

## The composition of the arthropod fauna of Bornean lowland rain forest trees

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**ABSTRACT.** Data on the taxonomic composition of the arboreal arthropod fauna of 10 Bornean lowland rain forest trees are presented, based on samples obtained using insecticide fogging. Combined samples from all trees comprised 23,874 individuals of at least 3000 species. The mean number of species on each tree was 616.7 with one tree sample containing more than 1007 species. The relative rank of the major orders of arthropods in terms of both species and individuals was remarkably constant across the trees. Hymenoptera, Coleoptera, Diptera and Hemiptera were the orders with the most species and individuals. Formicidae, though not particularly species rich, was the most abundant family in terms of individuals and the commonest species in six of the 10 trees was an ant. Refogging of one of the trees 10 days after initial sampling showed that the arthropod fauna had not completely recovered. What many arthropods are doing in the canopy is discussed.

**KEY WORDS:** arboreal insects, arthropods, Borneo, insect diversity, insecticide fogging.

### INTRODUCTION

Arguably the most important investigations of the structure of arthropod communities on tropical plants were those of Janzen and co-workers (Janzen 1973a,b, Janzen & Pond 1975, Janzen & Schoener 1968, Janzen *et al.* 1976). In spite of the drawbacks of sweeping as a sampling method, their samples provided some of the first quantitative data on the relative abundance of arthropod groups, and an opportunity to look at the effects of a wide range of factors on such communities. Until recently, equivalent data for arthropod communities in tropical trees were almost totally lacking. The use of insecticides to collect samples of arthropods from trees has begun to rectify this situation.

Samples obtained by applying insecticides have been used extensively to describe characteristics of arboreal communities such as abundance patterns of species, individuals, and biomass in temperate deciduous and coniferous trees (Barnard *et al.* 1986, Gagné & Martin 1968, Hijii 1984, Martin 1966, Moran & Southwood 1982, Southwood *et al.* 1982a,b). However, there have been fewer studies of arthropod communities in tropical trees. Recent work has sought to redress this imbalance (Adis *et al.* 1984, Adis & Schubart 1985, Erwin 1983a,b, Erwin & Scott 1980, Gagné 1979, Morse *et al.* 1988, Roberts 1973, Stork 1987a,b,

Stork & Brendell 1990 and in press). Nonetheless, there is still much that we do not know about the structure of tropical arboreal arthropod communities. In particular, there is relatively little detailed information on their taxonomic composition.

Most studies of the arthropod fauna of tropical trees have looked only at numbers of individuals in the major insect orders (Adis *et al.* 1984, Adis & Schubart 1985, Erwin 1983a,b, Stork & Brendell 1990 and in press). Species level information is available for some groups of insects from the canopy of the Central American tree, *Luehea seemanii* Triana & Planch (Coleoptera: Erwin & Scott 1980, Blattodea: Fisk 1983, Homoptera: Wolda 1979), but similar information is required for a greater proportion of the tree fauna and for the faunas of trees in other regions.

This paper uses data at the species and individual level to examine the broad taxonomic composition of the arboreal arthropod fauna of lowland rain forest trees in Borneo and to consider what many of these arthropods are doing in the canopy. Some comparisons are made with samples from studies carried out in other regions of the world although a detailed account of latitudinal and continental comparisons will be presented elsewhere (Stork & Gaston unpublished). Other aspects of the structure of the Bornean arboreal arthropod communities described here have been discussed elsewhere (guild structure: Stork 1987a; faunal similarity of different trees: Stork 1987b; body size-species abundance relationships: Morse *et al.* 1988).

#### METHODS

##### *Field site and tree selection*

Ten trees were selected for fogging in an area of primary forest on the alluvial terrace south of the Sungai (River) Benutan near Bukit Sulang, Ladan Hills Forest Reserve (4° 42' N, 114° 42' E) in Brunei, Borneo (Figure 1). The forest had little ground level vegetation although the low canopy was dense and dominated by rotan palms. The canopy was of mixed levels up to 50 m with a few 'super-emergents' reaching heights of over 70 m. During the fieldwork (29 August to 9 September 1982) there were several short periods of heavy rainfall. Some two weeks after the last fogging a period of several days of rain caused the field site to flood for at least several days up to a depth of more than a metre, confirming the view that this represented an area of typical lowland floodplain forest. Rainfall averages above 2500 mm in this region with no distinct rainy season. Fogged trees were identified by Dr M. Huby (Table 1) and none appeared to be in flower or fruit.

##### *Insecticide fogging procedure*

A synthetic pyrethroid insecticide, Reslin E, was diluted 1 part to 49 parts of diesel (equivalent to 0.8% active ingredient) and applied to trees using a Swing Fog SN11 insecticide fogging machine. This was hauled into the canopy of each

## Appendix I

The following table summarises the numbers of individuals and species of arthropods collected from ten Bornean trees (plus a refog sample from tree 5) using knock-down insecticides. Species estimates for some groups marked with a ? are not available and therefore species totals marked with \* are minimum figures. Numbers in brackets are immature stages. Groups were sorted by the following taxonomists: Collembola - M. N. Wetton; Neuroptera, Odonata, Ephemeroptera, Trichoptera - P. C. Barnard, S. J. Brooks; Orthoptera, Blattodea, Dermaptera, Phasmida, Mantodea - J. A. Marshall; Heteroptera, Auchenorrhyncha - M. D. Webb; Psylloidea, Aleyrodoidea, Psocoptera - D. Hollis; Coccoidea - A. C. Freeston; Thysanoptera - L. A. Mound, J. M. Palmer; Phthiraptera - C. H. C. Lyal; Lepidoptera larvae - J. D. Holloway, I. J. Kitching; Nematocera - A. M. Hutson; Brachycera - K. G. V. Smith; Cyclorrhapha - B. H. Cogan; Formicidae - B. Bolton; Other Aculeata, Symphyta - M. C. Day; Chalcidoidea - J. S. Noyes; Cynipoidea, Proctotrupidea, Ceraphronoidea - N. D. M. Fergusson, Ichneumonidae - I. D. Gauld; Braconidae - T. Huddleston; Staphylinidae - P. M. Hammond; Elateridae - C. M. F. von Hayek; Nitidulidae, Phalacridae, Corylophidae - R. J. W. Aldridge; Coccinellidae - R. D. Pope; Tenebrionidae, Lagriidae - M. J. D. Brendell; Anthribidae, M. L. Cox; Chrysomelidae - S. L. Shute; Curculionidae - R. T. Thompson; Other Coleoptera - N. E. Stork; Araneae - A. Russell-Smith; Opiliones - P. Hillyard. Further species assessments: Buprestidae - B. Levey; Scolytinae, Platypodinae - D. Bright; Cantharidae - W. Wittmer.

Group	Individuals	Species	Group	Individuals	Species
<b>Total</b>	<b>23874</b>	<b>3059*</b>	Oonopidae	23 (3)	4
<b>CRUSTACEA</b>	<b>84</b>	<b>?</b>	Oxyopidae	15 (13)	2
Isopoda	84	?	Pholcidae	7 (3)	4
<b>ARACHNIDA</b>	<b>1157</b>	<b>193*</b>	Pisauridae	3 (3)	1*
Acari	151	?	Salticidae	114 (49)	22
Pseudoscorpiones	12	?	Scytodidae	12 (12)	1*
Opiliones	47	11	Selenopidae	28 (28)	1*
Gagrellidae	14	5	Tetragnathidae	13 (9)	2
Phalangodidae	33	6	Theridiidae	217 (104)	51
Araneae	947	182*	Theridiosomatidae	1	1
Araneidae	77 (47)	33	Thomisidae	102 (50)	20
Clubionidae	106 (66)	16	Uloboridae	6 (4)	2
Ctenidae	28 (28)	1*	Zodariidae	7 (5)	2
Hahniidae	22 (7)	1	Unident. families	95 (92)	4
Linyphiidae	39 (11)	9	<b>MYRIAPODA</b>	<b>1</b>	<b>1</b>
Metidae	11 (7)	2	<b>HEXAPODA:</b>		
Mimeridae	2	2	Collembola	740	22
Mysmenidae	5 (3)	1	<b>INSECTA:</b>	<b>21902</b>	<b>2842*</b>

Brachycera:	430	80	Buprestidae	45	17
Dolichopodidae	315	47	Elateridae	295	27
Empididae	91	22	Eucnemidae	6	5
Stratiomyidae	16	7	Lycidae	23	9
Asilidae	7	3	Lampyridae	9	3
Solvidae	1	1	Cantharidae	25	10
Cyclorrhapha:	982	191	Anobiidae	14	9
Chloropidae	251	55	Ptinidae	13	6
Phoridae	216	22	Melyridae	22	7
Milichidae	169	25	Cleridae	11	10
Drosophilidae	94	24	Nitidulidae	21	11
Ephyridae	67	9	Phalacridae	48	19
Lauxaniidae	41	10	Cucujidae	4	4
Muscidae	32	7	Silvanidae	5	2
Sphaeroceridae	31	6	Languriidae	10	6
Tachinidae	7	6	Erotylidae	4	3
Cypselosomatidae	7	2	Cryptophilidae	2	2
Lonchaeidae	5	5	Corylophidae	200	33
Sepsidae	5	2	Endomychidae	14	8
Pipunculidae	4	3	Coccinellidae	46	20
Celyphidae	4	1	Discolomidae	2	1
Syrphidae	3	3	Lathridiidae	2	1
Platystomatidae	2	2	Colydiidae	11	7
Clusiidae	2	2	Mycetophagidae	2	1
Diopsideae	2	1	Cisidae	7	5
Odiinidae	2	1	Mordellidae	46	17
Syringogasteridae	2	1	Prionoceridae	1	1
Micropezidae	1	1	Anthicidae	488	12
Agromyzidae	1	1	Aderidae	124	45
Neriidae	1	1	Scaptidae	1	1
Tephritidae	1	1	Lagriidae	22	5
Coleoptera	4043	859*	Tenebrionidae	87	32
Larvae	122	?	Cerambycidae	26	18
Dytiscidae	1	1	Chrysomelidae:		
Cicindelidae	1	1	Cryptocephalinae	16	9
Carabidae	17	8	Eumolpinae	345	33
Hydraenidae	1	1	Galerucinae	142	45
Hydrophilidae	1	1	Alticinae	62	15
Histeridae	1	1	Hispinae	4	4
Ptiliidae	4	3	Cassidinae	1	1
Scaphidiidae	10	5	Anthribidae	80	38
Scydmaenidae	19	13	Attelabidae	35	14
Pselaphidae	64	25	Apionidae	409	14
Staphylinidae:			Brentidae	10	5
Steninae	13	2	Curculionidae:		
Osoriinae	8	8	Scolytinae	16	11
Oxytelinae	8	7	Platypodinae	2	1
Paederinae	272	27	Cyphericini	248	11
Aleocharinae	198	69	Sitoninae	41	2
Euaesthetinae	1	1	Alcidodinae	3	3
Tachyporinae	1	1	Hylobiinae	1	1
Clambidae	4	2	Acicnemidinae	5	4
Helodidae	17	7	Cryptorhynchinae	29	16
Scarabaeidae	3	2	Rhynchaeninae	12	9
Acanthoceridae	5	2	Anthomiinae	2	2
Ptilodactylidae	30	4	Otidocephalinae	1	1
Dryopoid fam.	1	1	Curculioninae	17	15
Chelonariidae	2	2	Eirrhiniinae	42	18
Dryopidae	21	8	Baridinae	5	4
Limnichidae	8	2	Zygopinae	36	23
Byrrhidae	1	1	Cossoninae	8	7
			Rhynchophorinae	1	1