Faculty of Resource Science and Technology

Species Diversity of Under-Storey Birds at Mount Jagoi, Bau, Sarawak

Tay Guan Khoon

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SPECIES DIVERSITY OF UNDER-STOREY BIRDS AT MOUNT JAGOI, BAU, SARAWAK

TAY GUAN KHOON

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DECLARATION

No portion of the work referred to in dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.

TAY GUAN KHOON

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Universiti Malaysia Sarawak

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LIST OF ABBREVIATION

a.s.l	Above sea level
ca.	*Circa*; approximately
mnh	Mist-net hours

Species Diversity of Under-storey Birds at Mount Jagoi, Bau, Sarawak

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Animal Resource Science and Management Programme
Faculty of Resource Science and Technology
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ABSTRACT

Avifauna surveys were conducted at four sites in Mount Jagoi, Bau in August and November 2011, and February 2012. The main objective of the survey was to catalogue a checklist of under-storey birds. This study also compared the species diversity of avifauna at different locations in that area. Twenty mist-nets were deployed for five days in each site, from 0600 to 1800 hour daily. A total of 296 birds from 52 species representing 21 families were captured. Little Spiderhunter (*Arachnothera longirostra*) was the most abundant species mist-netted (27.4%) and family Pycnonotidae had the most diverse species caught. Statistical analysis showed that there is significant difference between all the study sites.

Key words: avifauna, Bau, Shannon's index, species diversity, mist-netting

ABSTRAK

Satu kajian burung telah dijalankan di empat kawasan di Gunung Jagoi, Bau pada Ogos dan November 2011, dan pada Februari 2012. Tujuan utama kajian ini adalah untuk katalog satu senarai semak burung di bawah kanopi. Kajian ini juga membandingkan kepelbagaian spesis di kawasan yang berlainan. Dua puluh buah jaring telah diletak selama lima hari di setiap kawasan kajian, bermula dari pukul 6 pagi hingga pukul 6 petang setiap hari. Sebanyak 296 ekor burung yang terdiri daripada 52 spesis merangkumi 21 famili telah direkodkan. Little Spiderhunter (Arachnothera longirostra) ialah spesis yang paling dominan ditangkap (27.4%) dan famili Pycnonotidae mempunyai spesis yang paling pelbagai ditangkap. Analisis statistik menunjukkan bahawa terdapatnya perbezaan yang ketara antara kawasan-kawasan yang dikaji.

Kata kunci: avifauna, Bau, indek Shannon, kepelbagaian spesis, jaring

1.0 INTRODUCTION

Borneo is one of the diversity hotspot in the world and the epicentre of biological richness in the Malay Archipelago (Garbutt *et al.,* 2006). It is attested by unusually rich avifauna of 664 species of birds, of which 51 species are endemic species (Phillipps and Phillipps, 2009). By virtue of its plentiful species of birds, Borneo is an interesting area for avifauna studies.

Land conversion is the major driving force of global biodiversity loss (Sala *et al.*, 2000; Brooks *et al*., 2002). Currently, the tropical lowland rainforests are facing destruction by anthropogenic disturbances (Peh *et al.*, 2005). Anthropogenic disturbances such as agriculture activities are the factors affecting the forest fragment. Several studies were carried out in fragmented forests that were modified by human activities such as farming, have shown deleterious consequences for forest birds (Bellamy *et al*., 1996; Diaz *et al*., 1998; Telleria and Santos, 1999; Brook *et al.*, 2003; Clough *et al.*, 2008). Therefore, relatively small changes in land use may have a large impact on the local bird diversity (Hughes *et al.*, 2002). However, degraded habitats and landscapes may serve as surrogate habitats for some of the species (Peh *et al*., 2005). According to Davies and Margules (1998), modified landscapes are not necessarily deprived all of the native species, and some species remain unaffected or sometimes beneficial to certain species (Saunders and Ingram, 1995).

Mount Jagoi is one of the mountains situated in the district of Bau, Sarawak; a Malaysian state in the northwest part of Borneo. It has an elevation of 352 meters above sea level (a.s.l). On top of Mount Jagoi, there was an abandoned village called Kampung Bung Jagoi, that long time ago, was inhabited by the Jagoi Bidayuh — one of the indigenous ethnic groups of Sarawak. Most of the villagers' livelihoods depend on agriculture. The

original forest on the foot hill had been cleared for cultivation. Agriculture activities such as rubber (*Hevea brasiliensis*) plantations, orchards and farms were the main human impact on the hill forest; something that is still active and evident in the lower parts of Mount Jagoi today.

The major anthropogenic disturbances at Mount Jagoi are shifting cultivation and firewood collections. These are the factors that shape the habitat into a mosaic of agriculture land intermixed with old secondary forest, orchards, and plantations. Thus, forest fragments contain depauperate bird communities compared to larger similar continuous forest (Ford and Davison, 1996). Yet, different habitats influence the variety and abundance of species (Sutherland *et al.*, 2004).

The most recent study in Bau area was done in 2011 at Mount Singai by Setia (2011), which is ca. 20 km from Mount Jagoi. The objectives of her study were to determine the effect of disturbance on species richness and abundance of avifauna between the disturbed area and the less disturbed area at lower and middle elevations, and to determine species diversity and species similarity. Twenty-six species were recorded, and it was concluded that there was significant effect of disturbance on species richness and abundant at both elevations.

There are several studies conducted on bird community in mountain (Santubong, Sewa, Regu, Singai and etc.) in Kuching area but there has not been any survey on bird community in Mount Jagoi. The forest fragments and human disturbances in Mount Jagoi offered an attractive area to study the diversity of birds. Thus, the bird community in Mount Jagoi is expected to exhibit differences in species diversity between different types of forests.

1.1 OBJECTIVES

This research concerns mainly the birds in Mount Jagoi. The main objective of this study is to catalogue a checklist of under-storey birds in Mount Jagoi. The secondary objective is to determine the species diversity in Mount Jagoi. The hypotheses are:

H_0: There are no significant differences in terms of species diversity between the four study sites.

H_1: At least one site is significant different in terms of species diversity between the other sites.

2.0 LITERATURE REVIEW

2.1 Previous studies in Bau District

A study was conducted by Ng (2006) on bird community in three different fallow periods in Kampung Serasot, Bau. Kampung Serasot is situated ca. 5 km away to the east of the foothill of Mount Jagoi. She recorded 32 species and the only similar species for the three plots was Little Spiderhunter (*Arachnothera longirostra*). Little Spiderhunter was also the most dominant species in the five year plot and 20 year plot. Statistical analysis of Shannon diversity index concluded that there was no significant difference of bird diversities between each plot.

A recent study of bird community at Mount Singai was conducted by Setia (2011). She had recorded 26 species from 11 families. Little Spiderhunter was the most abundant species captured. The most diverse family captured is Timaliidae with six species recorded. Statistical analysis of Shannon diversity index concluded that there was no significant difference between bird diversity at lower and mid-elevation.

A study of under-story avifauna of limestone area near Fairy Cave, Bau was conducted by Rostina (2004). Fairy cave is located nearly 9 km to the northeast of Mount Jagoi. A total of 33 species were mist-netted in six days. Ten mist nets were set in forest patches adjacent to Fairy Cave's and in the farm land. The common species captured was Mossy-nest Swiflet (*Aerodramus salangana*), followed by Little Spiderhunter. Statistical analysis of Shannon diversity index showed that farm land had higher diversity compared to the forest patches adjacent to Fairy Cave.

A study was conducted by Sim and Kong (2004), on birds at 19 limestone hills in the Bau Limestone Area. The nearest study area is located ca. 1 km to the northeast of Mount

Jagoi. A total of 129 species from 40 families were recorded by sightings and vocalisations. The study had recorded five species were listed as totally protected animals and 29 species were listed as protected animals under the Sarawak Wildlife Protection Ordinance (1998). Three endemic species were recorded; Yellow-rumped Flowerpecker (*Prionochilus xanthopygius*), Dusky Munia (*Lonhura fuscans*) and Chestnut-crested Yuhina (*Staphida everetti*). Five submontane species were recorded; Scaly-breasted Bulbul (*Pycnonotus squamatus*), Chestnut-crested Yuhina (*Yuhina everetti*), Sunda Whistling Thrush (*Myiophoneus glacinus*), Blue-and-white Flycatcher (*Cyanoptila cyanomelana*) and Temmick's Sunbird (*Aethopyga temminckii*). The finding of this study was that species diversity is associated with the habitat. The birds were rather uniformly represented across the limestone sites, and the species were richer at site where mixed dipterocarp forests occur together with karst outcrops.

All these studies were conducted nearby Mount Jagoi. These study sites have undergone the similar disturbances by human activity and habitat modification. Bird communities that survive in these areas must have successfully adapted to the fragmented forest (Shankar Raman, 2006).

2.2 Other previous studies in Kuching and Samarahan Division

A study was conducted by undergraduate students of University Malaysia Sarawak from 16th to 23rd August 2008 in Gunung Sewa, Kampung Giam, Padawan to determine the abundance and diversity of bird species between the orchard and the limestone forests (Buloh *et al*., 2008). Twenty seven species were caught at Gunung Sewa; eight and ten species were captured in orchard forest and limestone forest respectively, and nine species were captured in both sites. Little Spiderhunter was the most dominant species with 20

individuals netted during this study period. Statistical analysis revealed that there was significant difference in species diversity index between orchard area and limestone area (Buloh *et al*., 2008).

A study was conducted in Padawan at Gunung Regu, Kampung Temurang by Leow *et al*., (2009) to determine the abundance and diversity of bird species between scree forest and limestone forest (doline). A total number of 117 individuals comprising of 34 species from 14 families were netted. Little Spiderhunter was the most abundant with 23 individuals captured. Two endemic species were caught, which were Bornean Blue-flycatcher (*Cyornis superbus*) and Yellow-rumped Flowerpecker. The statistical analysis showed that there was significant difference in diversity index between scree forest and doline (Leow *et al*., 2009).

Gunung Sewa (Buloh *et al*., 2008) and Gunung Regu (Leow *et al*., 2009) studies had concluded that bird community in two different habitats are significantly different in terms of species diversity. Bird diversity might differences between the types of vegetation and subjected to the availability of food.

A preliminary survey was conducted at Mount Santubong to determine the effect of altitude and habitat disturbance on the distribution and abundance of under-storey birds and small mammals during May and October 1997 (Tuen *et al*., 2000). A total of 118 individuals representing 28 species of under-storey birds were caught. Thirteen species were caught at lower altitude, 12 species at the middle and 12 species at the summit of Mount Santubong. At the lower elevation, a total of 15 species and 12 species were caught respectively at disturbed and undisturbed areas. Rufous-tailed Tailorbird (*Orthotomus sericeus*), White-chested Babbler (*Trichastoma rostratum*), Little Spiderhunter and Cream-vented Bulbul (*Pycnonotus simplex*) were the most abundant species comprising of 50.48%

(50.5% or roughly 50%) of all the birds capture. Little Spiderhunter was the only species that was found in all altitudinal range. It was concluded that the abundance and distribution of under-storey birds at Mount Santubong are not significantly (p-value>0.05) affected by altitude or disturbance (Tuen *et al*., 2000).

Mount Santubong and Mount Jagoi have similar human disturbances at the base of these mountains. Human settlement at the base of those mountains might have some influence on the bird communities. Generalist might have benefited from human disturbance, and some specialist might not be able to survive (Devictor *et al.*, 2008). For example, Little Spiderhunter was the species found abundant in all these studies. It might have advantages on utilize the flowering plant such as banana (Genus *Musa*) in the orchards.

3.0 MATERIALS AND METHODS

3.1 Locality and habitat description

The study was conducted at four sites in Mount Jagoi, Bau (Figure 1); Site A was on the mountain trail from the north of Kampung Duyoh to Kampung Bung Jagoi (01°21.182'N 110°02.057'E, 200-250 m a.s.l); Site B was located at the foot hill near Kampung Duyoh (01º20.807'N 110º02.383'E, 50-70 m a.s.l); Site C was located at the foot hill, ca. 1 km south of Kampung Serasot, Bau (01°21.938'N 110°02.395'E, 100-120 m a.s.l); and Site D was on the mountain trail to the summit from Kampung Bung Jagoi, ca. 100m north-east of Kampung Bung Jagoi, Bau (01°21.551'N 110 02.277'E, 340-350 m a.s.l). Sampling period at Site A and Site B was from 8th until 12th August 2011, Site C was sampled from 8th until 12th November 2011, while Site D was sampled from 2nd until 5th February 2012.

Fig.1. A Google Earth screen shot of the Mount Jagoi area and the study sites.

The distance between Site A and Site B was ca. 750 m, Site D was ca. 850 m to the north-east of Site A. Site C was located ca. 750 m from Site D. All the study sites were near to the mountain trails from the foothill (Kampung Duyoh and Kampung Serasot) to the summit of the mountain.

All of the sites were heavily degraded forest due to agriculture activities. Site A was located in a 40-year-old *temuda*. The *temuda* was a secondary growth with tall fruit trees of local species such as *cempedak* (*Artocarpus integer*), *tampui* (*Baccaurea macrocarpa*), and figs (*Ficus* sp.). Site B was located in a rubber (*Hevea brasiliensis*) garden and a pineapple (*Ananas comosus*) garden located along a footpath next to a small stream. This site is close to human settlement and farmland. Site C was located in a durian (*Durio* sp.) orchard and there were a few varieties of bamboos (Family: Poaceae) found along the forest trail. Site D was on the mountain trail to the summit from Kampung Bung Jagoi. It is a *temuda* with a few groves of local fruit trees such as *cempedak* and rambutan (*Nephelium lappaceum*) and the summit was mostly covered by shrubs (Table 1).

Table 1. Sampling sites and habitat description.

Site	Habitat Characteristics	Dominant Plant
A 01°21.182'N 110°02.057'E 200-250 m a.s.l	40-year-old *temuda*	*Cempedak* (*Artocarpus integer*), *tampui* (*Baccaurea macrocarpa*), and figs (*Ficus* sp.)
B 01º20.807'N 110º02.383'E 50-70 m a.s.l	Rubber and Pineapple garden	Rubber (*Hevea brasiliensis*), pineapple (*Ananas comosus*) and *Melastoma* sp.
C 01°21.938'N 110°02.395'E 100-120 m a.s.l	Durian orchard	Durian (*Durio* sp.) and bamboos (Family Poaceae)
D 01°21.551'N 110 02.277'E 340-350 m a.s.l	*Temuda* and shrub	*Cempedak* (*Artocarpus integer*) and Rambutan (*Nephelium lappaceum*)

3.2 Mist-netting (Sampling Methods)

Twenty mist-nets with three shelves (2.5 m x 9 m x 36 mm mesh) were set up at each of the study sites. The nets were set at ground level along paths or in the forest, and the nets were ca. 20 m apart from each other. The mist-nets were unfurled at dawn (ca. 0600 hour) and closed before dusk (1730-1800 hour). Nets were checked at two hour interval. Mist-nets were closed if it rained and reopen after the rain stopped. The birds captured in the net were removed and placed in cloth bags. The birds were banded using aluminium ring after being identified. The metal rings have different sizes; size A is the smallest and the size increase from A to E. Each ring has a unique serial number which belongs to Universiti Malaysia Sarawak. The captured birds were identified based on Myers (2009) and Smythies (1999), and released thereafter at the location of capture.

3.3 Statistical analysis

Species diversity is composed of two basic components, richness and evenness (Hurlbert, 1971) or number of species in a given area and how relative abundance or biomass is distributed among species (Magurran, 2004).

Shannon's diversity index (Magurran, 1988) was used to calculate the species diversity of Mount Jagoi by using DIVERS 1.2 program (Kreb, 1989). Diversity indices between studies sites were statistically compared using pairwise diversity comparisons, Zar's t-test (Hutcheson, 1970) computed by using Microsoft Excel.

3.3.1 Diversity Index

Shannon's information theory can be used to estimate species diversity index (Maurer and McGill, 2011). It is used only on random samples from a large community (Pielou, 1966). Shannon's diversity index is probably the most commonly used in determining species diversity (Maurer and McGill, 2011) because it is weighted towards the abundance of rare species (Kreb, 1989). The Shannon's diversity index was computed by DIVERS 1.2 program (Kreb, 1989), which has been improved for ease of data input and output (Laman, 2001). Shannon's Diversity Index (*H'*) is:

$$H' = -\sum p_i \ln p_i$$

Where,

p_i = proportion of individuals found in the *ith* species

3.3.2 Zar's T-test

Zar's t-test (Hutcheson, 1970) was used in this statistical analysis for pairwise comparison of diversity index *H'* between Site A and Site B, Site A and Site C, Site A and Site D, Site B and Site C, Site B and Site D, Site C and Site D. Zar's T-test were conducted at $\alpha = 0.05$ to show any significant differences between the paired sites.

Zar's t-test is:

$$t = \frac{H_1' - H_2'}{s_{H_1' - H_2'}}$$

Where

$$s_{H_1'-H_2'} = \sqrt{s_{H_1'}^2 + s_{H_2'}^2}$$

The variance of H'_1 and H'_2 is approximated by:

$$s_{H'}^2 = \frac{\sum f_i \log^2 f_i - \left(\sum f_i \log(f_i)\right)^2 / n}{n^2}$$

Degree of freedom for the Zar t-test is denoted as v:

$$\nu = \frac{\left(s_{H_1'}^2 + s_{H_2'}^2\right)^2}{\frac{\left(s_{H_1'}^2\right)^2}{n_1} + \frac{\left(s_{H_2'}^2\right)^2}{n_2}}$$

H'_1 = species diversity index in Site A

H'_2 = species diversity index in Site B

f_i = number/individual frequency for the i-th species

$s_{H_1'-H_2'}$ = differences in standard deviation between Site A and Site B

$n_1 - n_2$ = total number of individuals in Site A and Site B

4.0 RESULTS

A total of 296 individuals comprising 52 species from 21 families were netted during 3484 mist-net hour (mnh) shown in Table 1. Eighty-two individuals belonging to 23 species were caught in Site A. In Site B, 82 individuals from 24 species were caught. In Site C and Site D, 67 individuals from 25 species and 65 individuals from 26 species were caught, respectively. The species of birds recorded in this study are showed in Table 2.

Table 2. List of birds caught by mist nets in four sites at Mount Jagoi.

Family/Species	Common Name	Site				Total	RA (%)
		A	B	C	D		
Columbidae							
Chalcophaps indica	Emerald Dove	-	3	-	1	4	1.3
Trogonidae							
***Harpactes diardii*	Diard's Trogon	-	-	-	1	1	0.4
Alcedinidae							
Ceyx rufidorsa	Rufous-backed Kingfisher	-	1	1	-	2	0.7
Meropidae							
Nyctyornis amictus	Red-bearded Bee-eater	-	-	-	1	1	0.4
Ramphastidae							
**Megalaima monticola*	Mountain Barbet	1	-	-	-	1	0.4
Picidae							
Sasia abnormis	Rufous Piculet	-	2	4	-	6	2.0
Micropternus brachyurus	Rufous woodpecker	-	-	-	1	1	0.4
Eurylaimidae							
***Calyptomena viridis*	Green Broadbill	10	3	-	4	17	5.8
Vireonidae							
Erpornis zantholeuca	White-bellied Erpornis	3	1	-	1	5	1.7
Genera Incertae Sedis							
Philentoma pyrhoptera	Rufous-winged Philentoma	3	-	-	-	3	1.0

Family/Species	Common Name	Site				Total	RA (%)
		A	B	C	D		
Monarchidae							
Hypothymis azurea	Black-naped Monarch	-	1	-	-	1	0.4
Terpsiphone paradisi	Asian Paradise-flycatcher	-	-	3	-	3	1.0
Corvidae							
***Platylophus galericulatus*	Crested Jay	-	-	1	-	1	0.4
Nectarinidae							
Anthreptes simplex	Plain Sunbird	1	4	-	-	5	1.7
A. malacensis	Brown-throated Sunbird	1	1	-	-	2	0.7
Aethopyga siparaja	Crimson Sunbird	-	1	-	-	1	0.4
Hypogramma hypogrammicum	Purple-naped Sunbird	1	3	2	2	8	2.7
Arachnothera modesta	Grey-breasted Spiderhunter	2	2	-	-	4	1.4
A. longirostra	Little Spinderhunter	22	33	17	9	81	27.4
A. crassirostris	Thick-billed Spiderhunter	-	-	1	-	1	0.4
Dicaeidae							
Prionochilus maculatus	Yellow-breasted Flowerpecker	9	7	6	2	24	8.1
P. percussus	Crimson-breasted Flowerpecker	-	-	1	-	1	0.4
**P. xanthopygius*	Yellow-rumped Flowerpecker	3	2	-	2	7	2.4
Dicaeum trigonostigma	Orange-bellied Flowerpecker	-	1	-	-	1	0.4
Irenidae							
Irena puella	Asian Fairy-bluebird	-	-	-	1	1	0.4
Estrildidae							
**Lonchura fuscans*	Dusky Munia	-	-	-	1	1	0.4
Muscicapidae							
***Enicurus ruficapillus*	Chestnut-naped Forktail	-	-	-	1	1	0.4
***Cyornis turcosus*	Malaysian Blue Flycatcher	-	-	1	-	1	0.4
***Ficedula dumetoria*	Rufous-chested Flycatcher	1	-	2	-	3	1.0
***Rhinomyias umbratilis*	Grey-chested Jungle-flycatcher	3	-	1	1	5	1.7
Stenostiridae							
Culicicapa ceylonensis	Grey-headed Canary-flycatcher	-	-	-	2	2	0.7
Pycnonotidae							
Pycnonotus atriceps	Black-headed Bulbul	-	1	-	-	1	0.4
***P. eutilotus*	Puff-backed Bulbul	-	2	2	2	6	2.0
P. plumosus	Olive-winged Bulbul	2	-	-	-	2	0.7
P. simplex	Cream-vented Bulbul	2	1	-	6	9	3.0

Family/Species	Common Name	Site				Total	RA (%)
		A	B	C	D		
P. brunneus	Red-eyed Bulbul	5	1	1	8	15	5.1
P. erythropthalmos	Spectacled Bulbul	2	6	1	2	11	3.7
***Iole olivacea*	Buff-vented Bulbul	-	-	-	2	2	0.7
Tricholestes criniger	Hairy-backed Bulbul	2	2	3	5	12	4.1
Alophaxus phaeocephalus	Yellow-bellied Bulbul	-	-	3	-	3	1.0
Alophoixus ochraceus	Ochraceous Bulbul	-	2	-	-	2	0.7
Cettiidae							
Abroscopus superciliaris	Yellow-bellied Warbler	-	-	-	3	3	1.0
Timaliidae							
**Staphida everetti*	Chestnut-crested Yuhina	1	-	-	-	1	0.4
Stachyris poliocephala	Grey-headed Babbler	-	1	4	1	6	2.0
S. erythroptera	Chestnut-winged Babbler	1	-	2	3	6	2.0
Pellorneum capistratum	Black-capped Babbler	-	1	1	-	2	0.7
Malacopteron magnirostre	Moustached Babbler	3	-	-	2	5	1.7
M. cinereum	Scaly-crowned Babbler	2	-	5	-	7	2.4
***M. magnum*	Rufous-crowned Babbler	2	-	1	-	3	1.0
***Ophrydornis albogularis*	Grey-breasted Babbler	-	-	2	-	2	0.7
***Malacocincla malaccensis*	Short-tailed Babbler	-	-	1	-	1	0.4
Cisticolidae							
Orthotomus sericeus	Rufous-tailed Tailorbird	-	-	1	1	2	0.7
Total							**100.0**
Number of Individual		82	82	67	65	**296**	
Number of Species		23	24	25	26	**52**	
Number of Family		9	10	9	16	**21**	

Keys:
RA Relative abundance
* Endemic to Borneo
** Near Threatened status (IUCN Category)

The family Pycnonotidae was recorded as the most dominant family with ten species, followed by family Timaliidae with nine species, and family Nectarinidae with seven species. The results showed that family Nectarinidae had the highest number of individual with 102 out of 296 individuals or 34.7% of total individuals recorded. Little Spiderhunter was the most abundant species netted, with a total of 81 individuals (27.4%). This is

followed by Yellow-breasted Flowerpecker (*Prionochilus maculatus*) with a total of 24 individuals (8.1%) were the second most abundance species recorded, followed by Green Broadbill (*Calyptomena viridis*) with 17 birds (5.8%).

The study has recorded four species listed under First Schedule, Part II (Protected Animals) in Sarawak Wild Life Protection Ordinance 1998. They are Rufous-backed Kingfisher (*Ceyx rufidorsa*; family Alcedinidae), Rufous Piculet (*Sasia abnormis*; family Picidae), Rufous Woodpecker (*Micropternus brachyurus*; family Picidae), and Asian Paradise-flycather (*Terpsiphone paradise*). This study has recorded four endemic species of Borneo, namely Mountain Barbet (*Megalaima monticola*), Yellow-rumped Flowerpecker (*Prionochilus xanthopygius*), Dusky Munia (*Lonhura fuscans*) and Chestnut-crested Yuhina (*Staphida everetti*).

There is no threatened species recorded in this study but there are 12 species, including Diard's Trogon (*Harpactes diardii*), Green Broadbill (*Calyptomena viridis*), Crested Jay (*Platylophus galericulatus*), Chestnut-naped Forktail (*Enicurus ruficapillus*), Malaysian Blue Flycatcher (*Cyornis turcosus*), Rufous-chested Flycatcher (*Ficedula dumetoria*), Grey-chested Jungle-flycatcher (*Rhinomyias umbratilis*), Puff-backed Bulbul (*Pycnonotus eutilotus*), Buff-vented Bulbul (*Iole olivacea*), Rufous-crowned Babbler (*Malacopteron magnum*), Grey-breasted Babbler (*Ophrydornis albogularis*) and Short-tailed Babbler (*Malacocincla malaccensis*) that were listed as near threatened category under The International Union of Conservation of Nature and Natural Resources (IUCN) 2011, List of Threatened Animal (Red Data Book) (IUCN, 2011).

4.1 Cumulative graph

The species cumulative curves suggest the study was virtually complete for Site A, Site C and Site D (Figure 2). However, species cumulative curves for Site B did not reach asymptote. The highest number of species captured was on the second day at Site D with 16 species per day. Site D has recorded the highest number of species captured throughout the study.

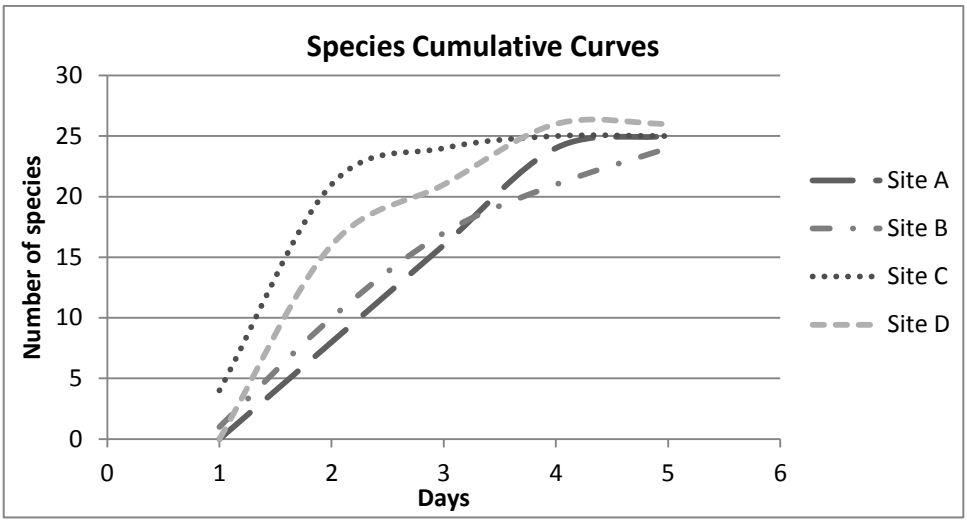

Figure 2. Graph showing cumulative number of species for this study.

4.2 Shared species between the four sites

A total of 52 species were recorded in four sites (Table 2). Twenty three species were recorded at Site A, 24 species were recorded at Site B, 25 species were recorded at Site C and 26 species were recorded at Site D (Table 2). There are three species shared between Site A and Site B, Site A and Site C, and Site B and Site C (Table 3). While only one species shared between Site A and Site D, Site B and Site D, and Site C and Site D.