DISTRIBUTION AND MORPHOMETRICS OF Kalophrynus palmatissimus (KIEW, 1984) FROM AYER HITAM FOREST RESERVE, SELANGOR AND PASOH FOREST RESERVE, NEGERI SEMBILAN, MALAYSIA

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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August 2019

Chairman : Dr. Marina binti Mohd. Top @ Mohd. Tah, PhD
Faculty : Science

A research study on an endemic frog species of Peninsular Malaysia, *Kalophrynus palmatissimus* (Kiew, 1984) (commonly known as Lowland Grainy Frog) at Ayer Hitam Forest Reserve (AHFR), Selangor and Pasoh Forest Reserve (PFR), Negeri Sembilan was carried out from November 2016 until September 2017. This leaf-litter frog species can be found in the lowland forests of Peninsular Malaysia including Pasoh Forest Reserve, Gombak Forest Reserve, Forest Research Institute Malaysia (FRIM), and Ayer Hitam Forest Reserve. The distribution of this species has severely declined and the quality of its habitat in Peninsular Malaysia also continues to decrease as suitable areas are being converted to non-timber plantations and undergo rapid development of infrastructure. This study was conducted to determine the distribution, population density, and morphometric and microhabitat structures of *K. palmatissimus* at AHFR and PFR. Fifteen and eighteen nocturnal 400 m transect lines with an interval distance of 20 m were used for frog surveys at AHFR and PFR, respectively. In addition, temperature, humidity, soil pH, wind, and light of different microhabitats were also recorded. A total of 34 and 31 individuals of *K. palmatissimus* were recorded at AHFR and PFR, respectively. The population density of *K. palmatissimus* recorded at AHFR was 5.31 individuals/km^2, whereas 6.02 individuals/km^2 was recorded at PFR. Fifteen morphometric traits of *K. palmatissimus* were measured. Most of the 15 morphometric traits of *K. palmatissimus* at AHFR and PFR positively correlated with each other. The AHFR's mean snout- vent length (SVL) (37.00 mm) was larger than PFR's mean SVL (30.29 mm). The AHFR's mean SVL for male and female *K. palmatissimus* were 35.30 mm and 39.40 mm, respectively, whereas the PFR's mean SVL for male and female *K. palmatissimus* were 28.60 mm and 33.50 mm, respectively. This species was abundantly found on the surface of forest litter (96.9 %), compared to sandy surface (1.5 %) and on the dead log (1.5 %). It was found that *K. palmatissimus* at AHFR and PFR highly preferred leaf litter with non-hairy/smooth type morphology as their habitats. The data collections from AHFR and PFR have significantly contributed to a better understanding of ecological distributions, morphometrics, and habitats of this species. This information could help future conservation programmes and management to protect this endemic species from extinction.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Ijazah Master Sains

TABURAN DAN MORFOMETRIK *Kalophrynus palmatissimus* (KIEW, 1984) DARI HUTAN SIMPAN AYER HITAM, SELANGOR DAN HUTAN SIMPAN PASOH, NEGERI SEMBILAN, MALAYSIA

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Satu kajian penyelidikan mengenai satu spesies katak endemik di Semenanjung Malaysia, *Kalophrynus palmatissimus* (Kiew, 1984) (dikenali sebagai Katak Berbintik Tanah Pamah) telah dijalankan di Hutan Simpan Ayer Hitam (AHFR), Selangor dan Hutan Simpan Pasoh (PFR), Negeri Sembilan bermula November 2016 hingga September 2017. Spesies katak sesampah hutan ini boleh ditemui di hutan tanah pamah Semenanjung Malaysia termasuk Hutan Simpan Pasoh, Hutan Simpan Gombak, Institut Penyelidikan Perhutanan Malaysia (FRIM), dan Hutan Simpan Ayer Hitam. Taburan spesies ini telah berkurangan dan kualiti habitatnya di Semenanjung Malaysia juga terus merosot disebabkan habitat yang sesuai telah ditukar menjadi kawasan penanaman bukan kayu dan infrastruktur yang pesat. Kajian ini dijalankan untuk menentukan taburan dan kepadatan populasi, dan morfometrik dan struktur mikrohabitat *K. palmatissimus* di AHFR dan PFR. Lima belas dan lapan belas garisan transek sepanjang 400 m berselang dengan jarak 20 m digunakan untuk tinjauan katak, masing-masing di AHFR dan PFR. Selain itu, suhu, kelembapan, pH tanah, angin dan cahaya dari setiap habitat yang berbeza juga telah direkodkan. Sebanyak 34 dan 31 individu *K. palmatissimus* telah direkodkan, masing-masing di AHFR dan PFR. Kepadatan populasi *K. palmatissimus* yang direkodkan di AHFR adalah 5.31 individu/km^2, manakala 6.02 individu/km^2 direkodkan di PFR. Lima belas ukuran morfometrik *K. palmatissimus* telah diambil. Kebanyakan daripada 15 ciri-ciri morfometrik *K. palmatissimus* di AHFR dan PFR berkorelasisecara positif antara satu sama lain. Nilai purata 'snout-vent length' (SVL) *K. palmatissimus* di AHFR (37.00 mm) lebih besar berbanding PFR (30.29 mm). Nilai purata SVL bagi individu jantan dan betina *K. palmatissimus* di AHFR masing-masing, adalah 35.30 mm dan 39.40 mm, manakala nilai purata SVL bagi individu jantan dan betina *K. palmatissimus* di PFR adalah 28.60 mm dan 33.50 mm. Spesies ini banyak ditemui di atas permukaan sesampah hutan (96.9 %), berbanding di atas permukaan pasir (1.5 %) dan di atas kayu mati (1.5 %). Didapati *K. palmatissimus* di AHFR dan PFR lebih suka mendiami sesampah hutan dengan struktur morfologi yang tidak berbulu/licin sebagai habitatnya. Data yang dikumpulkan di AHFR dan PFR telah menyumbang kepada pemahaman yang lebih baik mengenai ekologi taburan, morfometrik dan habitat spesies ini. Maklumat ini dapat membantu program pemuliharaan dan pengurusan masa depan untuk melindungi spesies endemik ini daripada kepupusan.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

%	Percentage
°C	Degree Celcius
a.s.l	Above sea level
ANOVA	Analysis of variance
cm	Centimeters
ED	Eye diameter
EN	Eye-nostril distance
FL	Foot length
FLL	Forelimb length
ha	Hectares
HAL	Hand length
HL	Head length
HW	Head width
IND	Internarial distance
IOD	Interorbital distance
km	Kilometers
lx	Lux
m/s	Meter per second
mm	Millimeters
N	Total abundance
p	Probability
Q	Probability
r	Correlation coefficient
RH	Relative humidity
SL	Snout length
SVL	Snout-vent length
TD	Tympanum diameter
THL	Thigh length
TL	Tibia length
UEW	Upper eyelid width
X^2	Chi square

CHAPTER 1

INTRODUCTION

1.1 General Background

The word 'anuran' originates from the Greek word: a- + oura tail. The order Anura (also called Salientia) consists of frogs and toads as all of them lack tails at the adult stage. Frogs and toads are ancient animals that have been around since 200 million years (Norhayati, 2017). The body of an adult anuran is commonly described by a stout body, bulging eyes, cloven tongue, and limbs folded beneath (Stuart et al., 2004). Frogs generally have moist and smooth skin, whereas toads have warty and dry skin (Norhayati, 2017). Anurans are members of the zoological class called Amphibia that have jumping abilities and croaking sounds. They can be found around the world and are among the most diverse wild animals in the world.

The habitat of amphibians including anurans is the tropical rainforest, where it is numerous and diverse. Most of them are dependent on water sources such as ponds, rivers, streams, rain pools, water holes, ditches, and water puddles (Norhayati, 2017). Anurans prey on a wide range of vertebrates, ranging from medium- to large-sized, and act as predators of various insects and other small vertebrates (Yong, Ahmad & Helpis, 2013).

Malaysia is rich in amphibian diversity with about 267 species including the caecilians with eight families, namely Bufonidae, Ceratobatrachidae, Dicroglossidae, Megophryidae, Microhylidae, Ranidae, Rhacophoridae, and Ichthyopiidae (Norhayati, 2017). Anurans are among the most specious group of vertebrates and can provide valuable data to monitor biological diversity in Malaysia (Chan, Daicus & Norhayati 2010). In Borneo, more than 180 species of frogs have now been found on the island and the number continues to grow (Inger, Stuebing, Grafe & Dehling, 2017). The majority of anurans are adapted to primary and secondary forests. Most of the species take advantage of human-influenced ecosystems and appear to tolerate disturbed habitats (Inger, Voris & Voris, 1992).

The genus *Kalophrynus* is reported to contain 25 nominal species with the greatest diversity in Borneo (Zug, 2015). Members of this genus are distributed from Northeast India, Northern Bangladesh, North Central Myanmar, Peninsular Myanmar, Southeast Asia (Laos, Thailand, Vietnam, and Cambodia), Southern China, Sumatra, Borneo, Peninsular Malaysia, and the Philippines (Zug, 2015). Six species have been reported in Peninsular Malaysia, namely *Kalophrynus limbooliati*, *K. palmatissimus*, *K. pleurostigma*, *K. robinsoni*, *K. tiomanensis*, and *K. yongi* (Zug, 2015). The known localities for these species in Peninsular Malaysia are usually at relatively low elevations, and the known highest record was 1,006 m a.s.l. for *K. robinsoni* (Dring, 1979).

This study focused on *K. palmatissimus* (Lowland Grainy Frog), which is a leaf-litter frog species that can be found in lowland forests. This species is from the family Microhylidae and can be found in forest litter on the forest floor (Sukumaran, 2004). It is usually dark brown in colour with dark blotches on the dorsal skin, and brown in colour at the throat and chest (Sukumaran, 2004).

The Ayer Hitam Forest Reserve (AHFR), Selangor and Pasoh Forest Reserve (PFR), Negeri Sembilan are lowland dipterocarp forest and secondary forest. Ayer Hitam Forest Reserve (AHFR), Selangor is situated about 20 km from Universiti Putra Malaysia and 45 km from Kuala Lumpur. It is near the Federal Territory of Putrajaya, Bandar Kinrara towards the north, Bandar Puteri to the west, and Taman Desaminium at the east. Ayer Hitam Forest Reserve is made up of Compartment 1, 2, 12, 13, 14 and 15 of the forest reserve, which covers 1,248 ha. The AHFR has undergone some disturbances over the last few decades, which led to a change in the forest's landscape undergrowth and affected the habitat and population of fauna (Paiman & Amat Ramsa, 2007; Shamsudin, Mohd Farhan & Kamarulizwan, 2015).

The Pasoh Forest Reserve (PFR), situated in Simpang Pertang, Negeri Sembilan, is an internationally recognised site for tropical forestry research. A well-equipped field research centre known as the Pasoh FRIM Research Station (PFRS) within the reserve is managed by the Forest Research Institute Malaysia (FRIM). The forest is connected to a various range of hills (the highest point is Bukit Palong at 645 m). Pasoh Forest Reserve is a dipterocarp forest that is surrounded by palm oil plantations and has been subjected to logging since the 1970s, sparing 600 ha of virgin forest. Loggings over the years have caused degradation of habitats and population of animals in this forest. The distribution of *K. palmatissimus* has severely declined, in which its available habitat is small and limited, as most suitable areas are being converted to non-timber plantations and undergoing rapid development of infrastructure (Norsham, Sukumaran & Tzi Ming, 2004). It is imperative that these areas receive strong protection and management.

1.2 Problem Statement

Kalophrynus palmatissimus is listed as an endangered species because the extent of its occurrence is less than 5,000 km^2 (IUCN, 2017). The distribution of this species has severely declined and the quality of its habitat in Peninsular Malaysia also continues to decrease (Norsham et al., 2004). It is threatened by the development of human settlements, commercialisation and industrial areas, annual and perennial non-timber crops, and road construction. Meanwhile, mining and quarrying for granite could be a potential future challenge faced by *K. palmatissimus* for the subpopulation occurring in the Panti Forest Reserve (IUCN, 2018).

A similar challenge is also faced by *Kalophrynus pleurostigma* as the main threat to this species is deforestation (logging and wood harvesting) (IUCN, 2018). *Kalophrynus interlineatus* is threatened by destruction and degradation of breeding

habitats caused by logging and fire suppression in China (IUCN, 2018). *Kalophrynus palmatissimus* is known to be present only at PFR, the Gombak Forest Reserve, FRIM, and Templer's Park (Templer FR) in Selangor (IUCN, 2017), and AHFR, Puchong, Selangor (Muhammad Faris, Mohammad Nur Firdaus, Shamarina & Marina, 2016). According to the Wildlife Conservation Act 2010, it is a protected species. However, there is still a lack of information about the habitat structure and distribution of this species in Malaysia, especially for AHFR and PFR. Therefore, this research was conducted in order to study the ecology and biology of *K. palmatissimus* at AHFR and PFR to assist in better management decisions.

1.3 Objectives

The objectives of this study were:

1. To determine the distribution and population density of *Kalophrynus palmatissimus* at two forest reserves; AHFR and PFR.
2. To examine the morphometrics of *Kalophrynus palmatissimus* at AHFR and PFR.
3. To determine the relationship between habitat types and distribution of *Kalophrynus palmatissimus* at AHFR and PFR.

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