

**DIVERSITY AND SPATIAL PATTERN OF  
GROUND-DWELLING ANTS IN  
DIFFERENT HABITAT TYPES,  
KALABAKAN, SABAH**

**MUHAMMAD AFIF BIN ZAKARIA**



**THISIS SUBMITTED IN PARTIAL FULFILLMENT  
FOR THE DEGREE OF MASTER OF SCIENCE**

**INSTITUTE FOR TROPICAL BIOLOGY AND  
CONSERVATION  
UNIVERSITI MALAYSIA SABAH  
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## ABSTRACT

Conversion of natural forests often leads to serious damage such as forest fragmentation, forest degradation as well as loss of total habitat which eventually leads to significant loss of biodiversity. Ants can be good bio-indicators due to their abundance, diversity and sensitivity to environmental changes. Logging activities can alter the structure of ant communities where forest specialists are more abundant in undisturbed habitat compared to disturbed habitat. A study of ant species composition in different habitats was conducted in the Stability of Altered Forest Ecosystem (SAFE) experimental sites and its surrounding areas in Sabah. This study investigates (i) difference in species richness and abundance of ant in different habitats, (ii) the effects of environmental variables on ant assemblage, (iii) species similarity and indicator species of each habitat and (iv) ant spatial distribution and species co-occurrence in local spatial scale. Ants were collected along 200m line transects according to the Ants of Leaf Litter (ALL) Protocol from old growth forest (OG), logged forest (LF) and oil palm (OP) plantation areas. Environmental variables namely forest quality, soil pH and temperature, low vegetation, canopy cover, humidity, abundance of liana, and leaf litter depth were collected. A total of 174 species belonging to 64 genera in twelve subfamilies were recorded in this study. Species richness was significantly higher in OG (121) than in LF (105) and OP (70) (ANOVA,  $df=2$ ,  $F=89.869$ ,  $p<0.001$ ). Canonical Correspondence Analysis (CCA) showed that air temperature, canopy cover, abundance of low vegetation, abundance of liana, soil pH, forest quality and litter depth influenced the ants' assemblage. Many species of ants such as *Strumigenys* sp.1, *Ponera* sp.3 and *Hypoponera* sp.1 were associated with environmental parameters characterising the OG (high canopy cover, leaf litter depth, soil pH, abundance of liana and forest quality). *Lophomyrmex bedoti* and *Crematogaster* sp.2 on the other hand were observed associate with low forest quality, low vegetation cover and high air temperature of OP. There are five potential species selected as biological indicator for each habitat except LF. *Lophomyrmex bedoti* was an indicator species for OP while *Strumigenys* sp.1, *Acropyga* sp.1, *Carebara* sp.1 and *Ponera* sp.2 were indicator species for OG. Null model analysis of species co-occurrence showed the observed C-score index has insignificant difference with simulated C-score index for all habitats. The ants' spatial distribution in this study is not structured by the non-random pattern of species co-occurrence. Here we can conclude that the diversity and species composition of ground-dwelling ants were different across habitat types. The differences in vegetation structure of each habitat resulting in changes to environmental conditions which directly influence ant species assemblage. Preserving the old growth forest and logged forest are indeed important since both habitats still can harbour high number of ant species. In contrast, oil palm plantation is not capable of serving as refuge for ground-dwelling forest ants.

## ABSTRAK

### ***Diversiti dan Corak Reruang Semut Tanah di Habitat Berbeza, Kalabakan, Sabah***

*Pengubahan hutan semula jadi selalunya mengakibatkan kerosakan serius seperti fragmentasi hutan, degradasi hutan dan juga kehilangan habitat yang seterusnya menyebabkan kepada kehilangan biodiversiti. Semut merupakan indikator yang bagus kerana kelimpahan, kepelbagaian dan kepekaannya terhadap perubahan sekeliling. Aktiviti pembalakan boleh mengubah struktur komuniti semut, di mana semut hutan lebih tinggi kelimpahannya di habitat tidak terganggu berbanding habitat terganggu. Fokus kajian ini adalah untuk menentukan komposisi spesies semut di habitat berbeza dalam kawasan kajian Stability of Altered Forest Ecosystem (SAFE) dan kawasan sekelilingnya di Sabah. Kajian ini mengkaji (i) perbezaan kekayaan spesies dan komposisi semut di habitat berbeza, (ii) kesan pemboleh ubah persekitaran terhadap komuniti semut, (iii) persamaan spesies dan bio-indikator bagi setiap habitat dan (iv) taburan reruang dan kewujudan bersama spesies semut di peringkat transek. Semut disampel pada transek sepanjang 200m dengan menggunakan protokol Ants of Leaf Litter (ALL) di hutan primer (OG), hutan dibalak (LF) dan ladang kelapa sawit (OP). Pemboleh ubah persekitaran seperti kualiti hutan, pH dan suhu tanah, tumbuhan renek, litupan kanopi, kelembapan, kelimpahan tumbuhan memanjat dan kedalaman sarap daun juga direkod. Sebanyak 174 spesies daripada 64 genera dalam dua belas subfamili telah direkodkan dalam kajian ini. Kekayaan spesies bagi OG adalah yang tertinggi (121) berbanding dengan LF (105) dan OP (70) (ANOVA,  $df=2$ ,  $F=89.869$ ,  $p<0.001$ ). Analisis Canonical Correspondence (CCA) menunjukkan suhu udara, litupan kanopi, kelimpahan tumbuhan renek, kelimpahan tumbuhan memanjat, pH tanah, kualiti hutan dan kedalaman sarap hutan mempengaruhi kehadiran spesies semut. Kebanyakan spesies semut seperti *Strumigenys sp.1*, *Ponera sp.3* dan *Hypoponera sp.1* dilihat berkait dengan pemboleh ubah persekitaran yang mencirikan OG (litupan kanopi, kedalaman sarap daun, pH tanah, kelimpahan liana dan kualiti hutan yang tinggi). *Lophomyrmex bedoti* dan *Crematogaster sp.2* sebaliknya dilihat berkait dengan kualiti hutan yang rendah, kelimpahan tumbuhan renek dan suhu udara tinggi yang mencirikan OP. Terdapat lima spesies semut berpotensi sebagai bio-indikator untuk setiap habitat kecuali hutan dibalak. *Lophomyrmex bedoti* adalah spesies indikator bagi ladang kelapa sawit, manakala *Strumigenys sp.1*, *Acropyga sp.1*, *Carebara sp.1* dan *Ponera sp.2* adalah spesies indikator bagi hutan primer. Null model analysis of species co-occurrence menunjukkan nilai indeks C-score yang diperhatikan tidak mempunyai perbezaan ketara dengan nilai indeks C-score simulasi untuk semua habitat. Taburan reruang semut dalam kajian ini tidak dipengaruhi oleh pola ketidak-rawakan kewujudan bersama spesies semut. Di sini kita boleh simpulkan bahawa kepelbagaian dan komposisi spesies semut tanah adalah berbeza bagi setiap habitat. Perbezaan struktur vegetasi di setiap habitat menyebabkan perubahan keadaan persekitaraan yang mempengaruhi kehadiran spesies semut. Memelihara hutan primer dan hutan dibalak sememangnya penting kerana kedua-dua habitat mampu menampung jumlah spesies semut yang tinggi. Ladang kelapa sawit sebaliknya, jelas menunjukkan ketidaksesuaian sebagai tempat perlindungan kepada komuniti semut tanah.*