Effects of selective logging on insect abundance and morphospecies richness in Bornean lowland forest.

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Table of contents

Abstract

Flying insects were sampled at two different forest types, two different heights (canopy and understorey) and within each forest type at two different sites. They were sorted to order, counted and the number of morphospecies estimated.
Forest type, height and site did not have any significant effect on total number of morphospecies and individuals. When the orders Coleoptera, Diptera, Hemiptera and Hymenoptera were considered separately, both Diptera and Hemiptera showed significant differences in the number of morphospecies and individuals between primary and secondary forest, when variances between sites within a forest type were subtracted. The Hemiptera were reduced in number. The number of Diptera went up.
These variances are likely attributed to differences in forest structure and canopy layer.

1. Introduction

Tropical rainforests are believed to support an immense diversity of life, especially the lowland forests in the wet tropics, which are thought to be the most species rich of all terrestrial ecosystems (Turner, 1996). Therefore there is great concern about how man-made disturbances affect these areas. In this paper I will focus on how these disturbances affect flying insects.

Human dominance of many ecosystems is reducing the diversity of species (Chapin et al., 2000; Purvis & Hector, 2000; Tilman, 2000). Chapin et al. (2000) go so far as calling it the beginning of the sixth major extinction event in history. Diverse ecosystems are shown, by both laboratory and field studies, to be more stable than less diverse ones (Purvis & Hector, 2000; Tilman, 2000), so the consequences of reduced biodiversity could potentially be very severe to humans, other animals and to plants (Chapin et al., 2000; Tilman, 2000).

In South-East Asia the principal cause of disturbances has been selective logging. Sixty percentage of the state of Sabah, Malaysia is under some sort of forest cover (Marsh, 1995) and of that 64% is subject to selective logging.

There have been only a few investigations on how disturbances affect the tropical forest fauna. Most studies made, have been done on vertebrates, which send out different signals, ranging from no consistent trends (in primates) to extinction of some species and a tendency of others to become dominant (in birds) (Johns, 1992). In a review article on forest fragmentation, Turner (1996) cites 22 studies, of which only three were on insects. The investigations that have been done, were restricted to specific orders of insects (Holloway, 1992; Turner, 1996; Willott, 1999) without relating them to other orders.

In 1977, Southwood (1978) presented a pie-chart showing that insects constitute an amazing 57% of all species described at that time (Southwood, 1978, cited in Stork, 1988) and the relative proportions remain largely the same today (Stork, 1988), although many new species have been described since then. Estimates of how many species of arthropods there are in all vary between 3-5 millions to over 17.5 millions and up to a possible staggering number of 80 million species (Stork, 1988; Purvis & Hector, 2000). The key to this immense diversity of insects is believed to be the rainforest canopy (Stork, 1988; Kanstrup, 2000).

Despite the general agreement that the canopy holds a large proportion of the rainforest diversity, this ecosystem is very understudied because of the difficulties in accessing it. Most research has been done using insecticide fogging and only very few studies have concentrated on flying insects only (ex. Willott, 1999). If sampling is only on or near to the ground, species richness in the primary forest may be underestimated and the taxonomic composition misjudged because of the large number of canopy specialists that will be missed. Furthermore, there is some evidence that canopy insects fly closer to the ground in secondary forest, where the canopy is lower (Davis & Sutton, 1998). If these are detected and included in the ground-based sampling in the secondary forest and not in the primary forest, then the estimate of the species richness of the secondary forest will be inflated and destroying possibilities for comparisons.

The aim with this study was therefore to get estimates on how selective logging affects flying insects in lowland tropical forest, both in the canopy and understorey. This has to my knowledge never been analysed before.

The primary objective was to investigate if there is any variation in number of species and number of individuals in primary and secondary forest, and compare that to the variation within the two forest types and to the variation between canopy and understorey.

The secondary object was to study any variation in size composition of insect orders from primary and secondary forest, i.e. to study to what extent different orders react to selective logging.

2. Methods and Materials

2.1 Sites

Fieldwork for this study was conducted at Danum Valley in the Malaysian state of Sabah, at the northeastern corner of Borneo. The Danum Valley Field centre (DVFC) is situated on the edge of a 438 km^2 conservation area, consisting of primary lowland dipterocarp rainforest (Willott, 1999), where trees of the family Dipterocarpaceae constitute up to 80% of the canopy trees (Davis, 2000). The conservation area lies within the 9730 km^2 logging concession, the Ulu Segama forest reserve, most of which has been selectively logged. The average yearly rainfall is 2669 mm (averaged over the period 1985-1998) (Kanstrup, 2000) and it is not strongly seasonal. Both plots were chosen because of their easy accessibility.

2.1.1 Primary forest site

The primary forest site was located approximately 250 meters from DVFC in undisturbed primary forest, close to a 40-meter high viewing platform, built in a 60-meter high dipterocarp tree, at 4°57’40’’ N, 117°48’05’’ E, and at an altitude of 150 m above sea level. The canopy traps (A) were placed approximately 40 m above ground and the understorey traps (B) 20 m. In spite of its vicinity to the DVFC and the clearing there, the site was surrounded by extensive primary forest 270° around, and the remaining part was at a distance of 50-100 m from the centre separated by primary forest and a small river.

2.1.2 Secondary forest site

A few km down the road running from the DVFC through the Ulu Segama Forest reserve, the secondary site was located near the banks of the Kalisun River, 4°58’20’’ N, 117°48’50’’ E at an altitude of 180 m above sea level. It was located in an area known as coupe ’89, logged last time in 1989. In Sabah the usual practice is a 35 year logging cycle (Collins et al., 1991) where all trees >60 cm dbh on slopes <20° are felled (Marsh, 1995; cited in Willott, 1999). In coupe ’89, an average of 107 m^3 of timber have been extracted per ha (Costa & Karolus, 1992).
Near the riverbank a few large trees had been left to prevent erosion, leaving at the study site a small area of relatively undisturbed forest in a mosaic of different vegetation types, ranging from open areas with grasses and ferns to areas dominated by young trees < 30 cm dbh. The site, which had a canopy height close to that of primary forest, was chosen to avoid biased results, i.e. in order to avoid getting insects that normally do not fly at that height, in to the canopy samples. The trap heights were the same as in the primary forest.

2.2 Sampling

The sampling of insects was conducted between August 19th and October 27th 1999. The traps used were 10*10*10 cm yellow painted wooden blocks covered with a sticky non-drying glue. The traps were not meant to be sticky traps, in the strictest sense of the word since, in most cases, the sticky surface acts only as a retentive or retaining element trapping insects in random flight or when they settle indiscriminately (Muirhead-Thomson, 1991), which was exactly what I intended for in this study.

The yellow colour was chosen because several investigations show yellow to be the colour most preferred by a wide range of insects (Muirhead-Thomson, 1991). The traps were tied to lines shot up into the trees with a longbow. They were put up as closely after each other in time as possible, and were left to hang for 24 hours at every sampling.

The sampled insects were sorted to order, counted and the number of morphospecies estimated, by giving each new encountered species a new number in each sample. The "Insects of Australia" (Mackerras et al., 1970) and for beetles (White, 1983) were used as an aid in estimating the number of species.

2.3 Statistics

For the descriptive statistics the material was sorted with MS SQL Server 2000, a database software. Mean value, standard deviation and 95% confidence intervals were calculated. The category "Other" in the pie charts comprised the orders Thysanoptera, Orthoptera, Ephemeroptera and Opiliones, all represented by very few specimens.

The two sites within each forest type were tested against each other (canopy vs. canopy and understorey vs. understorey) with a null hypothesis saying that they were identical. If the hypothesis was accepted, they could be pooled and thereafter treated as one sample (= true replicates) i.e. H_0: 1A = 2A, 4A = 5A, 1B = 2B, 4B = 5B. They were tested for goodness of fit using a G-test (likelihood ratio test) (Sokal & Rohlf, 1995: section 17.1), and the observed G-values were compared with a χ^2-distribution with one degree of freedom (Sokal & Rohlf, 1995: pp 689). Columns 1 and 2 (Sokal & Rohlf, 1995: table 17.1, pp. 688) were calculated from the observed numbers of species and individuals, respectively, with *n* being the sum of the two samples of observations. The expected proportions (column 3) were 0.5 for both sites since they, according to the hypothesis, contributed with exactly half each. Column 4 contains the expected frequencies according to the null hypothesis, and column 5 the ratios between the observed and expected values. The theoretical distribution of the L-value calculated in column 6 is complex and not well understood (Sokal & Rohlf, 1995: pp.689) but G = 2* ln L can be approximated by the χ^2 distribution, when sample sizes are large.

Before analysing the data with ANOVA's (Wilkinson et al., 1992) some assumptions had to be checked (Sokal & Rohlf, 1995: Biometry, pp. 393):

1. Fundamental assumption: Sampling of individuals must be random. The two sampling places within each site were not chosen to be in trees of a specific family or with a certain distance to each other. They were chosen because of their accessibility.

2. Assumption of independence of variates: The error term (ϵ_{ij}) in the expression for the expected value of a variate must be a random normal variable, if the variates are arranged in a logical order independent of their magnitude, for example the order in which they were obtained. The data were

arranged after sampling date and tested with a "test for serial independence of a continuous variable" (Sokal & Rohlf, 1995: box 13.1, pp. 395). The η value = $\sum d^2/\sum y^2$ was calculated as the sum of the first differences squared divided by the sum of the squared deviations from the mean value of observations. The value |1-η/2| was checked for significance in Table HH in Sokal & Rohlf (1995) with n = 10.

3. <u>Assumption of homogeneity of variances</u>: The error terms (ϵ_{ij}) must have identical variances. The assumption was tested with the F_{max}-test (Sokal & Rohlf, 1995: box 13.2, pp. 399). The greatest variance S^2_{max} witnin each series of observations was divided with the smallest S^2_{min} to yield the maximum variance ratio. The ratio was compared with Table G (Sokal & Rohlf, 1995) for $F_{max\ \alpha[a,\ n-1]}$, where α is the significance level (= 0.05), *a* is the number of samples (= 8) and *n* the number of observations in each sample.

4. <u>Assumption of normality</u>: The error terms (ϵ_{ij}) must be distributed normally. This was tested with a Kolmogorov-Smirnov goodness of fit test for one sample (Sokal & Rohlf, 1995: pp. 708). This test is especially useful with small samples. H_0 was that the data series from each trap, for both species and individuals, did not deviate significantly from a normal distribution with the same number of observations. The calculated D_{max} values were compared with Table Y in the statistical tables (Sokal & Rohlf, 1995).

The data were then analysed with ANOVA's using the software Systat (Wilkinson et al., 1992) and the general linear model. First three one-way ANOVA's were computed for the criterions: forest type (primary or secondary), storey (canopy or understorey) and sites (1 or 2 in primary, 4 or 5 in secondary). Next two regular two-way ANOVA's for forest type vs. storey and for storey vs. sites. Since the sites in each of the forest types not were the same, the two-way ANOVA for forest type vs. sites was made as a nested ANOVA, with sites nested within forest type. At last two regular two-way ANOVA's were made for storey vs. sites for each of the two forest types, primary and secondary.

The total amount of variance within a regular two-way ANOVA comes from four sources (Sokal & Rohlf, 1995: Biometry pp. 324). The four sources were calculated as follows. Part one comes from the variation in one of the criterions (ex. forest type in a forest type vs. storey test). The second part comes from the other criterion (in this example = storey) and the third from the interaction between them. The last source is the error term, equal to the variation within the subgroups.

The nested ANOVA is a pure model II nested ANOVA and calculated with three sources of variance (Sokal & Rohlf, 1995: Biometry pp. 276). The first source is like in the regular ANOVA from the variation in one of the criterions (groups) (ex. forest type in a forest type vs. sites test). The next is among the subgroups, here that means among the sites nested within the forest types. The last is the error term, the variation within the subgroups.

Finally a correlation analysis was made between number of species and number of individuals

3. Results

3.1 Fauna description

The results from the calculations of mean value and standard deviation for total number of species and individuals are given in Table 1. The mean value of species (with sd in parenthesis) in the primary forest was 57.25 (15.0) and in the secondary forest 52.13 (13.84), with the understorey mean being the largest for both forest types, 59.1 (16.77) and 52.6 (8.86) respectively. The mean value of number of individuals for primary and secondary forests respectively was 70.58 (18.91) and 68.63 (20.84). For individuals the understorey was not consistently the richest zone. The total number of species and individuals are given in Fig. 1. Mean value and standard deviation calculations for the four main orders are given in Tables 2-5. Mean values for both species and individuals are larger in primary- than secondary forest for Coleoptera, Hemiptera and Hymenoptera. For Diptera mean values were largest in secondary forest for both species and individuals.

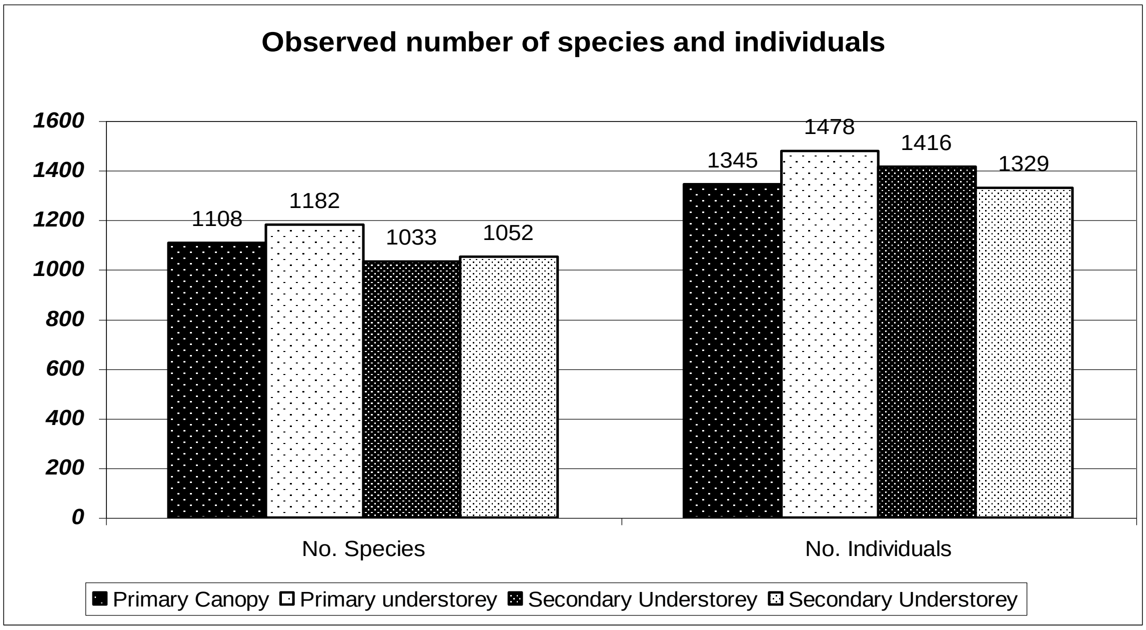

Figure 1. Total number of species and individuals sampled in primary canopy, primary understorey, secondary canopy and secondary understorey.

How the numbers of species and individuals were distributed on orders in primary and secondary forest is seen in Figure 2. For distribution among the canopy and understorey, see Figure 3 (in the supplements).

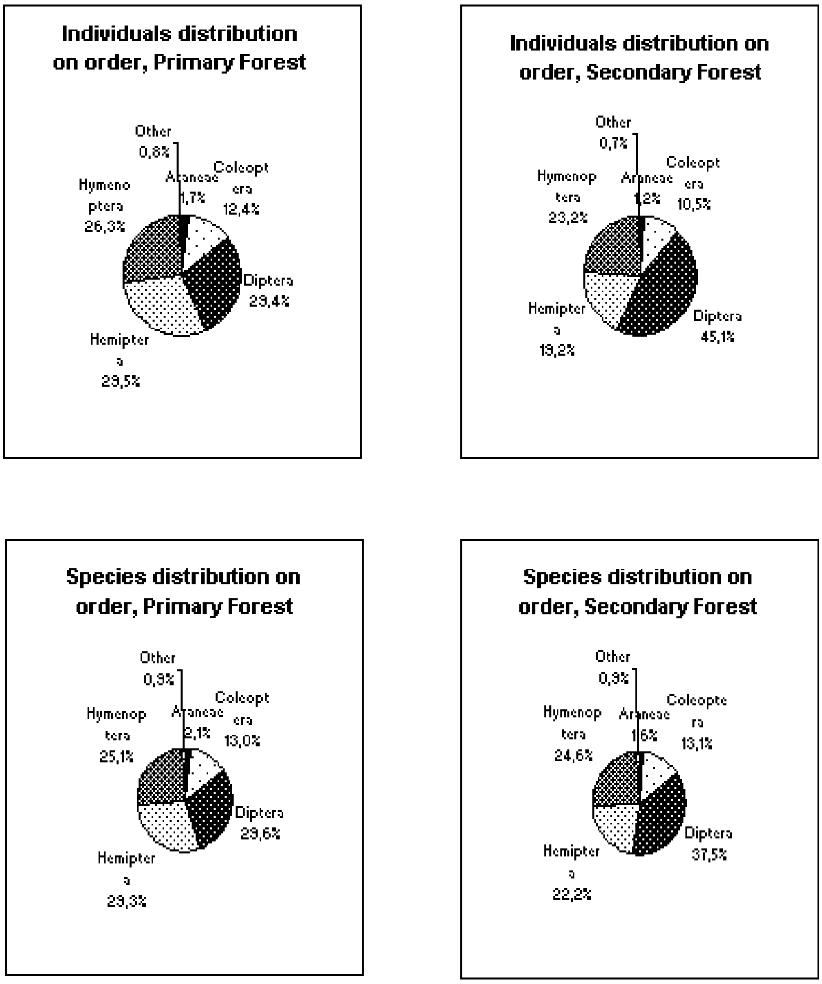

Figure 2. Distribution of sampled species and individuals among orders in primary and secondary forest.

How the number of individuals is distributed on morphospecies level is shown in Fig. 4. The numbers of species represented by only one individual per species is 1995 for primary and 1808 for secondary forest.

Species represented by only one individual make up 71.5% of the individuals in the primary forest and 66.8% in the secondary forest. The common species (represented by >3 individuals) make up 13.4% of the individuals in the primary and 18.4% in the secondary forest.

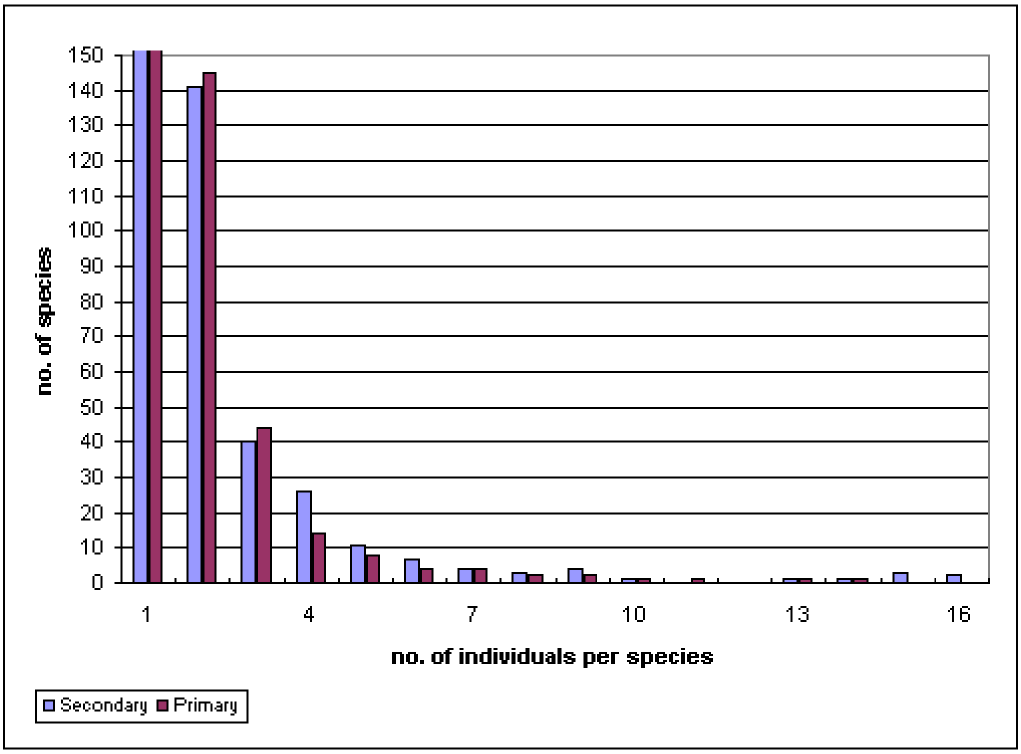

Figure 4. Distribution of species represented by 1-16 individuals in primary and secondary forest.

3.2 Analysis

In this study, the two sampling places within each site were assumed not to be significantly different for both canopy and understorey. H_0 was accepted for: primary canopy species and individuals, secondary understorey species and secondary canopy individuals. The rest of the site pairs could not be pooled. For calculations, see Tables 6-7.

Assumptions of ANOVA's:

- The sampling of individuals were made at random.
- The tests for independence of variates were accepted for all samples (P>0.05), except Diptera species, site 2B (P=0.036) and Hymenoptera species, site 4B (P=0.039). However both values were considered close enough to P=0.05 to justify analysing them with ANOVA's together with the rest of the data. For calculations see Table 8.
- The tests for homogeneity of variances showed significance in four cases. Those are Coleoptera species (P<0.01), Coleoptera individuals (P<0,01), Diptera individuals (P<0.01) and Hymenoptera individuals (P<0.01). The rest are either not significant (P>0.05) or very close to P=0.05 (P=0.048, P=0.042 and P=0.04). For calculations, see Table 9.
- In the Kolmogorov-Smirnov test for normality H_0 was rejected in 10 out of 80 tests on a 5% level. The significant deviations from normal distribution were evenly distributed on the orders Coleoptera, Diptera and Hymenoptera and with a single significant deviation in total number of species site 1A.

The one-way ANOVA's for total number of species and individuals and for Coleoptera, Diptera, Hemiptera and Hymenoptera species and individuals did not produce any significant differences at the 5% level. The test comparing forest types were close to significant for the Hemiptera individuals ($P=0.077$).

The two-way ANOVA's for total number of species and individuals did not produce any significant differences. Only the two-way nested ANOVA (sites within forest type) for species showed incipient significance ($P=0.12$).

The two-way nested ANOVA (sites within forest type) for Coleoptera species showed significance in the interaction between forest type and sites ($P=0.047$).

The two-way nested ANOVA for Diptera individuals showed significance for both forest type ($P=0.0008$) and for the interaction between forest type and sites ($P=0.0087$). The nested ANOVA for Diptera species was also close to significance ($P=0.078$) for forest type.

The two-way nested ANOVA for Hemiptera species was significant for both forest type ($P=0.0001$) and for the interaction between forest type and sites ($P=0.0022$). For Hemiptera individuals the nested ANOVA was also significant for forest type ($P<0.00005$) and for the interaction between forest type and sites ($P=0.0002$).

The Hymenoptera two-way ANOVA's for storey vs. sites in the primary forest showed significance for the interaction between storey and sites, for both species and individuals ($P=0.019$ and $P=0.014$ respectively).

The correlation test between number of individuals per sampling and number of species showed very high correlation ($P<0.00005$).

Figure 5. Total number of individuals caught per sampling per trap, as a function of total number of species per sampling per trap.

4. Discussion

The two sampling sites within each of the forest types in this study were placed close to each other. Therefore they were not expected to be very different. The statistical tests proved otherwise, and especially the primary understorey was found to be very heterogeneous. This corresponded well with the results of other studies in the area (Willott, 1999). The primary understorey was also shown to be the most diverse of the investigated habitats in regards to both species richness and to abundance of individuals.

Willott's (1999) study of butterflies gives a conservative estimate of 10% species loss from primary to secondary forest. That number is very similar to what I found here for the total number of insect species, but it could not be verified as significant using the ANOVA. The number of individuals lost from primary to secondary forest was very small. In the canopy the number even went up a bit. This could be a consequence of the particular site chosen in the secondary forest. A few larger trees had been left along the small river to prevent erosion, and this left the canopy layer partly intact and with this, part of the original primary forest structure. This should be changed in a repetitive study, to reflect a more typical secondary forest situation, with a low-lying and very open canopy layer.

Another reason that total number of individuals were not reduced could be the drastic alteration in habitat, caused by selective logging which triggers some species to become super abundant. Alternatively, a loss of predators like spiders and beetles could cause a reduction in prey diversity and the dominance of a few species. However, this seems not to be the case here, since the number of spiders did not seem to be much reduced in the secondary forest (pers. obs.) and the loss of Coleoptera from primary to secondary was not statistically significant. Kragh (2000) also found that forest type did not have a significance on spider morphospecies richness.

For other reasons the secondary site in this study was chosen to be similar to the primary site in having a heavy liana/ epiphyte load. This could cause phytophagous groups who feed on these to thrive in the secondary forest and cloud the picture of species and individuals loss. On the other hand it seems that one of the large phytophagous groups, the Homoptera, which comprises the vast majority of the Hemiptera sampled in this study, are the group most affected by logging of all the studied groups. This is probably a consequence of the reduced canopy layer, since they are the order with the most marked concentration in the upper canopy (Sutton et al., 1983). So in a more typical secondary site, the loss of hemipterans would be expected to be more pronounced.

Not all orders are affected by selective logging. The Hymenoptera did not show any significant differences between primary and secondary forest. There are many small parasitic wasps in the samples (pers. obs.), and they are generally strong fliers with a small β-diversity (low species turnover with distance). The Danum Valley Conservation area is only a few km away, and could act as a reservoir for recolonisation of the secondary forest for these strong fliers.

Recent results have suggested that the canopy supports at least half of the overall species richness in the tropical rain forest (Kanstrup, 2000). These results could not be reproduced in this study. The understorey was richest in species in both primary and secondary forest. The reason for this could be the topography, if the stratification of vegetation between forest floor and upper canopy is complex. Sutton et al. (1983) found that topography was a prime factor in determining the vertical stratification of the flying insects, and that a concentration of insects in the upper canopy are associated with simple topography. The secondary forest site in this study was located on a slope running towards a small river with a few large trees left to prevent erosion. These factors together

create a complex topography. In the primary forest, Hymenoptera showed a significant interaction between storey and site. This also indicates a complex forest structure, where the factors determining whether the canopy or understorey are the most species rich depends on which site is sampled.
The turnover of species between canopy and understorey could not be determined, since the sampling methods in this study did not allow for decisive keying of species. In a repetitive study the sticky traps could profitably be exchanged for another sampling method, i. e. light traps or flight intercept traps, that would allow for more decisive keying.

A repetitive study should also be designed to try and explain some of the variance, both within the two forest types and between them, that were not explained in this study. More samplings may elucidate the tendencies seen here. There has been some disagreement on the role of tree taxonomy in insect diversity. DeVries et al. (1997) believes that vegetation structure and taxonomy are a major influence on community diversity. Stork (1987) concludes that taxonomic relatedness of trees is a significant determinant of faunal similarity in less than half of the groups he has examined, and in none does it account for more than 30% of the total variation. He also concludes that in some phytophagous groups as Homoptera and Heteroptera it has little apparent affect at all.
Therefore, and because of the large variance that could not be explained with this study, it is a vital subject to address in future research.

The homogeneity tests applied in this study showed significance in four cases. This seems to be a consequence of large variance in means and could therefore be corrected with a log transformation. This would make the variances independent of their means. A longer sampling time would probably have yielded larger samples with less variance of mean in the replicates, and since the sampling methods were the same throughout this study I chose not to perform this transformation.

The Kolmogorov-Smirnov test for normality showed significance in 10 of 80 tests. The test were performed with a 5% significance level and would therefore be expected to yield 4 significant results by pure chance. Had the test been performed with a 1% significance level, there would only have been 4 significant deviations compared to 1 expected by chance. The consequences of nonnormality of error are not too serious, since means will follow the normal distribution more closely than the distribution of the variates themselves (Sokal & Rohlf, 1995). The significant deviations from normal distribution could also be the result of outliers, samples that deviate significantly from the norm of the rest in a series.
The test of normality of variances of total number of species and individuals were also tried with a G-test and this showed results very different from those of the Kolmogorov-Smirnov test. Therefore great care has to be applied when choosing test for normality, but the Kolmogorov-Smirnov test is simpler to compute and more powerful (Sokal & Rohlf, 1995).

A 3-way ANOVA to test for all three variables at the same time should be possible, but not with the computer software used in this study. The one-way ANOVA for the four sites did not show anything significant, and 2-way tests (storey vs. sites) in primary and secondary forest separately did not show any significance either.

The significant differences from primary to secondary forest seen in Hemiptera and Diptera were only seen in the nested ANOVA (sites within forest type), i. e. after the subtraction of the variance between sites. A new study should therefore look more into the heterogeneity of especially the primary forest, since it seems that the variation there is quite significant, possibly matching the variance between the two forest types.

In a repetitive study I would also look more into the responses of the Diptera to selective logging, since they seem to be the only group thriving in the secondary forest. Dividing the Diptera families into feeding guilds might give information on which groups that do well.

5. Conclusion

The results of this study suggest that insect species richness and especially abundance of individuals not necessarily is much affected by selective logging. The different insect orders react very differently to selective logging. The Hemiptera is much reduced in species richness and number of individuals, whereas the Diptera shows a larger species richness and more individuals in the secondary forest.

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Figures

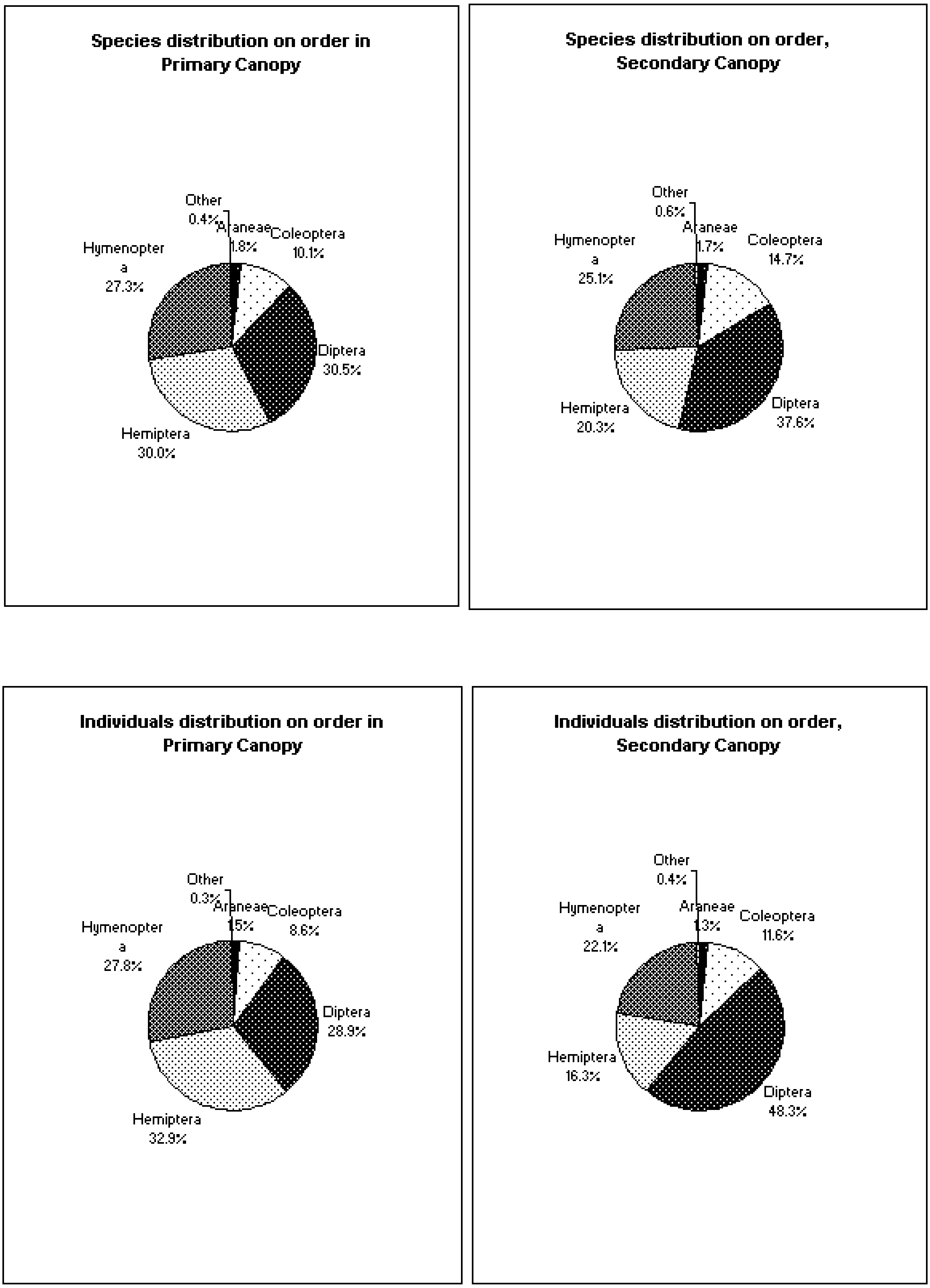

Figure 3. Distribution of sampled species and individuals on order i primary and secondary canopy.

Figure 3 (continued)

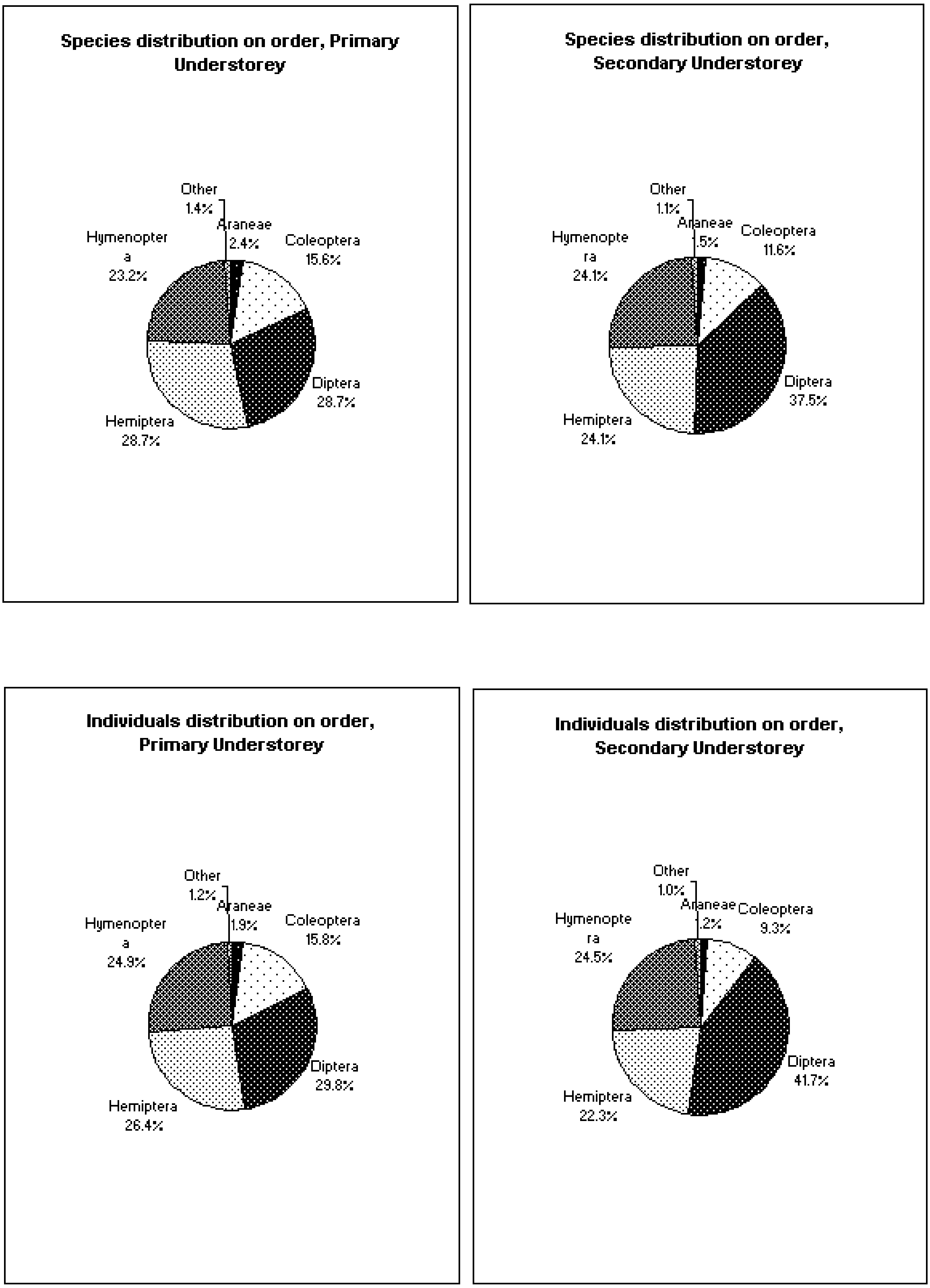

Figure 3 (continued). Distribution of sampled species and individuals on order in primary and secondary understorey.

Tables

Table 1. Total number of species and individuals sampled in primary and secondary forest, in both canopy and understorey. Mean, sd and 95% confidence intervals. Sd=standard deviation.

Species	Total	Mean	sd	95% conf.	min	max
Primary canopy	1108	55.4	13.2	0.8	54.6	56.2
Primary understorey	1182	59.1	16.8	1.0	58.1	60.1
Primary total	2290	57.3	15.0	0.6	56.7	57.9
Secondary canopy	1033	51.7	17.8	1.1	50.6	52.8
Secondary understorey	1052	52.6	8.9	0.5	52.1	53.1
Secondary total	2085	52.1	13.8	0.6	51.5	52.7

Individuals	Total	Mean	sd	95% conf.	min	max
Primary canopy	1345	67.3	14.7	0.8	66.5	68.1
Primary understorey	1478	73.9	22.3	1.1	72.8	75.0
Primary total	2823	70.6	18.9	0.7	69.9	71.3
Secondary canopy	1416	70.8	26.7	1.4	69.4	72.2
Secondary understorey	1329	66.5	13.1	0.7	65.8	67.2
Secondary total	2745	68.6	20.8	0.8	67.8	69.4

Table 2 - Coleoptera

Table 2. Number of species and individuals of the order Coleoptera sampled in primary and secondary forest, canopy and understorey. Mean, sd and 95% confidence intervals. Sd = standard deviation

Species	Total	Mean	sd	95% conf.	min	max
Primary canopy	112	5.6	3.4	0.6	5.0	6.2
Primary understorey	185	9.3	3.9	0.6	8.7	9.8
Primary total	297	7.4	4.0	0.5	7.0	7.9
Secondary canopy	152	8.0	7.4	1.2	6.8	9.2
Secondary understorey	122	6.4	3.0	0.5	5.9	7.0
Secondary total	274	7.2	5.6	0.7	6.5	7.9

Individuals	Total	Mean	sd	95% conf.	min	max
Primary canopy	116	5.8	3.5	0.6	5.2	6.4
Primary understorey	233	11.7	6.8	0.9	10.8	12.5
Primary total	349	8.7	6.1	0.6	8.1	9.4
Secondary canopy	164	8.6	8.6	1.3	7.3	10.0
Secondary understorey	124	6.5	3.1	0.5	6.0	7.1
Secondary total	288	7.6	6.5	0.7	6.8	8.3

Table 3 - Diptera

Table 2. Number of species and individuals of the order Diptera sampled in primary and secondary forest, canopy and understorey. Mean, sd and 95% confidence intervals. Sd = standard deviation

Species	Total	Mean	sd	95% conf.	min	max
Primary canopy	338	16.9	6.2	0.7	16.2	17.6
Primary understorey	340	17.9	6.5	0.7	17.2	18.6
Primary total	678	17.4	6.3	0.5	16.9	17.9
Secondary canopy	388	19.4	4.2	0.4	19.0	19.8
Secondary understorey	395	19.8	8.1	0.8	19.0	20.5
Secondary total	783	19.6	6.4	0.4	19.1	20.0

Individuals	Total	Mean	sd	95% conf.	min	max
Primary canopy	389	19.5	8.9	0.9	18.6	20.3
Primary understorey	441	23.2	13.0	1.2	22.0	24.4
Primary total	830	21.3	11.1	0.8	20.6	22.1
Secondary canopy	684	34.2	14.6	1.1	33.1	35.3
Secondary understorey	554	27.7	16.1	1.3	26.4	29.0
Secondary total	1238	31.0	15.5	0.9	30.1	31.8

Table 4 - Hemiptera

Table 4. Number of species and individuals of the order Hemiptera sampled in primary and secondary forest, canopy and understorey. Mean, sd and 95% confidence intervals. Sd = standard deviation

Species	Total	Mean	sd	95% conf.	min	max
Primary canopy	332	16.6	5.67	0.6	16.0	17.2
Primary understorey	340	17	5.55	0.6	16.4	17.6
Primary total	672	16.8	5.54	0.4	16.4	17.2
Secondary canopy	210	10.5	6.49	0.9	9.6	11.4
Secondary understorey	254	12.7	6.06	0.7	12.0	13.4
Secondary total	464	11.6	6.3	0.6	11.0	12.2

Individuals	Total	Mean	sd	95% conf.	min	max
Primary canopy	442	22.1	8.91	0.8	21.3	22.9
Primary understorey	390	19.5	8.01	0.8	18.7	20.3
Primary total	832	20.8	8.49	0.6	20.2	21.4
Secondary canopy	231	11.55	7.67	1.0	10.6	12.5
Secondary understorey	297	14.85	8.15	0.9	13.9	15.8
Secondary total	528	13.2	7.99	0.7	12.5	13.9

Table 5 - Hymenoptera

Table 5. Number of species and individuals of the order Hymenoptera sampled in primary and secondary forest, canopy and understorey. Mean, sd and 95% confidence intervals. Sd = standard deviation

Species	Total	Mean	sd	95% conf.	min	max
Primary canopy	302	15.1	9.43	1.1	14.0	16.2
Primary understorey	274	13.7	8.45	1.0	12.7	14.7
Primary total	576	14.4	8.87	0.7	13.7	15.1
Secondary canopy	259	12.95	7.04	0.9	12.1	13.8
Secondary understorey	254	12.7	6.19	0.8	11.9	13.5
Secondary total	513	12.825	6.55	0.6	12.3	13.4

Individuals	Total	Mean	sd	95% conf.	min	max
Primary canopy	374	18.7	12.94	1.3	17.4	20.0
Primary understorey	368	18.4	11.66	1.2	17.2	19.6
Primary total	742	18.55	12.16	0.9	17.7	19.4
Secondary canopy	313	15.65	11.56	1.3	14.4	16.9
Secondary understorey	325	16.25	7.82	0.9	15.4	17.1
Secondary total	638	15.95	9.75	0.8	15.2	16.7

Table 6

Table 6. Calculations for G-test (likelihood ratio test) of species between the two sampling locations in each site. G-test in Biometry section 17.1 (Sokal & Rohlf, 1995)

	f	f/n	p & q (exp)	f (exp)	f/f (exp)	sum = ln L	G	P
1A	527	0.4756	0.5	554	0.9513	-26.3311		
2A	581	0.5244	0.5	554	1.0487	27.6475		
sum	1108	1.0000	1	1108		1.3164	2.6328	>0.05
1B	676	0.5719	0.5	591	1.1438	90.8389		
2B	506	0.4281	0.5	591	0.8562	-78.5714		
sum	1182	1.0000	1	1182		12.2675	24.5351	<0.001
4A	556	0.5382	0.5	516.5	1.0765	40.9733		
5A	477	0.4618	0.5	516.5	0.9235	-37.9495		
sum	1033	1.0000	1	1033		3.0238	6.0475	<0.025
4B	523	0.4971	0.5	526	0.9943	-2.9914		
5B	529	0.5029	0.5	526	1.0057	3.0085		
sum	1052	1.0000	1	1052		0.0171	0.0342	>0.05

Table7

Table 7. Calculations for G-test (likelihood ratio test) of individuals between the two sampling locations in each site. G-test in Biometry section 17.1 (Sokal & Rohlf, 1995)

	f	f/n	p & q (exp)	f (exp)	f/f (exp)	sum = ln L	G	P
1A	662	0.4922	0.5	672.5	0.9844	-10.4176		
2A	683	0.5078	0.5	672.5	1.0156	10.5815		
sum	1345	1.0000	1	1345		0.1639	0.3279	>0.05
1B	800	0.5413	0.5	739	1.0825	63.4510		
2B	678	0.4587	0.5	739	0.9175	-58.4101		
sum	1478	1.0000	1	1478		5.0409	10.0818	<0.005
4A	701	0.4951	0.5	708	0.9901	-6.9653		
5A	715	0.5049	0.5	708	1.0099	7.0345		
sum	1416	1.0000	1	1416		0.0692	0.1384	>0.05
4B	615	0.4628	0.5	664.5	0.9255	-47.6088		
5B	714	0.5372	0.5	664.5	1.0745	51.2995		
sum	1329	1.0000	1	1329		3.6908	7.3816	<0.01

Table 8. Assumptions of ANOVA. Test for serial independence.

Critical values found in Table HH with n=10.

Species total			Individuals total		
Site	|1-h/2|	P	Site	|1-h/2|	P
1A	0.407	>0.05	1A	0.23	>0.05
2A	0.01	>0.05	2A	0.089	>0.05
1B	0.282	>0.05	1B	0.209	>0.05
2B	0.251	>0.05	2B	0.15	>0.05
4A	0.172	>0.05	4A	0.214	>0.05
5A	0.378	>0.05	5A	0.062	>0.05
4B	0.516	>0.05	4B	0.223	>0.05
5B	0.34	>0.05	5B	0.076	>0.05

Coleoptera species			Coleoptera individuals			Diptera species			Diptera individuals		
Site	|1-h/2|	P	Site	|1-h/2|	P	Site	|1-h/2|	P	Site	|1-h/2|	P
1A	0.448	>0.05	1A	0.431	>0.05	1A	0.327	>0.05	1A	0.423	>0.05
2A	0.202	>0.05	2A	0.144	>0.05	2A	0.377	>0.05	2A	0.519	>0.05
1B	0.238	>0.05	1B	0.12	>0.05	1B	0.141	>0.05	1B	0.311	>0.05
2B	0.006	>0.05	2B	0.438	>0.05	2B	0.583	P=0.036	2B	0.37	>0.05
4A	0.085	>0.05	4A	0.063	>0.05	4A	0.014	>0.05	4A	0.162	>0.05
5A	0.462	>0.05	5A	0.47	>0.05	5A	0.311	>0.05	5A	0.411	>0.05
4B	0.312	>0.05	4B	0.255	>0.05	4B	0.022	>0.05	4B	0.189	>0.05
5B	0.125	>0.05	5B	0.306	>0.05	5B	0.043	>0.05	5B	0.106	>0.05

Hemiptera species			Hemiptera individuals			Hymenoptera species			Hymenoptera individuals		
Site	|1-h/2|	P	Site	|1-h/2|	P	Site	|1-h/2|	P	Site	|1-h/2|	P
1A	0.278	>0.05	1A	0.125	>0.05	1A	0.116	>0.05	1A	0.07	>0.05
2A	0.131	>0.05	2A	0.023	>0.05	2A	0.048	>0.05	2A	0.098	>0.05
1B	0.084	>0.05	1B	0.083	>0.05	1B	0.324	>0.05	1B	0.073	>0.05
2B	0.111	>0.05	2B	0.221	>0.05	2B	0.022	>0.05	2B	0.02	>0.05
4A	0.014	>0.05	4A	0.045	>0.05	4A	0.368	>0.05	4A	0.27	>0.05
5A	0.148	>0.05	5A	0.323	>0.05	5A	0.216	>0.05	5A	0.222	>0.05
4B	0.099	>0.05	4B	0.046	>0.05	4B	0.574	P=0.039	4B	0.538	>0.05
5B	0.035	>0.05	5B	0.022	>0.05	5B	0.129	>0.05	5B	0.379	>0.05

Table 9. Tests for homogenity of variances. Critical Values were

compared with Table G (Sokal & Rohlf. 1995) for Fmax0.05[8.9]. s2 = variance.

Species					**Individuals**				
	stdev	s2				stdev	s2		
1A	11.334	128.46	s2max=	468.27	1A	12.865	165.51	s2max=	943.21
1B	10.469	109.6	s2min=	61.123	1B	12.454	155.11	s2min=	94.055
2A	14.881	221.43			2A	16.945	287.12		
2B	17.989	323.6	max ratio	7.6611	2B	28.421	807.73	max ratio	10.028
4A	21.64	468.27			4A	30.712	943.21		
4B	7.8181	61.123	P>0.05		4B	9.6982	94.055	0.05>P>0.01	
5A	12.658	160.23			5A	23.557	554.95	(P=0.042)	
5B	10.214	104.32			5B	14.63	214.05		

Coleoptera species					Coleoptera individuals				
1A	3.504	12.278	s2max=	83.344	1A	3.3349	11.122	s2max=	117.07
1B	3.2728	10.711	s2min=	4.2779	1B	2.7406	7.5109	s2min=	6.8267
2A	3.199	10.234			2A	3.6652	13.434		
2B	4.0947	16.767	max ratio	19.482	2B	9.4921	90.1	max ratio	17.149
4A	9.1293	83.344			4A	10.82	117.07		
4B	2.0683	4.2779	P<0.01		4B	2.6128	6.8267	P<0.01	
5A	3.8115	14.528			5A	4.3525	18.944		
5B	4	16			5B	4	16		

Diptera species					Diptera individuals				
1A	5.3996	29.156	s2max=	86.178	1A	9.1098	82.988	s2max=	307.21
1B	3.0569	9.3446	s2min=	9.3446	1B	3.802	14.455	s2min=	14.455
2A	5.0596	25.6			2A	6.3246	40.001		
2B	7.6503	58.527	max ratio	9.2222	2B	15.471	239.36	max ratio	21.253
4A	5.0288	25.289			4A	10.298	106.04		
4B	9.2832	86.178	0.05>P>0.01		4B	12.148	147.57	P<0.01	
5A	3.2998	10.889	(P=0.048)		5A	15.803	249.73		
5B	6.0928	37.122			5B	17.527	307.21		

Hemiptera species					Hemiptera individuals				
1A	5.0376	25.377	s2max=	56.456	1A	9.1263	83.289	s2max=	90.455
1B	5.6382	31.789	s2min=	9.1222	1B	9.5108	90.455	s2min=	14.9
2A	6.5115	42.4			2A	7.3364	53.823		
2B	3.0203	9.1222	max ratio	6.1889	2B	3.8601	14.9	max ratio	6.0708
4A	7.5137	56.456			4A	9.0068	81.122		
4B	5.7242	32.766	P>0.05		4B	8.7331	76.267	P>0.05	
5A	4.6679	21.789			5A	5.1164	26.178		
5B	4.3728	19.121			5B	4.2439	18.011		

Hymenoptera species

Hymenoptera individuals

1A	2.7508	7.5669	s2max=	77.405	1A	2.9833	8.9001	s2max=	237.34
1B	7.6776	58.946	s2min=	7.5669	1B	10.013	100.27	s2min=	8.9001
2A	8.798	77.405			2A	11.066	122.46		
2B	4.1486	17.211	max ratio	10.229	2B	8.5464	73.041	max ratio	26.667
4A	8.2496	68.056			4A	15.406	237.34		
4B	4.3919	19.289	0.05>P>0.01		4B	5.2926	28.012	P<0.01	
5A	6.0222	36.267	(P=0.04)		5A	6.6866	44.711		
5B	7.321	53.597			5B	8.1486	66.4		

Table 10. Test for normality of variances of species and individuals total

and the four main orders. Kolmogorov-Smoirnov test for one sample.

	Site	Dmax	P		Site	Dmax	P
Species Total	1A	0.32	<0.005	Individuals Total	1A	0.1	1
	1B	0.18	0.57		1B	0.13	1
	2A	0.14	0.41		2A	0.12	1
	2B	0.1	1		2B	0.13	1
	4A	0.21	0.25		4A	0.2	0.3
	4B	0.23	0.16		4B	0.16	0.78
	5A	0.15	0.88		5A	0.21	0.27
	5B	0.12	1		5B	0.14	1
Coleoptera Species	1A	0.24	0.10	Coleoptera Individuals	1A	0.26	0.05
	1B	0.13	1.0		1B	0.23	0.15
	2A	0.14	1.0		2A	0.18	0.51
	2B	0.16	0.79		2B	0.30	0.01
	4A	0.24	0.10		4A	0.25	0.07
	4B	0.20	0.30		4B	0.17	0.61
	5A	0.31	0.01		5A	0.33	0.01
	5B	0.14	1.0		5B	0.14	1.0
Diptera Species	1A	0.17	0.64	Diptera Individuals	1A	0.20	0.38
	1B	0.16	0.78		1B	0.23	0.14
	2A	0.15	0.99		2A	0.14	1.0
	2B	0.16	0.85		2B	0.20	0.39
	4A	0.28	0.03		4A	0.24	0.11
	4B	0.35	0.00		4B	0.28	0.03
	5A	0.12	1.0		5A	0.16	0.85
	5B	0.15	0.99		5B	0.25	0.08
Hemiptera Species	1A	0.13	1.0	Hemiptera Individuals	1A	0.17	0.64
	1B	0.24	0.09		1B	0.21	0.26
	2A	0.17	0.71		2A	0.17	0.55
	2B	0.21	0.27		2B	0.13	1.0
	4A	0.24	0.12		4A	0.23	0.17
	4B	0.23	0.15		4B	0.14	1.0
	5A	0.19	0.44		5A	0.21	0.27
	5B	0.24	0.12		5B	0.23	0.15
Hymenoptera Species	1A	0.26	0.34	Hymenoptera Individuals	1A	0.26	0.05
	1B	0.23	0.16		1B	0.18	0.49
	2A	0.19	0.44		2A	0.18	0.51
	2B	0.19	0.89		2B	0.19	0.48
	4A	0.32	0.00		4A	0.42	0.00
	4B	0.26	0.06		4B	0.20	0.36
	5A	0.29	0.02		5A	0.18	0.58
	5B	0.19	0.47		5B	0.14	1.0

Table 11. One way ANOVA's for species total

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	525.3125	525.3125	0.1624	0.6880	0.002
Error	79	255501.6875	3234.1986			
Total	80	256027				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	108.1125	108.1125	0.0334	0.8555	0.000
Error	79	255918.8875	3239.4796			
Total	80	256027				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Sites	3	994.9375	331.6458	0.1001	0.9597	0.004
Error	77	255032.0625	3312.1047			
Total	80	256027				

Table 12. One way ANOVA's for individuals total

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	76.050	76.050	0.0144	0.9049	0.000
Error	79	418425.950	5296.5310			
Total	80	418502				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	26.45	26.45	0.0050	0.9438	0.000
Error	79	418475.55	5297.1589			
Total	80	418502				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Sites	3	650.30	216.7667	0.0399	0.9893	0.002
Error	77	417851.70	5426.6455			
Total	80	418502				

Table 13 One way ANOVA's for Coleoptera species

Source of	Degrees of	Sum of	Mean	F- Ratio	P	R^2

variation	freedom *df*	squares SS	Square MS			
Forest type	1	6.6125	6.6125	0.0874	0.7683	0.001
Error	79	5978.3875	75.6758			
Total	80	5985				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	23.1125	23.1125	0.3063	0.5815	0.004
Error	79	5961.8875	75.4669			
Total	80	5985				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Sites	3	153.3375	51.1125	0.6749	0.5701	0.026
Error	77	5831.6625	75.7359			
Total	80	5985				

Table 14. One way ANOVA’s for Coleoptera individuals

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	46.5125	46.5125	0.4480	0.5053	0.006
Error	79	8202.4875	103.8290			
Total	80	8249				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	74.1125	74.1125	0.7162	0.3999	0.009
Error	79	8174.8875	103.4796			
Total	80	8249				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Sites	3	190.0375	63.3458	0.6052	0.6136	0.023
Error	77	8058.9625	104.6619			
Total	80	8249				

Table 15. One way ANOVA’s for Diptera species

Source of	Degrees of	Sum of	Mean	F- Ratio	P	R^2

variation	freedom df	squares SS	Square MS			
Forest type	1	137.8125	137.8125	0.3621	0.5491	0.005
Error	79	30065.1875	380.5720			
Total	80	30203				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	1.0125	1.0125	0.0026	0.9591	0.000
Error	79	30201.9875	382.3036			
Total	80	30203				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Sites	3	251.4375	83.8125	0.2155	0.8854	0.008
Error	77	29951.5625	388.9813			
Total	80	30203				

Table 16. One way ANOVA's for Diptera individuals

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	2080.80	2080.80	2.4174	0.1240	0.030
Error	79	68001.20	860.7747			
Total	80	70082				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	76.050	76.050	0.0858	0.7703	0.001
Error	79	70005.95	886.1513			
Total	80	70082				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Sites	3	3787.70	1262.5667	1.4665	0.2303	0.054
Error	77	66294.30	860.9649			
Total	80	70082				

Table 17. One way ANOVA's for Hemiptera species

Source of	Degrees of	Sum of	Mean	F- Ratio	P	R^2

variation	freedom df	squares SS	Square MS			
Forest type	1	540.80	540.80	2.2632	0.1365	0.028
Error	79	18877.20	238.9519			
Total	80	19418				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	33.80	33.80	0.1378	0.7115	0.002
Error	79	19384.20	245.3696			
Total	80	19418				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Sites	3	950.50	316.8333	1.3210	0.2737	0.049
Error	77	18467.50	239.8377			
Total	80	19418				

Table 18. One way ANOVA's for Hemiptera individuals

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	1155.20	1155.20	3.2111	0.0770	0.039
Error	79	28420.80	359.7570			
Total	80	29576				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	2.450	2.450	0.0065	0.9357	0.000
Error	79	29573.550	374.3487			
Total	80	29576				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Sites	3	2250.60	750.20	2.1140	0.1053	0.076
Error	77	27325.40	354.8753			
Total	80	29576				

Table 19. One way ANOVA's for Hymenoptera species

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	49.6125	49.6125	0.2003	0.6557	0.003

Error	79	19563.3875	247.6378			
Total	80	19613				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	13.6125	13.6125	0.0549	0.8154	0.001
Error	79	19599.3875	248.0935			
Total	80	19613				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Sites	3	114.8375	38.2792	0.1512	0.9286	0.006
Error	77	19498.1625	253.2229			
Total	80	19613				

Table 20. One way ANOVA's for Hymenoptera individuals

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	110.450	110.450	0.2572	0.6134	0.003
Error	79	33919.550	429.3614			
Total	80	34030				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	3.20	3.20	0.0074	0.9315	0.000
Error	79	34026.80	430.7190			
Total	80	34030				

Source of variation	Degrees of freedom df	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Sites	3	382.45	127.4833	0.2917	0.8312	0.011
Error	77	33647.550	436.9812			
Total	80	34030				

Table 21. Species total Two way ANOVA's for Forest type vs. storey, Storey vs. sites, Forest type vs. sites (nested within forest type) and for Storey vs. sites for primary and secondary separately.

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	525.3125	525.3125	0.1584	0.6917	0.003
Storey	1	108.1125	108.1125	0.0326	0.8572	

Interaction	1	37.8125	37.8125	0.0114	0.9152	
Error	77	255355.7625	3316.3086			
Total	80	256027				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	108.1125	108.1125	0.0311	0.8604	0.010
Sites	3	994.9375	331.6458	0.0955	0.9623	
Interaction	3	1472.8375	490.9458	0.1414	0.9348	
Error	73	253451.1125	3471.9330			
Total	80	256027				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	525.3125	525.3125	2.5309	0.1158	0.059
Sites (nested within forest type)	2	469.6250	234.8125	1.1313	0.3280	
Error	76	15774.2500	207.5559			
Total	79	16769.1875				

Primary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	136.9000	136.9000	0.0367	0.8492	0.012
Sites	1	336.4000	336.4000	0.0901	0.7657	
Interaction	1	1254.4000	1254.4000	0.3360	0.5657	
Error	37	138150.3000	3733.7919			
Total	40	139878				

Secondary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	9.0250	9.0250	0.0029	0.9575	0.003
Sites	1	133.2250	133.2250	0.0426	0.8377	
Interaction	1	180.6250	180.6250	0.0577	0.8115	
Error	37	115826.1250	3130.4358			
Total	40	116149				

Table 22. Individuals total Two way ANOVA's for Forest type vs. storey, Storey vs. sites, Forest type vs. sites (nested within forest type) and for Storey vs. sites for primary and secondary separately.

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	76.0500	76.0500	0.0140	0.9061	0.002
Storey	1	26.4500	26.4500	0.0049	0.9445	

Interaction	1	605.0000	605.0000	0.1115	0.7393	
Error	77	417794.5000	5425.9026			
Total	80	418502				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	26.4500	26.4500	0.0046	0.9459	0.005
Sites	3	650.3000	216.7667	0.0380	0.9900	
Interaction	3	1296.8500	432.2833	0.0758	0.9729	
Error	73	416528.4000	5705.8685			
Total	80	418502				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	76.0500	76.0500	0.1906	0.6636	0.021
Sites (nested within forest type)	2	574.2500	287.1250	0.7197	0.4902	
Error	76	30318.9000	398.9329			
Total	79	30969.2				

Primary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	442.2250	442.2250	0.0772	0.7827	0.006
Sites	1	255.0250	255.0250	0.0445	0.8341	
Interaction	1	511.2250	511.2250	0.0892	0.7668	
Error	37	211972.5250	5728.9872			
Total	40	213181				

Secondary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	189.2250	189.2250	0.0342	0.8543	0.003
Sites	1	319.2250	319.2250	0.0577	0.8115	
Interaction	1	180.6250	180.6250	0.0327	0.8576	
Error	37	204631.9250	5530.5926			
Total	40	205321				

Table 23. Coleoptera species. Two way ANOVA's for Forest type vs. storey, Storey vs. sites, Forest type vs. sites (nested within forest type) and for Storey vs. sites for primary and secondary separately.

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	6.6125	6.6125	0.0874	0.7682	0.027
Storey	1	23.1125	23.1125	0.3056	0.5820	
Interaction	1	132.6125	132.6125	1.7537	0.1893	

Error	77	5822.6625	75.6190			
Total	80	5985				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	23.1125	23.1125	0.3002	0.5855	0.061
Sites	3	153.3375	51.1125	0.6638	0.5770	
Interaction	3	187.5375	62.5125	0.8118	0.4914	
Error	73	5621.0125	77.0002			
Total	80	5985				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	6.6125	6.6125	0.2862	0.5942	0.080
Sites (nested within forest type)	2	146.7250	73.3625	3.1749	0.0474	
Error	76	1756.1500	23.1072			
Total	79	1909.4875				

Primary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	133.2250	133.6250	1.8565	0.1813	0.065
Sites	1	50.6250	50.6250	0.7055	0.4063	
Interaction	1	2.0250	2.0250	0.0282	0.8675	
Error	37	2655.1250	71.7601			
Total	40	2841				

Secondary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	22.5000	22.5000	0.2801	0.5998	0.055
Sites	1	96.1000	96.1000	1.1962	0.2812	
Interaction	1	52.9000	52.9000	0.6585	0.4223	
Error	37	2972.500	80.3378			
Total	40	3144				

Table 24. Coleoptera individuals Two way ANOVA's for Forest type vs. storey, Storey vs. sites, Forest type vs. sites (nested within forest type) and for Storey vs. sites for primary and secondary separately.

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	46.5125	46.5125	0.4580	0.5006	0.052
Storey	1	74.1125	74.1125	0.7297	0.3956	
Interaction	1	308.1125	308.1125	3.0337	0.0855	

Error	77	7820.2625	101.5619			
Total	80	8249				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	74.1125	74.1125	0.7107	0.4020	0.077
Sites	3	190.0375	63.3458	0.6074	0.6123	
Interaction	3	371.8375	123.9458	1.1885	0.3201	
Error	73	7613.0125	104.2878			
Total	80	8249				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	46.5125	46.5125	1.1835	0.2801	0.060
Sites (nested within forest type)	2	143.5250	71.7625	1.8260	0.1681	
Error	76	2986.8500	39.3007			
Total	79	3176.8875				

Primary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	342.2250	342.2250	3.0552	0.0888	0.081
Sites	1	21.0250	21.0250	0.1877	0.6674	
Interaction	1	1.2250	1.2250	0.0109	0.9173	
Error	37	4144.5250	112.0142			
Total	40	4509				

Secondary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	40.000	40.000	0.4211	0.5204	0.060
Sites	1	122.5000	12.5000	1.2895	0.2634	
Interaction	1	62.5000	62.5000	0.6579		
Error	37	3515.000	95.000			
Total	40	3740				

Table 25. Diptera species Two way ANOVA's for Forest type vs. storey, Storey vs. sites, Forest type vs. sites (nested within forest type) and for Storey vs. sites for primary and secondary separately.

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	137.8125	137.8125	0.3530	0.5542	0.005
Storey	1	1.0125	1.0125	0.0026	0.9595	
Interaction	1	0.3125	0.3125	0.0008	0.9775	

Error	77	30063.8625	390.4398			
Total	80	30203				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	1.0125	1.0125	0.0025	0.9603	0.021
Sites	3	251.4375	83.8125	0.2069	0.8913	
Interaction	3	374.7375	124.9125	0.3083	0.8193	
Error	73	29575.8125	405.1481			
Total	80	30203				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	137.8125	137.8125	3.2029	0.0775	0.071
Sites (nested within forest type)	2	113.6250	56.8125	1.3204	0.2731	
Error	76	3270.0500	43.0270			
Total	79	3521.4875				

Primary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	0.1000	0.1000	0.0003	0.9866	0.026
Sites	1	14.4000	14.4000	0.0411	0.8404	
Interaction	1	336.4000	336.4000	0.9611	0.3333	
Error	37	12951.1000	350.0297			
Total	40	13302				

Secondary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	1.2250	1.2250	0.0027	0.9588	0.008
Sites	1	99.2250	99.2250	0.2190	0.6425	
Interaction	1	38.0250	38.0250	0.0839	0.7737	
Error	37	16762.5250	453.0412			
Total	40	16901				

Table 26. Diptera individuals Two way ANOVA's for Forest type vs. storey, Storey vs. sites, Forest type vs. sites (nested within forest type) and for Storey vs. sites for primary and secondary separately.

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	2080.8000	2080.8000	2.3733	0.1275	0.037
Storey	1	76.0500	76.0500	0.0867	0.7692	
Interaction	1	414.0500	414.0500	0.4722	0.4940	

Error	77	67511.1000	876.7675			
Total	80	70082				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	76.0500	76.0500	0.0857	0.7705	0.076
Sites	3	3787.7000	1262.5667	1.4231	0.2429	
Interaction	3	1454.8500	484.9500	0.5466	0.6520	
Error	73	64763.400	887.1699			
Total	80	70082				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	2080.8000	2080.8000	12.3196	0.0008	0.228
Sites (nested within forest type)	2	1706.9000	853.4500	5.0530	0.0087	
Error	76	12836.5000	168.9013			
Total	79	16624.2				

Primary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	67.6000	67.6000	0.1178	0.7334	0.050
Sites	1	16.9000	16.9000	0.0294	0.8647	
Interaction	1	1040.4000	1040.4000	1.8130	0.1863	
Error	37	21233.1000	573.8676			
Total	40	22358				

Secondary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	422.5000	422.5000	0.3427	0.5618	0.044
Sites	1	1690.000	1690.000	1.3709	0.2491	
Interaction	1	0.4000	0.4000	0.0003	0.9857	
Error	37	45611.100	1232.7324			
Total	40	47724				

Table 27. Hemiptera species Two way ANOVA's for Forest type vs. storey, Storey vs. sites, Forest type vs. sites (nested within forest type) and for Storey vs. sites for primary and secondary separately.

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	540.8000	540.8000	2.2118	0.1410	0.030
Storey	1	33.8000	33.8000	0.1382	0.7111	
Interaction	1	16.2000	16.2000	0.0663	0.7976	

Error	77	18827.2000	244.5091			
Total	80	19418				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	33.8000	33.8000	0.1350	0.7144	0.059
Sites	3	950.5000	316.8333	1.2652	0.2927	
Interaction	3	153.1000	51.0333	0.2038	0.8935	
Error	73	18280.6000	250.4192			
Total	80	19418				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	540.8000	540.8000	17.5923	0.0001	0.289
Sites (nested within forest type)	2	409.7000	204.8500	6.6638	0.0022	
Error	76	2336.3000	30.7408			
Total	79	3286.8				

Primary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	1.6000	1.6000	0.0048	0.9450	0.018
Sites	1	96.1000	96.1000	0.2898	0.5935	
Interaction	1	122.5000	122.5000	0.3695	0.5470	
Error	37	12267.8000	331.5622			
Total	40	12488				

Secondary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	48.4000	48.4000	0.2733	0.6043	0.054
Sites	1	313.6000	313.6000	1.7705	0.1915	
Interaction	1	14.4000	14.4000	0.0813	0.7771	
Error	37	6553.6000	177.1243			
Total	40	6930				

Table 28. Hemiptera individuals Two way ANOVA's for Forest type vs. storey, Storey vs. sites, Forest type vs. sites (nested within forest type) and for Storey vs. sites for primary and secondary separately.

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	1155.2000	1155.2000	3.1493	0.0799	0.045
Storey	1	2.4500	2.4500	0.0067	0.9351	
Interaction	1	174.0500	174.0500	0.4745	0.4930	

Error	77	28244.3000	366.8091			
Total	80	29576				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	2.4500	2.4500	0.0066	0.9355	0.083
Sites	3	2250.6000	750.2000	2.0196	0.1186	
Interaction	3	206.5500	68.8500	0.1854	0.9060	
Error	73	27116.4000	371.4575			
Total	80	29576				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	1155.2000	1155.2000	20.8768	0.0000	0.349
Sites (nested within forest type)	2	1095.4000	547.7000	9.8980	0.0002	
Error	76	4205.4000	55.3342			
Total	79	6456				

Primary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	67.6000	67.6000	0.1283	0.7222	0.031
Sites	1	562.5000	562.5000	1.0680	0.3081	
Interaction	1	0.1000	0.1000	0.0002	0.9891	
Error	37	19487.8000	526.6973			
Total	40	20118				

Secondary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	108.9000	108.9000	0.4587	0.5024	0.071
Sites	1	532.9000	532.9000	2.2447	0.1426	
Interaction	1	32.4000	32.4000	0.1365	0.7139	
Error	37	8783.8000	237.4000			
Total	40	9458				

Table 29. Hymenoptera species Two way ANOVA's for Forest type vs. storey, Storey vs. sites, Forest type vs. sites (nested within forest type) and for Storey vs. sites for primary and secondary separately.

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	49.6125	49.6125	0.1955	0.6596	0.004
Storey	1	13.6125	13.6125	0.0536	0.8175	
Interaction	1	6.6125	6.6125	0.0261	0.8722	
Error	77	19543.1625	253.8073			

Total	80	19613				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	13.6125	13.6125	0.0556	0.8142	0.089
Sites	3	114.8375	38.2792	0.1564	0.9253	
Interaction	3	1615.2375	538.4125	2.1995	0.0954	
Error	73	17869.3125	244.7851			
Total	80	19613				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	49.6125	49.6125	0.8067	0.3719	0.024
Sites (nested within forest type)	2	65.2250	32.6125	0.5303	0.5906	
Error	76	4674.1500	61.5020			
Total	79	4788.9875				

Primary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	19.6000	19.6000	0.0744	0.7865	0.142
Sites	1	10.0000	10.0000	0.0380	0.8466	
Interaction	1	1587.6000	1587.6000	6.0280	0.0189	
Error	37	9744.8000	263.3730			
Total	40	11362				

Secondary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	0.6250	0.6250	0.0028	0.9579	0.009
Sites	1	55.2250	55.2250	0.2500	0.6201	
Interaction	1	21.0250	21.0250	0.0952	0.7594	
Error	37	8174.1250	220.9223			
Total	40	8251				

Table 30. Hymenoptera individuals Two way ANOVA's for Forest type vs. storey, Storey vs. sites, Forest type vs. sites (nested within forest type) and for Storey vs. sites for primary and secondary separately.

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	110.4500	110.4500	0.2508	0.6179	0.004
Storey	1	3.2000	3.2000	0.0073	0.9323	
Interaction	1	9.8000	9.8000	0.0223	0.8818	

Error	77	33906.5500	440.3448			
Total	80	34030				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	3.2000	3.2000	0.0077	0.9305	0.105
Sites	3	382.4500	127.4833	0.3054	0.8214	
Interaction	3	3170.7000	1056.9000	2.5318	0.0636	
Error	73	30473.6500	417.4473			
Total	80	34030				

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Forest type	1	110.4500	110.4500	0.8839	0.3501	0.039
Sites (nested within forest type)	2	272.0000	136.0000	1.0884	0.3419	
Error	76	9496.3000	124.9513			
Total	79	9878.75				

Primary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	0.9000	0.9000	0.0020	0.9644	0.156
Sites	1	78.4000	78.4000	0.1759	0.6774	
Interaction	1	2958.4000	2958.4000	6.6371	0.0141	
Error	37	16492.3000	445.7378			
Total	40	19530				

Secondary

Source of variation	Degrees of freedom *df*	Sum of squares SS	Mean Square MS	F- Ratio	P	R^2
Storey	1	12.1000	12.1000	0.0318	0.8595	0.028
Sites	1	193.6000	193.6000	0.5083	0.4803	
Interaction	1	202.5000	202.5000	0.5317	0.4705	
Error	37	14091.8000	380.8595			
Total	40	14500				

Appendices

Appendix 1. Total number of species and individuals collected in Danum Valley from august 19th to october 27th 1999, (1A & 2A = primary canopy, 1B & 2B = primary understorey, 4A & 5A = secondary canopy, 4B & 5B = secondary understorey).

Site	date	No. Species	No. Individuals
1A	19/08/1999	62	83
1A	29/08/1999	52	76
1A	01/09/1999	47	71
1A	03/09/1999	36	42
1A	08/09/1999	52	62
1A	11/09/1999	52	69
1A	18/09/1999	45	65
1A	20/09/1999	51	59
1A	09/10/1999	51	53
1A	27/10/1999	79	82
1B	19/08/1999	55	75
1B	29/08/1999	67	83
1B	01/09/1999	56	63
1B	03/09/1999	76	89
1B	08/09/1999	88	103
1B	11/09/1999	74	79
1B	18/09/1999	70	85
1B	20/09/1999	55	64
1B	09/10/1999	68	89
1B	27/10/1999	67	70
2A	19/08/1999	56	70
2A	29/08/1999	80	92
2A	01/09/1999	55	62
2A	03/09/1999	64	72
2A	08/09/1999	54	64
2A	11/09/1999	66	76
2A	18/09/1999	78	96
2A	20/09/1999	34	48
2A	09/10/1999	38	43
2A	27/10/1999	56	60
2B	19/08/1999	38	73
2B	29/08/1999	55	58
2B	01/09/1999	28	32
2B	03/09/1999	52	121
2B	08/09/1999	78	95
2B	11/09/1999	73	89
2B	18/09/1999	66	71
2B	20/09/1999	25	29
2B	09/10/1999	42	56
2B	27/10/1999	49	54
4A	19/08/1999	42	57
4A	29/08/1999	80	116
4A	01/09/1999	29	33
4A	03/09/1999	55	75
4A	08/09/1999	78	97
4A	11/09/1999	94	118
4A	18/09/1999	31	36
4A	20/09/1999	50	62
4A	09/10/1999	46	51
4A	27/10/1999	51	56

4B	19/08/1999	40	45
4B	29/08/1999	59	74
4B	01/09/1999	57	65
4B	03/09/1999	60	71
4B	08/09/1999	60	67
4B	11/09/1999	60	70
4B	18/09/1999	49	56
4B	20/09/1999	50	52
4B	09/10/1999	44	52
4B	27/10/1999	44	63
5A	19/08/1999	50	93
5A	29/08/1999	47	72
5A	01/09/1999	39	43
5A	03/09/1999	66	90
5A	08/09/1999	55	101
5A	11/09/1999	37	76
5A	18/09/1999	34	48
5A	20/09/1999	69	98
5A	09/10/1999	33	43
5A	27/10/1999	47	51
5B	19/08/1999	59	77
5B	29/08/1999	47	70
5B	01/09/1999	45	55
5B	03/09/1999	56	69
5B	08/09/1999	71	81
5B	11/09/1999	38	49
5B	18/09/1999	53	64
5B	20/09/1999	65	96
5B	09/10/1999	43	89
5B	27/10/1999	52	64
Total		**4375**	**5568**

Appendix 2. Number of species and individuals distributed on order collected in Danum Valley,
august to october 1999.

Site	date	order	No. Species	No. Individuals
1A	19/08/1999	Araneae	1	1
1A	19/08/1999	Coleoptera	7	7

1A	19/08/1999	Diptera	30	45
1A	19/08/1999	Hemiptera	19	25
1A	19/08/1999	Hymenoptera	5	5
1A	29/08/1999	Araneae	1	1
1A	29/08/1999	Coleoptera	4	4
1A	29/08/1999	Diptera	18	24
1A	29/08/1999	Hemiptera	20	38
1A	29/08/1999	Hymenoptera	9	9
1A	01/09/1999	Araneae	3	3
1A	01/09/1999	Coleoptera	3	4
1A	01/09/1999	Diptera	21	23
1A	01/09/1999	Hemiptera	11	32
1A	01/09/1999	Hymenoptera	9	9
1A	03/09/1999	Araneae	1	1
1A	03/09/1999	Coleoptera	6	6
1A	03/09/1999	Diptera	13	13
1A	03/09/1999	Hemiptera	9	13
1A	03/09/1999	Hymenoptera	6	8
1A	03/09/1999	Thysanoptera	1	1
1A	08/09/1999	Coleoptera	9	9
1A	08/09/1999	Diptera	16	19
1A	08/09/1999	Hemiptera	13	19
1A	08/09/1999	Hymenoptera	14	15
1A	11/09/1999	Araneae	2	2
1A	11/09/1999	Coleoptera	4	4
1A	11/09/1999	Diptera	16	16
1A	11/09/1999	Hemiptera	22	39
1A	11/09/1999	Hymenoptera	8	8
1A	18/09/1999	Araneae	1	1
1A	18/09/1999	Coleoptera	4	5
1A	18/09/1999	Diptera	18	19
1A	18/09/1999	Hemiptera	14	32
1A	18/09/1999	Hymenoptera	8	8
1A	20/09/1999	Coleoptera	6	6
1A	20/09/1999	Diptera	25	30
1A	20/09/1999	Hemiptera	15	18
1A	20/09/1999	Hymenoptera	5	5
1A	09/10/1999	Coleoptera	7	7
1A	09/10/1999	Diptera	20	21
1A	09/10/1999	Hemiptera	16	17
1A	09/10/1999	Hymenoptera	8	8
1A	27/10/1999	Coleoptera	15	15
1A	27/10/1999	Diptera	27	29
1A	27/10/1999	Hemiptera	25	25
1A	27/10/1999	Hymenoptera	11	12
1A	27/10/1999	Thysanoptera	1	1
1B	19/08/1999	Araneae	2	2
1B	19/08/1999	Coleoptera	8	13
1B	19/08/1999	Diptera	12	15
1B	19/08/1999	Hemiptera	24	28
1B	19/08/1999	Hymenoptera	9	17

1B	29/08/1999	Araneae	1	1
1B	29/08/1999	Coleoptera	11	12
1B	29/08/1999	Diptera	14	14
1B	29/08/1999	Ephemeroptera	1	2
1B	29/08/1999	Hemiptera	19	21
1B	29/08/1999	Hymenoptera	18	30
1B	29/08/1999	Opiliones	1	1
1B	29/08/1999	Orthoptera	1	1
1B	29/08/1999	Thysanoptera	1	1
1B	01/09/1999	Araneae	5	5
1B	01/09/1999	Coleoptera	7	9
1B	01/09/1999	Diptera	21	23
1B	01/09/1999	Hemiptera	9	9
1B	01/09/1999	Hymenoptera	13	16
1B	01/09/1999	Orthoptera	1	1
1B	03/09/1999	Araneae	2	2
1B	03/09/1999	Coleoptera	12	12
1B	03/09/1999	Diptera	11	12
1B	03/09/1999	Hemiptera	17	17
1B	03/09/1999	Hymenoptera	33	45
1B	03/09/1999	Thysanoptera	1	1
1B	08/09/1999	Coleoptera	16	17
1B	08/09/1999	Diptera	15	20
1B	08/09/1999	Hemiptera	24	25
1B	08/09/1999	Hymenoptera	32	40
1B	08/09/1999	Thysanoptera	1	1
1B	11/09/1999	Araneae	2	2
1B	11/09/1999	Coleoptera	12	12
1B	11/09/1999	Diptera	15	16
1B	11/09/1999	Hemiptera	25	25
1B	11/09/1999	Hymenoptera	19	22
1B	11/09/1999	Orthoptera	1	2
1B	18/09/1999	Coleoptera	10	12
1B	18/09/1999	Diptera	18	21
1B	18/09/1999	Hemiptera	25	26
1B	18/09/1999	Hymenoptera	17	26
1B	20/09/1999	Coleoptera	6	8
1B	20/09/1999	Diptera	16	16
1B	20/09/1999	Hemiptera	17	21
1B	20/09/1999	Hymenoptera	16	19
1B	09/10/1999	Araneae	1	1
1B	09/10/1999	Coleoptera	9	11
1B	09/10/1999	Diptera	13	14
1B	09/10/1999	Hemiptera	27	45
1B	09/10/1999	Hymenoptera	16	17
1B	09/10/1999	Orthoptera	1	1
1B	27/10/1999	Araneae	1	1
1B	27/10/1999	Coleoptera	15	16
1B	27/10/1999	Diptera	12	12
1B	27/10/1999	Hemiptera	16	16
1B	27/10/1999	Hymenoptera	22	24

1B	27/10/1999	Orthoptera	1	1
2A	19/08/1999	Araneae	1	1
2A	19/08/1999	Coleoptera	1	1
2A	19/08/1999	Diptera	23	27
2A	19/08/1999	Hemiptera	14	14
2A	19/08/1999	Hymenoptera	17	27
2A	29/08/1999	Araneae	1	1
2A	29/08/1999	Coleoptera	5	5
2A	29/08/1999	Diptera	16	19
2A	29/08/1999	Hemiptera	19	21
2A	29/08/1999	Hymenoptera	39	46
2A	01/09/1999	Coleoptera	3	3
2A	01/09/1999	Diptera	14	14
2A	01/09/1999	Hemiptera	20	22
2A	01/09/1999	Hymenoptera	18	23
2A	03/09/1999	Araneae	1	1
2A	03/09/1999	Coleoptera	6	6
2A	03/09/1999	Diptera	7	7
2A	03/09/1999	Hemiptera	26	27
2A	03/09/1999	Hymenoptera	23	30
2A	03/09/1999	Orthoptera	1	1
2A	08/09/1999	Araneae	1	1
2A	08/09/1999	Coleoptera	6	6
2A	08/09/1999	Diptera	15	15
2A	08/09/1999	Hemiptera	9	12
2A	08/09/1999	Hymenoptera	23	30
2A	11/09/1999	Araneae	1	1
2A	11/09/1999	Coleoptera	8	8
2A	11/09/1999	Diptera	9	10
2A	11/09/1999	Hemiptera	22	25
2A	11/09/1999	Hymenoptera	26	32
2A	18/09/1999	Araneae	1	1
2A	18/09/1999	Coleoptera	11	13
2A	18/09/1999	Diptera	11	11
2A	18/09/1999	Hemiptera	25	29
2A	18/09/1999	Hymenoptera	30	42
2A	20/09/1999	Araneae	1	1
2A	20/09/1999	Coleoptera	1	1
2A	20/09/1999	Diptera	7	8
2A	20/09/1999	Hemiptera	8	8
2A	20/09/1999	Hymenoptera	17	30
2A	09/10/1999	Araneae	2	2
2A	09/10/1999	Coleoptera	2	2
2A	09/10/1999	Diptera	14	18
2A	09/10/1999	Hemiptera	14	15
2A	09/10/1999	Hymenoptera	6	6
2A	27/10/1999	Araneae	2	2
2A	27/10/1999	Coleoptera	4	4
2A	27/10/1999	Diptera	18	21
2A	27/10/1999	Hemiptera	11	11
2A	27/10/1999	Hymenoptera	20	21

2A	27/10/1999	Orthoptera	1	1
2B	19/08/1999	Araneae	2	2
2B	19/08/1999	Coleoptera	5	35
2B	19/08/1999	Diptera	14	17
2B	19/08/1999	Hemiptera	11	12
2B	19/08/1999	Hymenoptera	7	7
2B	29/08/1999	Araneae	1	1
2B	29/08/1999	Coleoptera	11	11
2B	29/08/1999	Dictyoptera	1	1
2B	29/08/1999	Diptera	18	20
2B	29/08/1999	Hemiptera	14	15
2B	29/08/1999	Hymenoptera	10	10
2B	01/09/1999	Coleoptera	3	3
2B	01/09/1999	Diptera	13	16
2B	01/09/1999	Hemiptera	7	8
2B	01/09/1999	Hymenoptera	4	4
2B	01/09/1999	Thysanoptera	1	1
2B	03/09/1999	Araneae	2	2
2B	03/09/1999	Coleoptera	7	7
2B	03/09/1999	Diptera	22	61
2B	03/09/1999	Hemiptera	15	19
2B	03/09/1999	Hymenoptera	6	31
2B	03/09/1999	Thysanoptera	1	1
2B	08/09/1999	Araneae	4	4
2B	08/09/1999	Coleoptera	16	18
2B	08/09/1999	Diptera	26	37
2B	08/09/1999	Hemiptera	17	19
2B	08/09/1999	Hymenoptera	14	16
2B	08/09/1999	Orthoptera	1	1
2B	11/09/1999	Coleoptera	9	9
2B	11/09/1999	Diptera	38	48
2B	11/09/1999	Hemiptera	16	21
2B	11/09/1999	Hymenoptera	10	11
2B	18/09/1999	Araneae	1	1
2B	18/09/1999	Coleoptera	10	10
2B	18/09/1999	Diptera	25	29
2B	18/09/1999	Hemiptera	17	17
2B	18/09/1999	Hymenoptera	11	12
2B	18/09/1999	Orthoptera	1	1
2B	18/09/1999	Thysanoptera	1	1
2B	20/09/1999	Araneae	1	1
2B	20/09/1999	Coleoptera	10	10
2B	20/09/1999	Hemiptera	13	17
2B	20/09/1999	Hymenoptera	1	1
2B	09/10/1999	Araneae	1	1
2B	09/10/1999	Coleoptera	3	3
2B	09/10/1999	Diptera	20	31
2B	09/10/1999	Hemiptera	14	16
2B	09/10/1999	Hymenoptera	4	5
2B	27/10/1999	Araneae	2	2
2B	27/10/1999	Coleoptera	5	5

2B	27/10/1999	Diptera	17	19
2B	27/10/1999	Hemiptera	13	13
2B	27/10/1999	Hymenoptera	12	15
4A	19/08/1999	Araneae	1	1
4A	19/08/1999	Coleoptera	7	7
4A	19/08/1999	Diptera	15	25
4A	19/08/1999	Hemiptera	12	16
4A	19/08/1999	Hymenoptera	7	8
4A	29/08/1999	Araneae	1	1
4A	29/08/1999	Coleoptera	4	4
4A	29/08/1999	Diptera	24	36
4A	29/08/1999	Hemiptera	16	16
4A	29/08/1999	Hymenoptera	35	59
4A	01/09/1999	Araneae	1	1
4A	01/09/1999	Coleoptera	3	3
4A	01/09/1999	Diptera	14	18
4A	01/09/1999	Hemiptera	3	3
4A	01/09/1999	Hymenoptera	7	7
4A	01/09/1999	Thysanoptera	1	1
4A	03/09/1999	Araneae	1	1
4A	03/09/1999	Coleoptera	2	2
4A	03/09/1999	Diptera	25	45
4A	03/09/1999	Hemiptera	11	11
4A	03/09/1999	Hymenoptera	15	15
4A	03/09/1999	Thysanoptera	1	1
4A	08/09/1999	Coleoptera	20	21
4A	08/09/1999	Diptera	23	38
4A	08/09/1999	Hemiptera	24	27
4A	08/09/1999	Hymenoptera	10	10
4A	08/09/1999	Orthoptera	1	1
4A	11/09/1999	Araneae	1	1
4A	11/09/1999	Coleoptera	30	36
4A	11/09/1999	Diptera	26	37
4A	11/09/1999	Hemiptera	25	31
4A	11/09/1999	Hymenoptera	12	13
4A	18/09/1999	Araneae	1	1
4A	18/09/1999	Coleoptera	4	4
4A	18/09/1999	Diptera	15	18
4A	18/09/1999	Hemiptera	2	3
4A	18/09/1999	Hymenoptera	9	10
4A	20/09/1999	Coleoptera	14	16
4A	20/09/1999	Diptera	15	21
4A	20/09/1999	Hemiptera	11	13
4A	20/09/1999	Hymenoptera	10	12
4A	09/10/1999	Araneae	2	2
4A	09/10/1999	Coleoptera	5	5
4A	09/10/1999	Diptera	17	20
4A	09/10/1999	Hemiptera	11	11
4A	09/10/1999	Hymenoptera	11	13
4A	27/10/1999	Coleoptera	14	14
4A	27/10/1999	Diptera	14	18

4A	27/10/1999	Hemiptera	12	12
4A	27/10/1999	Hymenoptera	9	10
4A	27/10/1999	Orthoptera	2	2
4B	19/08/1999	Coleoptera	6	6
4B	19/08/1999	Diptera	15	15
4B	19/08/1999	Hemiptera	9	13
4B	19/08/1999	Hymenoptera	9	10
4B	19/08/1999	Orthoptera	1	1
4B	29/08/1999	Araneae	2	2
4B	29/08/1999	Coleoptera	7	8
4B	29/08/1999	Diptera	15	29
4B	29/08/1999	Hemiptera	20	20
4B	29/08/1999	Hymenoptera	15	15
4B	01/09/1999	Coleoptera	11	11
4B	01/09/1999	Diptera	15	19
4B	01/09/1999	Ephemeroptera	1	1
4B	01/09/1999	Hemiptera	15	17
4B	01/09/1999	Hymenoptera	15	17
4B	03/09/1999	Araneae	1	1
4B	03/09/1999	Coleoptera	5	5
4B	03/09/1999	Diptera	28	33
4B	03/09/1999	Hemiptera	9	9
4B	03/09/1999	Hymenoptera	16	21
4B	03/09/1999	Thysanoptera	1	2
4B	08/09/1999	Coleoptera	8	8
4B	08/09/1999	Diptera	16	17
4B	08/09/1999	Hemiptera	19	23
4B	08/09/1999	Hymenoptera	17	19
4B	11/09/1999	Araneae	2	2
4B	11/09/1999	Coleoptera	4	4
4B	11/09/1999	Diptera	39	49
4B	11/09/1999	Hemiptera	7	7
4B	11/09/1999	Hymenoptera	7	7
4B	11/09/1999	Thysanoptera	1	1
4B	18/09/1999	Coleoptera	7	7
4B	18/09/1999	Diptera	12	12
4B	18/09/1999	Hemiptera	21	28
4B	18/09/1999	Hymenoptera	9	9
4B	20/09/1999	Araneae	1	1
4B	20/09/1999	Coleoptera	6	6
4B	20/09/1999	Diptera	13	15
4B	20/09/1999	Hemiptera	18	18
4B	20/09/1999	Hymenoptera	7	7
4B	20/09/1999	Orthoptera	5	5
4B	09/10/1999	Coleoptera	4	4
4B	09/10/1999	Diptera	11	13
4B	09/10/1999	Hemiptera	22	23
4B	09/10/1999	Hymenoptera	6	11
4B	09/10/1999	Orthoptera	1	1
4B	27/10/1999	Araneae	1	1
4B	27/10/1999	Coleoptera	7	8

4B	27/10/1999	Diptera	8	11
4B	27/10/1999	Hemiptera	21	36
4B	27/10/1999	Hymenoptera	7	7
5A	19/08/1999	Araneae	2	2
5A	19/08/1999	Coleoptera	3	3
5A	19/08/1999	Diptera	21	58
5A	19/08/1999	Hemiptera	14	17
5A	19/08/1999	Hymenoptera	10	13
5A	29/08/1999	Coleoptera	4	4
5A	29/08/1999	Diptera	19	43
5A	29/08/1999	Hemiptera	13	13
5A	29/08/1999	Hymenoptera	11	12
5A	01/09/1999	Coleoptera	3	3
5A	01/09/1999	Diptera	21	23
5A	01/09/1999	Hemiptera	5	6
5A	01/09/1999	Hymenoptera	10	11
5A	03/09/1999	Araneae	2	2
5A	03/09/1999	Coleoptera	10	12
5A	03/09/1999	Diptera	17	36
5A	03/09/1999	Hemiptera	15	15
5A	03/09/1999	Hymenoptera	21	24
5A	03/09/1999	Orthoptera	1	1
5A	08/09/1999	Coleoptera	9	9
5A	08/09/1999	Diptera	25	65
5A	08/09/1999	Hemiptera	10	11
5A	08/09/1999	Hymenoptera	11	16
5A	11/09/1999	Araneae	1	1
5A	11/09/1999	Coleoptera	2	2
5A	11/09/1999	Diptera	19	57
5A	11/09/1999	Hemiptera	4	4
5A	11/09/1999	Hymenoptera	11	12
5A	18/09/1999	Araneae	1	1
5A	18/09/1999	Coleoptera	4	4
5A	18/09/1999	Diptera	14	24
5A	18/09/1999	Hemiptera	3	3
5A	18/09/1999	Hymenoptera	12	16
5A	20/09/1999	Coleoptera	12	13
5A	20/09/1999	Diptera	22	47
5A	20/09/1999	Hemiptera	10	10
5A	20/09/1999	Hymenoptera	25	28
5A	09/10/1999	Araneae	1	1
5A	09/10/1999	Diptera	24	34
5A	09/10/1999	Hemiptera	3	3
5A	09/10/1999	Hymenoptera	5	5
5A	27/10/1999	Araneae	3	3
5A	27/10/1999	Coleoptera	2	2
5A	27/10/1999	Diptera	18	21
5A	27/10/1999	Hemiptera	6	6
5A	27/10/1999	Hymenoptera	18	19
5B	19/08/1999	Coleoptera	2	2
5B	19/08/1999	Diptera	31	44

5B	19/08/1999	Hemiptera	13	15
5B	19/08/1999	Hymenoptera	13	16
5B	29/08/1999	Araneae	1	1
5B	29/08/1999	Coleoptera	9	9
5B	29/08/1999	Diptera	18	28
5B	29/08/1999	Hemiptera	7	8
5B	29/08/1999	Hymenoptera	12	24
5B	01/09/1999	Coleoptera	7	7
5B	01/09/1999	Diptera	22	32
5B	01/09/1999	Hemiptera	10	10
5B	01/09/1999	Hymenoptera	6	6
5B	03/09/1999	Diptera	16	23
5B	03/09/1999	Hemiptera	19	19
5B	03/09/1999	Hymenoptera	21	26
5B	03/09/1999	Opiliones	1	1
5B	08/09/1999	Araneae	1	1
5B	08/09/1999	Coleoptera	3	3
5B	08/09/1999	Diptera	26	31
5B	08/09/1999	Hemiptera	9	10
5B	08/09/1999	Hymenoptera	31	35
5B	08/09/1999	Thysanoptera	1	1
5B	11/09/1999	Araneae	2	2
5B	11/09/1999	Coleoptera	6	6
5B	11/09/1999	Diptera	20	22
5B	11/09/1999	Hemiptera	4	7
5B	11/09/1999	Hymenoptera	6	12
5B	18/09/1999	Araneae	1	1
5B	18/09/1999	Coleoptera	8	8
5B	18/09/1999	Diptera	19	19
5B	18/09/1999	Hemiptera	10	10
5B	18/09/1999	Hymenoptera	15	26
5B	20/09/1999	Araneae	1	1
5B	20/09/1999	Coleoptera	7	7
5B	20/09/1999	Diptera	32	60
5B	20/09/1999	Hemiptera	8	8
5B	20/09/1999	Hymenoptera	17	20
5B	09/10/1999	Coleoptera	1	1
5B	09/10/1999	Diptera	25	67
5B	09/10/1999	Hemiptera	4	4
5B	09/10/1999	Hymenoptera	13	17
5B	27/10/1999	Araneae	3	3
5B	27/10/1999	Coleoptera	14	14
5B	27/10/1999	Diptera	14	15
5B	27/10/1999	Hemiptera	9	12
5B	27/10/1999	Hymenoptera	12	20