THE SPATIAL DISTRIBUTION OF TERMITES IN PRIMARY FOREST AND MATURE OIL PALM PLANTATION IN TABIN, SABAH.

WONG MUM KENG

INSITUTE FOR TROPICAL BIOLOGY AND CONSERVATION
UNIVERSITI MALAYSIA SABAH
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THE SPATIAL DISTRIBUTION OF TERMITES IN PRIMARY FOREST AND MATURE OIL PALM PLANTATION IN TABIN, SABAH.

WONG MUM KENG

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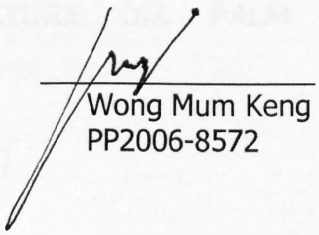

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CERTIFICATION

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ABSTRACT

THE SPATIAL DISTRIBUTION OF TERMITES IN PRIMARY FOREST AND MATURE OIL PALM PLANTAION IN TABIN, SABAH.

Oil palm-based industries have positive contribution to economic growth, reduced poverty and improved income equity which encourage massive conversion of forest into oil palm agriculture in Malaysia. The community ecology of termites at the local scale has been poorly studied in both the primary forest and oil palm plantation ecosystem, and there is very little information regarding the ecological processes operating within them. The objectives of this study are: 1. to discover termite diversity in the primary forest and the adjacent oil palm plantation, 2. to compare the spatial pattern of termites between primary forest and oil palm ecosystem and 3. to examine the ecological interactions between the termite community with the spatial structure of environmental variables and other soil fauna groups. This study was conducted in Lipad Virgin Jungle Reserve (5°12.60'N, 118°30.58'E) located within the Tabin Wildlife Reserved and the adjacent Permai oil palm plantation (5°08.64'N, 118°28.28'E). Termite sampling was done based on recommendations from previous termite studies that suggested manually dug and sorted soil pits (25 cm×25 cm×10 cm) at a minimum extent of 64 m and lag of 2 m. In this study, termite abundance and species richness had shown dramatic decline after conversion from primary forest to oil palm plantation. Out of a total of 29 species of termites that were encountered in this study, 26 species were found in the primary forest while only nine species in the oil palm plantation. Nevertheless, the spatial patterns generated using SADIE (Spatial Analysis by Distances Indices) analyses and ArcGIS 9.0 software showed that both soil and non-soil feeding termite groups distributed differently in which large gaps of termite distribution area are detected in oil palm plantation. These suggested that the oil palm plantation possess physical barrier that resists the colonization of poorly dispersing termites. Significant associations between soil-feeding termite and non-soil-feeding termite were detected in primary forest (X=0.1424) and oil palm plantation (X=0.245). However, termites at both sites responded differently in the association and dissociation between biotic factors (earth worm, non-predatory and predatory ants) along with environmental variables (stacked fronds, dead tree logs, mounds, trees, grass, soil pH, soil organic carbon and total soil nitrogen). In addition, based on logistic regression models, it is speculated that the occurrences of earth worms, dead wood and stacked fronds tend to increase the probability of termite occurrences; conversely, the appearance of non-predatory ants is likely to decrease the probability of termite occurrences.

ABSTRAK

Industri berasaskan kelapa sawit banyak menyumbang kepada pertumbuhan ekonomi, mengurangkan kadar kemiskinan, dan memperbaiki ekuiti pendapatan yang mana merubah sebahagian besar hutan kepada perladangan kelapa sawit di Malaysia. Maklumat mengenai proses ekologi yang berkaitan dengan anai-anai dalam ekosistem hutan dan ladang kelapa sawit adalah tidak banyak kerana kajian terhadap ekologi komuniti anai-anai dalam kedua-dua ekosistem tersebut adalah sangat kurang. Kajian ini adalah satu daripada kajian ekologi komuniti anai-anai yang dijalankan dengan objektif: 1. mengkaji diversiti anai-anai di hutan primer dan ladang kelapa sawit, 2. membandingkan corak taburan anai-anai antara hutan primer dan ladang kelapa sawit dan 3. memeriksa interaksi ekologi antara komuniti anai-anai dengan pembolehubah persekitaran dan kumpulan fauna tanah yang lain. Kajian ini dijalankan di Hutan Simpan Dara Lipad (5°12.60'N, 118°30.58'E) yang terletak di dalam Hutan Simpan Tabin dan Ladang Kelapa Sawit Permai yang berdekatan (5°08.64'N, 118°28.28'E). Persampelan anai-anai telah dijalankan berdasarkan cadangan daripada kajian anai-anai terdahulu di mana tanah digali mengikut ukuran, 25 cm×25 cm×10 cm, dan anai-anai dicari dalam tanah yang telah digali secara manual. Plot kajian adalah seluas 64 m dan jarak di antara lubang tanah adalah 2m. Dalam kajian ini, kelimpahan anai-anai dan kekayaan spesis menunjukkan penurunan dari segi bilangan apabila berlaku perubahan persekitaran daripada hutan ke ladang kelapa sawit. Sejumlah 29 spesis anai-anai telah dijumpai dalam kajian ini. Sebanyak 26 spesis didapati dari hutan primer tetapi hanya sembilan spesis dari ladang kelapa sawit. Tambahan pula, struktur taburan yang dibentuk menggunakan analisis Spatial Analysis by Distances Indices (SADIE) dan perisian ArcGIS 9.0 menunjukkan kedua-dua anai-anai pemakan tanah dan pemakan bukan tanah tertabur secara berbeza, di mana jurang taburan yang besar dikesan di ladang kelapa sawit. Hasil kajian juga menunjukkan bahawa ladang kelapa sawit mempunyai sempadan fizikal yang memberi rintangan terhadap pengkolonian anai-anai. Perkaitan signifikan di antara anai-anai pemakan tanah dan anai-anai pemakan tanah dapat dilihat di hutan primer (X=0.1424) dan ladang kelapa sawit (X=0.245). Anai-anai di kedua-dua tapak kajian menunjukkan respon yang berbeza dalam perkaitan antara faktor biotik (ulat, semut bukan pemangsa dan semut pemangsa) dengan pembolehubah persekitaran (dahan jatuh, kayu pokok mati, busut, pokok, rumput, pH tanah, organik karbon tanah dan jumlah nitrogen tanah). Tambahan pula, berdasarkan model regresi logistik, dapat dispekulasikan bahawa dengan kemunculan kayu pokok mati dan dahan jatuh boleh meningkatkan kebarangkalian bagi kemunculan anai anai. Sebaliknya, kemunculan semut bukan pemangsa dan ulat bercenderung menurunkan kebarangkalian bagi kemunculan anai-anai.

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LIST OF ABBREVIATIONS

AKSE	Average Kriging Standard Error
Cm	Centimeter
g	Gram
GIS	Geographic Information System
$K_2Cr_2O_7$	Potassium dichromate
HCl	Hydrochloride Acid
LISA	Local Indicator of Spatial Association
m	Meter
mm	Millimeter
M	Mole
ME	Mean Prediction Error
Mg	Milligram
Ml	Milliliter
MSPE	Mean Standardized Prediction Error
RMSE	Root Mean Square Prediction Error
RMSPE	Root Mean Square Standardized Prediction Error
V	Volume
N	North
E	East
DVCA	Danum Valley Conservation Area
ITBC	Institute for Tropical Biology and Conservation
SPSS	Statistical Package for the Social Sciences
UNEP	United Nation Environment Programme
TWR	Tabin Wildlife Reserve
DVCA	Danum Valley Conservation Area
LVJ	Lipad Virgin Jungle
POP	Permai Oil Palm Plantation
d.b.h	Diameter at Breast Height
C	Carbon
N	Nitrogen
CO_2	Carbon Dioxide
CH_4	Methane

LIST OF SYMBOLS

C_O	Nugget effect
C_1	Spatial component
I	Moran's I
C	Geary's C
I_i	Local indicator of spatial association
%	Percentage
Σ	Sum
$\bar{\sigma}(x_i)$	The prediction standard error for location x_i for cross-validation
d_{ij}	Inverse of distance between two location i and j
h	Lag
n(h)	The number of data pairs (x_i and $x_i + h$) separated by a distance h
n	Size samples
W_{ij}	Distance weight between location i and j
$\bar{x}$	Mean of the variable
x_i	Parameter value of the variable x at a particular location i
x_j	Parameter value of the variable x at all the other location (where i≠j)
$\hat{y}(h)$	Estimated semivariance
z_i	z-score of parameter value at a particular location i
z_j	z-score of parameter value at all the other location (where i≠j)
$\bar{z}$	mean of z-score of parameter value
$z(x_i)$	Parameter value at the location i of the samples
$z(x_i+h)$	Parameter value at another location i of the samples which separated by h
$z(x_i)$	Observed (known) value from cross-validation
$\hat{z}(x_i)$	The predicted value from cross-validation
s_z^2	The variance of z-score of parameter value in local Moran statistic
Z(C)	The empirical value calculated from a sample for Geary's C
E(C)	The theoretical mean of a random distribution for Geary's C
$S_{E(c)}$	The theoretical standard deviation of E(C) for Geary's C
Z(I)	The empirical value calculated from a sample for Moran's I
E(I)	The theoretical mean of a random distribution for Moran's I
$S_{E(I)}$	The theoretical standard deviation of E(I) for Moran's I
H′	The Shannon–Wiener diversity index
fi	The number of observation in category i for Shannon-Wiener diversity index
H'_{max}	The maximum possible diversity for Shannon–Wiener diversity index
J′	Evenness for Shannon-Wiener diversity index
S_j	Jaccard similarity coefficient
a	The number of elements shared by all group for Jaccard's index
b	The number of elements unique to the first group for Jaccard's index
c	The number of elements unique to the second group for Jaccard's index
I_a	The index of aggregation for SADIE
D	The overall aggregation by distance to regularity for SADIE
X_k	The index of spatial association for SADIE
q	The mean for the Local spatial association in SADIE

Z_k	The clustering indices for the Local spatial association in SADIE
N	The number of indices for the Local spatial association in SADIE
X_o	The Overall spatial association for SADIE
$\hat{f}(x)$	The Kernel density estimator
K	Kernel weighting function for the Kernel density estimator
v	The bandwidth for the Kernel density estimator
x	The grid point for the Kernel density estimator
X_i	The data point for the Kernel density estimator
n	The number of data observations for the Kernel density estimator
Y	The dependence variable for general logistic regression model
X	The independence variable for general logistic regression model
α	The intercept for general logistic regression model
β	The coefficient for general logistic regression model
p	The probability of an event

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