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ENVIRONMENTAL CHARACTERIZATION ON ANURAN ASSEMBLAGE IN TWO HABITAT TYPES OF TERLA FOREST RESERVE

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ENVIRONMENTAL CHARACTERIZATION ON ANURAN ASSEMBLAGE IN TWO HABITAT TYPES OF TERLA FOREST RESERVE

By

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ENVIRONMENTAL CHARACTERIZATION ON ANURAN ASSEMBLAGE IN TWO HABITAT TYPES OF TERLA FOREST RESERVE

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Faculty : Science

Forest conversion to agricultural farmland modifies land into small patches, making amphibians more dependable to external environmental changes. Besides, monitoring studies of the restoration process in birds and mammals are greater compared to anuran studies. A study on anuran between two habitat types was conducted in Cameron Highlands from June 2018 until February 2019 to investigate the species diversity, richness, evenness, distribution, the relationship between environmental characteristics to anuran assemblage, and species indicator. Ten permanent quadrats measuring 25 m x 25 m were installed in the restoration area. While 400 m transect line with an interval distance of 20 m were carried out in the adjacent forest. A total of 15 species of anuran belonging to six families was recorded in both habitats. *Duttaphrynus melanostictus* (56.0%) and *Rhacophorus bipunctatus* (43.7%) were the highest captured in the restoration site and forest respectively. The Shannon-Wiener Diversity Index, (*H'*) showed high species diversity in the forest (*H'*= 1.71). However, the species evenness in the forest is low (*E*= 0.42). Microhabitat structures showed a significant trend with the anuran species; horizontal position (F= 1.18, $p< 0.05$), vertical position (F= 1.45, $p< 0.05$), and substrate position (F= 1.15, $p< 0.05$). However, soil moisture and soil pH were insignificant (F= 0.1, $p> 0.05$). The vegetation percentage cover was statistically significant with the anuran abundance, (F= 1.56, $p< 0.05$). The macroclimate factors such as relative humidity (r_s= -0.34, $p< 0.05$), wind speed (r_s= 0.43, $p< 0.05$), and rainfall (r_s= 0.07, $p< 0.05$) have a significant but weaker correlations with the species richness in both habitats. Correlation analysis for microclimatic factors (temperature, relative humidity) in the restoration showed temperature (r_s= -0.65, $p< 0.05$) has a strong negative correlation to the abundance of *D. melanostictus* and relative humidity (r_s= 0.51, $p< 0.05$) has a strong positive correlation to *Polypedates leucomystax*, whereas in the forest, relative humidity (r_s= -0.93, $p< 0.05$) has a very strong negative correlation to *Microhyla annectens*. *Duttaphrynus melanostictus* and *P. leucomystax* in restoration area and *R. bipunctatus* in the adjacent forest were identified as best indicator species. Restoration area has great potential of harbouring more species diversity. Therefore, these findings

provide an understanding of the habitat requirements needed by the anuran inhabiting a degraded forest.

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

PENGKELASAN ALAM SEKITAR TERHADAP KOMPOSISI KATAK DI DUA JENIS HABITAT DI HUTAN SIMPAN TERLA

Oleh

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Penukaran hutan menjadi ladang pertanian mengubah tanah kepada kawasan kecil mengakibatkan amfibia lebih bergantung pada perubahan persekitaran luaran. Selain itu, kajian pemantauan proses pemulihan pada burung dan mamalia lebih luas dibandingkan dengan kajian anuran. Satu kajian penyelidikan mengenai anuran di dua habitat telah dijalankan di Cameron Highlands bermula Jun 2018 sehingga Februari 2019, untuk menentukan kepelbagaian, kekayaan, keserataan, taburan, hubungan spesies anuran dengan ciri-ciri alam sekitar, dan spesies indikator. Sejumlah sepuluh kuadrat kekal berukuran 25 m × 25 m telah dipasang di kawasan restorasi manakala garisan transek berukuran 400 m dengan jarak selang 20 m dilakukan di kawasan hutan. Sejumlah 15 spesies anuran yang terdiri daripada enam famili telah direkodkan di dua habitat. *Duttaphrynus melanostictus* (56.0%) dan *Rhacophorus bipunctatus* (43.7%) adalah tangkapan tertinggi masing-masing di kawasan restorasi dan hutan. Analisis Indeks Kepelbagaian Shannon-Wiener, (*H'*) menunjukkan kepelbagaian spesies yang tinggi di kawasan hutan (*H'*= 1.71) namun, keserataan spesies di kawasan hutan adalah rendah (*E*= 0.42). Struktur mikrohabitat mempamerkan signifikan secara statistik dengan kelimpahan anuran; posisi horizontal (F= 1.18, $p< 0.05$), posisi vertikal (F= 1.45, $p< 0.05$), dan posisi substrat (F= 1.15, $p< 0.05$). Namun, kelembapan tanah dan pH tanah tidak signifikan (F= 0.1, $p> 0.05$). Peratusan vegetasi penutup lahan menunjukkan nilai yang tidak signifikan dengan kelimpahan anuran, (F= 1.56, $p< 0.05$). Faktor makroiklim seperti kelembapan udara ($r_s = -0.34$, $p< 0.05$), kelajuan angin ($r_s = 0.43$, $p< 0.05$), dan hujan ($r_s = 0.07$, $p< 0.05$) turut berkolerasi namun lemah dengan kekayaan spesies di kedua habitat. Analisis korelasi untuk faktor mikroiklim (suhu, kelembapan udara) yang dicatatkan di kawasan restorasi menunjukkan suhu ($r_s = -0.65$, $p< 0.05$) berkolerasi negatif yang kuat dengan kelimpahan *D. melanostictus* dan kelembapan udara ($r_s = 0.51$, $p< 0.05$) berkolerasi positif yang kuat terhadap *Polypedates leucomystax*, manakala, di dalam hutan, kelembapan udara ($r_s = -0.93$, $p< 0.05$) menunjukkan korelasi negatif yang sangat kuat terhadap kehadiran *Microhyla annectens*. *Duttaphrynus melanostictus* dan *P. leucomystax* di kawasan restorasi dan *R. bipunctatus* di hutan berhampiran dikenal pasti sebagai spesies indikator terbaik. Kawasan restorasi mempunyai potensi besar untuk menyimpan lebih banyak kepelbagaian spesies, oleh itu, penemuan ini

memberikan pemahaman mengenai keperluan habitat yang diperlukan oleh anuran yang mendiami hutan yang terdegradasi.

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I certify that a Thesis Examination Committee has met on (date of viva voce) to conduct the final examination of Nadia Simon on her thesis entitled "Environmental Characterization on Anuran Assemblage in Two Habitat Types of Terla Forest Reserve" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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%	Percentage
°C	Degree Celsius
cm	Centimetre
m	Metre
mm	Milimetre
km	Kilometre
ha	Hectare
m/s	Metre per Second
a.s.l	Above sea level
e.g	Example given
sp.	Species
spp.	Species (plural)
RA	Restoration Area
FR	Forest Reserve
SVL	Snout-vent length
TL	Tibia length
TMF	Tropical Montane Forest

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Tropical rainforests are located between 10° north and 10° south of the equator, where the climate is humid and wet and there is no distinct dry season. Tropical rainforests are found in four biogeographic realms; Central and South America, Central and West Africa, Indo-Malaya, and Australia (Hill & Hill, 2001). The vast diversity of flora composition is occurring in the rainforests along with the groups of fauna species such as birds, reptiles, mammals, amphibians, and invertebrates. Tropical rainforests provide them with greater habitat and food resources for their survival (Rajpar & Zakaria, 2014).

Malaysia has the oldest and most complex tropical rainforest which houses a diverse flora and faunal community. To date, there are 307 known species of mammals, 785 species of birds, 242 species of amphibians, and 567 species of reptiles recorded. Even so, there are still new species discoveries that added to the growing inventory list (National Policy on Biological Diversity 2016-2025, 2016).

The mountain region in Peninsular Malaysia composed is jagged, hilly, with steep slopes. This complex topography has added a compelling component to the upland systems, making this region as high in herpetofauna diversity and endemism (Das et al., 2004; Grismer et al., 2010; Sumarli et al., 2015). The variety of topography also contributes to any kind of environments such as the water bodies that are essential for habitat and breeding sites for the amphibians (Shahriza et al., 2011). An earlier amphibian inventory by Berry (1975) stated that in Peninsular Malaysia, about 83 species of amphibians were recorded. Recently, Norhayati (2017) reported that 111 species of anuran comprising of six families known to be recorded in Peninsular Malaysia. The six families are Bufonidae, Dicroglossidae, Megophryidae, Microhylidae, Ranidae, and Rhacophoridae.

1.2 Problem Statement

Amphibians are one of the fauna groups considered as threatened in the montane region of Malaysia (Peh et al., 2011). Amphibians, particularly are most suffered to environmental changes caused by habitat loss, fragmentation, and degradation (Lima et al., 2019). The anuran diversity may decline resulted from the habitat loss due to agricultural development (Peh et al., 2011). While in the face of nature's degradation, Malaysia has been categorized among the highest tropical forest degradation (Sodhi et al., 2004; Sodhi & Brook, 2006).

The largest threats to forests in Cameron Highlands has been caused by selective logging, plantations (tea estates), farming, and extraction of forest products (rattan, bamboo, fruit, resins, medicinal herbs) (Wazir-Jahan, 1990). The forest conversion to agriculture land coupled with land clearing exposed Cameron Highlands to several damages such as mudslides, landslides, as well water pollution problem (Razali et al., 2018) by removing all the natural habitat topsoil. Thus, farmers will usually use untreated chicken manures as organic fertilizers on a newly-open land because the richness in the nitrogen (NPK) content that helps speed up the growth of the crops (Barrow et al., 2009). About 90% of the farmers used chemical pesticides (indoxacarb, fipronil, chlorpyrifos combined with cypermethrin, lambda-cyhalothrin, and abamectin) to manage pest and disease on crops (Mazlan & Mumford, 2005). Other types of pesticides such as fungicides, insecticides, and herbicides are included to cater the pest and disease control (Mispan et al., 2015). The usage of fertilizers and pesticides can cause runoff and erosion to water bodies during rainfall and reported to have high persistence (more than 10 years) hence, a huge tendency to bio-accumulate in the soil (Farina et al., 2016). The soil erosion offers the agriculture soil combined with pesticides and heavy metal elements into water bodies (Barrow et al., 2009). Later, the water bodies are constantly threatened by repeated agriculture runoff and nutrient loss from the exposed agriculture soil (Tan & Mokhtar, 2011).

Anurans are significantly impacted by direct human disturbances because almost all amphibians and reptiles have a limited home range and can survive within a small patch of a landscape. The land that modifies into small patches due to uncontrolled agriculture, logging, and urbanization making the amphibians more dependable to the external environmental changes and higher exposure to extinction after disturbances compared to birds and mammals (Blaustein et al., 1994). Being a biological indicator organism, anuran play a substantial part in maintaining human and ecosystems health (Hayes et al., 2002) and part of aquatic and terrestrial environments. Anurans are carnivorous groups of amphibians (Elmer & Cannatella, 2008) and they feed on invertebrates and small vertebrates (Huaimei et al., 2013), so they are an important link affecting the transfer of energy between insects and other invertebrates. The anuran is sensitive to the external environment due to skin permeability and they are ectothermic, meaning they are disabled to thermoregulate accurately and susceptible to temperature and environmental humidity (Pough et al., 1998; Sparling et al., 2000; Rios-López & Mitchell Aide, 2007).

Several studies have been reported in the montane region on anuran diversity and inventories (Leong & Lim, 2003; Grismer et al., 2010; Norhayati et al., 2011, Ibrahim et al., 2012; Sumarli et al., 2015; Ehwan, 2017). Meanwhile, habitat comparison studies were conducted in amphibian species composition and richness in the logged forests and regenerating logged forests (Izam et al., 2016), green corridor in an oil palm plantation to nearby oil palm plantation without green corridor (Ehwan, 2011), and anuran species diversity in the non-forest site and forest site (Noor Bahiah et al., 2019). Additionally, most of the studies focusing on birds and mammals monitoring to the restoration process (Blaustein et al., 1994), however, short monitoring after restoration on anuran and anuran diversity in Cameron Highlands is yet to be explored.

1.3 Research Objectives

This study aimed at anuran species diversity and distribution in the restoration and its adjacent forest. The objectives of this study are:

i) To compare the species diversity, richness, evenness, and distribution of anuran in restoration site and adjacent forest;
ii) To investigate the relationship between the environmental characteristics (microhabitat, vegetation percentage cover, microclimate) with anuran in restoration site and adjacent forest;
iii) To determine the species indicator associated with environmental parameters in the restoration site and adjacent forest.

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LIST OF PUBLICATIONS

Proceedings

Nadia Simon, Marina Mohd. Top @ Mohd. Tah, Nadirah Rosli, Siti Fara Najua Mohd. Nasir, Muhammad Faris Abd. Aziz, Mohamad Roslan Mohamad Kasim and Mohamad Azani Alias. *The Diversity of Anuran Species in Urban Forest in Selangor*. Paper presented at 14th International Annual Symposium, Universiti Malaysia Terengganu, Malaysia. July 2019.

Nadia Simon, Marina Mohd. Top @ Mohd. Tah, Mohd. Zaki Hamzah and Nor Azwady Abdul Aziz. *Anuran Inventory of the Montane Forest in Cameron Highlands, Pahang, Malaysia*. Paper presented at Malaysia International Biology Symposium 2019, Bukit Tinggi, Pahang, Malaysia. August 2019.

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