Ant diversity of Maliau Basin Conservation Area, Sabah, Malaysia

Sukarman Sukimin, Maryati Mohamed and Hassan Aris

Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah, Locked Bag 2073, 88999 Kota Kinabalu, Sabah, Malaysia.

ABSTRACT. The purpose of this study is to determine the diversity of ants in the Maliau Basin Conservation Area. Collection was made using five different sampling protocols: Winkler Bag along 100m length transect, Pitfall Trap made in a belt transect 100m length, Pitfall Trap in 5x5m plot, Manual in 100m transect length, and Manual Random. A total of 210 morphospecies from 10 subfamilies were identified to at least genus level. The species composition showed a comparatively high species diversity in the subfamily Myrmicinae, followed by Formicinae and Ponerinae. Manual collection in 100 m length recorded the highest number of species (96). Whereas, Pitfall Trap in 100m length recorded the lowest number of species (43). The Winkler Bag was the most effective in collecting individuals (2,992) followed by Pitfall Trap in 5x5m plot and Pitfall Trap in100 m length (2,341). Generally, the Pitfall Trap recorded the highest number of individuals as in most of the previous studies. This area has lower ant abundance but is higher in species richness.

Keywords: Ants, diversity, Ginseng Camp, Maliau Basin.

INTRODUCTION

Ants are a major component of arthropod fauna in tropical rainforests in terms of species richness and biomass, and play important roles as predators, prey, detritivores and mutualisms with plants in the forest ecosystem (Holldobler & Wilson, 1990). This insect is not only diverse in species composition and high in abundance, but is also important for the functioning of the ecosystem. Some ants are known as seed dispersers, decomposers, nutrient recyclers and are also a source of food for other animals (e.g. birds and mammals). Some even exhibit mutualistic relationship with plants and other animals (Holldobler & Wilson 1990; Alonso, 2000; Hashimoto & Homathevi, 2003).

The ant fauna of Borneo is very diverse and unique. The island has nine subfamilies, 94 genera and more than 1000 described species (Hashimoto & Homathevi, 2003). Worldwide, there are 16 subfamilies, ca. 300 genera and ca. 15,000 described species of ants (Bolton, 1995). Thus, Borneo represents ca. 30% of ants genera and ca. 7% of ants species, although Borneo covers less than 0.2% of the earth's land surface. There are six genera of ants endemic to Borneo, namely *Bregmatomyrma, Epelysidris, Ishakidris, Loweriella, Secostruma, Tetheamyrma,* (Hashimoto & Homathevi, 2003).

Several studies done in Malaysia, especially in Sabah, showed that ants could be used as an indicator of changes in the environment. Maryati (1994) compared ant species composition and suggested that an area not ideal for ants, such as degraded forests or highlands, showed a high representation of species in the subfamily Ponerinae, followed by Formicinae.

The objective of the research is to reveal the ant diversity in Maliau Basin Conservation Area (MBCA), particularly around Ginseng Camp. As the ant diversity of MBCA has never been studied previously, this study would give the first checklist of ants and its diversity in the area.

MATERIAL AND METHODS

Study site

Three study sites were selected as sampling sites: (1) Around Ginseng Camp (582 – 700 m a.s.l.), (2) Along the trail of Ginseng Camp to Maliau Waterfall (GCMW; 256 – 780 m a.s.l.) and (3) Along the trail of Ginseng Camp to Agathis Camp (GCAC; 460 – 700 m a.s.l.).

Ant Collection

Ants were collected using five different sampling protocols as follows:

Winkler Bag in 100 m length

All leaf litter in the 5cm topsoil layer, which can be easily scraped from the more compact soil (in one subplot 1m x 1m) was sieved (1cm x 1cm size). Branches and twigs were broken during the sieving process to collect ants nesting in them. The fine leaf litter from sifting was then placed in a debris bag and taken to the base camp and then placed into a mesh bag (4mm x 4mm size). For extraction, they were left in the Winkler's Bag in a secure location, sheltered from wind and rain. As the debris dried up slowly, ants crept out of the mesh and fell into the alcohol. Samples were then removed from Winkler Bags after 72 hours. This time frame is recommended for collecting ants because by then, most of the species would have fallen into the 75% ethanol at the bottom of the bag (Bestelmayer *et al.,* 2000; Ward, 2000).

Pitfall Trap in100 m length

Pitfall trapping along a transect was conducted along a 100m x 2m belt transect. Each transect was divided into 20 sections, each 5m long. The pitfall traps (using plastic cups) with a diameter of 8cm and 15cm depth were installed in the ground, at the same level with the forest floor. The pitfall traps were filled with diluted soapy water, ¼ way up into each cup. The soapy water was made by mixing one teaspoon of dish washing liquid soap with 125ml of water. The soapy water was added to reduce surface tension so that ants that fall into the water will sink to the bottom of the cup. Traps were made in the middle of each 5m that have been measured. Traps were left for 24 hours. Ants were collected the next day using a tea sieve and left inside a coded vial with 75% ethanol. This process was repeated for three days. Four different baits (corned beef, tuna in soil, sweet/candy and control) were used. This method was used for collecting nocturnal and diurnal ants.

Pitfall Trap in 5x5m plot

A smaller quadrate (5m x 5m) was marked. The small quadrate was divided into 25 squares each (1m x 1m). A hole was dug at the center of each square. These traps were left overnight and were collected the next day.

Hand collection in 100 m length

A transect of 100m x 2m was set up and divided into sections of 5m each. Two persons then collected all ants seen within 30 minutes using fine tip forceps; one person collected along the left side and another on the right side. It took 10 hours for two persons to set the transect and collect samples. Collection was conducted from 9 am to 4 pm for two days. All ants collected were preserved in vials containing 75% ethanol.

Manual Random

Ants were randomly collected using fine tip forceps. Specimens were placed into coded vial with 75% ethanol. This sampling protocol was used at all the sites. The other protocols were done only around Ginseng Camp.

RESULTS

Ant Composition

A total of 9,317 individuals of ants were sampled in this study. This comprised of 210 species from 52 genera belonging to ten subfamilies (Table 1, Appendix 1; Plate 1), namely Aenictinae, Amblyoponinae, Cerapachyinae, Dolichoderinae, Dorylinae, Ectatomminae, Formicinae, Myrmicinae, Ponerinae and Pseudomyrmicinae. The

Table 1. Number and % of genera and species of each subfamily obtained for all sampling protocols.

Subfamily	Genera (%)	Species (%)
Aenictinae	1 (1.9)	2 (0.9)
Amblyoponinae	2 (3.8)	2 (0.9)
Cerapachyinae	1 (1.9)	4 (1.9)
Dolichoderinae	4 (7.7)	11 (5.2)
Dorylinae	1 (1.9)	1 (0.5)
Ectatomminae	1 (1.9)	5 (2.4)
Formicinae	10 (19.2)	66 (32.2)
Myrmicinae	22 (42.3)	80 (38.1)
Ponerinae	9 (17.31)	35 (16.7)
Pseudomyrmicinae	1 (1.9)	4 (1.9)
Total	52	210

subfamilies with the highest representation were Myrmicinae with 80 species, followed by Formicinae (66 species) and Ponerinae (35 species). These subfamilies dominated samples collected, accounting for more than 84% of the total number of genera and 89% of the total species. The Dorylinae included only one species, and the subfamily Leptanillinae was not recorded in this study. The taxonomic arrangement and species name followed Bolton's catalogue (1995) and Bolton (2003).

After ranking (Table 2), four genera included more than five percent of all species (*Polyrhachis*: 27 species, *Pheidole*: 16 species, *Crematogaster*: 15 species and *Camponotus*: 13 species). Twenty-two of 52 genera comprised only one species.

The diversity of ant communities based on sampling protocols used

The TM (Manual in 100m transect) recorded the highest species number (96 species) followed by MR (Manual Random) which recorded 95 species. The lowest number came from the PT100m (Pitfall Trap in 100m transect) protocols with only 43 species (Figure 1).

Myrmicinae, Formicinae and Ponerinae were dominant in term of species number in this study. Species composition of Myrmicinae was sampled most successfully by PT5x5m compared with other protocols. The species of family Formicinae were sampled most successfully by MR (Figure 2). Species of Ponerinae were sampled the most by the TM method (x^2=42.405, df=7, p=0.000; Chi-Square test.

Shannon-Wiener (H') and Evenness (E) index

The number of species recorded for each sampling protocols showed that TM recorded the highest number of species (96 species) with the value H'=3.93 (Table 3). The lowest number of species recorded was by the PT100m (43 species). Interestingly the Shannon-Weiner index shows that PT100m had more diverse ant species than PT5x5m. This was due to evenness: the community of ants from PT100m was more even (E=0.62) than PT5x5m. Even though the PT5x5m protocol recorded higher number of species (49) compared to PT100m (42), the community of ants in PT5x5m protocol was not even; this resulted in an H' value lower than PT100m. PT100m method was diverse because of the evenness of ants, while the PT5x5m was diverse because of the species richness.

Figure 3 shows that the longest tail is exhibited by TM, which indicates that the TM sampling protocol is more diverse than other protocols in term of species richness. From

Table 2. The ant genera ranked after number of species. The proportion of species number of the genus to total species number (205 species) is given in %.

Genus	sp.	%	Genus	sp.	%	Genus	sp.	%
Polyrhachis	27	13.2	*Pseudolasius*	4	1.9	*Prionopelta*	1	0.5
Pheidole	16	7.8	*Vollenhovia*	4	1.9	*Odontoponera*	1	0.5
Crematogaster	15	7.3	*Myrmoteras*	3	1.5	*Oecophylla*	1	0.5
Camponotus	13	6.3	*Myrmecina*	3	1.5	*Lepisiota*	1	0.5
Pachycondyla	10	4.9	*Pyramica*	3	1.5	*Euprenolepis*	1	0.5
Paratrechina	10	4.9	*Monomorium*	3	1.5	*Acropyga*	1	0.5
Strumigenys	8	3.9	*Aenictus*	2	0.9	*Eurhopalothrix*	1	0.5
Leptogenys	6	2.9	*Anochetus*	2	0.9	*Pheidologeton*	1	0.5
Oligomyrmex	6	2.9	*Diacamma*	2	0.9	*Epelysidris*	1	0.5
Technomyrmex	5	2.4	*Cataulacus*	2	0.9	*Proatta*	1	0.5
Hypoponera	5	2.4	*Mayriella*	2	0.9	*Pristomyrmex*	1	0.5
Echinopla	5	2.4	*Cardiocondyla*	2	0.9	*Dacetinops*	1	0.5
Tetramorium	5	2.4	*Dorylus*	1	0.5	*Recurvidris*	1	0.5
Tetraponera	4	1.9	*Loweriella*	1	0.5	*Aphaenogaster*	1	0.5
Cerapachys	4	1.9	*Philidris*	1	0.5	*Acanthomyrmex*	1	0.5
Dolichoderus	4	1.9	*Myopone*	1	0.5	*Lophomyrmex*	1	0.5
Ponera	4	1.9	*Odontomachus*	1	0.5			
Gnamptogenys	4	1.9	*Amblyopone*	1	0.5			

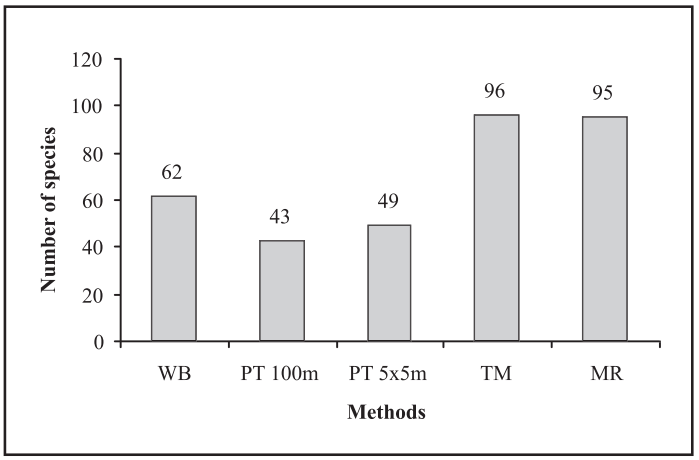

Figure 1. Ants species composition of five different sampling protocols (WB- Winkler Bag; PT100m - Pitfall Trap in 100m transect; PT5x5m - Pitfall Trap in 5x5 plot; TM - Transect Manual; MR - Manual Random).

this graph, the pattern between TM and MR is almost similar showing that the ant diversity in the MR and TM was almost uniform, including the distribution of ant species. The shorter tail was again from PT100m and this shows a low species richness compared to the other four protocols.

Species similarity and cluster analysis

Data analysis using the cluster analysis shows the similarity of ants collected by different sampling protocols when all the data was collected. Similarity of ants collected was grouped by sampling protocols that were used

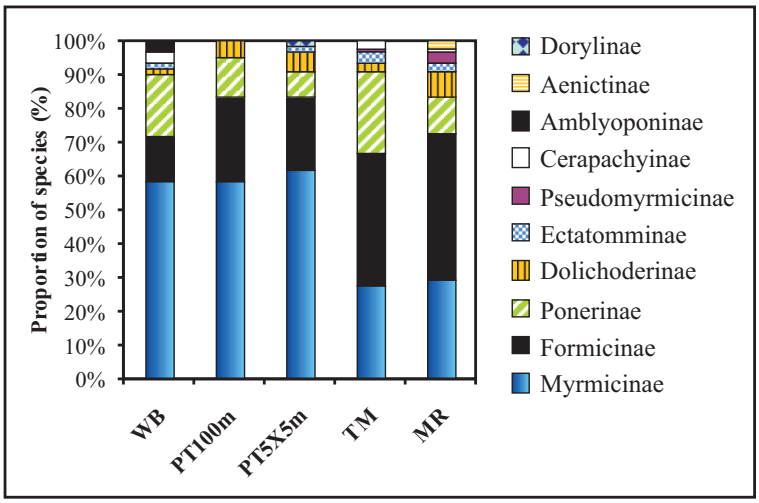

Figure 2. Proportion of ant species belonging to different subfamilies in the five sampling protocols (WB-Winkler Bag; PT-Pitfall Trap; TM-Transect Manual; MR-Manual Random).

Table 3. Measure of ant diversity in different sampling protocols

Methods	No. of species	H'	E	Variance H
WB	62	2.774	0.6724	0.0007217
PT100m	43	2.342	0.6225	0.0008142
PT(5X5)	49	2.233	0.5737	0.0011412
TM	96	3.931	0.8612	0.0010221
MR	95	3.835	0.8421	0.0014451

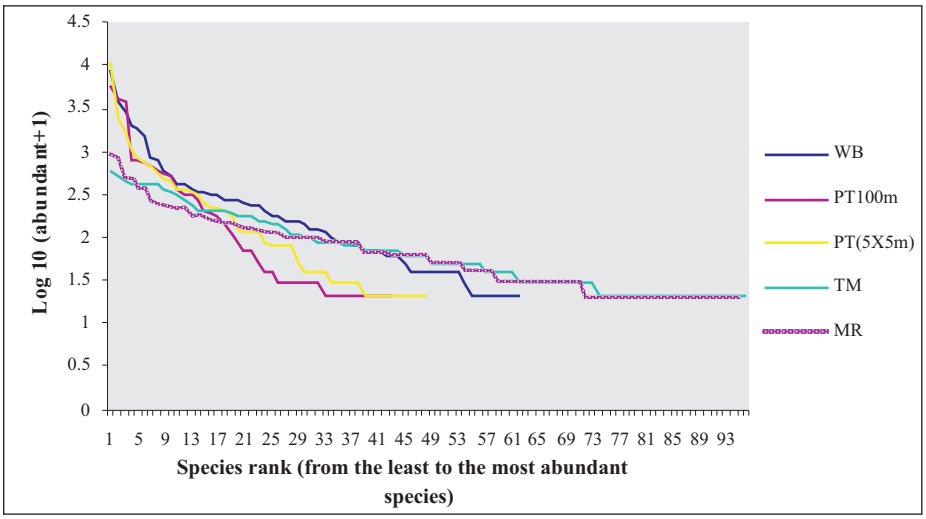

Figure 3. Species abundance curve for four sampling protocols.

to sample them. WB (Winkler Bag) formed one group as well as the PT100m (Pitfall Trap in 100m transect) with PT5x5m (Pitfall Tran in 5x5m plot) and TM (Transect Manual) with MR (Manual Random; Figure 4). This situation indicated that ants collected were affected by the sampling protocols used.

Table 4 shows the overlapping of species yielded by five sampling protocols from the Sorenson (C_s) index. The highest value of overlapping was between PT100M and PT(5X5M) followed by WB and PT100m. Overlapping indicates that the similarity of ant species captured by these protocols was high. A similar pattern of overlapping was shown in the cluster analysis that PT100M and PT(5X5M) formed one group (Figure 4).

DISCUSSION

This study showed that Maliau Basin has high ant species richness. In nine days, 210 species were recorded using five different sampling protocols. The subfamily of Myrmicinae was higher in terms of number of species followed by Formicinae, Ponerinae and Dolichoderinae. Comparing the number of species with previous studies, the number of ant species collected in this study was relatively higher than those collected by Hashimoto & Maryati (2004), at the Crocker Range Park. Their collection comprised of 116 species and 37 genera from three sites; Mahua, Ulu Senagang and Ulu Kimanis, in the Crocker Range Park region in October and August 2002 using five sampling protocols (hand collecting, litter shifting, honey baiting, cracking logs and Malaise trap). Hashimoto *et al.* (1999) found 125 species and 46 genera in Tabin Wildlife Reserve in eight days, even though they only used manual collection. The different number of species recorded by these researches could be due to difference in habitats. Stratification and radiation of some groups into vegetation and canopy are responsible for the high diversity of ants in the tropical rain forest (Brühl *et al.,* 1998). In this study, all study sites are primary forests (lowland Dipterocarp) but other researches have included secondary forests in their studies. This study showed that ant from the subfamily of Myrmicinae was higher in terms of number of species than other subfamilies, similar to previous studies. The descending sequence in terms of number of species of subfamily is Myrmicinae > Formicinae > Ponerinae > Dolichoderinae > Ectatomminae > Pseudomyrmicinae > Cerapachyinae > Amblyoponinae > Aenictinae > Dorylinae.

The difference in sampling protocols and time spent on collection can also influence species number. Species composition of Myrmicinae was sampled most successfully using Pitfall Trap in 5x5m plot (PT5x5m).

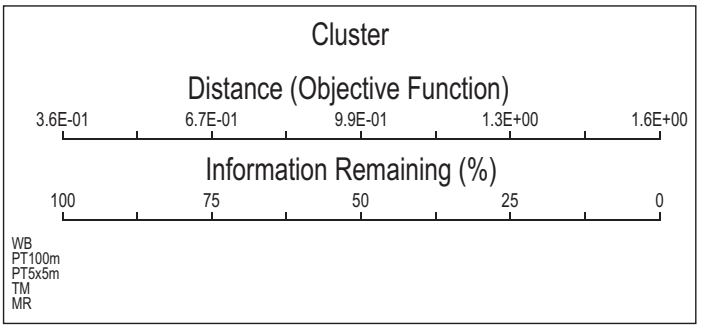

Figure 4. Cluster analysis using presence and absence of data (WB=Winkler Bag; PT=Pitfall Trap; TM=Transect Manual; MR=Manual Random).

Table 4. Species overlap /similarity between the five sampling protocols

	WB	PT100m	PT(5X5m)	TM	MR
WB		0.209	0.207	0.152	0.127
PT100m			0.283	0.165	0.087
PT(5X5m)				0.2	0.09
TM					0.194
MR					

The Myrmicinae was observed to be the most abundant subfamily with highest species because of their rapid recruitment to food sources such as baits and ability to defend food (Andersen, 1995). Manual Collection is especially useful for short-term faunal inventory (Bestelmeyer *et al.,* 2000). Abundance, however, is difficult or impossible to record with this technique. Even though this method was easy to run but considerable expertise is also required for it to be efficient, for example good eye sight (Maryati 1994; Bestelmeyer *et al.,* 2000).

ACKNOWLEDGEMENTS

We would like to express our gratitude to Effazila Waty Abin and Roslinda Sanan for their assistance in collection work. This research was partially funded by UMS.

REFERENCES

Andersen, A.N. 1995. A classification of Australian ant community, base on functional groups which parallel plant life-forms in relation to stress and disturbance. *Journal of Biogegraphy* 20: 15-29.

Holldobler, B. & E.O. Wilson. 1990. *The ants*. Cambridge, Massachusetts: The Belknap Press of Harvard University Press.

Hashimoto, Y., & Maryati Mohamed. 2004. A preliminary survey of ant fauna at Crocker Range Park. In: Maryati Mohamed, Zulhazman Hamzah, T. Tachi & J. Nais (eds.). *Crocker Range scientific expedition 2002*. Kota Kinabalu: Universiti Malaysia Sabah, pp. 51-71.

Hashimoto, Y. & R. Homathevi. 2003. *Inventory and collection: Total protocol for understanding of biodiversity*. Kota Kinabalu: BBEC, pp. 83 – 162.

Hashimoto, Y., Maryati Mohamed & H. Sakata. 1999. The ants (Hymenoptera: Formicidae) of the Tabin Wildlife Reserve, Sabah. In: Maryati Mohamed, M. Andau, Mohd. Noh Dalimin & T.P.Malim (eds.) *Tabin scientific expedition*. Kota Kinabalu: Universiti Malaysia Sabah, pp. 69-74.

Alonso, L.E. 2000. Ants as indicator of diversity. In: Agosti, D., J.D. Majer, L.E. Alonso & T.R. Schultz (eds.). *Ants: Standard methods for measuring and monitoring biodiversity*. Washington and London. Smithsonian Institution Press, pp. 80 - 88.

Bestelmeyer, B.T., D. Agosti, L.E. Alonso, C.F.C. Brandao, W.L. Jr. Brown, J.H.C. Delabie & R. Silvere. 2000. Field techniques for the study of ground-dwelling ants. In: Agosti, D., Majer, J. D., Alonso, L. E. & Schultz, T. R. (eds.). *Standard methods for measuring and monitoring biodiversity:* Ants. Washington and London: Smithsonian institution press, pp. 122-144.

Bolton, B. 1995. *A new genera catalogue of the ants of the world*. Cambridge, Massachusetts: Harvard Universiti Press.

Bolton, B. 2003. *Synopsis and classification of formicidae*. Gainesville. American Entomological Institute.

Brühl, C.A., G. Gunsalam, G. & K.E Linsenmair. 1998. Stratification of ants (Hymenoptera, Formicidae) in a Primary forest in Sabah, Borneo. *Journal of Tropical Ecology* 14: 285-297.

Ward, P. S. 2000. Broad-scale patterns of biodiversity in leaf litter ant communities. In: Agosti, D., J.D. Majer, L.E. Alonso & T.Z. Schultz. (eds.). *Standard methods for measuring and monitoring biodiversity:* Ants. Washington and London: Smithsonian Institution Press, pp. 99-121.

Maryati Mohamed. 1994. Penggunaan kaedah yang sesuai bagi pengumpulan semut (Formicidae: Hymenoptera). Prosiding Simposium Sumber Alam Kebangsaan Pertama, Jilid 2. Kota Kinabalu: UKM Kampus Sabah, pp. 181-192.

Appendix 1. List of ant species collected with five sampling protocols (1=Winkler Bag, 2=Pitfall Trap in 100m transect length, 3=Pitfall Trap in 5x5m plot, 4=Manual in 100m transect length, 5=Manual Random).

No	Subfamily/Species	1	2	3	4	5	Total
	Aenictinae						
1.	*Aenictus gracilis* Emery, 1893	0	0	0	0	12	12
2.	*Aenictus* sp.2	0	0	0	0	24	24
	Amblyoponinae						
3.	*Amblyopone* sp.1	6	0	0	0	0	6
4.	*Prionopelta* sp.1	182	2	0	0	0	184
	Cerapachyinae						
5.	*Cerapachys* sp.1	3	0	0	0	0	3
6.	*Cerapachys* sp.3	0	0	0	0	1	1
7.	*Cerapachys* sp.4	1	0	0	1	0	2
8.	*Cerapachys* sp.5	0	0	0	8	0	8
	Dolichoderinae						
9.	*Dolichoderus coniger* Mayr 1870	0	0	0	0	8	8
10.	*Dolichoderus seningosus*	0	0	0	0	92	92
11.	*Dolichoderus* sp.6	0	0	0	0	2	2
12.	*Dolichoderus thoracicus* Fr.Smith 1860	0	0	4	0	2	8
13.	*Loweriella* sp.1	0	1	0	0	2	3
14.	*Philidris* sp.1	0	0	0	0	10	10
15.	*Technomyrmex* sp.1	0	0	0	7	9	16
16.	*Technomyrmex* sp.2	1	59	85	4	0	151
17.	*Technomyrmex* sp.4	0	0	0	2	0	2
18.	*Technomyrmex* sp.6	0	0	2	0	0	3
19.	*Technomyrmex* sp.7	0	0	0	0	1	1
	Dorylinae						
20.	*Dorylus (Alaopone)* sp.1	0	0	7	0	0	7
	Ectatomminae						
21.	*Gnamptogenys binghamii* Forel, 1900	0	0	0	1	0	4
22.	*Gnamptogenys* sp.1	0	0	0	6	3	9
23.	*Gnamptogenys* sp.2	0	0	0	40	24	64
24.	*Gnamptogenys* sp.3	0	0	1	0	0	1
25.	*Gnamptogenys* sp.5	25	0	0	0	0	25
	Formicinae						
26.	*Acropyga* sp.1	79	0	0	0	0	79
27.	*Camponotus (Colobopsis)* sp.1	0	1	0	20	37	58
28.	*Camponotus gigas* Latreille, 1802	0	65	30	19	9	121
29.	*Camponotus* sp.10	0	51	24	4	17	96
30.	*Camponotus* sp.11	0	0	0	0	9	9
31.	*Camponotus* sp.12	0	0	3	4	0	7
32.	*Camponotus* sp.2	0	0	0	0	13	13
33.	*Camponotus* sp.3	0	0	0	1	2	3
34.	*Camponotus* sp.4	0	0	0	1	2	3

35.	*Camponotus* sp.5	0	0	0	19	2	21
36.	*Camponotus* sp.6	0	1	0	0	0	1
37.	*Camponotus* sp.7	0	1	1	2	8	25
38.	*Camponotus* sp.8	0	0	0	1	9	10
39.	*Camponotus* sp.9	0	0	0	4	2	6
40.	*Echinopla melanarctos* F. Smith, 1857	0	0	0	26	0	26
41.	*Echinopla* sp.1	0	0	3	8	44	55
42.	*Echinopla* sp.2	0	0	0	1	9	10
43.	*Echinopla* sp.3	0	0	0	4	0	4
44.	*Echinopla* sp.4	0	0	0	8	0	8
45.	*Euprenolepis* sp.1	0	540	108	1	0	645
46.	*Lepisiota* sp.1	0	0	0	0	9	9
47.	*Myrmoteras diastematum* Moffett, 1985	1	0	0	0	0	1
48.	*Myrmoteras* sp.1	0	0	1	0	1	2
49.	*Myrmoteras* sp.2	1	0	0	0	0	1
50.	*Oecophylla smaragdina* Stitz,1916	0	0	0	0	17	17
51.	*P. (Myrma) noesaensis* Forel, 1915	0	0	0	6	6	12
52.	*P. (Myrmhopla) phalerata* Menozzi, 1926	0	0	0	0	1	1
53.	*P.(Chariomyrma)* sp.1	0	0	0	0	1	1
54.	*P.(Cyrtomyrma) rastellata* Latreille, 1802	0	0	0	0	1	1
55.	*P.(Mymhopla)* sp.2	0	0	0	0	3	3
56.	*P.(Myrma) inermis* F. Smith, 1858	0	0	0	1	2	3
57.	*P.(Myrma) nigropylosa* Mayr, 1872	0	0	0	15	5	20
58.	*P.(Myrma)* sp.3	0	0	0	5	0	5
59.	*P.(Myrma) striata* Mayr, 1862	0	0	0	0	3	3
60.	*P.(Myrma) villipes* F. Smith, 1857	0	0	0	0	14	14
61.	*P.(Myrmhopla) abdominalis* F. Smith, 1858	0	0	0	0	1	1
62.	*P.(Myrmhopla) calypso* Forel, 1911	0	0	0	0	2	2
63.	*P.(Myrmhopla) chalibea* F. Smith, 1857	0	0	0	0	5	5
64.	*P.(Myrmhopla) chepalotes* Emery,1893	0	0	0	0	27	27
65.	*P.(Myrmhopla) hector* F. Smith, 1857	0	0	0	0	3	3
66.	*P.(Myrmhopla) hyppomanes* F. Smith, 1861	0	0	0	2	0	2
67.	*P.(Myrmhopla) rufipes* Fr. Smith, 1858	0	0	0	5	1	6
68.	*P.(Myrmhopla)* sp.4	0	0	0	0	2	2
69.	*P.(Myrmhopla)* sp.5	0	0	0	0	1	1
70.	*P.(Myrmhopla)* sp.6	0	0	0	0	1	1
71.	*P.(Myrmhopla) wheeleri* Mann, 1919	0	0	0	0	5	5
72.	*P.(Myrmhopla)armata* Le Guillou, 1842	0	0	0	1	0	1
73.	*P.(Polyrhachis) behamata* Durury, 1773	0	0	0	0	84	84
74.	*P.(Polyrhachis) furcata* Fr. Smith, 1858	0	0	0	42	0	42
75.	*P.(Polyrhachis) olybria* Forel, 1912	0	0	0	2	15	17
76.	*P.(Polyrhachis) ypsilon* Emery, 1887	0	0	0	0	14	14
77.	*Paratrechina longicornis* Latreille, 1802	0	0	8	1	0	9
78.	*Paratrechina* sp.1	0	0	0	6	7	13
79.	*Paratrechina* sp.2	14	2	46	9	2	73
80.	*Paratrechina* sp.3	0	20	11	58	0	94
81.	*Paratrechina* sp.4	0	0	0	0	5	5
82.	*Paratrechina* sp.5	201	3	12	4	0	240
83.	*Paratrechina* sp.6	0	0	0	0	5	5
84.	*Paratrechina* sp.7	282	17	7	3	0	313
85.	*Paratrechina* sp.8	0	4	0	13	0	17
86.	*Paratrechina* sp.9	0	0	0	1	0	1
87.	*Polyrhachis (Myrma) orsylla* F. Smith 1861	0	0	0	20	12	32

88. *Pseudolasius* sp.1	882	0	0	14	1	897
89. *Pseudolasius* sp.2	83	0	0	22	0	105
90. *Pseudolasius* sp.3	0	0	0	20	0	20
91. *Pseudolasius* sp.4	0	0	0	7	0	7
Myrmicinae						
92. *Acanthomyrmex forex* Emery,1893	7	0	1	4	1	17
93. *Aphaenogaster* sp.1	0	0	0	0	15	15
94. *Cardiocondyla* sp.1	11	0	0	0	0	11
95. *Cardiocondyla* sp.2	0	0	0	0	8	8
96. *Cataulacus insularis* F. Smith, 1857	0	0	0	10	21	31
97. *Cataulacus* sp.1	0	0	0	0	1	1
98. *Crematogaster* sp.1	0	0	0	0	2	2
99. *Crematogaster* sp.10	30	81	3	29	0	145
100. *Crematogaster* sp.11	0	1	0	0	0	1
101. *Crematogaster* sp.12	0	0	1	0	0	1
102. *Crematogaster* sp.13	0	0	0	0	1	1
103. *Crematogaster* sp.14	0	0	0	0	11	11
104. *Crematogaster* sp.15	0	1	0	0	0	1
105. *Crematogaster* sp.2	0	0	0	41	10	51
106. *Crematogaster* sp.3	0	0	0	0	21	21
107. *Crematogaster* sp.4	0	0	0	0	22	22
108. *Crematogaster* sp.5	0	0	2	34	0	36
109. *Crematogaster* sp.6	0	0	0	0	4	4
110. *Crematogaster* sp.7	0	0	0	1	0	1
111. *Crematogaster* sp.8	0	0	2	0	0	2
112. *Crematogaster* sp.9	0	0	16	0	0	16
113. *Dacetinops* sp.1	0	0	0	1	0	1
114. *Epelysidris* sp.1	33	0	0	0	0	33
115. *Eurhopalothrix* sp.1	6	0	0	0	0	6
116. *Lophomyrmex bedoti* Emery, 1893	30	377	52	0	2	461
117. *Mayriella* sp.1	1	0	0	1	0	2
118. *Mayriella* sp.2	51	6	3	0	0	51
119. *Monomorium* sp.1	27	74	68	0	0	169
120. *Monomorium* sp.2	0	0	0	2	4	6
121. *Monomorium talpa* Emery, 1911	0	2	0	0	0	2
122. *Myrmecina* sp.1	6	0	7	0	1	14
123. *Myrmecina* sp.2	0	0	0	2	0	4
124. *Myrmecina* sp.3	5	0	0	0	0	5
125. *Oligomyrmex* sp.1	19	596	36	0	0	716
126. *Oligomyrmex* sp.2	23	0	0	0	0	23
127. *Oligomyrmex* sp.3	144	0	0	0	0	144
128. *Oligomyrmex* sp.4	58	13	0	0	0	74
129. *Oligomyrmex* sp.5	0	78	1	0	0	79
130. *Oligomyrmex* sp.6	3	0	0	0	0	3
131. *Pheidole acantha* Eguchi 1997	0	0	0	0	0	1
132. *Pheidole aristotelis* Forel, 1911	40	26	75	3	0	144
133. *Pheidole quadricuspis* Emery, 1900	0	6	0	0	0	6
134. *Pheidole* sp.1	0	0	0	0	1	1
135. *Pheidole* sp.10	388	54	43	4	0	489
136. *Pheidole* sp.11	9	0	0	1	0	11
137. *Pheidole* sp.12	0	1	0	0	4	5
138. *Pheidole* sp.13	0	0	0	44	16	60

139. *Pheidole* sp.14	0	0	0	17	0	17
140. *Pheidole* sp.2	16	10	155	17	0	273
141. *Pheidole* sp.3	0	0	0	0	0	1
142. *Pheidole* sp.4	26	1	2	18	0	49
143. *Pheidole* sp.5	0	0	0	0	6	6
144. *Pheidole* sp.6	0	2	0	0	4	6
145. *Pheidole* sp.7	5	30	21	13	0	78
146. *Pheidole* sp.8	0	0	0	9	0	9
147. *Pheidole* sp.9	0	1	35	2	0	38
148. *Pheidologeton affinis* Jerdon, 1851	0	18	1110	6	0	1125
149. *Pristomyrmex* sp.1	0	0	1	0	0	1
150. *Proatta butteli* Forel 1921	0	0	2	0	0	2
151. *Pyramica* sp.1	3	3	7	50	0	63
152. *Pyramica* sp.2	14	0	0	0	0	14
153. *Pyramica* sp.5	0	0	1	0	0	1
154. *Recurvidris* sp.1	8	8	11	0	0	27
155. *Strumigenys juliae* Forel, 1905	40	1	0	0	0	41
156. *Strumigenys signea* Forel, 1905	12	0	0	1	0	13
157. *Strumigenys* sp.1	3	0	0	0	0	3
158. *Strumigenys* sp.2	14	0	1	0	0	15
159. *Strumigenys* sp.3	3	0	0	0	0	3
160. *Strumigenys* sp.4	1	0	0	0	0	1
161. *Strumigenys* sp.6	5	0	0	0	0	5
162. *Strumigenys* sp.7	8	0	0	0	0	8
163. *Tetramorium eleates* Forel, 1913	3	0	0	0	0	3
164. *Tetramorium mixtum* Forel, 1902	35	0	1	7	0	44
165. *Tetramorium neshena* Bolton, 1976	3	2	1	1	6	14
166. *Tetramorium noratum* Bolton, 1977	0	0	21	0	0	21
167. *Tetramorium pacificus* Mayr, 1870	0	0	0	2	8	10
168. *Vollenhovia* sp.1	0	1	0	0	0	1
169. *Vollenhovia* sp.2	0	0	0	1	0	1
170. *Vollenhovia* sp.3	0	0	0	0	1	1
171. *Vollenhovia* sp.4	2	0	0	0	0	2
Ponerinae						
172. *Anochetus agilis* Emery 1901	0	0	0	3	0	3
173. *Anochetus rugosus* Fr.Smith 1857	0	2	0	0	1	3
174. *Centromyrmex* sp.1	0	0	0	0	0	1
175. *Diacamma intricatum* F. Smith 1857	0	0	0	1	0	1
176. *Diacamma rugosum* Forel, 1900	0	30	20	37	49	147
177. *Hypoponera* sp.1	17	0	0	0	1	18
178. *Hypoponera* sp.2	26	0	0	0	0	26
179. *Hypoponera* sp.3	13	0	0	0	0	13
180. *Hypoponera* sp.4	0	0	0	2	0	2
181. *Hypoponera* sp.5	1	0	0	0	0	1
182. *Leptogenys mutabilis* Fr. Smith 1861	0	0	245	17	0	294
183. *Leptogenys* sp.1	0	0	0	12	5	17
184. *Leptogenys* sp.2	0	0	0	0	8	8
185. *Leptogenys* sp.3	0	0	0	0	0	2
186. *Leptogenys* sp.4	0	0	1	0	0	1
187. *Leptogenys* sp.5	0	0	0	3	0	3
188. *Leptogenys* sp.6	22	0	0	0	0	22
189. *Leptogenys* sp.7	0	0	0	5	0	5

190. *Myopone* sp.1	0	0	0	0	1	1
191. *Odontomachus* sp.1	0	0	0	1	11	12
192. *Odontoponera transversa* F. Smith 1857	4	37	33	42	37	181
193. *Pachycondyla sharpi* Forel, 1901	0	0	0	2	0	2
194. *Pachycondyla* sp.1	3	2	11	6	1	30
195. *Pachycondyla* sp.2	0	0	0	5	0	5
196. *Pachycondyla* sp.3	0	0	0	2	0	2
197. *Pachycondyla* sp.4	0	0	0	40	0	61
198. *Pachycondyla* sp.5	0	0	0	1	0	1
199. *Pachycondyla* sp.6	0	0	0	1	0	1
200. *Pachycondyla* sp.7	0	0	0	1	1	2
201. *Pachycondyla striolata* Donisthorpe, 1933	1	0	0	2	0	3
202. *Pachycondyla tridentata* F.Smith 1858	0	0	0	0	3	3
203. *Ponera* sp.1	0	0	0	8	0	8
204. *Ponera* sp.2	7	0	0	3	0	10
205. *Ponera* sp.3	12	0	0	0	0	12
206. *Ponera* sp.4	33	0	0	6	0	39
Pseudomyrmicinae						
207. *Tetraponera attenuata* F. Smith, 1877	0	0	0	10	4	14
208. *Tetraponera* sp.1	0	0	0	0	1	1
209. *Tetraponera* sp.3	0	0	0	0	1	1
210. *Tetraponera* sp.4	0	0	0	0	6	6
Total	62	43	49	96	95	210

Plate 1. 1. *Dorylus (Alaopone)* sp.1 (Dorylinae); 2. *Aenictus gracilis* Emery 1893 (Aenictinae); 3. *Amblyopone* sp.1 (Amblyoponinae); 4. *Cerapachys hewitti* Arnold 1926 (Cerapachyinae); 5. *Tetraponera attenuate* F. Smith 1877 (Pseudomyrmicinae); 6. *Gnamptogenys binghamii* Forel 1900 (Ectatomminae); 7. *Dolichoderus coniger* Mayr 1870 (Dolichoderinae); 8. *Pachycondyla tridentate* F. Smith 1858 (Ponerinae); 9. *Polyrhachis (Myrmhopla) rufipes* Fr. Smith 1858 (Formicinae); 10. *Proatta butelli*