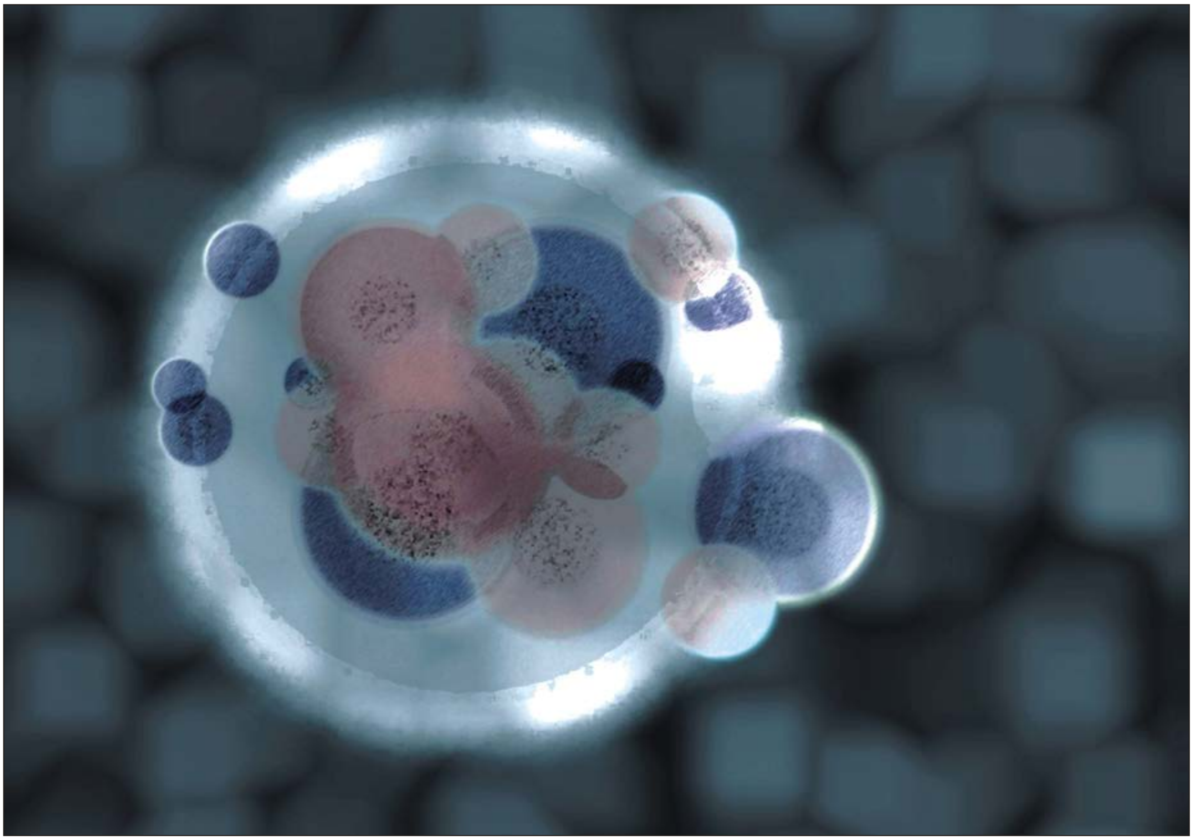

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Ant Community in Logged and Primary Forest

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Abstract: The impact of the change in environmental factors on ant community was studied in three different forest habitats: five-year old logged forest; ten-year old logged forest and primary forest. Sampling was done for one week in every three-month using pitfall trap. A total of 31,501 formicids comprising 9 subfamilies and 52 morphospecies were collected. Ponerinae and Myrmicinae were the most abundant having 13,989 and 9,635 individuals. The alpha (α) diversity index indicated that primary forest had higher value (4.77) than that of five-year old logged (4.15) and ten-year old logged forest (4.01). There was a 57% species similarity between primary forest and 5-year old logged forest, 49% between 10-year old logged and primary forest, and 38% between 5-year old and 10-year old logged forest. The possible environmental effects among the forest habitats on the ant abundance were discussed.

Key words: Pitfall trap, ponerinae, primary and logged forest

INTRODUCTION

Land-use change is one of the antropogenic impacts. Land degradation can pose edaphic and biological limitations to secondary succession such as soil erosion and compaction, nutrient losses, changes in microclimate, changes in disturbance regime, competition with exotic species, and a reduced supply of plant propagules[1]. Some terrestrial invertebrates have been proposed as bioindicators of ecological change following environmental stress or disturbance associated with human land-use. They are one of the terrestrial invertebrates used as bioindicators[2]. Ants are important components of ecosystems, constituting an important part of the animal biomass and acting as ecosystem engineers[3]. Ants have important influences on soils[4], vegetation and other faunal groups through their involvement in a wide range of key ecological processes. Ants are relatively sedentary and responsive to change occurring in relatively small scales in space and time and most of them are easily sampled and observed[2]. As such, the objective of this study was to quantify the effect of three different forest habitats on ant communities in dipterocarp forest.

MATERIALS AND METHODS

Study Site: The study was conducted at The Sungai Lalang Forest Reserve, Semenyih, Selangor from February 1999 to January 2000. The total study area is 729 ha with the elevation ranges from 50-800 m above sea level. The average annual temperature is 26.5°C and total annual precipitation ranges from 432 to 514 mm. The Sungai Lalang Forest Reserve comprises of number of forest types ranging from lowland to hill dipterocarp forests that are dominated by *Shorea* species.

In this study, three forest habitats were chosen, namely a primary forest and two forests that were selectively logged in the last five and ten years, respectively.

Ant Trapping: Ants were trapped using pitfall traps. This trap consisted of plastic cups, 10 cm in diameter and 11 cm in height. They were placed in the ground with their rim leveled with the soil surface. A cover, at least 5 cm from the ground surface was placed over the trap. Each cup was filled with water and a few drops of detergent and sorbic acid. The cups were left for seven days before they were collected. Specimens from the traps were preserved in bottles containing 70% ethyl alcohol. A total of 75 traps have been set in every forest habitat.

Microhabitat and Microclimate sampling: Six microhabitat parameters were recorded, i.e., number of shrubs, number of understorey plants, amount of cover shade, percentage of canopy cover, and type of litter as well as litter depth.

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For the three forest habitats, nine habitat plots were chosen for microhabitat sampling. Each plot was about 250 m^2 and was further divided into 25 m^2 (5x5 m) sub-plots. These plots were located in the vicinity of the insect sampling plot.

The microclimate parameters such as temperature, light intensity and relative humidity were recorded in every site. The rainfall data was taken from Semenyih Dam Station. Temperature and relative humidity were recorded in Thermohygrograph and light intensity was measured using lux meter (Extech instruments: Model 401025).

RESULTS AND DISCUSSION

Composition and Abundance: A total of 31,501 individuals were sampled from the study. The ten-year old logged forest had significantly more number of individuals collected (19,511) than that of five-year old logged forest (7,193) and primary forest (4,797) (Table 1). Higher numbers of Formicidae families were collected from logged forest. This indicated that formicids are more abundant in logged forests and disturbance positively affects the ant communities. A total of 52 morphospecies ant representing 9 sub-families was collected. Myrmicinae, Ponerinae, and Dolichoderinae sub-families dominated the sample. The other sub-families collected were Cerapachynae, Formicinae, Leptanillinae, Aenictinae, Pseudomyrmicinae and Dorylinae.

Analysis of samples from all habitat showed that the Ponerinae was the dominant sub-family with 13,989 individuals followed by Myrmicinae with 9,635 and Dolichoderinae with 3,144. About 45% of total sample belonged to Ponerinae sub-family. Ponerinae species is common in the forest floor[5]. The Myrmicinae is a species rich and abundant group as compared to other subfamilies of formicids[2,5]. The results were similar to the record of Yahya[6] in Lahad Datu, Sabah.

Ponerinae had the highest number of individuals in both logged forests, while Myrmicinae was most abundant in primary forest (Table 1). The individuals per sub-family caught in the traps were significantly different in the different forest habitats (Friedman's test, X^2=10.02; $p<0.05$). This indicates that proportion of sub-families was affected by different forest habitats.

The ANOVA test showed that forest habitat had a significant effect on the number of individuals collected (F=16.03; df=2; $p<0.05$). The mean number of formicid collected was significantly higher ($p<0.05$) in the ten-year old logged forest (20.15) than in the five-year old logged forest (16.07) and primary forest (15.57) (Table 2).

Pioneer tree species emerging after forest disturbance create new microhabitats for many insects, as these habitats could provide extra niche for a greater number of species to inhabit. This phenomenon is shown by the ants, in which the replacement of pioneer trees after logging resulted good relationship with Formicidae. This family was the most dominant hymenopteran insects in the recently logged forest. The gaps in logged forest will initiate the growth of the pioneer trees, particularly *Macaranga* species that are not common in primary forest, which provides abundant food resources[7] and shelter to the ants[8].

Diversity: The value of Shannon-Weiner diversity index (H') among the forest habitats was different significantly. Formicidae family had higher richness index and alpha diversity in primary forest compared with logged forests (Table 3). The high diversity in primary forest is probably due to higher species richness in primary forest than at five-year old logged and ten-year old logged forests.

Therefore, the evenness index becomes high in primary forest. This indicates that the different ages of logged-over forests influenced diversity of ant species. The species diversity will decrease when the age of logged-over forest decreases.

The felling of certain plant species has directly or indirectly affected the insects that depend on them for shelter and food. Primary forest had denser canopy and slightly less understorey plants. Higher diversity in these habitats indicated that this insect group could utilize the habitats. The richness and diversity of ant species exhibit humped patterns in relation to gradients of stress and dominance[9]. When the number of dominant ants is low, the species diversity will increase. The abundance of dominant species increase with favorable conditions and this normally leads to decrease in species diversity, presumably because of competitive exclusion[10].

The habitat in the logged forest is ecologically different compared with that of primary forest. Simplification of the forest structure and loss of dominant competitor species, however, have enabled some species to survive in the disturbed habitat and thereby increased certain species richness[11].

Similarity: Formicidae in primary forest had high similarity to five-year old logged forest compared to ten-year old logged forest (Table 4). It means that primary forest and five-year old logged forest have more overlapping compared with ten-year old logged forest. Primary forest and five-year old logged forest recorded 0.57 of Jaccard Similarity Index, indicating that there was a 57% species similarity between the two habitat types, whereas between the ten-year old logged forest and primary forest, there was a 49 % species similarity.

Table 1: Number of formicid individuals collected from three different forest habitats

Sub-family	Morphospecies	Five-year old logged	Ten-year old logged	Primary forest	Total
Myrmicinae	12	1534	5707	2397	9635
Ponerinae	15	4721	8168	1100	13989
Cerapachynae	2	406	1708	522	2636
Dolichoderinae	10	307	2461	376	3144
Formicinae	4	23	409	209	641
Pseudomyrmicinae	6	133	511	145	789
Aenictinae	1	6	388	34	428
Dorylinae	1	57	159	14	230
Leptanillinae	1	6	0	0	6
Number of individuals		7193	19511	4797	31501
Number subfamily		9	8	8	9

Table 2: Mean number of abundance with standard error of Formicidae caught in pitfall trap

Forest habitat	Mean of abundance ± SE
5-year old logged	16.07±2.66 b
10-year old logged	20.15±1.57 a
Primary forest	15.57±1.47 b

Mean with different letters are significantly different (tukey HSD test, $p<0.05$)

Table 3: Species diversity indices for Formicidae family

Diversity Indices	Five-year old logged	Ten-year old logged	Primary forest
R1	3.38	3.34	3.78
R2	0.37	0.24	0.48
H'	1.77b	2.54a	2.41a
α	4.15	4.01	4.77
E4	0.52	0.70	0.71
E5	0.42	0.67	0.68

R1 = Margalef Richness Index, R2 = Menhinick Richness Index,
H' = Shannon Diversity Index,
α = Alpha Diversity index (log series Fisher's)
E4 = Hill Evenness Index, E5 = Modified Hill Evenness Index,

Table 4: Jaccard Similarity Index of Formicidae family among different forest habitats in the pitfall traps

Forest habitat	Ten-year old logged	primary forest
Five-year old logged	0.38	0.57
Ten-year old logged	1.00	0.49

Table 5: Relationship between numbers of individuals (N) of Formicidae in pitfall traps and environmental variables

Forest habitat	Regression	R^2
5-year old logged	N=24.72–0.54T–0.09RH–0.04R-LI-0.03Cc	0.74
10-year oldlogged	N=0.94-0.31Ld+0.07R–LI+0.02Cc	0.78
Primaryforest	N =26.41+0.03Cs-0.46LI+0.13R+0.03Up	0.73

N = Number of individuals, LI = light intensity,
Up = Understorey plant, Ld = Litter depth,
RH = Relative humidity, R = Rainfall,
T = Temperature, Cs = Cover shade, Cc = Canopy cover

Environmental Effect: The abundance of ant community in the three forest habitats showed a different model among them. The coefficient of determinants, R^2 values, from forward stepwise multiple linear regression analysis showed that temperature, relative humidity, rainfall, light intensity and canopy cover as habitat variables were the important factors determining the ant abundance in the five-year old logged forest. The relationship between those variables and the number of ant was negative (Table 5). It means that ground ant communities were affected by temperature, rainfall, light intensity, relative humidity and canopy cover. The number of Formicidae individuals increases as those factors decreases.

In ten-year old logged forest, litter depth and light intensity were the significant and negative predictors for Formicidae, while rainfall was positive determinant. The relationship between the canopy cover and the capture of Formicidae was significant positive (Table 5). The abundance of ant increases with increase of the canopy cover and rainfall while the decrease of light intensity.

In primary forest, abundance of understorey plants, rainfall and cover shade were significant positive predictor for Formicidae, whereas light intensity had negative significant effect for Formicidae. This explained that light intensity, rainfall, understorey plant and cover shade had affected the ant community. The number of ground ant increases when those factors increase except light intensity factor.

This evidence indicated that different forest habitats were occupied by different group of ant. Recently logged forest was dominated by the group of ant that tolerance to open area. Heat-intolerant species of ants dominated the primary forest and old logged forest. According to Retana and Cerda[12], dominant ants are heat-intolerant species that are restricted largely by physical conditions, while subordinates are heat-tolerant species that are active over a wider range of temperature. Therefore, variations in vegetation structure may either enhance or reduce ant diversity by increasing or reducing habitat heterogeneity, microclimate suitability or the activity of dominant species. This is supported by the results of Holldobler and Wilson[13], they found that the combination of temperature and humidity can be used to define climates favorable for ant activity.

The abundance of understorey plants due to high light environment in the logged forest influenced ant composition. Change of plant composition may change status of plant cover and diversity, litter and paucity of logs, which influenced ant recolonization in rehabilitated mineral sand mine[14]. The ecological associations of ants with the plant have been reported extensively in the literatures[8,15].

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REFERENCES

1. Warren, M.W. and X. Zou, 2002. Soil macrofauna and litter nutrients in three tropical tree plantations on a disturbed site in Puerto Rico. Forest Ecol. Manage., 170: 161-171.
2. Gomez, C., D. Casellas, J. Oliveras and J.M. Bas, 2003. Structure of ground-foraging ant assemblages in relation to land-use change in the Northwestern Mediteranean region. Biodiv. Conserv., 12: 2135-2146.
3. Folgarait, P.J., 1998. Ant biodiversity and its relationship to ecosystem functioning: A review. Biodiv. Conserv., 7: 1221-1244.
4. Lobry de Bruyn, L.A., 1999. Ants as bioindicators of soil function in rural environments. Agric. Ecosys. Environ., 74: 425-441.
5. Malsch, A.K.F., K. Rosciszewski and U. Maschwitz, 2003. The ant species richness and diversity of a primary lowland rain forest, the Pasoh Forest Reserve, West-Malaysia. Pasoh: Ecology of a Lowland Rain Forest in Southeast Asia. In Okuda T., N. Manokaran, Y. Matsumoto, K. Niiyama, S.C. Thomas and P.S. Ashton (Eds.). Springer. pp: 347-373.
6. Yahya, B.E., 2000. The Use of Three Insect Groups as Biological Indicator in Three Tropical Ecohabitat of Sabah. M.Sc Thesis, School Sci. Technol. Univ. Malaysia Sabah.
7. Maschwitz, U., B. Fiala, S.T. Davies and K.E. Linsenmair, 1996. A Southeast Asian Myrmecophyte with two alternative inhabitants: *Camponotus* or *Crematogaster* as partners of Macaranga lamellate. Ecotropica, 2: 29-40.
8. Fiala, B., U. Maschwitz, T.Y. Pong and J. Helbig, 1989. Studies of a South East Asian ant-plant association: protection of *Macaranga* trees by *Crematogaster borneensis*. Oecologia, 79: 463-470.
9. Andersen, A.N., 2000. Global Ecology of Rainforest Ants. Ants: Standard Methods for Measuring and Monitoring Biodiversity. In: Agosti, D., J.D. Majer, L.E. Alonso and T.R. Schultz (Eds.). Smithsonian Institution Press, Washington, pp: 25-36.
10. Andersen, A.N., 1992. Regulation of “momentary” diversity by dominant species in exceptionally rich ant communities of the Australian seasonal tropics. Am. Nat., 140: 401-420.
11. Majer, J.D. and O.G. Nichols, 1998. Long term recolonization pattern of ants in Western Australia rehabilitated bauxite mines with reference to their use as indicators of restoration success. J. Applied. Ecol., 35: 161-182.
12. Retana, J. and X. Cerda, 2000. Patterns of diversity and composition of Mediterranean ground ant communities tracking spatial and temporal variability in the thermal environment. Oecologia, 123: 436-444.
13. Holldobler, B. and E.O. Wilson, 1990. The Ants. Belknap Press, Cambridge.
14. Majer, J.D., 1985. Recolonization by ants of rehabilitated mineral sand mines on Borth Stradbroke Island, Queensland, with particular reference to seed removal. Aust. J. Ecol., 10: 31-48.
15. Maschwitz, U. and B. Fiala, 1995. Investigations on ant-plant associations in the Souteast Asian: Genus *Neonauclea* Merr (Rubiaceae). Acta Oecol., 16: 3-18.