SB KL
<i>Metaphrynella sundana</i> (Peters, 1867)	Inger, 1956	SB SW KL
<i>Microhyla berdmorei</i> (Blyth, 1856)	Inger et Stuebing, 1989	SB SW KL
<i>Microhyla borneensis</i> Parker, 1928	Inger, 1966	SB SW
<i>Microhyla maculifera</i> Inger, 1989	Inger, 1989	SB
<i>Microhyla perparva</i> Inger et Frogner, 1979	Inger et Stuebing, 1997	SB SW
<i>Microhyla petrigena</i> Inger et Frogner, 1979	Inger et Stuebing, 1992	SB SW
Ranidae		
<i>Fejervarya cancrivora</i> (Gravenhorst, 1829)	Boulenger, 1920	SB SW KL
<i>Fejervarya limnocharis</i> (Gravenhorst, 1829)	Mocquard, 1890	SB SW KL BN
<i>Hoplobatrachus chinensis</i> (Osbeck, 1765)	Matsui, 1979	SB**
<i>Huia cavitympanum</i> (Boulenger, 1893)	Boulenger, 1893	SB SW KL
<i>Ingerana baluensis</i> (Boulenger, 1896)	Boulenger, 1896	SB SW
<i>Limnonectes finchi</i> (Inger, 1966)	Inger, 1966	SB
<i>Limnonectes ingeri</i> (Kiew, 1978)	Inger et Stuebing, 1989	SB SW KL BN
<i>Limnonectes kuhli</i> (Tschudi, 1838)	Mocquard, 1890	SB SW KL BN
<i>Limnonectes leporinus</i> (Anderson, 1923)	Boulenger, 1920	SB SW KL BN
<i>Limnonectes malesianus</i> (Kiew, 1984)	Inger et Stuebing, 1997	SB SW
<i>Limnonectes palavanensis</i> (Boulenger, 1894)	Boulenger, 1920	SB SW KL
<i>Limnonectes paramacrodon</i> (Inger, 1966)	Inger, 1966	SB SW BN
<i>Meristogenys amoropalamus</i> (Matsui, 1986)	Matsui, 1986	SB SW KL
<i>Meristogenys kinabaluensis</i> (Inger, 1966)	Inger, 1966	SB SW
<i>Meristogenys orphnocnemis</i> (Matsui, 1986)	Matsui, 1986	SB KL
<i>Meristogenys whiteheadi</i> (Boulenger, 1887)	Boulenger, 1887	SB
<i>Occidozyga baluensis</i> (Boulenger, 1896)	Boulenger, 1896	SB SW KL BN
<i>Occidozyga laevis</i> (Günther, 1859)	Inger, 1956	SB SW KL BN
<i>Rana (Odorrana) hosii</i> Boulenger, 1891	Inger, 1966	SB SW KL
<i>Rana (Chalcorana) raniceps</i> (Peters, 1871)	Smith, 1931	SB SW KL BN
<i>Rana (Hylarana) erythraea</i> (Schlegel, 1837)	Boulenger, 1920	SB SW KL BN
<i>Rana (Pulchrana) baramica</i> Boettger, 1901	Inger, 1966	SB SW KL BN
<i>Rana (Pulchrana) glandulosa</i> Boulenger, 1882	Inger, 1966	SB SW BN
<i>Rana (Pulchrana) luctuosa</i> (Peters, 1871)	Mocquard, 1890	SB SW
<i>Rana (Pulchrana) picturata</i> Boulenger, 1920	Inger et al., 1996	SB SW KL BN
<i>Rana (Pulchrana) signata</i> (Günther, 1872)	Mocquard, 1890	SB SW
<i>Rana (Sylvirana) nicobariensis</i> (Stoliczka, 1870)	Smith, 1931	SB SW KL
<i>Staurois latopalmaris</i> (Boulenger, 1887)	Boulenger, 1887	SB SW KL
<i>Staurois natator</i> (Günther, 1858)	Hanitsch, 1900	SB SW KL BN
<i>Staurois parvus</i> Inger et Haile, 1960	Matsui, this study	SB SW
<i>Staurois tuberiinguis</i> Boulenger, 1918	Boulenger, 1918	SB SW

TABLE 1. continued

Rhacophoridae		
<i>Nyctixalus pictus</i> (Peters, 1871)	Smith, 1931	SB SW KL
<i>Philautus amoenus</i> Smith, 1931	Smith, 1931	SB
<i>Philautus aurantium aurantium</i> Inger, 1989	Inger, 1989	SB
<i>Philautus aurantium gunungensis</i> Malkmus et Riede, 1996	Malkmus et Riede, 1996	SB
<i>Philautus bunitus</i> Inger, Stuebing et Tan, 1995	Inger et al., 1995	SB
<i>Philautus disgregus</i> Inger, 1989	Inger, 1989	SB
<i>Philautus erythrophthalmus</i> Stuebing et Wong, 2000	Stuebing et Wong, 2000	SB
<i>Philautus hosii</i> (Boulenger, 1895)	Inger, 1966	SB SW
<i>Philautus ingeri</i> Dring, 1987	Dring, 1987	SB SW
<i>Philautus longicrus</i> (Boulenger, 1894)	Inger et Stuebing, 1989	SB SW
<i>Philautus mjobergi</i> Smith, 1925	Smith, 1931	SB SW KL
<i>Philautus petersi</i> (Boulenger, 1900)	Boulenger, 1900	SB SW
<i>Philautus saueri</i> Malkmus et Riede, 1996	Malkmus et Riede, 1996	SB
<i>Philautus tectus</i> Dring, 1987	Inger et Stuebing, 1989	SB SW BN
<i>Polypedates colletti</i> (Boulenger, 1890)	Inger, 1966	SB SW
<i>Polypedates leucomystax</i> (Gravenhorst, 1829)	Boulenger, 1887	SB SW KL BN
<i>Polypedates macrotis</i> (Boulenger, 1891)	Inger, 1966	SB SW KL
<i>Polypedates ottilophus</i> (Boulenger, 1893)	Inger, 1956	SB SW KL
<i>Rhacophorus anguillirostris</i> Ahl, 1927	Mocquard, 1890	SB
<i>Rhacophorus appendiculatus</i> (Günther, 1859)	Inger, 1956	SB SW KL BN
<i>Rhacophorus baluensis</i> Inger, 1954	Inger, 1954	SB SW
<i>Rhacophorus cyanopunctatus</i> Manthey et Steiof, 1998	Inger, 1966	SB SW KL
<i>Rhacophorus dulitensis</i> Boulenger, 1892	Inger, 1966	SB SW
<i>Rhacophorus everetti macroscelis</i> Boulenger, 1896	Boulenger, 1896	SB SW
<i>Rhacophorus gauni</i> (Inger, 1966)	Inger et Stuebing, 1989	SB SW
<i>Rhacophorus harrissoni</i> Inger et Haile, 1960	Inger et Stuebing, 1992	SB SW KL
<i>Rhacophorus kajau</i> Dring, 1983	Inger et Stuebing, 1989	SB SW
<i>Rhacophorus nigropalmatus</i> Boulenger, 1895	Inger, 1966	SB SW KL
<i>Rhacophorus pardalis</i> Günther, 1859	Smith, 1931	SB SW KL
<i>Rhacophorus reinwardti</i> (Schlegel, 1837)	Inger et Stuebing, 1989	SB SW
<i>Rhacophorus rufipes</i> Inger, 1966	Inger et Stuebing, 1989	SB SW
<i>Theloderma horridum</i> (Boulenger, 1903)	Inger et al., 1995	SB***

* SB=Sabah, SW=Sarawak, KL=Kalimantan, BN=Brunei; **artificial introduction: ***Found in Peninsular Malaysia.

togenys) to be described (Matsui, unpublished).

The greatest reason for species increment is exploration of new localities, and most of the earlier records are related to expeditions to several localities of Sabah, especially to Mt. Kinabalu. However, due to its vast area, a complete amphibian survey in this state will take much time and effort. On the other hand, habitat destruction is rapidly proceeding, and

intensive faunal surveys are urgently needed.

The second reason for the species increase is that accumulation of comparable museum specimens had enabled close examination of morphological variations. This led to the finding of a number of cryptic species. Inger's (1964) description of *Bufo juxtasper* Inger, 1964 was made under this circumstance, and Kiew's (1978) description of *Limnonectes ingeri*

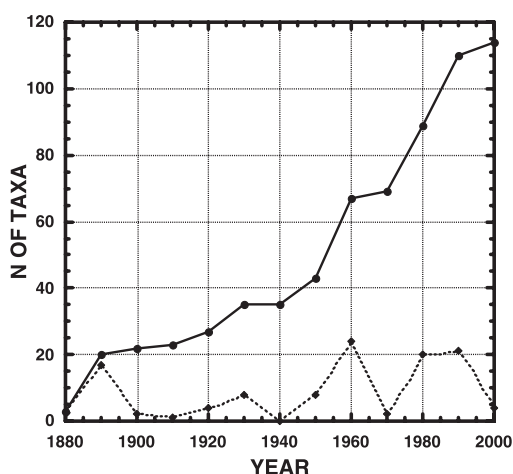


FIG. 1. Number of species/subspecies recorded from Sabah (broken line=new record for each decade; solid line=accumulation).

(Kiew, 1978) and Matsui's (1986) descriptions of *Meristogenys amoropalamus* (Matsui, 1986) and *Meristogenys orphnocnemis* (Matsui, 1986) were also made by similar processes.

The information greatly contributed in recent increment of records is the one from acoustics. Dring (1984) for the genus *Leptobrachella*, and Dring (1987) for the genus *Philautus* showed the utility of acoustic analyses for amphibian inventory. In descriptions by Malkmus's (1996) *Leptobrachium gunungense* Malkmus, 1996, Malkmus and Riede's (1996) *Philautus aurantium gunungensis* Malkmus et Riede, 1996 and *Philautus saueri* Malkmus et Riede, 1996, and Matsui (1997)'s *Leptolalax arayai* Matsui, 1997, call characteristics had an important role. Further, once one learns a particular frog voice, he or she can record the occurrence of the species even if specimens can not be captured. Knowledge of frog voices will also lead to discovery of new species in the field.

The method expected to offer useful information for constructing a more complete inventory is the biochemical method. In the amphibian taxa from Sabah, utility of this approach has been suggested for detecting distinct specific status of *Leptobrachium gunungense* Malkmus, 1996 (Malkmus et al., 2002). Although reports based on biochemical infor-

mation are still meager at the present moment, studies using this method are rapidly increasing as seen in an example for two species of what is currently referred to as *Staurois tuberilinguis* (Matsui et al., in preparation). The presence of artificially introduced amphibian species is also known in Sabah. Occurrence of introduced *Hoplobatrachus chinensis* (Osbeck, 1765) reported by Matsui (1979) is a typical example, and this species, after widening its range, is now becoming a notorious predator of native small animals in rice paddies.

Future thorough amphibian surveys, if conducted before vast unstudied areas are developed and natural environments are lost, will further increase the contents of the inventory. Verification of distribution of particular frogs by their calls will be effective in such surveys. Also, association of larval and adult forms using DNA sequence analyses will contribute to ascertain species distribution through collection of larval specimens. This biochemical method, combined with detailed morphological inspection, will also make it possible to elucidate cryptic species that are difficult to identify by morphology alone. If these methods are applied, the number of species will increase further, and the amphibian inventory of Sabah will reach completion.

ACKNOWLEDGMENTS

I am grateful to T. Shimada for assistance in the literature survey. I am also indebted to I. Das, T. Hikida, M. Hoogmoed, R. F. Inger, B.-H. Kiew, R. Malkmus, U. Manthey, A. Ohler, I. Okochi, H. Ota, Y. Shibata, P. Yambun, and H.-S. Yong for obtaining valuable references. I thank I. Das for critical reading of an earlier version of the manuscript. The Economic-Planning Unit kindly permitted us to conduct the project, and Universiti Malaysia Sabah and JICA kindly provided all the facilities for conducting research in Sabah. The field trip was made possible by a grant under The Monbusho Scientific Research Program (No. 15370038).

LITERATURE CITED

- AHL, E. 1927. Zur Systematik der asiatischen Arten der Froschgattung *Rhacophorus*. Sitz. ber. naturf. Freunde Berlin 1927: 35–47.
- BOULENGER, G. A. 1882. Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum. Taylor and Francis, London.
- BOULENGER, G. A. 1887. On new reptiles and batrachians from North Borneo. Ann. Mag. Nat. Hist. Ser. 5. 20: 95–97.
- BOULENGER, G. A. 1891. Remarks on the herpetological fauna of Mount Kina Baloo, North Borneo. Ann. Mag. Nat. Hist. Ser. 6. 7: 341–345.
- BOULENGER, G. A. 1892. An account of the reptiles and batrachians collected by Mr. C. Hose on Mt. Dulit, Borneo. Proc. Zool. Soc. London 1892: 505–508, pls. 29–30.
- BOULENGER, G. A. 1893. Description of new reptiles and batrachians obtained in Borneo by Mr. A. Everett and Mr. C. Hose. Proc. Zool. Soc. London 1893: 522–528.
- BOULENGER, G. A. 1896a. Description of new batrachians in the British Museum. Ann. Mag. Nat. Hist. Ser. 6. 17: 401–403.
- BOULENGER, G. A. 1896b. Description of three new reptiles and a batrachian from Mt. Kinabalu, North Borneo. Ann. Mag. Nat. Hist. Ser. 7. 4: 451–453.
- BOULENGER, G. A. 1899. Description of two new batrachians obtained by Mr. Everett on Mt. Kinabalu, North Borneo. Ann. Mag. Nat. Hist. Ser. 6. 17: 449–450.
- BOULENGER, G. A. 1900. Description of new reptiles and batrachians from Borneo. Proc. Zool. Soc. London 1900: 182–187.
- BOULENGER, G. A. 1918. Remarks on the batrachian genera *Cornufer*, Tschudi, *Platymantis*, Günther, g.n. and *Staurois*, Cope. Ann. Mag. Nat. Hist. Ser. 9. 1: 372–375.
- BOULENGER, G. A. 1920. A monograph of the South Asia, Papuan, Melanesian, and Australian frogs of the genus *Rana*. Rec. Indian Mus. 20: 1–226.
- DAS, I. 2003. Collecting in the “land below the wind”, herpetological explorations of Borneo. Bonn. Zool. Beitr. 52: 231–243.
- DRING, J. 1984 (1983). Frogs of the genus *Leptobrachella* (Pelobatidae). Amphibia-Reptilia 4: 89–102.
- DRING, J. 1987. Bornean treefrogs of the genus *Philautus* (Rhacophoridae). Amphibia-Reptilia 8: 19–47.
- FLOWER, S. S. 1899. Notes on a second collection of reptiles and batrachians made in the Malay Peninsula and Siam, from November 1896 to September 1898, with a list of the species recorded from those countries. Proc. Zool. Soc. London 1899: 885–916, pls. 59–60.
- GÜNTHER, A. 1858. Catalogue of the Batrachia Salientia in the Collection of the British Museum. Brit. Mus., London.
- HANITSCH, R. 1900. An expedition to Mt. Kinabalu, British North Borneo. J. Str. Br. Roy. As. Soc. Singapore 34: 49–88.
- INGER, R. F. 1954. On a collection of amphibians from Mt. Kinabalu, North Borneo. J. Wash. Acad. Sci. 44: 250–251.
- INGER, R. F. 1956. Some amphibians from the lowlands of North Borneo. Fieldiana: Zool. 34: 389–423.
- INGER, R. F. 1960. A review of the oriental toads of the genus *Ansonia* Stoliczka. Fieldiana: Zool. 39: 473–503.
- INGER, R. F. 1964. Two new species of frogs from Borneo. Fieldiana: Zool. 44: 151–159.
- INGER, R. F. 1966. The systematics and zoogeography of the Amphibia of Borneo. Fieldiana: Zool. 52: 1–402.
- INGER, R. F. 1985. Tadpoles of the forested regions of Borneo. Fieldiana: Zool. New Ser. 26: v+1–89.
- INGER, R. F. 1989. Four new species of frogs from Borneo. Malayan Nat. J. 42: 229–243.
- INGER, R. F. AND R. B. STUEBING. 1989. Frogs of Sabah. Sabah Parks Publication no. 10. Sabah Parks Trustees, Kota Kinabalu.
- INGER, R. F. AND R. B. STUEBING. 1991. A new species of frog of the genus *Leptobrachella* Smith (Anura: Pelobatidae), with a key to the species from Borneo. Raffles Bull. Zool. 39: 99–103.
- INGER, R. F. AND R. B. STUEBING. 1992. The montane amphibian fauna of Northwestern Borneo. Malayan Nat. J. 46: 41–51.
- INGER, R. F. AND R. B. STUEBING. 1997. A Field

- guide to the Frogs of Borneo. Natural History Publications, Kota Kinabalu.
- INGER, R. F. AND F.-L. TAN. 1996. Checklist of the frogs of Borneo. *Raffles Bull. Zool.* 44: 551–574.
- INGER, R. F., R. B. STUEBING, AND F.-L. TAN. 1995. New species and new records of anurans from Borneo. *Raffles Bull. Zool.* 43: 115–131.
- INGER, R. F., M. LAKIM, A. BUIN, AND P. YAMBUN. 1997. A new species of *Leptolalax* (Anura; Megophryidae) from Borneo. *Asiat. Herpetol. Research* 7: 48–50.
- INGER, R. F., F.-L. TAN, AND P. YAMBUN. 2000. The frog fauna of three parks in Sabah, Malaysia—Kinabalu Park, Crocker Range Park, and Tawau Hills Park. *Sabah Parks Nat. J.* 3: 7–28.
- INGER, R. F., F.-L. TAN, AND P. YAMBUN. 2001. A new species of toad of the genus *Ansonia* (Anura: Bufonidae) from Borneo. *Raffles Bull. Zool.* 49: 35–37.
- KAMPEN, P. N. VAN. 1923. The Amphibia of the Indo-Australian Archipelago. E. J. Brill, Leiden.
- KIEW, B. H. 1978. The nomenclature and identity of the Javanese frog *Rana macrodon* Dumeril and Bibron. *Malayan Nat. J.* 31: 219–229.
- KIEW, B. H. 1984. A new species of frog (*Kalophrynus baluensis* n. sp.) from Mt. Kinabalu, Sabah, Malaysia. *Malayan Nat. J.* 38: 151–156.
- MALKMUS, R. 1992. *Leptolalax pictus* sp. n. (Anura: Pelobatidae) vom Mount Kinabalu/ Nord-Borneo. *Sauria*, Berlin 14: 3–6.
- MALKMUS, R. 1996. *Leptobrachium gunungense* sp. n. (Anura: Pelobatidae) vom Mount Kinabalu, Nord-Borneo. *Mit. Zool. Mus. Berl.* 72: 297–301.
- MALKMUS, R. AND K. RIEDE. 1996a. Die Baumfrosche der Gattung *Philautus* vom Mount Kinabalu-Tail I: Überblick und die *aurifasciatus*-Gruppe mit Beschreibung einer neuen Art (*Philautus saueri* n. sp.) *Sauria*, Berlin 18: 27–37.
- MALKMUS, R. AND K. RIEDE. 1996b. Die Baumfrosche der Gattung *Philautus* vom Mount Kinabalu-Tail II: Die *vermiculatus*-Gruppe mit Beschreibung einer neuen Unterart (*Philautus aurantium gunungensis* n. ssp.) und die *hosei*-Gruppe. *Sauria*, Berlin 18: 21–28.
- MALKMUS, R. AND M. MATSUI. 1997. *Megophrys kobayashii*, ein neuer pelobatider Frosch vom Mount Kinabalu. *Sauria*, Berlin 19: 31–37.
- MALKMUS, R., U. MANTHEY, G. VOGEL, P. HOFFMANN, AND J. KOSUCH. 2002. Amphibians and Reptiles of Mount Kinabalu (North Borneo). A. R. G. Gantner Verlag, Koenigstein. 424 pp.
- MATSUI, M. 1979. Amphibians from Sabah I. Systematic and natural history notes. *Contr. Biol. Lab. Kyoto Univ.* 25: 303–346.
- MATSUI, M. 1986. Three new species of *Amolops* from Borneo (Amphibia, Anura, Ranidae). *Copeia* 1986: 623–630.
- MATSUI, M. 1997. Call characteristics of Malaysian *Leptolalax* with a description of two new species (Anura: Pelobatidae). *Copeia* 1997: 158–165.
- MATSUI, M., T. HIKIDA, AND H. NAMBU. 1985. The amphibians and reptiles collected from Borneo, Malaysia. *Bull. Toyama Sci. Mus.* 8: 151–159+4 pls.
- MATSUI, M., J. NABHITABHATA, AND S. PANHA. 1999. On *Leptobrachium* from Thailand with a description of a new species (Anura: Pelobatidae). *Jpn. J. Herpetol.* 18: 19–29.
- MOCQUARD, F. 1890. Recherches sur la faune herpétologique des îles de Bornéo et de Palawan. *Nouv. Arch. Mus. Nat. Hist. Nat. Ser. 3.* 2: 115–168.
- SMITH, M. 1925. Contributions to the herpetology of Borneo. *Sarawak Mus. J.* 3: 15–34, 1 fig.
- SMITH, M. 1931. The herpetology of Mt. Kinabalu, North Borneo, 13,455 ft. *Bull. Raffles Mus.* 5: 3–32, pls. 2.
- STEJNEGER, L. 1905. Three new frogs and one new gecko from the Philippine Islands. *Proc. U. S. Nat. Mus.* 28: 343–348.
- STUEBING, R. B. AND A. WONG. 2000. A new species of frog, *Philautus erythrophthalmus* (Rhacophoridae) from southwestern Sabah, Malaysia. *Raffles Bull. Zool.* 48: 293–296.

Accepted: 8 June 2006