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Termite (Isoptera) community in the Western Ghats, South India: influence of anthropogenic disturbance of natural vegetation

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Abstract

A comparative study of termites communities was carried out in the Western Ghats in order to understand the impact of human disturbance on the pristine ecosystems such as the wet evergreen forest of South India. Termites communities were studied in six sites with varying degrees of disturbance (3 forests, 2 pastures, 1 *Acacia* plantation) at six different times over one year and for three depths of soil. Twelve species, representing 3 subfamilies and 9 genera were recorded over a total of 27,879 individuals. These results show that the termite community in the natural forest system is greatly affected when the habitat is even slightly disturbed. One species was recorded exclusively in forest systems (*Microcerotermes fletcheri*) and two species were found exclusively in non-forest sites (*Dicuspiditermes pername* and *Pericapritermes ceylonicus*). Maximum number of species was recorded in an undisturbed evergreen forest (10 species) and the minimum in a slightly disturbed forest (4 species). During monsoon, there was a sharp fall in termite abundance and biomass in all the plots while highest abundance and biomass were observed during the dry season. Finally, termite abundance and biomass correlated strongly with soil nitrogen and organic matter.

Keywords: Anthropogenic disturbance, evergreen forest, habitat change, India, soil organic matter, soil properties, termites, Western Ghats.

Peuplements de termites (Isoptères) dans les Ghâts Occidentaux (Inde du Sud) : influence de la perturbation anthropique sur la végétation naturelle.

Résumé

Une étude comparée des peuplements de termites a été réalisée dans les Ghâts Occidentaux de façon à mieux comprendre l'impact de l'activité humaine sur des écosystèmes naturels comme la forêt dense humide sempervirente du Sud de l'Inde. Les peuplements de termites ont été étudiés dans six habitats plus ou moins anthropisés (3 forêts, 2 pâturages, 1 plantation d'*Acacia*) à six dates au cours d'une année et pour trois profondeurs de sol. Douze espèces représentant 3 sous-familles et 9 genres ont été relevées, pour un total de 27 879 individus. Ces résultats montrent que le peuplement de termites de la forêt naturelle est grandement affecté même par une faible perturbation. L'espèce *Microcerotermes fletcheri* semble inféodée aux systèmes forestiers et deux espèces *Dicuspiditermes pername* et *Pericapritermes ceylonicus* n'ont jamais été récoltées dans ces milieux forestiers. Le nombre maximum d'espèces a été enregistré dans la forêt non perturbée (10 espèces) et le minimum dans une forêt légèrement perturbée (4 espèces). Les biomasses et densités de termites étaient maximales en saison sèche et ont diminué fortement pendant la mousson. Enfin, les densités et biomasses de termites étaient fortement corrélées avec la teneur en azote et en matière organique du sol.

Mots-clés : Perturbation anthropique, forêt sempervirente, modification de l'habitat, Inde, matière organique du sol, propriétés du sol, termites, Ghâts Occidentaux.

INTRODUCTION

Western Ghats region in South India, that once harboured a vast tract of pristine forest land is now mostly a mosaic of degraded forest habitats interspersed with pastures, plantations and occasional pockets of undisturbed evergreen forests. This region thus provides a good opportunity to study the effect of human disturbance on the forest lands in a small geographical area. The present study was conducted as a part of an integrated research programme to study the land use in a disturbed area in Shimoga region in Karnataka Western Ghats and the effect of disturbance on vegetation, soil organic matter and soil fauna.

Termites are an important component of the tropical ecosystems. Although, the geomorphological importance of termites have become apparent from the late eighteenth century onwards (Goudie, 1988, 1990), intensive studies during the last two decades have precisely indicated the roles played by different termite populations in different habitats. Termites act as important herbivores and decomposers in the tropics (Wood & Sands, 1978; Abensperg-Traun & De Boer, 1990). The magnitude and dimension of the ecological role played by termites is a function of their population density and biomass (Lee & Wood, 1971; Lee, 1983). The present study hence examines the species richness, population density and biomass of termites across six different habitats (3 forests, 2 pastures, 1 Acacia plantation) at different periods of time over one year and the response of the community to the changing soil characters at different habitats.

MATERIALS AND METHODS

Geography

The study was conducted in the Western Ghats in the Kogar area belonging to Sagar Forest Range, Shimoga Division, Karnataka State (Long. 14°00′ N, Lat. 74°45′ E) between April 1991 and April 1992. Average elevation of this region is 600 to 800 m above sea level.

Climate

The climate is the tropical monsoon climate (Legris, 1963) determined by the South-West or summer monsoon. This region has 6-7 dry months (Pascal, 1982) and receives an average annual rainfall higher than 5000 mm. The monsoon peaks in July-August.

Geology and soil

The bedrock is composed of greywackes in the west of the study area and gneisses in the east, covered by weakly or moderately desaturated ferrallitic soil (Bourgeon, 1992). In the outcrop of the Ghats the soils on the steep slopes are deep ferrallitic soils, have vertical drainage and are relatively little evolved in the class of ferrallitic soil (Peterschmitt, 1993) and are susceptible to erosion. On the reverse side of the Ghats (Precambrian schists), there is considerable lateral differentiation where the soils at the top of the slope are red, then yellow and finally white (hydromorphs) at the bottom of the slope (Peterschmitt, 1993). These soils have vertical as well as lateral drainage.

Vegetation

This area consists of mosaics of evergreen, semi-evergreen and moist deciduous forest interspersed with pastures and *Acacia* plantations. The vegetation has been described as *Dipterocarpus indicus – Diospyros candollena* type (Pascal, 1988). Pastures are continuous layers of grass. Common grasses are *Ischemum indicum* (Houtt.) Merril. and *Arundinella sp.* (Puyravaud, pers. comm.).

Study sites

Six study sites were chosen in this region: one undisturbed evergreen forest (F1), one slightly disturbed evergreen forest (F2), one highly disturbed evergreen forest (F3), one pasture with thickets (PT), one open pasture (PO) and one *Acacia* plantation (AP) (*table* 1).

Termite sampling

Termites were sampled along with other groups of soil fauna by using TSBF (Tropical Soil Biology and Fertility Programme) methodology (Anderson & Ingram, 1989). Sampling points were chosen along random transects. Each transect had 6 to 10 sampling points spaced 5 m apart. A trench was dug up to 30 cm depth around a 25 × 25 cm area at each sampling point to get a soil monolith. Soil monoliths were divided into three layers (0-10, 10-20 and 20-30 cm) and then termites were hand sorted separately from each layer. All the termite individuals were preserved in 4% formalin. Specimens were later sorted to castes and species in the laboratory and the preserved specimens were counted and weighed. Sampling was done in all six plots at six different times over one year, *i.e.* in May, August, October, December in 1991 and, February and April in 1992.

Soil analyses

Soil samples (0-10, 10-20, 20-30 cm depth) were collected in October 1991 from three soil monoliths at each site, and were analysed for pH, particle size distribution and carbon and nitrogen contents.

Table 1. – Description of the sampling plots.

Plots	F1	F2	F3	PT	PO	AP
Location	Kogar Village	Herbettu Village	Herbettu Village	Sulvalli Village	Herbettu Village	Katinkar Village
Habitat	Undisturbed, primary evergreen forest. Slightly logged in the past	Relatively undisturbed primary forest. Slightly logged at present	Highly disturbed, slashed forest. Turning into deciduous forest.	Pasture with thickets	Open pasture	*Acacia* Plantation
Vegetation (trees)	*Knema attenuata* *Pterospermum sp.* *Cryptocarya sp.* *Olea dioica* *Syzygium gardneri* *Diospyros candolleana* *Holigama sp.* *Calophyllum sp.* *Psychotria nigra*	*Syzygium cumini* *Dimocarpus longan* *Olea dioica* *Garcinia morella* *Holigama arnottiana* *Knema attenuata* *Lagerstroemia microcarpa*	*Terminalia bellerica* *Lagerstoemia microcarpa* *Holigama sp.* *Garcinia morella* *Memecylon talbotianum* *Leea indica* *Glochidion sp.* *Flacourtia montana* *Aglaia sp.*	*Phoenix humillis* *Cartunaregam dumetorum* *Gardenia sp.* *Ziziphus spp.* *Careya arborea* *Emblica officinalis*		*Acacia sp.*

Statistical analyses

Seasonal variation in abundance and biomass (log transformed data), species richness and soil characteristics at different soil depths were tested with one way ANOVA. Variation in abundance and biomass and soil characteristics across different sampling sites were checked with Kruskal-Wallis test of variance. Relations between various soil parameters and termite abundance and biomass were tested using simple as well as multiple regression models.

RESULTS

Community composition

Twelve species, representing 3 subfamilies and 9 genera were recorded from a total of 27,879 individuals (52.23 g of biomass) sampled from the six plots. While termite biomass constituted 12.55% of the total macro-invertebrate biomass, the total number of termite individuals constituted 82.12% of the total number of invertebrate individuals collected from these plots over one year. Termitinae was the most dominant subfamily (63.2%) followed by Macrotermitinae (19.9%) and Nasutitermitinae (2.84%). Workers, that could not be identified constituted 14.1% of total individuals (*table* 2). In all the plots, either *Labiocapritermes distortus, Procapritermes fontanelles* or *Odontotermes obesus* were the most dominant species both in terms of abundance and biomass (*table* 2).

In most of the plots, the species accumulation curve reached a plateau after the fifth sampling except in the disturbed forest plot (F3) (*fig.* 1). Species richness was maximum in undisturbed evergreen forest (F1) (10 species) followed by pasture with thicket (PT) (9 species). Slightly disturbed forest (F2) recorded the least number of species (4 species) (*table* 2 and *fig.* 1).

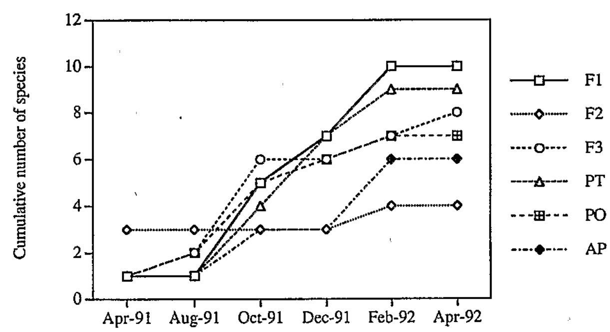

Figure 1. – Species accumulation curve for different plots. F1 = Undisturbed forest, F2 = Slightly disturbed forest, F3 = Highly disturbed forest, PT = Pasture with thickets, PO = Open pasture, AP = *Acacia* plantation.

Periodic fluctuation

There was sharp fall in termite abundance and biomass in all the plots during the monsoon month of August (*table* 3). Although abundance and biomass averaged for all the plots were maximum in February, peak abundance and biomass were different for different plots (*table* 3). One way ANOVA with log transformed seasonal data averaged for all the plots showed significant variations in abundance ($F=2.531$, $df=5$, $p<0.05$) and biomass ($F=4.844$, $df=5$, $p<0.005$) at different sampling months. *P. fontanelles, Microtermes obesi* and *Dicuspiditermes spp.* were the most abundant species during the monsoon in all the plots, while *L. distortus* and *Odontotermes spp.* were the most abundant species during the dry season (*fig.* 2). Communities in all sites

Table 2. – Biomass and density proportions (%) of different species (averaged for all sampling months and depths) across the sampling plots.

	Undisturbed evergreen forest (F1)		Slightly disturbed evergreen forest (F2)		Highly disturbed evergreen forest (F3)		Pasture with thickets (PT)		Open pasture (PO)		Acacia plantation (AP)	
Total no. of individuals sampled*	5717		8388		4906		407		2174		2587	
Total biomass*	10.07		12.86		9.96		7.93		5.95		5.46	
Dominant species (by abundance)	*L. distortus*		*P. fontanelles*		*O. obesus*		*O. obesus*		*L. distortus*		*L. distortus*	
Dominant species (by biomass)	*L. distortus*		*P. fontanelles*		*O. obesus*		*O. obesus*		*L. distortus*		*L. distortus*	
Total number of species	10		4		8		9		7		6	
Shannon's diversity index	0.774		0.594		0.732		0.905		0.682		0.513	
Sub family – Species	Abundance	Biomass	Abundance	Biomass	Abundance	Biomass	Abundance	Biomass	Abundance	Biomass	Abundance	Biomass
Macrotermitinae												
Odontotermes obesus	18.16	26.57	0.97	1.46	16.84	23.25	37.81	18.61	16.10	8.94	5.06	4.78
Odontotermes horni	0.23	0.44	13.04	22.85	0.63	1.78	0	0	10.35	26.12	0	0
Termitinae												
Dicuspiditermes fletcheri	6.03	4.99	0	0	1.35	1.96	5.79	7.22	2.39	3.53	20.72	30.02
Dicuspiditermes pername	0	0	0	0	0	0	5.36	10.43	3.27	5.32	5.06	8.44
Dicuspiditermes graveyli	5.70	6.61	0	0	1.94	2.24	10.40	18.17	0	0	0	0
Labiocapritermes distortus	43.03	34.30	26.75	22.02	20.73	13.57	1.12	1.59	39.14	38.38	66.91	54.24
Procapritermes fontanelles	8.34	5.54	45.03	36.95	15.61	10.08	1.07	1.26	0	0	0.08	0.04
Pseudocapritermes fletcheri	0.03	0.03	0	0	0.16	0.88	0	0	0.05	0.08	0	0
Pericapritermes ceylonicus	0	0	0	0	0	0	9.42	17.20	0	0	0	0
Microcerotermes fletcheri	11.32	8.72	0	0	0	0	0	0	0	0	0	0
Microtermes obesi	2.31	2.00	0	0	0	0	7.33	4.68	2.81	1.19	0.19	0.16
Nasutitermitinae												
Trinervitermes sp.	0.40	0.42	0	0	10.33	10.51	6.31	10.27	0	0	0	0
Unidentified workers	4.44	10.39	14.21	16.71	22.40	35.74	15.39	10.57	25.90	16.44	1.97	2.31

* Total number of individuals and biomass (formalin preserved wet weight) of termites collected from all the sampling pits, soil depths, sampling sites and sampling dates.

Table 3. – Mean density (ind · m^{-2}) and biomass (g · m^{-2}) (wet weight of formalin preserved specimens) at different seasons and at different habitats. Means ± standard errors. For codes, see *table* 1.

	April 91	August 91	October 91	December 91	February 92	April 92	
Density (ind · m^{-2})							Mean
F1	1 626±146	NS*	926±1 030	2 701±6 592	4 414±9 955	386±1 081	2 011
F2	3 112±5 516	130±170	4 142±11 957	1 674±2 339	2 741±4 008	2 893±4 308	2 449
F3	229±324	346±966	1 832±4 524	1 307±3 716	1 518±2 662	2 778±7 755	1 335
PT	206±377	610±1 085	1 218±1 723	2 501±4 152	1 717±3 456	504±1 439	1 126
PO	208±529	171±255	1 030±1 915	1 398±3 739	363±867	371±1 118	590
AP	2 123±5 199	0	446±852	142±392	1 589±2 978	688±2 159	831
Mean	1 251	251	1 599	1 621	2 057	1 270	
Biomass (g · m^{-2})							Mean
F1	3.75±5.37	NS*	1.23±1.33	5.98±16.25	6.53±14.33	0.61±1.65	3.62
F2	4.17±7.01	0.12±0.15	5.43±15.12	2.38±3.39	4.31±6.40	5.92±11.18	3.72
F3	0.31±0.38	0.89±2.53	5.97±16.38	2.00±5.35	2.21±3.59	4.88±14.20	2.71
PT	0.44±0.58	1.11±1.55	2.62±4.54	4.63±4.61	3.04±5.67	1.57±4.59	2.24
PO	0.99±2.55	0.47±0.86	1.62±2.23	3.82±9.84	0.49±1.03	2.47±7.71	1.64
AP	3.54±8.68	0	1.08±2.31	0.17±0.46	4.30±8.90	1.06±2.77	1.69
Mean	2.20	0.52	2.99	3.16	3.48	2.75	

NS* = not sampled.

except in F2 showed highest abundance and biomass during the dry season (*table* 3). One species namely, *Pseudocapritermes fletcheri* was found exclusively in the rainy season while three species were recorded only in the dry season (*Microcerotermes fletcheri* in F1, *Trinervitermes sp.* in forests and pasture with thicket and *Pericapritermes ceylonicus* in PT) (*fig.* 2). Species richness fluctuated too seasonally at all the plots (one way ANOVA, $F=2.487$, $df=5$, $p<0.05$).

Inter-habitat variation

Although species richness did not vary significantly across different habitats the maximum number of species was recorded from F1 (*fig.* 1). Maximum diversity, calculated using the relative biomasses of different species (Shannon-Weiner's diversity index), was however observed at PT. This is due to greater community evenness in PT compared to than F1. There was variation in the species composition in the different habitats (*table* 2). Maximum termite abundance and biomass were recorded from the forest plots. The overall total density of the soil fauna was also highest in the forested plots as compared to the non-forest plots. Plots in PT recorded greater abundance and biomass than plots in PO and AP (*tables* 2 and 3). There was significant variation in abundance (Kruscal Wallis statistic = 21.543, $p<0.001$) and biomass (Kruscal Wallis statistic = 20.003, $p<0.001$) across different habitats.

Relation to soil depth

Termite abundance and biomass varied significantly at different depths ($F_{density} = 7.823$, $df=2$, $p<0.001$, $n=108$; $F_{biomass}=4.566$, $df=2$, $p<0.001$, $n=108$). Biomass and abundance, averaged for all the plots and all sampling periods were maximum at 0-10 cm soil depth and decreased at 10-20 and 20-30 cm soil depths (*fig.* 3). Species richness varied significantly among different soil depths ($F=9.684$, $p<0.01$).

Relation to soil characteristics

Most of the soil characteristics established a gradient from F1 to AP (*table* 4). Organic matter (calculated as carbon × 1.72) content was higher than 5% in forest sites (F1, F2 and F3), between 4 and 5% in pastures (PO and PT) and lower than 4% in AP. Nitrogen content of F1 was twice that of AP. Coarse sand content increased from 7% in F1 to 48% in AP. Clay content was higher than 40% in forest plots while it was lower than 30% in AP. Most of the soil characteristics showed significant differences among different sites (Kruscal Wallis test) except organic matter. Nitrogen and organic matter contents varied significantly at different depths ($F_{nitrogen} = 4.154$, $p<0.05$, $n = 18$; $F_{organic\ matter} = 8.771$, $p<0.005$, $n=18$).

Termite abundance and biomass correlated strongly with nitrogen and organic matter contents at all soil depths and at different plots. It must be noted that the correlation between termite abundance and percentage of nitrogen may not indicate a direct relationship but essentially indicates the relationship between termite abundance with the production status of the ecosystem. Percentage of nitrogen was found to be the best predictor for abundance and biomass (abundance = $27.61X-39.76$, $R^2=0.57$, $p<0,001$, $n=18$; biomass = $0,032X-0.23$, $R^2=0.53$, $n=18$, $p=0.001$, $n=18$) in step wise regression. The

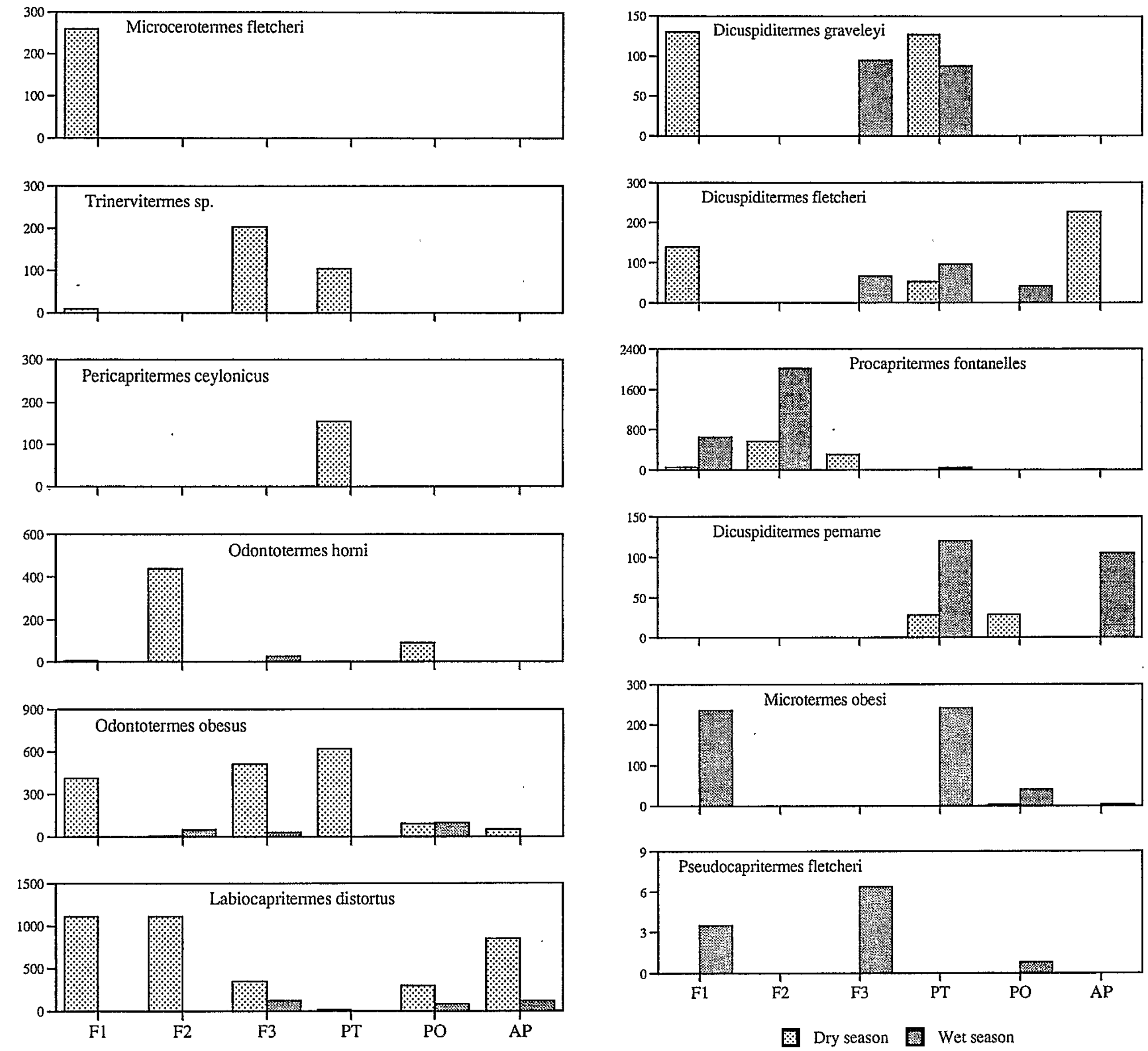

Figure 2. – Densities (ind/m^2) of species at the dry (mean of Apr-91, Dec-91, Feb-92 and Apr-92) and at the wet (mean of Aug-91 and Oct-91) seasons. Due to the high values of standard errors, only mean values are displayed. Standard errors are at least as high as mean values.

second best predictor for abundance and biomass was the percentage of organic matter (abundance = $0.04X-3.834$, $R^2=0.50$, $p<0.002$, $n=18$; biomass = $0.014X-0.013$, $R^2=0.45$, $p<0.002$, $n=18$). At 0-10 cm the density and biomass were positively correlated with percentage of clay (R^2 density$=0.85$, $n=6$, $p<0.05$; R^2 biomass$=0.94$). At 0-10 cm depth regressions were also better for nitrogen (R^2 density$=0.72$, $n=6$; R^2 biomass$=0.76$) and organic matter (R^2 density$=0.50$, $n=6$, R^2 biomass$=0.58$, $n=6$). Soil parameters also affected species richness at different plots. The best predictor model for species richness includes organic matter (X1), fine sand (X2), and nitrogen (X3) contents, ($Y=2.405\ X1 + 0.349\ X2 - 3.339\ X3 - 2.968$, multiple $R^2=0.67$).

DISCUSSION

Community structure

Termitinae were found to be the most abundant subfamily. Most of the members of this family found in South India, except *Microcerotermes fletcheri*, which is an arboreal carton nest builder, are subterranean (Sen Sarma, 1974; Ferry, 1992, 1994). The next most dominant group was the subfamily

Table 4. – Soil parameters (0-10 cm; average of three samples) at different plots. For codes, see *table* 1.

	F1	F2	F3	PT	PO	AP
pH (water)	5.49	5.67	5.73	5.45	5.02	5.34
Coarse sand (>200 μm) %	7.20	8.13	9.10	13.53	32.77	48.07
Fine sand (50-200 μm) %	8.60	6.27	7.37	12.97	5.93	7.57
Coarse silt (20-50 μm) %	6.23	5.80	8.40	8.57	4.60	4.10
Fine silt (2-20 μm) %	33.27	29.43	32.00	25.03	19.47	12.63
Clay (<2 μm) %	44.70	50.37	43.13	39.90	37.23	27.63
Carbon %	3.93	3.38	3.13	2.48	2.72	1.97
Nitrogen %	0.34	0.30	0.30	0.20	0.19	0.18
C/N	11.56	11.27	10.43	12.40	14.32	10.94
Organic matter %	6.76	5.81	5.38	4.27	4.68	3.39

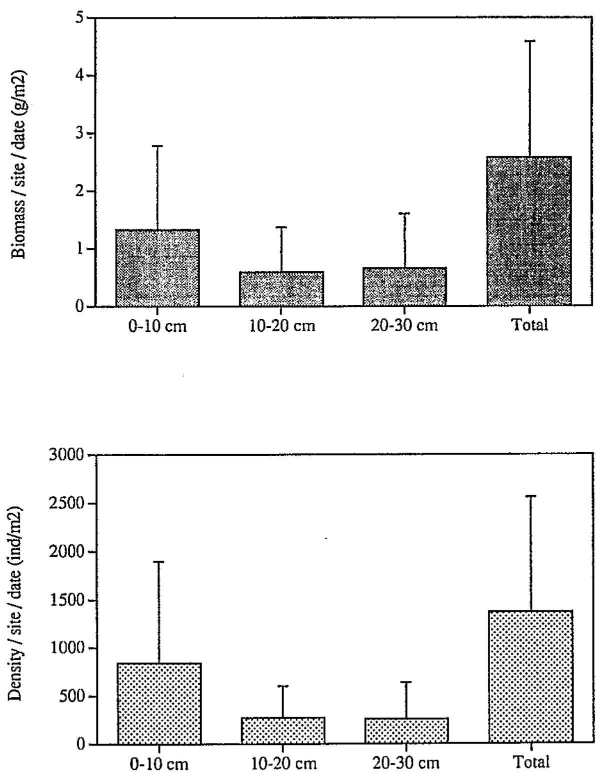

Figure 3. – Mean biomass (g/m²) and density (ind/m²) of termites/site/date at different depths. Mean and standard errors.

Macrotermitinae with two species, of which one species (*Odontotermes horni*) was subterranean. The other species in this group, *Odontotermes obesus* is a mound builder and the second most abundant species found in this area. This is also one of the two species which were recorded from all the habitats and thus has wide ecological amplitude. The other species found in all the habitats is *Labiocapritermes distortus*, belonging to subfamily Termitinae. Our observations are in accordance with earlier observations that subterranean termites are probably more abundant than the mound builders in many tropical regions (Sands, 1972; Abbadie & Lepage, 1989; Abensperg-Traun & De Boer, 1990; Whitford *et al.*, 1992).

Periodic fluctuation in the community

An overall fall in the termite abundance and biomass was observed during the monsoon month of August while they increased immediately after the monsoon (October) and peaked during the month of February. This observation is contrary to the study of Abensperg-Traun (1991) which reports an increase in the subterranean termite density in an Australian ecosystem during autumn and spring and observed the minimum density during summer when soil moisture is minimum. Abensperg-Traun & De Boer (1990) reported a four-fold increase in the termite abundance after the winter rain. This may be attributed to the increased productivity of the system following rain with availability of more sunlight and also appropriate moisture in the soil conducive for vegetation growth. The termites are more active during this period due to increased availability of food in the system. A drop in biomass of the community in most of our plots during the peak monsoon month is probably due to very high rainfall, leading to saturation of soil with moisture which may impede normal termite activity. The worst affected species during monsoon were the ones with above ground nests, e.g. mound builder *O. obesus* and *Trinervitermes sp.* which were totally absent in our samples in the month of August. However, the moisture tolerance of different species may vary (Ferry, 1992). In our study, *Dicuspiditermes fletcheri* and *D. graveleyi* were most abundant during August compared to other species. The other dominant subterranean species, *L. distortus* maintained its dominance during all other sampling months and was absent during August. The low termite activity may also be due to the physical perturbation of the foraging parties during rain. This has been recorded earlier with *Macrotermes* foraging in Kenya (Lepage, unpub. data). The other species that builds external nests is the arboreal nesting *Microcerotermes fletcheri* whose abundance also dropped during the rainy season in our study.

Variation across habitats – relation to soil characteristics

Deforestation and conversion to pastures and plantations seriously alter the structure and chemical characteristics of the soil and impedes its productivity (Miragaya & Caceres, 1990). The situation becomes worse in high rainfall areas where there is even greater loss of nutrients due to leaching, runoff and erosion.

In our case, it led to a soil disturbance gradient from the undisturbed forest to disturbed forests, to pastures and the plantation. Termite communities are affected considerably by habitat change (Sands, 1965; Lepage, 1984; Holt & Coventry, 1988; Abensperg-Traun & De Boer, 1990; Burghouts *et al.*, 1992). Our study also supports these observations. There was a distinct gradient of abundance and biomass from the undisturbed evergreen forest to the open pasture and *Acacia* plantation. Open pasture and *Acacia* plantation had exhibited lower biomass and density than forest sites. The change in vegetation, soil parameters and microclimate considerably modify termites communities.

Although there was no significant variation in the species richness across different plots, the species composition varied considerably from plot to plot. A number of species was conspicuously absent in open pasture and found either in the forest or in the scruby pasture with thickets. These species include the wood feeder and mound building *Trinervitermes sp.* and arboreal carton nest building *Microcerotermes fletcheri* which depend exclusively on the tree vegetation for their food and nesting site.

The wood feeder species *Trinervitermes sp.* commonly recorded in forest was also observed in pasture with thicket. In this habitat, *Trinervitermes sp.* feed on the preponderant *Phoenix humilis* and have been observed to make mounds and galleries at the base of *Phoenix humilis* (Basu, pers. obs.). Presence of the species *Pericapritermes sp.* in this habitat but found absent in other habitats, increased the species richness of pasture with thickets.

Termite abundance and biomass showed strong dependence on the quantity of organic matter and nitrogen in the soil. The diversity and supply of soil organic matter is one of the most important factor determining the soil faunal activity and species diversity (Lal, 1987). Burghouts *et al.* (1992) have related termite activity to the soil organic matter. Nitrogen has been credited as one of the most important factor for vegetation growth (West, 1991) and is therefore a good indicator for the productivity of the soil. In this area, the effect of forest disturbance and consequent soil degradation was also observed for earthworms community (Blanchart & Julka, 1996).

Soil depth and termite activity

Termite abundance and biomass averaged over all plots and sampling periods were maximum at 0-10 cm depth. More species were active at 0-10 cm depth and number of species gradually decreased at different depths. However, at different depths species richness varied from plot to plot. In pasture, termite species richness was minimum at 0-10 cm depth, while in undisturbed evergreen forest it was maximum at 0-10 cm soil depth. Reduced species richness at the top soil zone in pasture may be due to higher temperature at this zone which, according to other studies, seriously affect the activity of many termite species (Abensperg-Traun & De Boer, 1990). Our study has shown significant variation in organic matter at different depths. Top soil in the forest area and in areas with higher density of vegetation like scruby pasture with thicket is enriched with maximum organic matter and other nutrients and have possibly attributed to higher termite activity in this zone at the above habitats.

CONCLUSION

Anthropic disturbance strongly affects functioning of natural ecosystems through modifications of vegetation, soil properties and soil fauna communities. In the Western Ghats, the habitat changes have led to strong modifications of termite community in terms of species richness, species composition, biomass and density. As the sampling in this study was restricted to the soil, the species richness as observed in this paper is probably underestimated to a certain extent. Sampling from various niches within habitats like logs, trees, etc. would probably provide a more complete estimate. However, apart from the observations on the periodicity of different populations, this study established a relationship between the disturbance of the habitat and termite communities.

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