

ACKNOWLEDGEMENTS

Alhamdulillah, praise to Allah s.w.t for giving me this wonderful opportunity and strength to complete such a meaningful journey of my life. I feel grateful for the love, spirit, trust and encouragement giving by peoples surrounding me until the completion of my study.

First of all, my gratitude goes out to Department of Higher Education for their financial support of my study through Fundamental Research Grant Scheme (FRGS). I would like to extend my gratitude to University of Malaya especially Faculty of Sciences for giving me the opportunity and scholarship to pursue my study. Thank you to Selangor Forestry Department and Negeri Sembilan Forestry Department for their cooperation and guidance during my study.

A huge appreciation goes out to my supervisor, Associate Professor Dr. Rosli bin Ramli for his willingness, guidance, knowledge and support throughout this journey. Thank you for trusting me and never give up on me until the end of my study. Also thank you to Dean of Faculty of Sciences, Professor Dato' Dr. Mohd Sofian bin Azirun for sharing his knowledge and experiences during my study. Thank you also to Head of Department, Institute of Biological Sciences, Professor Dr. Rosli bin Hashim for his guidance and support, and allowed me to stay in Pusat Pengajian Luar Universiti Malaya (PPLUM) during my duration of study.

I also dedicated this appreciation to committed staffs in Institute of Biological Sciences; Mr. Muhaiyidin, Mr. Fadzlee, Mr. Ngadiran, Hj. Mokhtar, Mr. Ismeail, Mr. Anuar, Mr. Izuwan, Mr. Ismaili, Mr. Salleh and Mr. Rosli Idris for their willingness and strong

enthusiasm in helping me collecting data until the end of my research. I would like to thank staffs of PPLUM; Mr. Mat Uda, Hj. Karim, Mr. Sharani and Mr. Marisi for their effort and courage in helping me throughout my sampling. Big thanks to all drivers of ISB (Mr. Azhar, Mr. Farizwan, Mr. Fauzi, Mr. Zaidee, and Mr. Nizam) whom are very committed and dedicated doing their job to ensure that my research can be done in respective place and time.

Most important, my deepest appreciation goes out to my beloved family especially my parents and Zulhilmi, for their support, encouragement and prayers in helping me going through the hardship of my academic dream. Thank you for your never ending trust, patience and spirit that you gave me. Last but not least, thank you to my supportive friends for whom always filled my journey with passion, humor and positive vibes.

Thank you.

ABSTRACT

Community structure of understorey birds can be influenced by habitat structure, microclimate and food resources. Heavy utilization of natural resources in tropical forest for economic purposes has become one of major threat to tropical forest birds. A comparative study on understorey birds inhabiting different habitats of lowland forest was conducted in Ulu Gombak Forest Reserve (UGFR), Selangor and Triang Forest Reserve (TFR), Negeri Sembilan. Mist-netting method was applied to gather information on understorey bird's assemblages inhabiting logged forests (LF) and Virgin Jungle Reserve (VJRs) of the two lowland forests. The effect of seasonal variation such as rainfall and migratory season on understorey birds composition was also studied. A total of 2,370 birds of 120 species were recorded in both study areas after 48 samplings. VJRs were highly diversified compared to LF with domination of primary forest birds such as babblers (Timaliidae) and flycatchers (Muscicapidae). However, increasing number of secondary forest bird such as Little spiderhunter (*Arachnothera longirostra*) in VJRs raised question on the quality of the reserves. Presence of primary forest birds in logged forests indicating the process of habitat recovery. The results showed that diversity of understorey birds was not influenced by rainfall. Presence of migratory species within the study areas provided evidence of being suitable stopover sites. The information gathered from this work is hoped to support efforts in formulating forest management practices and conservation strategies for wildlife in general and specifically understorey avifauna.

ABSTRAK

Struktur komuniti burung bawah kanopi dipengaruhi oleh struktur habitat, mikroiklim dan sumber makanan. Eksploitasi sumber semulajadi di hutan tropika untuk tujuan ekonomi telah menjadi satu ancaman terhadap burung hutan tropika. Satu kajian mengenai burung bawah kanopi di hutan tanah pamah yang mempunyai habitat berlainan telah dijalankan di Hutan Simpan Ulu Gombak, Selangor (UGFR) dan Hutan Simpan Triang, Negeri Sembilan (TFR). Teknik tangkapan menggunakan jaring kabut telah digunakan untuk mengumpul maklumat mengenai kelimpahan burung di hutan yang telah dibalok dan hutan dara di dua hutan tanah pamah. Kesan variasi musim seperti hujan dan musim penghijrahan ke atas komposisi burung bawah kanopi turut dikaji. Sebanyak 2,370 burung daripada 120 spesies telah ditangkap di kedua-dua kawasan kajian selepas 48 pensampelan. Kelimpahan burung adalah tinggi di hutan dara berbanding hutan yang telah dibalok dan didominasi oleh burung hutan dara seperti burung rimba (Timaliidae) dan burung sambar (Muscicapidae). Walau bagaimanapun, peningkatan bilangan burung spesis hutan sekunder seperti Kelicap Jantung Kecil (*Arachnothera longirostra*) di hutan dara menimbulkan persoalan mengenai kualiti hutan tersebut. Kehadiran burung hutan dara di hutan yang telah dibalok menunjukkan habitat tersebut dalam proses pemulihan. Keputusan kajian menunjukkan kelimpahan burung bawah kanopi tidak dipengaruhi oleh faktor hujan. Kehadiran burung hijrah di dalam kawasan menunjukkan bukti bahawa kawasan kajian berupaya menyediakan tempat persinggahan yang sesuai. Maklumat yang diperolehi melalui kajian ini diharap dapat menyokong usaha dalam merekabentuk strategi pengurusan hutan dan pemuliharaan hidupan liar secara amnya dan khususnya untuk burung bawah kanopi.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS	ii
ABSTRACT	iii
ABSTRAK	iv
TABLE OF CONTENTS	v
LIST OF FIGURES	viii
LIST OF TABLES	x
CHAPTER 1 INTRODUCTION	
1.1 Tropical rainforest	1
1.2 Community structure of birds in lowland forest	3
1.3 Ecological importance of birds in tropical forest	5
1.4 Factors influence bird diversity in lowland forest	
1.4.1 Habitat variation	6
1.4.2 Food availability	8
1.4.3 Seasonal variation	1
1.5 Importance of diversity assessment	1
1.6 Research objectives	1
CHAPTER 2 METHODOLOGY	
2.1 Study sites	
2.1.1 Ulu Gombak Forest Reserve, Selangor	13
2.1.2 Triang Forest Reserve, Negeri Sembilan	15
2.2 Sampling design	
2.2.1 Mis-netting method	17
2.2.2 Morphological measurements	19
2.2.3 Ringing method	19
2.3 Feeding guild	20
2.4 Rainfall data	20
2.5 Bird status	21
2.6 Status of abundance	22
2.7 Global conservation status	23
2.8 Data analysis	
2.8.1 Classification of species	25
2.8.2 Capture rate	25
2.8.3 Diversity analysis	26
2.8.4 Statistical analysis	27

CHAPTER 3 RESULTS

3.1	Understorey birds assemblages in UGFR and TFR	28
3.1.1	Species composition	
3.1.1(a)	Highest species representatives	31
3.1.1 (b)	Highest individuals representatives	31
3.1.2	Species similarity between UGFR and TFR	32
3.1.3	Specialist species of UGFR and TFR	34
3.1.4	Feeding guild composition	
3.1.4.1	Highest species and individuals representatives in UGFR	35
3.1.4.2	Highest species and individuals representatives in TFR	37
3.2	Monthly distribution of understorey birds	
3.2.1	Ulu Gombak Forest Reserve (UGFR)	39
3.2.1.1	Community structure of understorey birds in UGFR	41
3.2.2	Triang Forest Reserve (TFR)	42
3.2.2.1	Community structure of understorey birds in TFR	44
3.3	Rainfall pattern	
3.3.1	Rainfall and total birds in UGFR	45
3.3.2	Rainfall and total birds in TFR	47
3.4	Seasonal migration	
3.4.1	Occurrences of migratory birds and resident/migratory population	49
3.4.2	Occurrences of migratory birds in UGFR during migratory season	49
3.4.3	Occurrences of migratory birds in TFR during migratory season	52
3.4.4	Population of migratory birds during non-migratory season	54
3.5	Understorey birds assemblages in different habitats	
3.5.1	Logged forest and Virgin Jungle Reserve	
3.5.1.1	Species composition	56
3.5.1.2	Uncommon species	62
3.5.1.3	Species similarity of logged forest and VJR	63
3.5.1.4	Specialist species	65
3.5.1.5	Species similarity of logged forest between UGFR and TFR	67
3.5.1.6	Specialist species of logged forest	68
3.5.1.7	Species similarity of VJR between UGFR and TFR	69
3.5.1.8	Specialist species of VJR	70

CHAPTER 4	DISCUSSION	
4.1	Understorey birds assemblages in UGFR and TFR	71
4.2	Monthly variation in relation to rainfall and migratory season	75
4.3	Understorey birds assemblages in different habitats	78
CHAPTER 5	CONCLUSION	83
REFERENCES		85
APPENDIX		91

LIST OF FIGURES

1. Figure 2.1: Location of study sites
2. Figure 3.1-1: Capture rate and total number of individuals and species captured in UGFR and TFR
3. Figure 3.1-2: Species accumulation curve of UGFR and TFR
4. Figure 3.1-3: Feeding guild composition of avifauna in UGFR and TFR
5. Figure 3.2-1: Monthly abundance of avifauna in UGFR
6. Figure 3.2-2: Monthly abundance of understory birds in TFR
7. Figure 3.3-1: Monthly rainfall and total individuals in UGFR
8. Figure 3.3-2: Monthly rainfall and bird's capture rate in UGFR
9. Figure 3.3-3: Monthly rainfall and total individuals in TFR
10. Figure 3.3-4: Monthly rainfall and bird's capture rate in TFR
11. Figure 3.4-1: Monthly abundance of migratory birds species in UGFR
12. Figure 3.4-2: Monthly abundance of the most abundant migratory species and species that have resident/migratory population in UGFR
13. Figure 3.4-3: Monthly distribution of migratory bird species in TFR
14. Figure 3.4-4: Monthly distribution of the most abundant migratory bird species in TFR
15. Figure 3.4-5: Occurrence of migratory birds during non-migratory season in UGFR
16. Figure 3.4-6: Occurrence of migratory birds during non-migratory season in TFR
17. Figure 3.5-1: Capture rate and total number of birds and species captured in LF and VJRs of both study areas
18. Figure 3.5-2(a): Number of bird species (by family) captured in logged forest (LF) and virgin jungle reserve (VJR)

19. Figure 3.5-2(b): Number of bird individuals (by family) captured in logged forest (LF) and virgin jungle reserve (VJR)
20. Figure 3.5-3: Species accumulation curve for understorey birds in different habitats of both study sites.

LIST OF TABLES

1. Table 3.1-1: Diversity values of understorey birds in UGFR and TFR
2. Table 3.1-2: First-order Jackknife estimator for understorey birds of both study sites
3. Table 3.1-3: List of similar understorey birds species which has significant difference ($p\text{-value}=p<0.05$) in species abundance between Ulu Gombak Forest Reserve (UGFR) and Triang Forest Reserve (TFR) using Chi-square test (χ^2)
4. Table 3.1-4: Feeding guild composition of understorey birds ($p\text{-value}=p<0.05$) inhabiting Ulu Gombak Forest Reserve (UGFR) and Triang Forest Reserve (TFR) (χ^2 =chi-square value).
5. Table 3.2-1: Values of diversity indices of UGFR's avifauna for 2009-2010
6. Table 3.2-2: Diversity indices value of understorey birds in TFR for 2009-2010.
7. Table 3.5-1: Diversity indices values of understorey birds inhabiting LF and VJR
8. Table 3.5-2: First-order jackknife estimator of species diversity of understorey birds in different habitats (LF=logged forest, VJR=Virgin Jungle Reserve, SD=Standard deviation)
9. Table 3.5-3: First-order jackknife estimator of understorey bird in logged forest and VJR in UGFR and TFR (SD = Standard deviation)
10. Table 3.5-4: List of similar understorey birds species which has significant difference in species abundance between logged forest (LF) and virgin jungle reserve (VJR) using Chi-square test (χ^2).
11. Table 3.5-5: List of Red-Listed birds (based on IUCN Red List) that were captured in logged forest (LF) and virgin jungle reserve (VJR). (NT=Near-Threatened, VU=Vulnerable)

12. Table 3.5-6: List of specialist species that were classified under IUCN Red List which were captured in logged forest (LF) or virgin jungle reserve (VJR). (NT=Near-Threatened)