A COMPARATIVE STUDY OF FROG SPECIES AT STREAMS, RIDGES AND DISTURBED HABITATS IN BASE CAMP AND PADANG POINT, GAYA ISLAND

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ABSTRACT *The aim of this study was to identify the species of frogs that can be found at streams, ridges and disturbed habitats of Gaya Island. Field sampling was carried out for 16 nights consecutively starting from 18th January until 3rd February 2013. This research was conducted using the standard method of Visual Encounter Survey. The sampling effort for this study was 53 hours. Six sites representing three different frogs' habitats were selected, namely streams, ridges and disturbed areas. The transect line with dimensions of 10m x 100m was used for the sampling survey. The results show that there were five species of frogs from two families that were present in Gaya Island. The five species were Inger's dwarf frog (Ingerana baluensis), Grass frog (Fejervarya limnocharis), Mangrove frog (Fejervarya cancrivora), Green paddy frog (Hylarana erythraea) and Dark-eared tree frog (Polypedates macrotis). The highest number of frogs caught was in the stream area, consisting of 69 individuals, followed by 18 individuals at the disturbed area and two individuals at the ridges. This preliminary study indicated that there was a relationship between frog species diversity with the variety of the habitat sites. These findings present a baseline data for the frog species in Gaya Island. Future studies should be encouraged in order to have an in-depth understanding of the frogs' natural habitats in Gaya Island.*

KEYWORDS. Frogs, Gaya Island, North Borneo, Sabah, Species diversity.

INTRODUCTION

Frogs are classified as amphibians in the order of Anuran. An amphibian is classified as an animal that live in both aquatic and land environment (Ibrahim, 2005). According to Inger and Stuebing (2005), at least 150 species of frogs were recorded in Borneo and about 100 species were found in Sabah alone. However, most of the collections were from the mainland of Sabah, particularly in Kinabalu Parks, Crocker Range Park, Lower Segama and the west coast of Sabah (Ramlah, 2011).

According to Arneson (2013), frogs can be used as biological indicators as they are sensitive to the changes of the environment. Frogs are good indicators of ecosystem health, as they are relatively long lived and are present in stable populations in undisturbed habitats.

Amphibians have permeable skin that causes them to be more susceptible to damage as a result of changes in habitat.

Global frog populations are declining and currently their numbers are threatened by the destruction of their natural habitats, environmental pollution and land degradation. In Malaysia, the forest dwelling frog species is threatened by logging and development that makes them vulnerable to extinction (Ibrahim, 2005). The ongoing global destruction of tropical forest is a major contributor to biodiversity loss (Gillespie *et al*., 2012). Southeast Asia is amongst the tropical regions that is experiencing the highest rates of deforestation. Deforestation is caused by unsustainable logging practices and conversion of land to oil palm plantations. Furthermore, the impacts of these large-scale land use changes on biodiversity are not fully understood, and may further accelerate the extinction rate (Gillespie *et al*., 2012).

Different amphibian communities are known to inhabit different habitats. However, there are only a few published studies that have further investigated this phenomenon (Ibrahim, 2005). To date, there are some published studies on terrestrial wildlife in Gaya Islandsuch as Sompud *et al.*,(2013; 2016), Gilbert *et al.*(2018) and Siti Saryati *et al.*,(2016) but there is no published information yet on the frogs community in Gaya Island. This study thus presents the findings of the species of frogs found at streams, ridges and disturbed habitats in Gaya Island.

MATERIAL AND METHODS

Study Area

The study sites were situated in Gaya Island (Figure 1). There were six sites that represented three different frogs' habitats. For the purpose of this study, three categories of frog habitats were selected, i.e., stream areas, disturbed areas, and ridge areas. Each habitat type was replicated with two sites. These three categories were selected based on the differences of physical condition (humidity).

The physical condition data was not recorded, but it can be described based on the nearest existent of water bodies. The stream habitat can be classified as the most humid area. This site provides water resources continuously for frog, except during drought season. The sites selected for stream habitat were Base Camp stream (N 06º 00' 54.8", E 116 º 01' 12.8") and Bakau Stream (N 06º 00' 57.81", E 116 º 00' 55.6").

The sites selected for disturbed habitat were Base Camp (N 06º 00' 49.5", E 116 º 01' 13.7") and Padang Point (N 06º 00' 45.8", E 116 º 00' 36.1"). This type of habitat can be described as the place with the existence of man–made pond or water patches. However, the water resources were only available during rainy days. The sites selected for the ridge habitat were located at a ridge, along the Police Beach trail (N 06º 00' 51.0", E 116 º 01' 07.5") and at a ridge, along the Sunset Viewtrail (N 06º 00' 43.6", E 116 º 01' 09.1").

Ridge habitat was categorized as the site with limited water resources. The frogs that inhabit in this type of habitat will always move to the nearest water bodies in order to get their water resources.

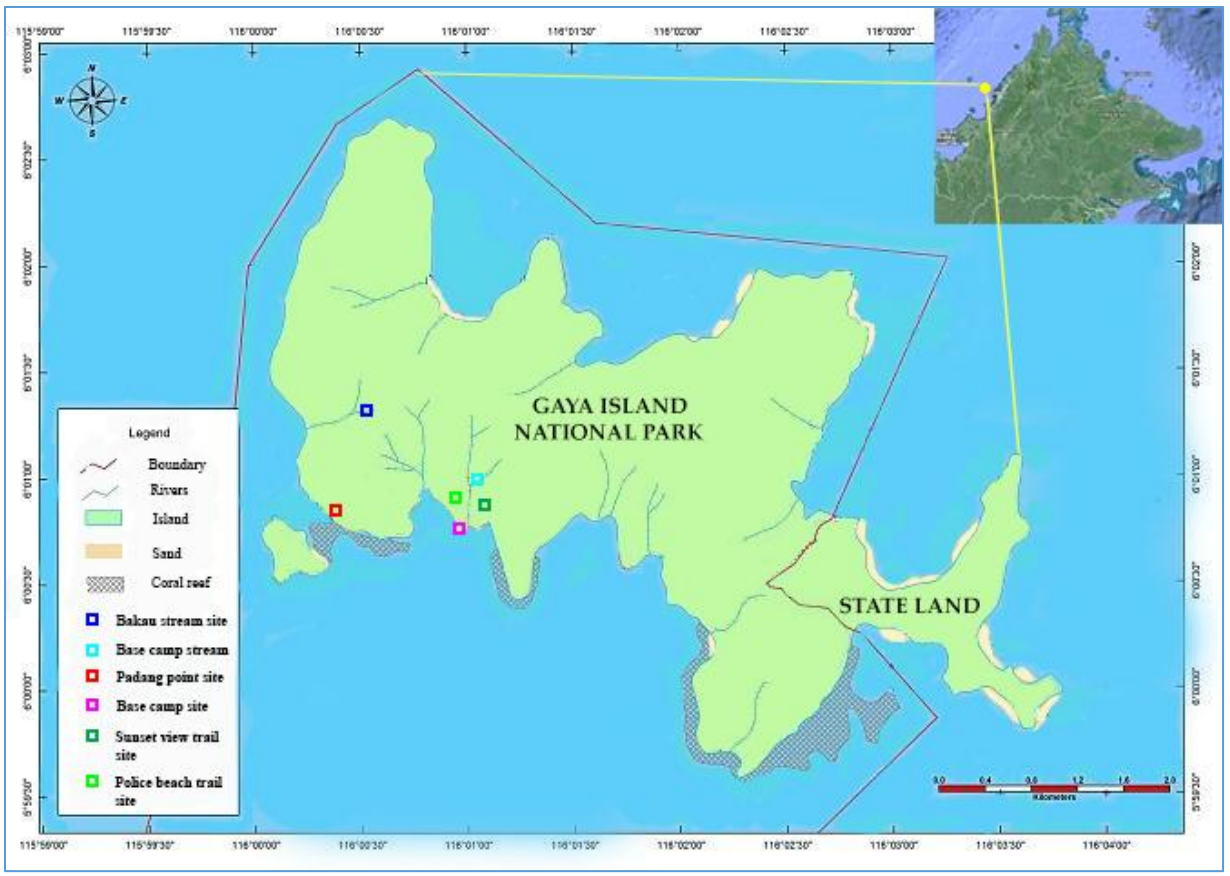

Figure 1: The Study Sites Situated in Gaya Island**.**

Methods

Field sampling was carried out for 16 consecutive nights, starting from 18th January until 3rdFebruary, 2013. This research was conducted using the standard method of Visual Encounter Survey adapted from Heyer *et al*.,(1994). The method involvedwas spotting frog by using a high powered headlamp. Each encountered frog was captured by using hand. Species identification of the frogs was done using fieldguide reference from Inger & Stuebing (2005) and Imbun (2013). Photos were taken for each new recorded frog. Only newly recorded captured species were preserved in 10% formalin. Those that were not preserved were released at the location where they were captured, after their data were recorded.

The field data collection was conducted between 1900 – 2100 hours using a standard method adapted from Maklarin *et al*. (1999). This period was the recommended time for sampling survey of frogs, as it is the peak activity time for frogs. The transect line was selected

randomly with the dimensions of 10m x 100m. This sampling dimensions was adapted and modified from Phochayavanich *et al*. (2010). Each of the transect line was divided into several sub transect with 5m intervals. There were 20 sub transects that were established and each sub transect was surveyed for 1 minute. This is to ensure that the survey duration at each transect line was consistent. Lastly, each of the transect lines was surveyed for four times with equal sampling efforts to ensure a valid comparison between those three habitat types of frog. The overall sampling effort for this research was 53 hours. Apart from the standard survey, we also conducted occasional survey that covers the distance of 1.2km to 2km per survey walk. The occasional survey was conducted for 16 consecutive days that elapsed for two hours and 30 minutes.

RESULTS

There were 89 numbers of frogs that were recorded from all three types of habitats (Table 2). The highest number of frogs caught was at the streams area that consisted of 69 individuals. This was followed by 18 individuals at disturbed area and two individuals at ridges area.The findings of this survey show that there were five species of frogs from two families that were recorded in Gaya Island. The five species were Inger's dwarf frog(*Ingerana baluensis*), Grass frog (*Fejervarya limnocharis*), Mangrove frog (*Fejervarya cancrivora*), Green paddy frog (*Hylarana erythraea*) and Dark-eared tree frog(*Polypedates macrotis*).

The disturbed area recorded the highest number of species (four species), followed by stream (two species) and ridge (one species). The Inger's Dwarf frog dominated the stream site. Nevertheless,this species was not recorded in the ridge and disturbed areas. In disturbed area, the Grass frog and Dark-eared tree frog was the most commonly found. Interestingly, the Dark-eared tree frog was recorded in all three habitats, i.e., stream, ridge and disturbed areas. The physical features of these frogs were shown in Plate1 to 5.

Table 2: Frog Captured by Visual Encounter Survey

Family	**Species**	**Common name**	**No. of capture**		
			Streams	**Ridges**	**Disturbed Area**
Ranidae	*Ingerana baluensis*	Inger's Dwarf Frog	68	0	0
	Fejervarya limnocharis	Grass Frog	0	0	8
	Fejervarya cancrivora	Mangrove Frog	0	0	3
	Hylarana erythraea	Green Paddy Frog	0	0	1
Rhacophoridae	*Polypedates macrotis*	Dark – eared Tree Frog	1	2	6
		Total	69	2	18

Plate 1: The Inger's Dwarf Frog (*Ingerana baluensis*)

Plate 2: Grass Frog (*Fejervarya limnocharis*)

Plate 4: Green Paddy(*Hylarana erythraea*)

Plate 5: Dark-eared Tree Frog(*Polypedates macrotis)*

DISCUSSION AND RECOMMENDATIONS

Tracy *et al*. (2008) stated that frogs maintain moist skins for a variety of reasons, including respiration.Frog also needs to remain in a humid environment because it enables them to reproduce. Physiological constraints coupled with reproductive characteristics may cause many frog species to be especially sensitive to local changes in climate and microhabitat. Neckel-Oliveira (2007) reported that the concentration of water vapor in microhabitats is fundamental for maintaining the water balance of the embryo needed for successful hatching. The existences of water resources play a major role that affects frog life cycle. Hydration state and environmental temperature have a major influence on the physiology and behavior of anuran amphibians. Rogowitz *et al*. (1999) explained that species jumping performance declines with the increase in water loss. This observation is also true with greater duration of exposure to dehydrating conditions. Dehydrated frog skin can be damaged that leads tostiffening and no longer viable (Tracy *et al.*, 2008). Frogs cannot live far away from water resources as they need water to keep their body humid due to their permeable skin types. These past studies affirm and explain why our findings show that the highest number of captured individual frogs was in streams habitat due to the ideal moist environmental condition.

The number of species recorded in each site indicated that the frogs required a specific habitat to live in. There are two major groups of frog in Borneo based on their general habits and habitats (Inger and Stuebing, 2005). These two major groups are forest dwelling frogs and frogs that live in human based environment. The findings of our study show that the disturbed area recorded the highest number of frog species. The Green Paddy Frog (*Hylarana erythraea*), Mangrove Frog (*Fejevarya cancrivora*) and Grass Frog (*Fejevarya limnocharis*)were amongst the species recorded in disturbedareas. This resultwas similar withthe findings of Evan *et al*., (2011). Their study recorded more species ofdisturbedarea dwelling frogas compared to theforest dwelling frog. These findings seem to reflect that the disturbed area provide a good habitat for frogs. However, Wong (2004) reported that the mosaic of habitats created in disturbed area can cause influx of the variety of frog species. Inger and Stuebing (2005) documented that there are only nine species that are closely associated with human economic activity. Frogs show a better preference for natural habitat. The natural environment support greater number of species as opposed to the constructed habitat (Hazell *et al*., 2004).In addition to that, the disturbed areas only provide suitable habitat for certain types of frog (Wong, 2004).

Frog plays an important role in the forest ecosystem.They act as a water quality controller that balances the food chain and nutrient cycle (Hutchens and DePerno, 2009). The results from our study indicate for further research to be done so as to investigate the frog community in Gaya Island. This may assists the Gaya Island National Park management to better natural habitat for the forest dwelling frogs.

CONCLUSION

This preliminary results show that there is a relationship between frog species diversity with the variety of the habitat sites in Gaya Island. These findings can be used as baseline information for future research of forests dwelling frog species. Further studies need to be conducted in Gaya Island in order to protect the frog natural habitats.

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REFERENCES

Arneson, N. 2013. *Amphibian community composition and its relationship to salinity along the Salt Creek in Wilderness Park, Lancaster County, Nebraska*. Environmental Studies Undergraduate Student Thesis. Paper 114.

Gilbert, E.A., Sompud, J. Igau, O.A., Lakim, M., Repin, R., & Biun, A. 2018. A Preliminary Survey on the Effect of Anthropogenic Noise on Bird Community in Gaya Island. Transaction on Science and Technology, 5(1): 31-39.

Gillespie, G. R., Ahmad, E., Elahan, B., Evans, A., Ancrenaz, M., Goossens, B., & Scroggie, M. P. 2012. Conservation of amphibians in Borneo: Relative value of secondary tropical and non – forest habitats. *Biological Conservation*, **152**, pp. 136 – 144.

Hazell, D., Hero, J. M., Lindenmayer, D., & Cunningham, R. 2004. A comparison of constructed and natural habitat for frog conservation in an Australian agricultural landscape. Biological Conservation, **119**(1), pp. 61-71.

Heyer, W. R., Donnelly, M. A., Mcdiarmid, R. W., Hayek, L. C., & Foster, M. S. 1994. *Measuring and Monitoring Biological Diversity Standard Methods for Amphibians*. Library of Congress Cataloging, United States of America.

Hutchens, S., & DePerno, C. 2009. Measuring species diversity to determine land-use effects on reptile and amphibian assemblages. *Amphibian-Reptilia,* **30**(1), pp. 81 – 88.

Ibrahim, J. 2005. Kajian dan Pemakanan Berudu beberapa Spesis Katak Hutan di Utara *Semenanjung Malaysia*. Laporan Komprehensif Geran USM Jangka Pendek 304/PJJAUH/634167.

Imbun, P.Y. 2013. *Amfibia Sabah*. Dewan Bahasa dan Pustaka, Kuala Lumpur.

Inger, R. F., & Stuebing, R. B. 2005. *A Field Guide to the Frogs of Borneo Second Edition*. Natural History Publications, Kota Kinabalu.

Maklarin, L., Paul. Y.& Satie, A. 1999. A Comparative Study of the Amphibian Population in Reference to Habitat Disturbance across an Elevation Gradient in Kinabalu Park, Sabah, Malaysia. *Sabah Parks Nature Journal*, **2**, pp. 27 – 44.

Neckel-Oliveira, S. 2007. Effects of forest disturbance on breeding habitat availability for two species of anurans in the Amazon. *Copeia*, **2007**(1): pp. 186-192.

Phochayavanich, R., Voris. H. K., Khonsue. W., Thunhikorn. S., & Thirakhupt. K. 2010. Comparison of Stream Frog Assemblages at Three Elevations in an Evergreen Forest, North –Central Thailand. *Zoological Studies*, **49** (5), pp. 632 – 639.

Ramlah, Z. 2016. Assemblages of Frogs Species at Balambangan Island, Sabah, Malaysia. *Borneo Journal of Resource Science and Technology*, **1(1)**, pp. 59 – 62.

Rogowitz, G. L., Cortes-Rivera, M., & Niever–Puigdoller, K. 1999. Water loss, cutaneous resistance, and effects of dehydration on locomotion of Eleutherodactylus frogs. *Journal of Comparative Physiology B* , **169**, pp. 179 – 186.

Siti Saryati H. A. M, Farnidah H. J., Nor Bazilah R., Suhair H. A. S. & Nur Izati I. 2016. Non-Flying Small Mammals of Gaya Island, Sabah, Malaysia. *Sabah Parks Nature Journal* , **10**, pp. 15-18.

Sompud, J., Immit, A.R. & Lakim, M. 2013. The preliminary Survey of Avifauna in Gaya Island, Sabah, Malaysia. *Malayan Nature Journal*, **65**(4), pp. 295-299.

Sompud, J., Igau, O. A., Mojiol, A.I., Gilbert, E.A., Mobik, C.S., Megat Amir & Mohd HIsyamuddin K. 2016. Impacts of Development on Avifauna at Gaya Island, Sabah, Malaysia. *Sabah Parks Nature Journal*, **10**, pp. 9-14.

Tracy, C. R., Christian, K. A., Betts, G., & Tracy, C. R. 2008. Body temperature and resistance to evaporative water loss in tropical Australian frogs. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology, **150**(2), pp. 102-108.

Wong, A. 2004. Impact of Forestry Practices on Frog Communities in Sabah. In Final Report of Biodiversity Impacts of Climatic Change, Fire and Forest Restoration Techniques and The Watershed Roles of Conservation Area In South East Asia. (RE-SEA-001) 2004. Asean Regional Centre for Biodiversity Conservation and the European Commission, pp. 17-30.