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Distributional Characteristics of Termites (Insecta: Isoptera) among Different Types of Habitats in Dak Lak Area

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Abstract: The sampling was followed the method of rapid biodiversity assessment of termites by Jones and Eggleton (2000), and have conducted for the first time in Dak Lak. In the studied natural habitats both termite richness and relative abundance were decreased from primary forest to secondary forest then to savanna (20 species → 11 species → 9 species) and (56 encounters → 30 encounters → 27 encounters) respectively. In the tree plantations, both richness and abundance in pine plantation higher than those in rubber plantation (13 species and 8 species) and (62 encounters and 53 encounters) respectively. The litter feeders dominated in habitats with high human impacts (secondary forest and savanna), while the soil feeders dominated in tree plantations or in rehabilitated ecosystem (pine plantation and rubber plantation). Beside human impacts on habitats, soil moisture played a very important role in the distribution of termites in the studied habitats.

Keywords: Termite distribution, habitat, Dak Lak.

1. Introduction

Termites are social insects and play a key role in the tropical ecosystem function. They are one of the main decomposers in tropical terrestrial ecosystems [1]. Termite species process a variety of plant organic matter at all stages of decomposition, from leaf litters, fallen branches and rotten woods, to soil humus. The activities of termites help to improve soil structure and contribute to the efficient recycle of nutrients in the ecosystem. Therefore, although some species cause economic loss for human, most of termite species are useful for ecosystems. The existence of most termite species in nature depends on the vegetation and the land on which the plants grow. Nevertheless, many economic and agricultural activities of human being such as logging, land clearance for growing industrial crops, have negative impacts on natural habitats, consequently to the inhabiting termite assemblages.

Dak Lak is one of the areas of Tay Nguyen plateau (or the Central Highland) with favourable natural conditions for the existence of termites. During the process of development, the area of natural forests was decreased or partly changed into agroforests. Investigations on termites in Dak Lak have been implemented recently [2, 3], but most were qualitative

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studies. Our quantitative study is to contribute to the data of termite distribution in different types of habitats in Dak Lak area, and to partially fill in the gaps of knowledge of termite fauna in this area.

2. Material and methods

The field sampling followed the method of rapid biodiversity assessment of termites by Jones and Eggleton [4], and was conducted in five types of habitats in Dak Lak, namely: primary forest, secondary forest and savanna (in Yok Don National Park), pine plantation (in Hoa Thang commune), and rubber plantation (in Ea Kao commune, Buon Ma Thuot city). One belt transect was conducted in each type of habitat with the size of 100 m long and 2 m wide, and divided into 20 successive quadrate sections of 5 m x 2 m. Two people sampled in each section for 30 minutes (a total of one hour of collecting per section). Termites were collected in the whole sections by searching in all potential microhabitats including woods, leaf litters, and surface soil down to 10-15 cm depth, visible nests, and galleries up to a height of 2 m of the trees. Termite specimens were preserved in small vials containing 75-80% alcohol, labelled with section number of each transect and deposited in the laboratory of Institute for Ecology and Works Protection, Vietnam Academy for Water Resources and in the laboratory of the Department of Invertebrate Zoology, Faculty of Biology, VNU University of Science for later identification to species or morpho-species. The morphological identification of termites was determined by using respective literature on termites [5-8]. Species richness is the number of species and morpho-species obtained over the whole transect. Relative abundance is the number of encounters per transect where the presence of a species in one section represents one encounter. Feeding guilds were determined based on known feeding habits and collectors' observations in the field [9]. These groups were: Wood feeders (W): species that feed on dead wood; Litter feeders (L/F): species that feed on leaf and small woody litter (fungus growing termites); Soil feeders (S/H): species that feed on mineral soil and humus; Soil/wood (S/W) interface feeders: species that feed on very decayed wood that has become soil-like [10]. The biodiversity indices of termites in the studied habitats were calculated by using the software Primer version 6.

3. Results and discussions

3.1. Taxonomic composition of termites in different habitats

The analytical results of termite assemblages in five types of habitats (primary forest (Pf) secondary forest (Sf), savanna (Sav), rubber plantation (Rp) and pine plantation (Pp)) are shown in Table 1. A total of 36 species of 15 genera, six subfamilies and two families was found in studied area. Among them, four species (accounted for 11.1% of the total species number) belonged to the family Rhinotermitidae, 32 species (89.9%) to Termitidae. The species number found in primary forest was the highest (20 species equivalent to 55.6% of the total species number in the studied area) followed by species number in pine plantation (13 species, 36.1%), in secondary forest (11 species, 30.6%), in savanna (nine species, 25%) and in rubber plantation (8 species, 22.2%). The relative abundance in pine plantation was the highest (62 encounters), followed by the one in primary forest (56 encounters), in rubber plantation (53 encounters), in secondary forest (30 encounters) and in savanna (27 encounters).

Table 1. The list of termite species in different habitats in Dak Lak area

NO.	Scientific name	Feeding group	Encounters in habitats				
			Pf.	Sf.	Sav.	Rp.	Pp.
	Rhinotermitidae						
	Coptotermitinae		**2**		**1**		
1	*Coptotermes gestroi*	W			1		
2	*Coptotermes curvignathus*	W	2				
	Rhinotermitinae		**2**	**1**			
3	*Schedorhinotermes javanicus*	W	1				
4	*Schedorhinotermes rectangularis*	W	1	1			
	Termitidae						
	Macrotermitinae		**32**	**24**	**24**	**35**	**47**
5	*Macrotermes carbonarius*	L/F	2				
6	*Macrotermes gilvus*	L/F	2	2		9	8
7	*Macrotermes annandalei*	L/F				6	6
8	*Macrotermes malaccensis*	L/F		1			
9	*Macrotermes measodensis*	L/F	2				
10	*Macrotermes latignathus*	L/F					7
11	*Odontotermes angustignathus*	L/F	2				
12	*Odontotermes hainanensis*	L/F	4				
13	*Odontotermes pahamensis*	L/F	6			12	18
14	*Odontotermes ceylonicus*	L/F	5	3	5	2	2
15	*Odontotermes measodensis*	L/F		1	2		
16	*Odontotermes formosanus*	L/F	3		1		
17	*Odontotermes proformosanus*	L/F	1				
18	*Odontotermes* sp.	L/F		1	3		
19	*Microtermes obesi*	L/F		5	7		
20	*Microtermes pakistannicus*	L/F			4	4	6
21	*Hypotermes sumatrensis*	L/F	2		2		
22	*Hypotermes obscuriceps*	L/F	3	11		2	
	Termitinae		**10**			**18**	**11**
23	*Discuspiditermes garthwaitei*	S/H	6			13	3
24	*Pericapritermes latignathus*	S/H				5	
25	*Pericapritermes semarangi*	S/H					2
26	*Pericacpritermes* sp.	S/H					2
27	*Procapritermes* sp.	S/H					2
28	*Pseudocapritermes parasilvatcus*	S/H					2

29	*Termes propinquus*	S/H	4				
	Amitermitinae		**3**	**3**	**2**		**3**
30	*Microcerotermes burmanicus*	S/W	3				
31	*Globitermes sulphureus*	S/W		3	2		3
	Nasutitermitinae		**7**	**2**			**1**
32	*Aciculioditermes sarawakensis*	W					1
33	*Nasutitermes ovatus*	W	3	1			
34	*Nasutitermes regularis*	W	3				
35	*Bulbitermes prabhae*	W	1				
36	*Bulbitermes laticephalus*	W		1			
	Sum of hits (relative abundance)		**56**	**30**	**27**	**53**	**62**
	Number of species		**20**	**11**	**9**	**8**	**13**

Pf. Primary forest; Sf. Secondary forest (Khop forest);
Sav. Savanna; Rp. Rubber platation, Pp. Pine platation

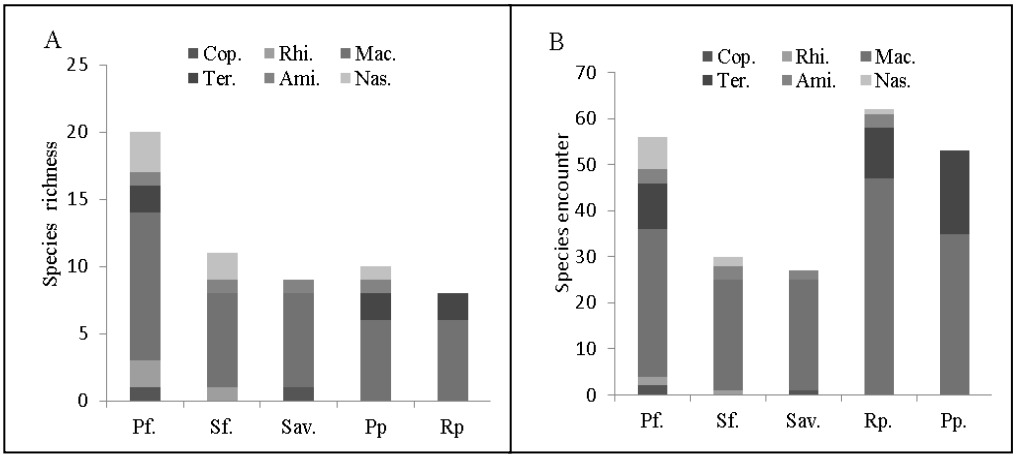

Figure 1. Species numbers (A) and relative abundance (number of encounters) (B) of subfamilies in different types of habitats in Dak Lak area (Pf. primary forest; Sf. secondary forest (Khop forest); Sav. savanna; Rp. rubber plantation, Pp. pine plantation; Cop. Coptotermitinae; Rhi. Rhinotermitinae; Mac. Macrotermitinae; Ter. Termitinae; Ami. Amitermitinae; Nas. Nasutitermitinae).

Among natural habitats, the data showed that both termite richness and relative abundance tended to decrease from primary forest to secondary forest then to savanna (20 species → 11 species → 9 species) and (56 encounters → 30 encounters → 27 encounters) respectively. Between different tree plantations, both richness and abundance in pine plantation were higher than those in rubber plantation (13 species and nine species) and (62 encounters and 53 encounters) respectively (Figure 1). It suggested that human impacts, e.g., overexploitation or deforestation, could be the main causes of the decrease of termite richness and abundance in natural habitats, while in tree plantations or rehabilitated forests, other factors, such as the types of planted trees should be taken into account. Our findings were analogous to those of [11], that the termite assemblage may be attributed to not only the

plant diversity in agroecosystem but also particular kinds of plants.

Results in Table 1 also showed that among 36 species, two species were encountered in four or five habitats (they were called euryhabitat species), 21 encountered in only one habitat (stenohabitat species) and 13 encountered in two or three habitats. Of these 21 stenohabitat species, 11 were found in primary forest, two in secondary forest, one in both savanna and in rubber plantation, and six found in pine plantation. It seemed that during the process of rehabilitation of forest ecosystem, the closer ecosystem conditions get to those of the primary forest, the more number of stenohabitat species could be found. The results suggested that termite richness could be used as a bio-indicator for evaluating levels of rehabilitation of forest ecosystem.

In order to better understandings of the richness and abundance of termites in studied habitats, the biodiversity indices of termites were calculated and shown in Table 2. The values of the Shannon-Wiener index (H') in five habitats (Pf, Sf, Sav, Rp and Pp) fluctuated between 1.894 (Rp) and 2.857 (Pf). Based on these values (1<H'<3), biodiversity of termites in the habitats was determined at medium level. For the Margalef species diversity index (d), we also obtained results that the values of this index tended to change among the studied habitats in similar trend to those of H' index (Table 2).

Some results from the analyses of soil samples collected in studied habitats were shown in Table 3. We found that the pH values in all of studied habitats were rather low (from 3.30 in Sf to 5.07 in Pf), values of organic mulch (OM) was the highest in Sf (5.24%) and the lowest in Pf (2.63%). It was noticeable that the soil moisture (SM) changed significantly among the studied habitats, with the highest in Pp (27.30%), followed by those in Pf (16.98%), in Rp (11.31%), in Sav (10.48%), and in Sf (4.32%).

Analytical results also showed that only the values of SM were directly proportional to those of relative abundance (RA) in studied habitats, suggesting that soil moisture played a very important role in the distribution of termites in the studied habitats. However, this was only a preliminary assessment, in order to get better understandings about the influence of soil conditions on the termite assemblage, the further soil analyses should be done in future.

Table 2. Biodiversity indices of termites in different habitats

No.	Habitat	S	RA	d	$H'_{(loge)}$	1-Lambda
1	Primary forest (Pf)	20	56	4.720	2.857	0.9526
2	Secondary forest (Sf)	11	30	2.940	1.988	0.8345
3	Savanna (Sav)	9	27	2.427	2.012	0.8755
4	Rubber plantation (Rp)	8	53	1.763	1.894	0.8454
5	Pine plantation (Pp)	13	62	2.908	2.235	0.8715

Table 3. Analytical results of soil samples from studied habitats

No.	Habitat	S	RA	pH (KCl)	OM (%)	SM (%)
1	Primary forest (Pf)	20	56	5.09	2.63	16.98
2	Secondary forest (Sf)	11	30	3.30	5.24	4.32
3	Savanna (Sav)	9	27	4.12	3.37	10.48
4	Rubber plantation (Rp)	8	53	4.29	3.87	11.31
5	Pine plantation (Pp)	13	62	3.95	2.75	27.30

3.2 Functional composition of termites in studied habitats

The functional groups (feeding groups) of termites in studied habitats consisted of four groups: wood feeders (W) with nine species, accounted for 25% of the total of species in studied area; litter feeders (L/F) with 18 species (50%); soil feeders (S/H) with seven species (19.4%); soil/wood (S/W) interface feeders with two species (5.6%) (Table 1). The compositions of functional groups were rather different in different habitats. For examples, in primary and secondary forests, the litter feeders dominated (55% and 63% respectively), followed by the wood feeders (30% and 27.3% respectively), while in pine plantation and rubber plantation although litter feeders also dominated (46.2% and 75% respectively), but the soil feeders (38.4% and 25% respectively) were more abundant than the wood feeders. Among the natural habitats, the species percentages of L/F increased while those of W decreased, from primary forests to secondary forest, then to savanna. In tree plantations, the species percentages of L/F in pine plantation were lower than those in rubber plantation, while the species percentages of S/H in pine plantation were higher than those in rubber plantation (Table 4).

The data on relative abundance of feeding groups in different habitats in Table 5 showed that the ratio of litter feeders to soil feeders (S/H : S/W) was rather high in secondary forest and savanna (8.0 and 12.0 respectively) and lower in pine plantation (3.4) and in rubber plantation (1.9). This indicated that the litter feeders dominated in habitats with high human impacts (Sf and Sav), while the soil feeders dominated in tree plantations or in rehabilitated ecosystem (Pp and Rp). These findings provide additional basic data for the use of abundance of termite feeding groups in assessing the degrees of rehabilitation of forest ecosystem.

Table 4. Numbers of termite species and percentages of feeding groups in different habitats

Feeding groups	Pf		Sf		Sav		Pp		Rp	
	sp.	%	sp.	%	sp.	%	sp.	%	sp.	%
Wood feeders (W)	6	30	3	27.3	1	11.1	1	7.7	0	0
Litter feeders (L/F)	11	55	7	63.6	7	77.8	6	46.2	6	75
Soil feeders (S/H)	2	10	0	0	0	0	5	38.4	2	25
Soil/wood feeders (S/W)	1	5	1	9.1	1	11.1	1	7.7	0	0
Total	20	100	11	100	9	100	13	100	8	100

Table 5. Relative abundance of feeding groups in different habitats

Feeding groups	Pf		Sf		Sav		Pp		Rb	
	hit	%	hit	%	hit	%	hit	%	hit	%
Wood feeders (1)	11	19.6	3	10	1	3.7	1	1.6	0	0
Litter feeders (2)	32	57.1	24	80	24	88.9	47	75.8	35	66.0
Soil feeders (3)	10	17.9	0	0	0	0	11	17.7	18	34.0
Soil/wood feeder (4)	3	5.4	3	10	2	7.4	3	4.8	0	0
Total	56	100	30	100	27	100	62	100	53	100
(2)/(3)+(4)		2.5		8.0		12.0		3.4		1.9

4. Conclusions

1. Among natural habitats in this study, both termite richness and relative abundance tended to decrease from primary forest to secondary forest then to savanna (20 species → 11 species → 9 species) and (56 encounters → 30 encounters → 27 encounters) respectively. Between different tree plantations, both richness and abundance in pine plantation were higher than those in rubber plantation (13 species and eight species) and (62 encounters and 53 encounters) respectively.

2. The litter feeders dominated in habitats with high human impacts (Sf and Sav), while the soil feeders dominated in tree plantations or in rehabilitated ecosystem (Pp and Rp).

3. Beside human impacts on habitats, soil moisture played a very important role in the distribution of termites in the studied habitats.

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Đặc trưng phân bố của mối (Insecta: Isoptera) Holmgren theo các kiểu sinh cảnh khác nhau ở khu vực Đắk Lắk

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Tóm tắt: Nghiên cứu định lượng mối theo phương pháp đánh giá nhanh của Jones và Eggleton (2000) lần đầu tiên được thực hiện ở Tây Nguyên nói chung và Đắk Lắk nói riêng. Đặc trưng phân bố của mối trong 5 sinh cảnh của khu vực điều tra thể hiện: ở các sinh cảnh rừng tự nhiên cả số lượng loài và độ phong phú tương đối đều giảm khi đi từ rừng nguyên sinh đến rừng thứ sinh và trảng cây bụi, số loài tương ứng là 20 loài, 11 loài và 9 loài; và độ phong phú tương đối là 56, 30 và 27 (hit). Ở các sinh cảnh rừng trồng các giá trị trên phụ thuộc vào loại cây trồng: 13 loài (rừng thông), 8 loài (rừng cao su), rừng thông có độ phong phú tương đối là 62 hit, cao hơn rừng cao xu (53 hit). Tập hợp mối trong khu vực nghiên cứu gồm 4 nhóm chức năng. Nhóm ăn mảnh vụn (nhóm mối có vườn nấm) chiếm ưu thế trong các sinh cảnh rừng tự nhiên có sự tác động mạnh của con người (rừng thứ sinh và trảng cây bụi), mức độ ưu thế giảm đi trong các sinh cảnh rừng trồng (rừng thông và rừng cao su) với sự gia tăng tỉ lệ phần trăm của các loài mối đất. Tiến hành phân tích một số chỉ số của mẫu đất ở các sinh cảnh nghiên cứu cho thấy, cùng với sự tác động của con người, giá trị độ ẩm của đất trong khu vực nghiên cứu có vai trò quan trọng góp phần quyết định đặc trưng phân bố của mối. Ngoài ra, dẫn liệu thu được đã đưa đến một gợi ý quan trọng có thể sử dụng mối để đánh giá mức độ phục hồi của hệ sinh thái một vấn đề còn chưa được nghiên cứu nhiều hiện nay.

Từ khoá: Phân bố của mối, sinh cảnh, Đắk Lắk.