Arthropod communities in selected dipterocarp trees in rainforestation sites in Baybay, Leyte, Philippines

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Abstract

The taxonomic composition, association and trophic functions, abundance and diversity of arthropods associated with "Apitong", *Dipterocarpus warburgii* Brandis and "Dalindingan", *Hopea plagata* and "Lauan" *Shorea negrosensis* in the rainforestation sites in Baybay, Leyte, Philippines were studied. The orders Diptera, Hymenoptera, Coleoptera and Araneida were consistently abundant in the canopy samples in the three dipterocarp trees. Acari, Collembola, Hymenoptera and Coleoptera were the abundant arthropods in the litter samples. The number of species of arthropods in the sweep net samples did not vary so much between trees in both sites, but higher mean species richness was observed in the close canopy, ViSCA rainforestation site. The species under the orders Coleoptera, Hymenoptera and Homoptera contributed mainly to the total species composition in all of the trees. There was moderate species diversity of the canopy arthropods of the three trees in both sites, but there was no definite trend of the monthly diversity of the species. Instead, the indices fluctuated irregularly with months. Mean evenness indices, generally indicated unequal abundance of the arthropods in the canopy of the trees.

Analysis of the trophic functions of the canopy arthropod groups included the major guilds, such as the phytophages which relatively contributed high percentages in terms of the number of individuals. This was true for all species of trees in all sites. The leaf feeding beetles, Chrysomelidae and snout beetles, Curculionidae were the commonly encountered phytophagous groups. The proportion of "tourists" or migrant species, however, was comparatively high, while the predators, parasitoids and ant guilds had moderate proportions. In the litter samples,

decomposers/scavengers greatly predominated, although there were predatory Coleoptera and parasitic Hymenoptera that were recorded. Considerable proportion of ants was recorded in the canopy as well as in the litter arthropod samples of the trees. Qualitative comparison of arthropod species of each dipterocarp tree between two sites yielded low to moderate similarity in selected faunal groups.

Introduction

Trees are structurally complex, providing great niche diversification, encouraging potential colonists and are considered stable resource for exploiters with relatively short generation span (Lawton, 1978, Feeny 1975 and Southwood 1978 as cited by Moran and Southwood 1982). Dipterocarp trees are known to be the dominant component of a dipterocarp forest in the Indo-Malayan rainforest formation. Their canopies, as well as that of other tree species are believed to hold an immense diversity of arthropods (Stork 1987). These arthropods are the major life form inhabiting in the forests and make up the biggest proportion in terms of species. They carry out functions of a herbivore, carnivore or decomposer, and themselves representing a major food source for insectivorous organisms (Longman and Jenik 1987). Their immense species richness in the canopy raises immediate questions as to what all the species are doing there and how they interact (Stork 1991), but until recently invertebrate communities in the canopy of tropical trees are poorly known. A perhaps more informative view of the canopy arthropods can be gained by looking at them of their feeding habits and guilds (Stork 1987).

Symbiotic relationship of arthropods with the tree canopy have been reported by many researchers. Price in 1984, stated that insects are very important pollen transporters. Ants were observed to dominate ecosystems in a way unequaled by another organisms (La Salle and Gauld, 1993). They were reported to dominate in the Bornean tree canopy (Stork, 1988). In addition, to their sheer biomass, a multitude of mutualistic ant-plant association are known which ensure the survival of many plant species and influence both composition and abundance of arthropod taxa.

In the Philippines as well as in other countries, much of these dipterocarp forests are gone, if not, are totally depleted of old mother dipterocarp trees. Cutting of these trees did not only reduce the floral composition of the forest, but also resulted in the displacement of the minute and numerous invertebrate fauna which are associated with these trees. Locally, there has not been much information on arthropod communities of some dipterocarp trees published. Some available information are basically based on the results of studies made in other countries. This information is scanty and may be found scattered in published journals. First hand information on arthropod associations in these trees are deemed beneficial considering the economic importance they have as our natural resources. Studies such as these are still few and lacking in Leyte and in the Philippines, in general. Thus, this study was conceived to know the taxonomic composition of arthropods associated with dipterocarp trees in Mount Pangasugan, study their associations and trophic functions and assess their abundance and diversity.

Methodology

Establishment of sampling sites. Two rainforestation sites were selected as sampling sites for this study. One is located

in the Closed Canopy project of ViSCA-GTZ and the other one is in Barrio Marcos, Baybay, Leyte. Arthropod sampling was done on three dipterocarps, namely "Apitong" *(Dipterocarpus warburgii)*, "Dalindingan" (*Hopea plagata*) and "Lauan" *(Shorea negrosensis)*. Sample trees in the closed canopy area were approximately 5-6 years old with an average height of 3 meters. Those sample trees in Barrio Marcos site were around 3-4 years old, averaging 2 meters tall.

Sampling of arthropods. Arthropod sampling was done twice a month with the use of three methods: aerial net trapping and twig/branch beating for canopy arthropods and leaf litter collection for soil arthropods.

For aerial net trapping, three continuous sweeps were done around the canopy of each tree. The arthropods collected were killed in a jar containing cotton moistened with ethyl acetate before placing them in a mocassin paper envelopes.

For the twig/branch beating, four randomly selected main branches of each sample tree were each beaten twice. The first tap was to loosen the arthropod and the second tap was to dislodge them. Arthropods that fell on the beating sheet after tapping were collected, killed in ethyl acetate and placed separately in vials with 70% alcohol ready to be ready for sorting and identification.

Leaf litter collection on the other hand, was made at the basement of each of the sample tree within approximately half of a meter radius. Collected leaf litters were placed in plastic bags and brought to the laboratory for processing and extraction in Tullgren funnel.

Processing and sorting of specimens. Arthropods obtained from aerial net trapping and beating were brought to the laboratory for processing. Those contained in leaf litters were extracted through Tullgren funnel extraction before preserving in 70% ethyl alcohol for classification.

Specimens were then sorted according to site and tree species. The abundance of each species was recorded for each tree species and the respective sampling method used. From the pooled data, some ecological indices were calculated to describe the arthropod community structure of each tree species.

Classification and identification of specimens. Identification was made up to the lowest category possible, based on references/keys available. Specimens with uncertain identities were sorted according to obvious morphological differences.

Individuals were assigned to "operational species" based on morphological criteria. These "species" were identified to family level, genus and to species level. Those which could not be keyed out to species were sent to experts for identification and or confirmation.

Based on the literature information about the family, each of the "operational species" was assigned to respective trophic guilds. In the absence of a thorough examination of the trophic function of each species, the habit of the families can be used to analyze their trophic functions (Hammond, 1990). A reference collection was established and are kept at the Biological Museum of ViSCA, Baybay, Leyte.

Results and discussions

Arthropod composition, abundance and distribution

The arthropods collected from the canopy of three dipterocarp trees in two sites represented 12 groups (Figs. 1 and 2), although those collected specifically using the beating

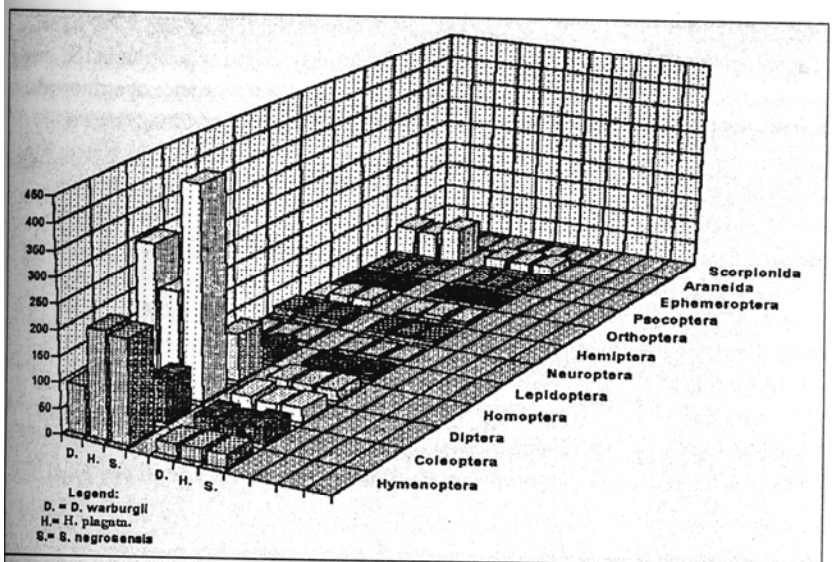

FIGURE 1. Total number of arhtropods (N) and the number of species (S) recorded in the net sweeping samples of the three dipterocarp trees in the rainforestation site of ViSCA, Baybay, Leyte.

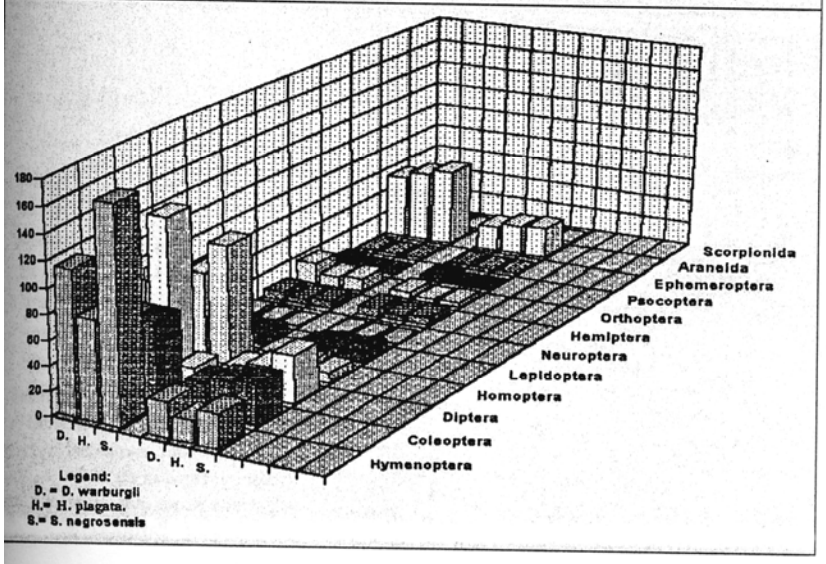

FIGURE 2. Total number of arhtropods (N) and the number of species (S) recorded in the net sweeping samples of the three dipterocarp trees in the rainforestation site of Barrio Marcos, Baybay, Leyte.

method, only 9 arthropod groups were represented (Figs. 3 and 4). The orders Hymenoptera and Coleoptera were found to be consistently abundant in the canopy samples regardless of sampling method. In addition, Diptera were also abundant particularly those caught by sweep net while Aranae (spiders) were abundantly sampled in the beating method. The abundance of Hymenoptera can be accounted to the great numbers of ants (Formicidae) in the samples. Forty two (42) major insect and 4 spider families were represented and the breakdown of the families for each order is presented in Appendix Table 1. Generally, the results indicated that more number of arthropod individuals were sampled in the canopies of "Apitong" , "Dalindingan" and "Lauan" in the rainforestation site in the closed canopy area in ViSCA than in Barrio Marcos site. This could be attributed to the proximity of the former sampling site to forested areas. In addition, associated vegetation in the area may have also contributed to the abundance of arthropods. The vegetational structure in the closed canopy area is generally complex or thicker than in the Barrio Marcos site.

On the other hand, arthropod composition in the litter samples from the three dipterocarp trees in the two sites yielded relatively similar results (Figs. 5 and 6). Mites (Acari) mostly Oribatidae, some Acaridae, were very dominant in all litter samples. At least 3 genera of the family Oribatidae were recognized.

Aside from mites, Collembolans, Coleoptera and Hymenoptera were moderately dominant including other arthropod orders, but frequently in negligible numbers. Three families of Collembolans (Appendix Tables 2 and 3)

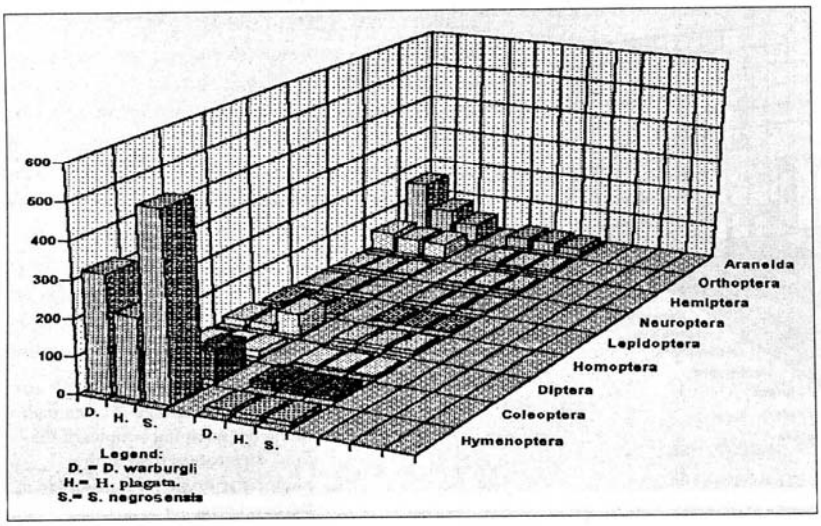

FIGURE 3. Total number of arhtropods (N) and the number of species (S) recorded in the canopy samples collected by beating method in the three dipterocarp trees in the rainforestation site of ViSCA, Baybay, Leyte.

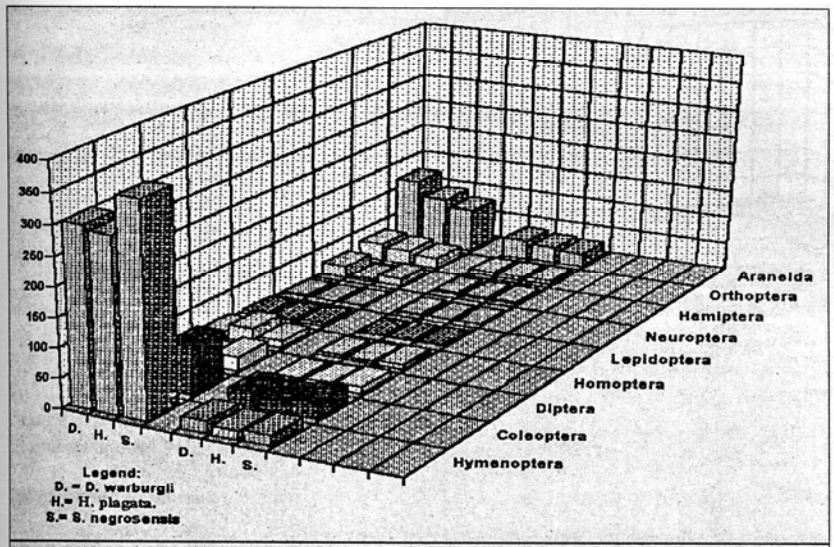

FIGURE 4. Total number of arhtropods (N) and the number of species (S) recorded in the canopy samples collected by beating method in the three dipterocar trees in the rainforestation site of Barrio Marcos, Baybay, Leyte.

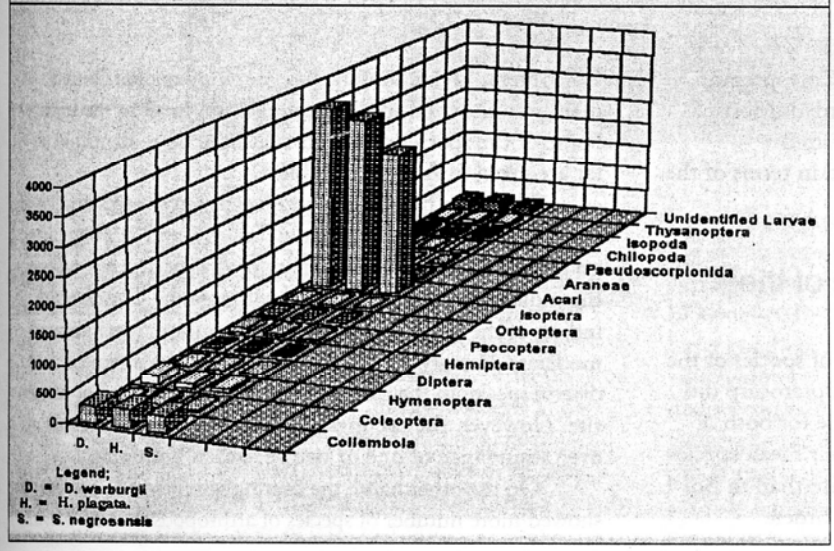

FIGURE 5. Total number of arhtropods by taxa contained in leaf litters of the three dipterocarp trees in the rainforestation site of ViSCA, Baybay, Leyte.

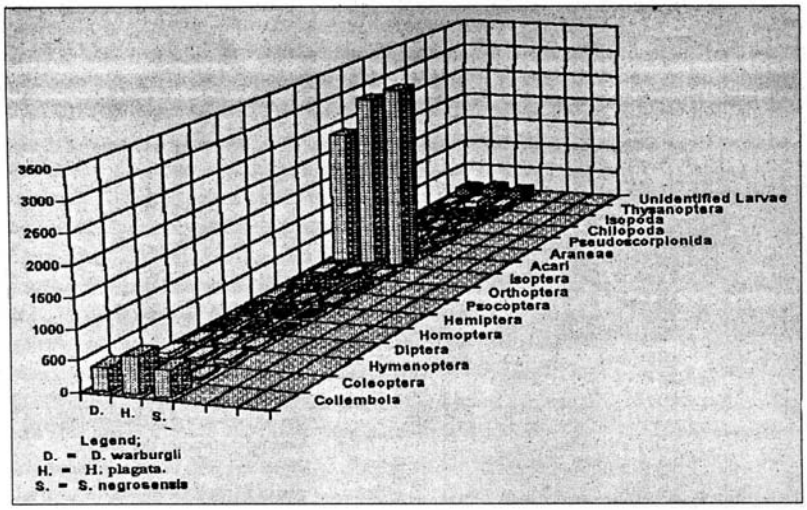

FIGURE 6. Total number of arhtropods by taxa contained in leaf litters of the three dipterocarp trees in the rainforestation site of Barrio Marcos, Baybay, Leyte.

were also recognized and quite a number of Coleopteran families associated with litters were also recorded. Most of the Hymenopterans encountered were small sized parasitoids, although ants greatly contributed in terms of the number of individuals.

Arthropod community structure of the dipterocarp trees

In terms of the species richness, the number of species of the arthropods in the sweep net samples of the dipterocarp did not vary so much between trees. This was true for both of the sampling sites. However, a generally higher mean species richness was observed in the closed canopy site than in Bo. Marcos site. The species of insects under the orders Coleoptera, Hymenoptera and Homoptera contributed mainly to the total species composition in all of the trees. Some of the species of insects that have been identified so far are given in Appendix Table 1.

The monthly arthropod diversity in sweep samples of the three tree species is given in Tables 1 and 2. There was no definite trend of the diversity of the species, but rather the indices fluctuated irregularly with months. The diversity indices of the samples in all of the dipterocarp trees indicated moderate diversity. The mean monthly indices indicated more diverse species in the closed canopy site than in the Bo. Marcos site. However, the evenness indices indicate that there is an over abundance of one or two species in both sites.

On the other hand, the beating samples of *D. warburgii* showed more number of species of arthropods than *H. plagata*

TABLE 1. Monthly species richness (R), diversity (H) and evenness (E) indices of the arthropods collected by sweep net in the three dipterocarp trees in the closed canopy siteiSCA, Baybay, Leyte.

Month	*D. warburgii*			*H. plagata*			*S. negrosensis*		
	R	H	E	R	H	E	R	H	E
1996									
July	1.67	1.31	0.39	1.79	1.87	0.79	2.41	1.97	0.88
August	0.69	0.85	0.45	2.08	2.00	0.64	0.95	0.73	0.18
September	2.01	1.78	0.61	1.67	1.49	0.38	2.50	2.08	0.78
October	1.29	0.95	0.40	1.21	1.22	0.60	1.25	0.91	0.37
November	3.67	2.76	0.71	3.00	2.66	0.74	3.17	2.76	0.74
December	3.83	2.62	0.58	3.28	2.73	0.72	3.15	2.56	0.50
1997									
January	3.21	2.38	0.75	1.96	1.70	0.37	2.95	2.20	0.35
February	3.60	2.78	0.76	2.50	1.91	0.38	3.25	2.69	0.76
March	3.02	2.51	0.75	3.30	2.52	0.88	2.90	2.23	0.46
April	2.54	1.99	0.29	3.05	2.22	0.35	3.13	2.66	0.49
May	2.52	1.58	0.17	3.39	2.66	0.60	1.59	1.17	0.11
June	3.88	2.81	0.87	3.75	2.72	0.61	2.47	1.93	0.42
July	5.60	3.52	0.97	4.43	3.27	0.85	3.79	2.93	0.59
August	4.85	3.25	0.96	4.84	3.36	0.93	3.50	2.49	0.44
September	4.27	3.06	0.93	3.77	2.91	0.87	3.27	2.55	0.79
October	4.75	3.22	0.96	3.83	2.92	0.83	2.67	1.90	0.30
November	3.05	2.40	0.77	3.40	2.64	0.77	3.67	2.75	0.70
December	4.51	3.23	0.86	3.41	2.80	0.77	2.03	1.53	0.33
Mean	**3.28**	**2.39**	**0.68**	**3.04**	**2.42**	**0.67**	**2.70**	**2.11**	**0.51**

and *S. negrosensis* trees in both sites. Moreover, its monthly mean species diversity was also slightly higher than in the two tree species. Species richness difference between fauna of trees may be influenced by the morphological features (Moran and Southwood 1982). The broader leaves of *D. warburgii* may have provided more niches to support more species of arthropods. The monthly computed diversity indices (Tables 3 and 4) showed no definite trend or pattern, but rather fluctuated irregularly at very minimal values. Evenness indices in all trees species in both sites showed however, uneven to uniform distribution of species (E range of 0.07 to 1.00).

The species richness and diversity data obtained from the sweep samples of the three trees in the two sites indicated relatively higher indices than the beat samples. Results of some studies have shown that using sweep net method has a good chance of recording or collecting those species which are very rapid in their movements and those easily disturbed (Rubia et al. 1988 and Linsley et al. 1952). Beating tends to exclude actively flying insects, thus may be under represented in the catches. Sweep samples may provide a realistic picture of the tree foliage diversity, although sweep sampling in forest vegetation or similar

TABLE 2. Monthly species richness (R), diversity (H) and evenness (E) indices of the arthropods collected by sweep net in the three dipterocarp trees in the Barrio Marcos, Baybay, Leyte.

Month	*D. warburgii*			*H. plagata*			*S. negrosensis*		
	R	H	E	R	H	E	R	H	E
1996									
July	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
August	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
September	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
October	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
November	2.87	2.56	0.80	3.16	2.48	0.68	3.28	2.49	0.55
December	3.10	2.43	0.94	3.73	2.77	0.83	2.84	2.30	0.90
1997									
January	2.59	2.12	0.81	2.85	2.16	0.96	2.77	2.25	0.94
February	3.27	2.50	0.74	3.66	2.80	0.77	4.06	3.04	0.86
March	4.67	3.19	0.93	2.57	2.41	0.73	2.75	2.36	0.87
April	3.78	2.07	0.49	2.09	1.60	0.36	3.20	2.58	0.81
May	3.34	2.65	0.88	2.68	2.37	0.88	2.84	2.36	0.80
June	3.57	2.63	0.54	3.44	2.58	0.87	3.53	2.72	0.83
July	3.44	2.85	0.77	2.75	2.66	0.60	3.83	3.03	0.59
August	3.00	2.39	0.90	3.30	2.55	0.91	4.06	3.09	0.91
September	3.47	2.06	0.69	3.29	2.57	0.64	3.00	2.12	0.41
October	3.09	2.88	0.89	3.49	2.69	0.91	3.45	2.58	0.61
November	3.53	2.66	0.95	3.06	2.37	0.80	2.33	2.18	0.66
December	2.18	2.00	0.80	4.28	3.17	0.81	4.00	2.92	0.57
Mean	**2.55**	**1.94**	**0.62**	**2.46**	**1.95**	**0.60**	**2.55**	**2.00**	**0.57**

habitats may be affected by other factors, such as space limitation or penetration (Jansen 1973).

Guild composition

From the results, the phytophagous guild contributed the greatest proportion in the canopy arthropod along with the migrant/tourist species (Fig. 7 and 8). These phytophages included the sap suckers, defoliators, miners, stemborers and root feeders. Of the different phytophagous species, the leaf feeding beetles, Chrysomelidae and Cucurlionidae were the commonly encountered groups. Damage on the foliage of the trees of the adult chrysomelid beetles were also very evident. Immatures of the beetles were however rarely observed. The taxa which have been allocated to guilds are listed in Appendix Table 4.0

The migrant or "tourists" are considered to be not actually feeding on the canopy. This is mainly constituted by the Dipterans which make up the large proportion of this guild. These migrant species of small Dipterans were probably using these trees only as resting sites, especially during unsuitable microclimatic conditions, as flight paths

TABLE 3. Monthly species richness (R), diversity (H) and evenness (E) indices of the arthropods collected by beating in the three dipterocarp trees in the closed canopy site of ViSCA, Baybay, Leyte.

Month	*D. warburgii*			*H. plagata*			*S. negrosensis*		
	R	H	E	R	H	E	R	H	E
1997									
March	1.14	1.24	0.61	1.26	1.22	0.80	1.65	1.66	0.71
April	2.10	2.28	0.40	2.14	1.97	0.88	1.54	1.55	0.37
May	3.13	2.70	0.81	3.50	2.69	0.91	2.00	1.82	0.43
June	4.03	3.26	0.78	3.47	2.54	0.97	2.80	2.58	0.76
July	3.50	2.92	0.76	2.16	1.40	0.15	2.28	1.60	0.21
August	3.72	2.90	0.82	3.34	2.67	0.79	2.53	2.14	0.54
September	3.00	2.54	0.84	2.07	1.80	0.72	1.25	0.98	0.24
October	2.57	2.17	0.55	2.56	1.90	0.51	1.03	1.20	0.29
November	0.39	0.20	0.07	1.73	1.63	0.82	1.39	1.42	0.45
December	2.72	2.34	0.59	1.03	0.81	0.25	0.86	1.43	0.46
1998									
January	2.20	1.47	0.15	1.75	1.99	0.49	1.40	0.73	0.06
February	2.56	2.31	0.43	2.85	2.54	0.53	1.49	1.02	0.15
March	3.41	2.82	0.88	2.67	2.25	0.57	2.40	2.21	0.82
Mean	**2.65**	**2.24**	**0.59**	**2.35**	**1.95**	**0.65**	**1.74**	**1.49**	**0.42**

or mating and swarming sites. Indirectly, they also served as food sources, preys or hosts of some predators and insect parasitoids. From published related studies, it was shown that this guild consistently made up a large bulk of the non- or not actively feeding tree canopy arthropods.

A moderate proportion of predators and parasites were also recorded (Fig. 7 and 8). For the predatory guilds, a number of families representing at least seven orders were recorded, although the families under the Araneida group were the ones frequently encountered. The parasitoid group is mainly represented by the families under the order Hymenoptera, most of which are medium sized belonging to families Ichneumonidae, Braconidae and Chalcidoidea.

Ants are known to be a major component of the forests, although, some studies have shown that their contribution is much in terms of numbers of individuals but not in species. However, in the present results, at least fifteen (15) species of ants have been encountered (Appendix Table 1). The role of ants in the canopy is known to be quite diverse from direct plant feeders to predation. Because of this, they influence arthropod community structure in which they live, thus may be contributory factor to arthropod diversity in the tropics (Stork 1988).

It is evident that the canopy of trees provides suitable niches of the arthropods considering also the presence of the abundant source of food in the canopy. In addition, the results generally indicated that, the abundance of phytophagous species are not very high considering that it accounted

TABLE 4. Monthly species richness (R), diversity (H) and evenness (E) indices of the arthropods collected by beating in the three dipterocarp trees in Barrio Marcos, Baybay, Leyte.

Month	*D. warburgii*			*H. plagata*			*S. negrosensis*		
	R	H	E	R	H	E	R	H	E
1997									
March	1.73	1.10	1.00	0.00	0.00	0.00	0.00	0.00	0.00
April	3.60	2.85	0.74	2.94	2.34	0.94	2.45	2.17	0.71
May	3.13	2.63	0.76	2.30	2.09	0.59	2.37	1.83	0.44
June	2.75	2.23	0.40	3.47	2.70	0.86	2.82	2.22	0.39
July	3.66	2.81	0.87	3.13	2.45	0.62	2.67	2.17	0.52
August	2.35	1.60	0.18	2.29	2.03	0.47	3.66	2.72	0.79
September	2.50	1.84	0.38	2.60	2.23	0.64	0.73	0.32	0.04
October	2.76	2.25	0.60	1.01	1.08	0.18	2.53	2.28	0.58
November	1.60	1.83	0.47	2.93	2.17	0.43	2.67	2.30	0.60
December	3.05	2.41	0.46	2.81	2.08	0.41	2.01	1.38	0.18
1998									
January	2.80	2.32	0.48	2.90	2.43	0.57	2.88	2.16	0.38
February	3.24	2.46	0.51	3.31	2.70	0.77	3.80	2.76	0.93
March	3.21	2.27	0.41	2.24	1.84	0.35	2.58	2.15	0.85
Mean	**2.80**	**2.20**	**0.56**	**2.30**	**2.01**	**0.52**	**2.40**	**1.88**	**0.50**

only less than 50% of the total composition. It maybe indicative that there is balancing check exerted by predatory and parasitic guild in the tree habitats.

On the other hand, the major guild composition in the litter arthropods was dominated by the scavengers, which accounted at most 90% of the total numbers (Figs. 9 and 10). Mites and Collembolans were the most frequently encountered scavengers/saprophagous soil fauna of these dipterocarp trees although, some of these mite families are known to feed also on tiny soil animals. These arthropods are known or found out to be the major group in tropical forest habitat (Wallwork 1976).

The rest of the guild composition occurred in very minimal proportion. Of these minor guilds, the predatory soil arthropods were encountered quite often than the others, at least 3% of the total composition. Beetle fauna are also richly represented in the sampling sites. The commonly encountered families of which are the ground dwelling Carabidae, Staphylinidae which are known to be predatory in habits. In addition, Ptilidae and Tenebrionidae which are known to be dominant scavengers or possibly fungivorous in habits were also very common. A moderate proportion of the predatory guild is contributed by the ground dwelling spiders (Aranae) which were quite common in the samples. A noticeable proportion of arthropods with undetermined guild was noted. However, this consists primarily of larvae or immatures of unidentified groups.

Ants are also known to be a major component in the soil fauna and may occur in astonishing abundance and diversity. However, in the results, the proportion was not

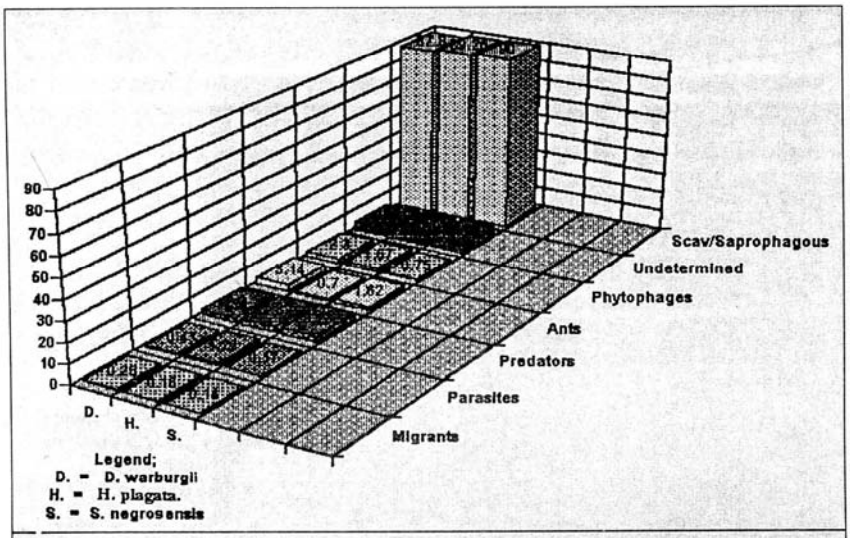

FIGURE 9. Percentage distribution of litter arthropods by guilds in the three dipterocarp trees in the rainforestation site of ViSCA, Baybay, Leyte.

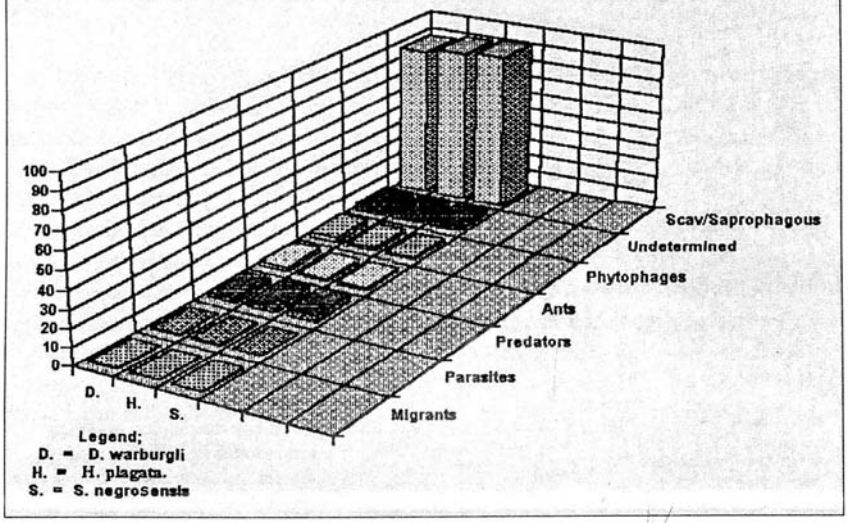

FIGURE 10. Percentage distribution of litter arthropods by guilds in the three dipterocarp trees in the rainforestation site of Barrio Marcos, Baybay, Leyte.

relatively high. Wallwork (1976) mentioned that scarcity of ants in some forest floors suggests some characters of the soil fauna, and that environmental variables interact but the effect may be difficult to evaluate.

Similarity of arthropod fauna of the dipterocarp trees

Qualitative similarity coefficients (Jaccard's measure) showed that only the spider fauna of the three tree species were closely similar than the other insect groups/orders (Table 5). This was true for both the sweeping and beating samples, although the spider samples of the latter method generally showed a closer similarity in species composition (at least 50%).

The other insect groups such as Coleoptera, Hymenoptera and Homoptera, however showed that at least one third of its respective species group composition were alike, particularly in the beating samples.

Similarity indices of arthropod species composition in the samples caught by net sweeping for the three trees was generally lower than in beating samples. This may be accounted to the sampling method itself which may have affected the species caught during trapping or beating, in any case.

The results of the study may indicate host plant specificity of some insect/arthropod species. However, the results may not be conclusive enough. Further studies have to be conducted.

TABLE 5. Similarity coefficients (Jaccard's measure) of some canopy arthropod groups of three dipterocarp trees in the two sampling sites, ViSCA and Barrio Marcos, Baybay, Leyte.

Arthropod Groups	*D. warburgii*		*H. plagata*		*S. negrosensis*	
	Beating	Sweeping	Beating	Sweeping	Beating	Sweeping
Coleoptera	0.39	0.18	0.33	0.15	0.24	0.24
Hymenoptera	0.37	0.26	0.47	0.17	0.34	0.33
Homoptera	0.07	0.52	0.27	0.41	0.21	0.16
Aranaeidae	0.59	0.32	0.54	0.35	0.59	0.39

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