

ANURAN (FROG AND TOAD) EXPLORATIONS OF SABAH, BORNEO, FOR CONSERVATION, AND PUBLIC ENVIRONMENTAL AWARENESS

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ABSTRACT

Sabah, a Malaysian State on Borneo, is a haven for anurans (frogs and toads) with 109 species (representing more than 73% of the total species in Borneo), and the degree of endemism at approximately 17%. However, it is becoming increasingly evident that localized calamities such as natural habitat destruction, alteration and fragmentation, pollutions, and introduction of exotic species, coupled with systemic catastrophes like global warming, and the potential prevalence of chytridiomycosis, are exerting pressure on local anuran species diversity and abundance. Hence, persistent and extensive inventory-based studies on anurans are much vital to substantiate feasible conservation strategies, and public environmental awareness activities towards communal participation. Since 2000, the Institute for Tropical Biology and Conservation (ITBC) has intensified her inventory-based studies on anurans throughout Sabah. Studies at Tabin Wildlife Reserve (2000), Maliau Basin Conservation Area (2001), Crocker Range Park (2002) and Tawau Hills Park (2007) have up-dated previous inventories, and recorded new locality records. Studies at populated areas at West Coast and Kudat Divisions (2000 – 2001), Trus Madi (2001), Pulau Banggi (2003), Lower Segama (2003), Kota Kinabalu City Bird Sanctuary (2006) and Kulamba Wildlife Reserve (2006) have generated initial anuran inventories. Accumulatively, 71 species representing all five families of anurans in Sabah were recorded with ten species under Bufonidae and Microhylidae each, eight species under Megophryidae, 24 species under Ranidae, and 19 species under Rhacophoridae. Anuran specimens were deposited at BORNEENSIS, reference collection centre at ITBC, and respective data are being digitalized into MUSEBASE, Collection Data Management System used at ITBC.

KEYWORDS – Anurans, Sabah, Borneo, inventory-based studies, conservation

INTRODUCTION

Sabah, a Malaysian State on Borneo, is a haven for anurans (frogs and toads) or tailless amphibians (Amphibia: Anura). Of the six families present in Borneo, five can be found in Sabah, namely Bufonidae (True Toads), Megophryidae, Microhylidae (Narrow-mouthed Frogs), Ranidae (True Frogs), and Rhacophoridae. The other Bornean anuran family: Bombinatoridae, is represented by a single species (*Barbourula kalimantanensis*) that has only ever been sampled in West Kalimantan (Inger & Stuebing, 2005). All anuran genera under the five families in Borneo, except *Pseudobufo* (Anura: Bufonidae), have been recorded from Sabah. A total of 109 species of anurans are currently known from Sabah, representing more than 73% of the total species in Borneo. Eighteen species are endemic to Sabah, based on IUCN, Conservation International, and NatureServe (2004), and Inger & Stuebing (2005). The species are *Ansonia anotis*, *A. fuliginea*, *A. guibei*, *Pedostibes everetti*, *P. maculatus* (Anura: Bufonidae), *Leptobranchella palmata*, *Leptobrachium gunungensis*, *Leptolalax arayai*, *L. maura*, *Megophrys kobayashii* (Anura: Megophryidae), *Kalophrynus baluensis*, *Microhyla maculifera* (Anura: Microhylidae), *Philautus amoenus*, *P. aurantium*, *P. bunitus*, *P. erythrophthalmus*, *P. gunungensis*, and *P. saueri* (Anura: Rhacophoridae). Thus, the degree of endemism for anurans in Sabah is approximately 17%. Other than *Microhyla maculifera*, *Leptobranchella palmata* and *Pedostibes everetti* that have only been sampled in lowlands at elevation lower than 650 m above sea level, the rest of the endemic species are highland dwellers.

In 2004, the Global Amphibian Assessment (GAA): an on-going global amphibian assessment and monitoring project being carried out in collaboration among IUCN-The World Conservation Union via the Species Survival Commission (SSC), Conservation International through its Centre for Applied Biodiversity Science (CABS), and NatureServe, revealed a startling finding that 31.5% of the global anuran species are threatened, with 7.7% are listed as Critically Endangered, 12.6% are Endangered, and 11.2% are Vulnerable. About 33 species (0.63%) are already extinct. Globally, Rhacophoridae and Bufonidae are the two amphibian families with the highest numbers of extinct species which are 18 and 6 respectively, reported at Asia (Sri Lanka, and India), South America (Ecuador, Costa Rica, and Venezuela), and the United States of America. Extinction of anurans represents 4.2% of all extinction known throughout the world since 1500. Also, more than 40% of anuran species are facing population decline as denoted by population disappearance, and local extinctions around the globe (IUCN, Conservation International, and NatureServe, 2006).

The threats of anuran species diversity and abundance erosion, and eventually, total extinction, are real and poignant. The primary step in addressing the issue is to investigate and comprehend the various causes of species diversity and abundance erosion, in order to propose remedial strategies. Localized calamities such as natural habitat destruction, alteration and fragmentation, pollutions, and introduction of exotic species have long been associated with the loss of anuran species diversity and abundance. Natural habitats are often converted into plantations, estates, orchards, and animal farms to produce raw materials, and food for local consumption, as well as international tradings (Ooi, 1993; Khim & Barom, 1998). Open areas with monotonous vegetation and topography, unfavourable physical and chemical attributes of the surroundings, particularly due to excessive usage of pesticides, as well as the introduction of exotic anuran species with high invasive ability, gravely disrupt the survivability of anurans. Systemic catastrophes like global warming, and the prevalence of chytridiomycosis have also been identified as the causes of anuran species diversity and abundance erosion. Increased average temperature of the Earth brings detrimental effects to the breeding ecology of anurans, and mortality to poikilothermic anurans with water dependant adults and tadpoles. Another rather newly realized causative agent in anuran species diversity and abundance loss is the prevalence of chytridiomycosis: a water-borne disease caused by *Batrachochytrium dendrobatidis* (Bd) fungus (e.g., Berger *et al.*, 1998; 1999; Daszak *et al.*, 1999; Young *et al.*, 2001; Lips *et al.*, 2003; Muths *et al.*, 2003; Rachowicz *et al.*, 2005). As Bd fungus resides in keratinized areas of the hosts, the symptoms of chytridiomycosis on heavily infected tadpoles are disfigured mouthparts and abnormality of the jaw sheaths, while on heavily infected adults are abnormality in behaviour and postures, muscle discoordination, thickened skin, excessive shedding, discolouration, lethargy, and anorexia (Annis *et al.*, 2004; Boyle *et al.*, 2004; Speare *et al.*, 2005). Worldwide, Bd fungus has infected about 100 species in the wild (Young *et al.*, 2001; Lips *et al.*, 2003; Berger *et al.*, 2004). Unlike the other causes, chytridiomycosis has yet to be detected in Sabah, but it is not an assurance of impossibility.

Subsequently, conservation strategies ought to be recommended, initiated, and implemented throughout all strata by all parties concerned with the conservation of anurans. However, feasible conservation strategies require sufficient and consistent comprehension of anuran diversity and distribution in the wild. Such comprehension is only achievable through persistent and extensive inventory-based studies on anurans.

ANURAN EXPLORATIONS BY ITBC

The Institute for Tropical Biology and Conservation (ITBC) being a centre of excellence on terrestrial tropical biology and conservation, has been involved in inventory-based studies on anurans since the commencement of the institute in June 1996. The studies have been intensified beginning from 2000 to encompass both the populated and protected areas all over Sabah (Kueh & Maryati, 2005a; Kueh, 2007).

Studies at north-eastern Tabin Wildlife Reserve on October 16th – 22nd, 2000 (Kueh & Maryati, 2003), southern Maliau Basin Conservation Area at Agathis Camp on May 12th – 14th, 2001 (Kueh & Maryati, 2005a; 2005b), Crocker Range Park on August 26th – September 12th, 2002 (Kueh *et al.*, 2004), and Tawau Hills Park on February 15th – 21st, 2007, up-dated previous respective anuran inventory. On the other hand, studies at populated areas at West Coast and Kudat Divisions on December 13th, 2000 – April 28th, 2001 (Kueh, 2006), Trus Madi on October 30th – November 4th, 2001 (Kueh, 2004a), Pulau Banggi on July 25th – August 2nd, 2003 (Kueh & Maryati, 2005b), Lower Segama on September 17th – 26th, 2003 (Kueh & Yambun, 2006), Kota Kinabalu City Bird Sanctuary on February 4th – 26th, 2006 (Noraini, 2006), and Kulamba Wildlife Reserve in November 2006, generated premier anuran inventories.

Accumulatively, 71 species representing all five families of anurans in Sabah were recorded from the intensified inventory-based studies. As the sampling duration for each locality differed, the numbers of species recorded were incomparable. The longest sampling duration was spent at Crocker Range Park, of 17 days, and enabled 46 species to be sampled. Anuran exploration of Crocker Range Park yielded the largest collection of species by ITBC from a single locality thus far.

Pertaining to new locality records, anuran explorations of Tabin Wildlife Reserve and Crocker Range Park unveiled one and 12 records each (Kueh, 2004b). New locality records for Tabin Wildlife Reserve was *Metaphrynella sundana* (Anura: Microhylidae) or the Tree Hole Frog. One specimen was found inside a hollow tree stump along a muddy path. *Metaphrynella sundana* is a flat and hilly primary forest dweller, having predilection for trees with DBH of more than 14 cm and height of more than 9 m. *Metaphrynella sundana* is endemic to Borneo (Malkmus *et al.*, 2002; Inger & Stuebing, 2005). New records for Crocker Range Park were three species under Bufonidae (*Ansonia spinulifer*, *Leptophryne borbonica* and *Pedostibes maculatus*), two species under Microhylidae (*Metaphrynella sundana* and *Microhyla borneensis*), three species under Ranidae (*Limnonectes ingeri*, *Rana erythraea* and *R. luctuosa*), as well as four species under Rhacophoridae (*Philautus aurantium*, *P. hosii*, *P. mjöbergi* and *Rhacophorus pardalis*). All the

species, except *Philautus aurantium*, are lowlands dwellers. Besides *Leptophryne borbonica*, *Rana erythraea*, *R. luctuosa* and *Rhacophorus pardalis*, the new records were endemic to Borneo. *Philautus aurantium* or the Golden-legged Bush Frog is also endemic to Sabah (Malkmus *et al.*, 2002; Inger & Stuebing, 2005).

The discovery of new locality records is imperative to ascertain the distribution range of anurans in terms of the Extent of Occurrence and Area of Occupancy. Distribution range determines the conservation status of species and therefore, appropriate conservation strategies for each categories. Currently, one anuran species in Sabah and Malaysia is listed as Critically Endangered: *Leptobranchella palmata*, with total range area of merely 99 km². Ten species in Malaysia are listed as Endangered of which 7 are endemic to Borneo, while 32 species in Malaysia are Vulnerable of which 27 are endemic to Borneo (Inger & Stuebing, 2005; AmphibiaWeb, 2007).

Of the 71 species of anurans collected, 10 species were under Bufonidae, eight species under Megophryidae, 10 species under Microhylidae, 24 species under Ranidae, and 19 species under Rhacophoridae. The percentage of species representation for each family is highest for Ranidae with 60% of representation (24 of the total 40 species in Borneo), followed by Rhacophoridae with 52.8%, Microhylidae with 47.6%, Megophryidae with 36.4%, and Bufonidae with 35.7% (Figure 1).

Anuran specimens sampled were preserved in 70% ethanol, and deposited in the Vertebrate Collection Room, BORNEENSIS, ITBC's reference collection centre. Tissue samples were obtained from specimens prior to preservation, from most of the recent collections for future DNA analyses. Data from anuran specimens are being digitalized into MUSEBASE, ITBC's Collection Data Management System for efficient management and easy data retrieval. MUSEBASE allows data to be effectively shared among interested individuals via the Internet (Kueh & Maryati, 2005a; Kueh *et al.*, 2006).

Inevitably, feasible conservation strategies should also include public environmental awareness activities utilizing information and knowledge obtained from inventory-based studies on anurans, to ensure communal participation. 'ITBC Frog Museum' is a project undertaken by ITBC since 2003 to crystallize information and knowledge on anurans into activities and displays that captivate the attention and liking of the general public, especially the children, policy-makers, mass media, and the private sector, which ultimately warrant consolidated involvement by all factions in the conservation of anurans (Kueh & Maryati, 2007). To date, 'ITBC Frog Museum' has received positive response from many parties for its exhibitions, publications, and specialized talks and lectures on anurans. 'ITBC Frog Museum' is also the Environmental Education (EE) arm of

the National Technical Sub-Committee on Faunal Biodiversity (Amphibia) that is led by ITBC, and participated by over 10 institutions involved in amphibian research nationwide.

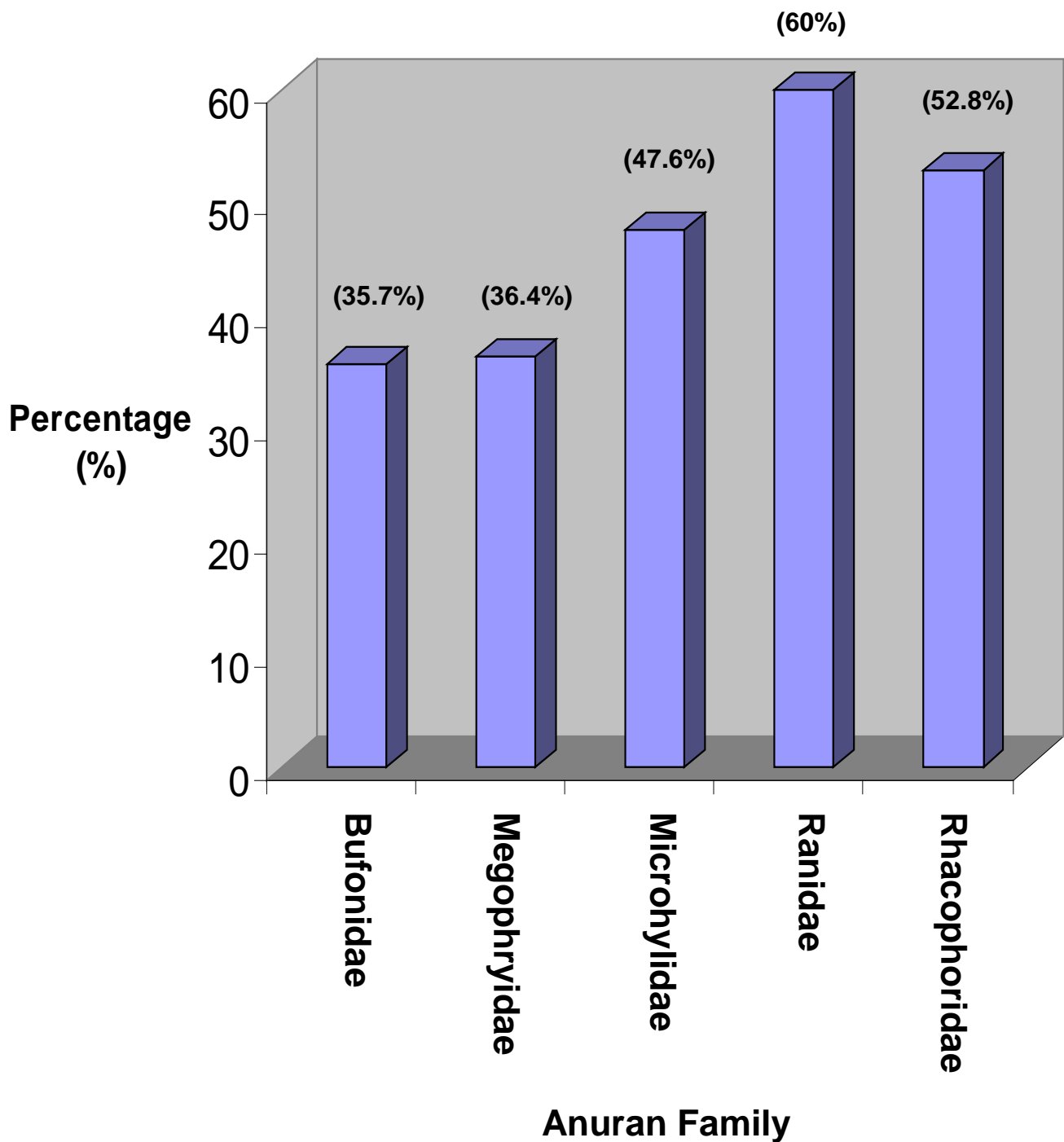


Figure 1. Percentage of species representation for each family, from ITBC's intensified inventory-based studies on anurans since 2000.

CONCLUSION

Sabah is rich in anuran diversity, and even more unique in her anuran endemism. However, anuran populations in Sabah, as elsewhere in the world, are threatened with diversity and abundance erosion, and extinction. Hence, feasible conservation strategies are urgently needed, and must be founded on sufficient and consistent comprehension of anuran diversity, abundance and distribution from persistent and extensive inventory-based studies. ITBC has intensified her inventory-based studies since 2000, and is determined to augment the anuran explorations of Sabah, Borneo, for enhanced conservation of our national heritage: anurans.

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