

**STUDY ON ANURAN ALONG RIPARIAN IN MESILAU NATURE PARK,  
SABAH**

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**DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE  
DEGREE OF BACHELOR OF SCIENCE WITH HONOURS**

**CONSERVATION BIOLOGY PROGRAMME  
SCHOOL OF SCIENCE AND TECHNOLOGY  
UNIVERSITI MALAYSIA SABAH**

**APRIL 2008**

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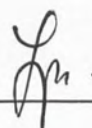


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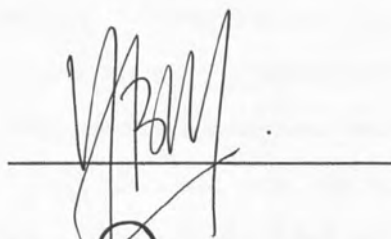
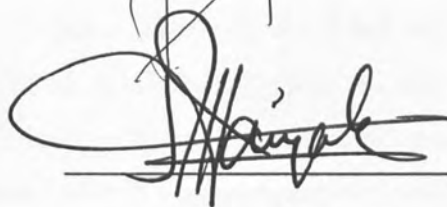
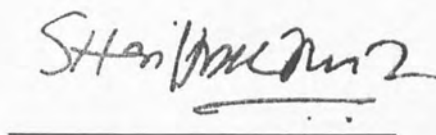
## ACKNOWLEDGEMENT

I would like to thank Universiti Malaysia Sabah for giving me an opportunity to complete this dissertation. I am grateful to Pn. Anna Wong for the encouragement and support given. I would like to also thank En. Ahmad Sudin, Pn. Petherine Jimbau and En. Nordin Hj. Wahid for the lab equipments, field equipments and chemicals provided during this study.

I am grateful to Director of Sabah Park for giving me the permission to conduct my study in Mesilau Nature Park. A special thank to the Zoological Research Officer, En. Maklarin Lakim. I am thankful for the support and guidance given. I also appreciate the companionship and help and knowledge that En. Paul Yambun gave in the field. Thanks to the officers and staffs in Kinabalu Park Headquarters who are willing to share their information and knowledge in helping me to complete my dissertation.

I am also thankful to the staffs at Mesilau Nature Park and also Mesilau Nature Resort. Thanks for their kindness, care and warmth that all of them have given to me. Last but not least, thanks to Mr. Christopher Wong, Ms. Chan Tsuey Tyug, Ms. Penny Poon, Ms. Tang Huoy Min and Ms. Yong Huai Mei for helping me and supporting me. I am also very grateful to my family for being considerate and by giving me moral support.



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## ABSTRACT

A study was conducted to estimate the species diversity, composition and abundance of riverine anuran in Mesilau Nature Park (MNP). MNP is situated at 1850 m to 1950 m a.s.l between the tropical lower and upper montane forest region. Sampling was done at night, once every four weeks time, starting from September to December 2007. Riparian frogs were sampled along the two 250m X 10m transect lines at Mesilau River and Tibabar Stream. Thirteen anuran species were identified from a total of 43 individuals caught. The 13 species were *Philautus amoenus*, *Philautus petersi*, *Philautus longicrus*, *Philautus mjobergi*, *Philautus aurantium*, *Rhacophorus angulirostris*, *Ansonia fuliginea*, *Leptolalax arayai*, *Megophrys baluensis*, *Limnonectes finchi*, *Ingerana baluensis*, *Meristogenys amoropalamus* and *Meristogenys whiteheadi*. They were from four families namely: - Bufonidae, Megophryidae, Ranidae and Rhacophoridae where Rhacophoridae was the most dominant (77%). *Philautus amoenus* (42%) was the most abundant frog species recognised. The other 11 species of anuran had an average of two individuals for each species. The total density calculated was 21.5 individual/ha. There were four different types of microhabitat for frogs: on rock, plant leaves, twig of woody plants and epiphyte. The riparian of MNP has species diversity of 0.7973 and evenness of 0.0965 with dominance value of 0.4186.

## ABSTRAK

Satu kajian telah dijalankan untuk menganggar kepelbagaian spesies, komposisi dan kelimpahan anuran di habitat sungai, di Mesilau Nature Park (MNP). MNP berada pada ketinggian 1850 m hingga 1950 m atas aras laut. Persampelan dijalankan pada waktu malam dengan selang masa lebih kurang empat minggu sekali, bermula dari September sehingga Disember 2007. Anuran ditangkap dengan menggunakan kaedah transek 250 m X 10 m di sepanjang Sungai Mesilau dan Sungai Tibabar. Sebanyak 13 spesies anuran telah dicamkan terdiri daripada *Philautus amoenus*, *Philautus petersi*, *Philautus longicrus*, *Philautus mjobergi*, *Philautus aurantium*, *Rhacophorus angulirostris*, *Ansonia fuliginea*, *Leptolalax arayai*, *Megophrys bahuensis*, *Limnonectes finchi*, *Ingerana baluensis*, *Meristogenys amoropalamus* dan *Meristogenys whiteheadi*. Kesemua individu tergolong dalam empat famili, iaitu Bufonidae, Megophryidae, Ranidae dan Rhacophoridae dengan Rhacophoridae adalah yang paling dominan (77%). *Philautus amoenus* (42%) adalah spesies anura yang mempunyai kelimpahan yang paling tinggi. Secara purata, 11 spesies anuran yang lain masing-masing mempunyai dua individu. Jumlah kepadatan spesies adalah 21.5 individu/ha. Terdapat empat jenis mikrohabitat untuk katak- katak iaitu atas batu, daun tumbuhan, batang atau ranting dan epifit. Riparian MNP mempunyai nilai kepelbagaian spesies 0.7973 dan nilai keseragaman spesies 0.0965 dengan nilai kedominan 0.4186.

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## LIST OF SYMBOLS

%	Percent
$^{\circ}\text{C}$	Degree Celsius
a.s.l	Above sea level
sp.	Species
g	Gram
m	Metre
$\text{m}^2$	Metre square
cm	Centimetre
mm	Millimetre
min	Minute
MNP	Mesilau Nature Park
MR	Mesilau River
SVL	Snout- vent length
TS	Tibabar Stream





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## CHAPTER 1

### INTRODUCTION

#### 1.1 Introduction

Anuran came from the Greek words, *an* meaning 'without' and *oura* meaning tail; meaning without tail. Anuran is also formerly known as Salientia from the Latin word *saltare* which means leaping. Frogs are the most diverse and abundant group of amphibians, occurring in all terrestrial and freshwater habitats. Their locomotion, feeding diet and reproductive specialization enabled them to explore almost any habitat. They range from tropics to sub-arctic regions, but most are found in tropical rainforests (Beebee, 1996; Duellman & Trueb, 1994; Hickman *et al.*, 2006). In Borneo, 138 species of frogs was recorded in 1996 and up to 155 species in 2006 (Matsui, 2006). Comparison of anuran diversity on tropical islands reveals that Borneo is third for anuran diversity after Madagascar and New Guinea (Duellman, 1999).

The distribution patterns of frogs existing in various altitudes are led by individual feeding and breeding habits. High altitudinal places have significantly lower number of certain frog species due to stream current, the presence of organic matter and little microhabitat (Inger & Stuebing, 2005). On the other hand, it has been widely accepted as a general pattern that species richness declines with increasing elevation gradient (Hofer *et al.*, 1999; Maklarin *et al.*, 1999; Rahbek, 1995). This may be caused by the steep topography of the streams and strong currents which lead to few breeding and feeding grounds (Inger & Stuebing, 2005).

## 1.2 Riparian

Riparian systems are transitional semi-terrestrial areas regularly influenced by fresh water. These systems usually extend from the edge of water bodies to the edges of upland communities (Naiman *et al.*, 2005). It consist of the land immediately alongside of small stream and rivers including river banks; areas surrounding lakes and wetlands and river floodplains that interact with the river in times of flood (Nagle, 2003). A stream is a small narrow river or brook while a river is a large natural stream of water flowing in a channel towards the sea (Macmillan School Dictionary, 2004; Oxford Advanced Learner's English- Chinese Dictionary, 1997). Riparian zones often are high in biodiversity at regional or continental scale (Naiman *et al.*, 2005). Water is utmost important to tadpoles and aquatic frogs; any slight changes to its habitat may have dramatic effects. Pollution by pesticides, herbicides and fertilizers through waterways and also, alternation or destruction of streams will bring to the loss of species diversity (Beebee, 1996; Inger & Stuebing, 2005).



The type of water bodies and its altitudinal location assist in determining tadpoles as the larvae of the individual frog species occupy different habitat niches. The microhabitats for streams can be divided into nine and for stagnant water can be divided into seven (Inger, 1985; Malkmus, 2002). The microhabitats that can be distinguished from streams are torrent, riffle, shingle area, leaf drift, open pool, side pool, pothole on rock bank, seepage area and pool of intermittent stream. As for stagnant water, it can be divided into seepage area, rain pool, animal wallow, log cavity, hole in living surface root, buttress tank, hole in trunk or large branch and water filled vegetation from cavity and leaf axils to natural cup shaped litter or dead pitcher plants.

Torrent has strong current with surface of water broken and occasionally foaming with bed rocks and boulders (Inger, 1985; Malkmus, 2002). Riffle is surface of water with moderate current in shallow waves but never foaming with bed of gravel. Current which is moderate to weak with surface of smooth water and bed of flattened rocks are called shingle area. As for leaf drift, it is areas with weak current and deep accumulations of dead leaves which drift up to 1.5 m and 10 m long. Open pool is ponded parts of the stream which comprises of bottom silt to sand and gravel. Side pool would be an embayment of the main channel, which is partially or completely cut off from the current. The bottom comprises of fine to coarse sand and usually covered with dead leaves with weak or no current. Trickle of water less than 2 cm deep, usually emerging from a steep clay bank is called a seepage area. Pool of intermittent stream can have a maximum surface dimension up to 0.5 m and a depth up to 5 cm. Fine silt, sand and pea- gravel are the main composition and current are only generated after moderate to heavy rain (Inger, 1985; Malkmus, 2002).



### 1.3 Justification

Kinabalu Park encompasses 75,370 hectares and extends in elevation from humid lowland tropical rainforests to sub-alpine vegetation around the summit area. With such diversity in vegetation, it attracted the interest of local and foreign researches and made Kinabalu the most studied area in Sabah (Ghazally & Lamri, 1996). The first scientific expedition on Mount Kinabalu was in the 1980s lead by John Whitehead (Malkmus *et al.*, 2002). Researches have generated several numbers of publications, research reports, monographs, memoirs, theses and dissertations on Kinabalu since 1852 (Ghazally & Lamri, 1996). However, as part of Kinabalu Park, little anuran studies are done in Mesilau Nature Park (MNP). Few studies and published papers was done on Mesilau. The discovery of *Leptotalax maurus* at Mesilau by Inger *et al.* (1997) was the beginning of researches done in MNP. In 1999, Maklarin Lakim *et al.* (1999) have done a comparative study of amphibian population in reference to habitat disturbance across an elevational gradient in Kinabalu Park. One of the sampling sites was in MNP. They were comparing the species composition and richness between primary and secondary forest. Now, Maklarin Lakim and his team are still trying to make a checklist for the anuran in MNP. This gave motivation and urged the discovery of new species or new records in this study.

## 1.4 Objectives

This study was to provide some understanding of the riverine frog species diversity in MNP. Baseline information for biodiversity analysis can be formed to help in further studies in MNP. This in turn helps to form a checklist of the anuran species in MNP. Therefore, the objectives of this study were:

1. To determine the species composition and diversity of the riverine anuran in Mesilau Nature Park (MNP).
2. To determine the abundance of the riverine anuran in Mesilau Nature Park (MNP).



## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Literature review

Many studies were done on anuran all over the world, from diversity studies to genetic analysis (e.g. Duellman, 1999; Hamer *et al.*, 2002; Leong & Chou, 1999 and Savina, 2004). In Borneo, there are ongoing processes of discovering new species and gaining of knowledge (Malkmus *et al.*, 2002). Borneo has a long history of herpetological collection and intensive collections made by Inger and others from Field Museum of Natural History, Chicago making it a well studied island. One of the significant collections was collected by Marquis and Odoardo in north- west Borneo (Das, 2002). In Mount Kinabalu, the main burst of exploration took place between 1885 and 1930. The leading persons were John Whitehead and A. H. Everett. Their names were given to species of frogs (e.g. *Amolops whiteheadi* and *Pedostibes everetti*).



The first scientific expedition on Mount Kinabalu was lead by an ornithologist, John Whitehead. In the following decades, many botanists and zoologist studied there. In the year 1931, M. A. Smith published a paper called *The Herpetology of Mt. Kinabalu, North Borneo, 13, 455ft.* At that time, there were 40 species of frogs and toads known from Mount Kinabalu (Inger *et al.*, 1996). The most important decade for Bornean amphibian systematics was in the 1960s. Inger (1966) compiled his comprehensive monograph *The Systematics and Zoogeography of Amphibia of Borneo*. In the monograph, he described a bufonid, *Ansonia guibei* from Mesilau. In the following decades, the cycle of new finding, identifying and renaming went on an on. Some of the researchers that played significant role in anuran research from 1960s to present are Inger, Stuebing, Matsui and Malkmus.

In the year 1996, Inger compiled a checklist of the frogs of Borneo based on specimens examined and literature records where those cover divisions of Borneo from which material was not seen. Inger described a bufonid, *Ansonia guibei* from Mesilau, Kinabalu in the same year. Inger *et al.* (1997) discovered a new species of frog, *Leptotalax maurus* in 1997 when they were doing a monitory work for Sabah Parks in different elevation in Kinabalu Park. One of the sites was Mesilau, where the new species were found at 1860 m in floor litter of oak- chestnut forest. In 1999, Maklarin *et al.* had done a comparative study of the amphibian population in reference to habitat disturbance across an elevation gradient in Kinabalu Park, Sabah. The studies aim was to evaluate the amphibian population within Kinabalu Park (e.g. Poring, Mesilau and Sayap) and adjacent unprotected areas (Mamut Copper Mining, Mount Kinabalu Golf Course and Kampung Sayap).



A study on the frog fauna of three parks, Kinabalu Park, Crocker Range Park and Tawau Hills Park was done by Inger *et al.* (2000). In their study, they stated that there is still a need to do sampling in montane areas of Tawau Hills, sampling of more localities in Crocker Range Park and further investigation at flat areas of Kinabalu Park. Only little had been done population biology of Sabah frogs and much remains to be done on population sizes and fluctuation, movements of individuals, and lengths of the aquatic and terrestrial phases of all the life cycles.

The study of *Philautus* frogs in Sabah started from the 1930s, but the taxonomy of this group is still in the preliminary stages (Bossuyt & Dubois, 2001; Matsui, 2006). In 2001, Bossuyt and Dubois published a paper that reviews the specific taxonomy of the frog genus *Philautus*. *Philautus* were characterised by the aerial direct development of eggs into froglets without going through aquatic tadpole stage (Bossuyt & Dubois, 2001). Due to their small size compared to other larger frog species makes them difficult to study thus attracts less attention. Besides that, the high variability of colouration within species was misleading when external morphology and colouration was the only guide for species identification. This problem was enhanced by their ability to alter their colourations and patterns (Malkmus *et al.*, 2002). As a result, key for identification up to species level based on morphological traits was very difficult. Therefore, other characters such as bioacoustic analysis and molecular studies were best used for identification (Bossuyt & Dubois, 2001). However, the use of bioacoustic analysis or molecular studies was only applicable when all the data of the frog species was complete. Furthermore, the ability to identify specific frog species callings can only be obtained through experience.

In the year 2006, Matsui published an article called *Anuran Inventory in Sabah- past and Future*. The purpose of this paper was to discuss how the anuran inventory in Sabah came to its status now and what the future holds for the development of anuran inventory in Sabah. With the help of acoustic information and biochemical methods such as DNA analysis, Matsui thinks that a more intensive anuran inventory of Sabah should be made before habitat destruction destroy them all.

Until year 2006, from 150 species of frogs in Borneo there are 113 species and one subspecies had been recorded in Sabah. From there, 26 species are considered as endemic to Sabah (Matsui, 2006). Exploration of new localities and expeditions to several localities in Sabah especially Mount Kinabalu increased the species number. However, due to the enormous size of the area, a complete survey in will take much time and effort. In addition, there are still areas that are unreachable by footstep such as the steep clefts of Mount Kinabalu. On the other hand, habitat destruction is increasing in speed; therefore intensive faunal surveys are urgently needed.

It was known that animal species usually live within relatively narrow altitudinal ranges and Kinabalu Parks' unique biological features of an altitudinal range of habitats unmatched elsewhere on the island of Borneo has long been recognised as important to the international scientific community (Ghazally & Lamri, 1996). Naturalists had been attracted to Mount Kinabalu and had long expected to find species restricted to specific elevations. Cryptic species were frequently localised, and some restricted to patches of forests of a few dozen hectares in extent or to one or two adjacent hill streams. This makes the discovery of their existence difficult, unless an effort is made to conduct an exhaustive inventory (Das, 2002). Therefore, intensive





sampling of key habitats and faunal revisions has to play an important role. It has become important to collect more specimens from previously unexplored habitats with the intention to inventories and document their conservation status and to obtain an overall picture of diversity and distributions of anuran in Borneo (Zainudin, 2002).

Former studies were mostly done at Kinabalu Park rather than Mesilau Nature Park even though the park is in the vicinity. However, several scientists like Robert F. Inger, Maklarin Lakim, Paul Yambun and Alim Biun had found a new species of frog at Mesilau in 1997. It was during a program for monitoring populations of amphibians at three sites at differing elevations in Kinabalu Park initiated by Sabah Parks (Inger *et al.*, 1997). Now, Maklarin Lakim and his team are still trying to make a checklist for the anuran in Mesilau Nature Park. The main purpose of this study was to study the anuran along riparian forest of Mesilau Nature Park. Mesilau Nature Park is part of Kinabalu Park which is a totally protected area.

## 2.2 Frog Life Style

Aquatic frogs are lifetime stream bank sitters; they never leave the banks of streams. Their tadpoles always develop in those streams or rivers, and when they emerged from water, they still stay nearby to feed and mate. Semi- aquatic frogs are frog species that are found along the banks but live away from the water during juvenile stage. There are also stream breeders which only uses the stream for breeding (Inger & Stuebing, 2005).

The frogs can be categorised into one of the four kinds of life styles (Inger & Stuebing, 2005). Frogs that spend their lifetime at the banks of streams are called lifetime stream bank sitters. Their tadpoles will only develop in those streams or rivers and the newly transformed froglets will stay near to feed and grow. As for frogs that commonly found along stream banks but live away from the water during juvenile or pre- reproductive stage are called adults only stream bank sitters. These tadpoles grew in quiet areas of small stream often with rotting vegetation called leaf drift. When they transform to froglets, they leave the stream and into the forest. They will only come back to the stream after maturity to breed and spend their life there.

The third group are called stream breeder/ forest wanderer which only use the streams for breeding. They live their lifetime in the forest and only returns to the stream at intervals for breeding. The froglets emerged from the pool of the side of the stream and hops towards the forest to live for the rest of their lives before heading back to the stream to breed. Forest wanderers are frogs that spend their whole life wandering in the forest and rarely come to the stream banks not even for breeding. Majority of these frogs forage within the forest floor litter and most of them laid eggs in small pond in the forest while some use water filled tree holes or lay within leaf litter with no standing water but with high and stable humidity.

### **2.3 Morphology and Physiology**

Body shape and size of frogs are normally associated with its family and often appointed to a certain genus. Female frogs are usually larger than male frogs and sexual size dimorphism is great in some frogs (Davies & Withers, 1993; Duellman &



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