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Diversity of Termite Species and their Distribution in Various Habitats in Palakkad District, Kerala

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***Abstract*:** Information on termites' diversity and distribution in Palakkad district of Kerala was observed. In total, 50 species were recorded under two families. The family Termitidae dominated with 49 species while the other one was Rhinotermitidae. Different termites' habitats were observed for the different sampling blocks. The damp wood and subterranean species were dominant and the epigeal and hypogeal mounds were frequently observed than arboreal mounds in the sampling blocks analysed. Moderate species diversity was also observed and species were rather similar in abundance. Of the total termite samples collected, 98% belonged to the single species *O. obesus*, which was the major detritivorous species of termites indicates the beneficial role of these termites as efficient decomposers of tropical ecosystem.

***Keywords*:** Termites, Isoptera, Palakkad, Diversity, Distribution, Habitat

Termites (order Isoptera) is dominant soil macro arthropods in tropical ecosystems (Govorushko 2019) and play an important role in ecosystem functioning as decomposers, especially in the tropics. Among the soil invertebrates, termites act as ecosystem engineer, contribute to spatial heterogeneity, which in turn has important consequences for ecosystem structure and functioning in terms of soil turnover, litter decomposition, nutrient cycling and productivity (Acanakwo et al 2019, Chakraborty and Singh 2020) as well as alteration of microhabitats, associated species assemblages and vegetation characteristics (Beaudrot et al 2011, Muvengwi et al 2017). Certain termite species are vigorous pests of wooden structures and vegetation in urban settings, agricultural and forested ecosystems leading to substantial economic loss (Paul et al 2018, Chakraborty and Singh 2020). This populous insect order is also associated with a significant contribution to greenhouse gas emissions (Sugimoto et al 2000). Such negative ecological impacts prompted scientists to quantify and suggest models of termite populations, biomass and abundance (Sapunov 2008). There are areas as well as habitat-wise differences in termite species assemblages, abundance, spatial distribution and mound-building habits. At the regional scale, major environmental determinants are temperature, rainfall, topography, altitude and edaphic conditions (Jones et al 2010). The variation in diversity of termites in various habitats is attributed to anthropogenic disturbance, cropping patterns, topography, and bioclimatic factors (Kalleshwaraswamy et al 2018). At the local scale, vegetation, soil type and condition, food availability, disturbances, competition, and predation mainly determine mound architecture, abundance and spatiality (Korb 2010). Proper understanding and up-scaling of the roles of termites in ecosystem progressions need region specific baseline information, estimates and observing of abundance and spatial ecology. Two-thirds of described termite species belong to the family Termitidae. They are the most dominant and widely distributed group and comprise of 8 subfamilies, 238 living genera and living 2072 species (Krishna et al 2013). Although, the economic importance of termites has become apparent, intensive studies during the last two decades have specifically indicated the roles played by diverse termite populations in different habitats.

MATERIAL AND METHODS

Study area: The investigations were carried out in different sampling sites selected in various blocks of Western Ghats region of Palakkad district of Kerala, India (Fig. 1). Termite species were collected from fifty different sampling sites varying in habitat and geographical conditions. The geographical data about the experimental sites in various

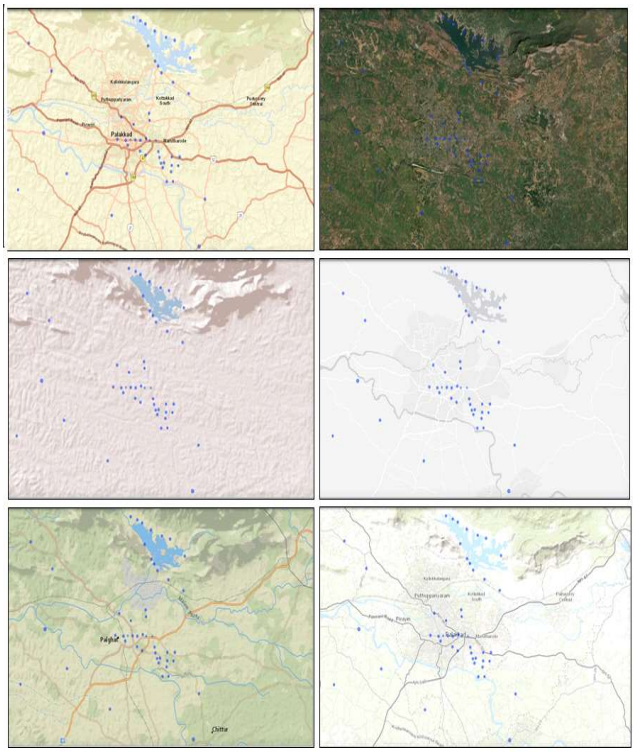

Fig. 1. Map showing different view of sampling station in Palakkad district of Kerala

blocks were recorded with the use of the global positioning system (GPS). The location of the sampling blocks and their habitat was noted manually.

Sampling blocks: Palakkad is situated as a, right at the central part of Kerala and is the largest district in Kerala having geographical area of 4475.94 sq km and is the gateway to Kerala due to the presence of the Palakkad Gap, in the Western Ghats. The district covers 13.5% of the total forest area in the State and 37% of the total ecological fragile land (EFL) in the State. The total forest zone in Palakkad district is 1527.35 sq km, out of these 51.77 sq km belonging to EFL zone, 276 sq km is dense forest, 693 sq km is moderate forest and the rest 606 sq km is open forest land. In view of the physical features, the district is distributed into two natural divisions-midland and highland. The midland region entails of valleys and plains. It leads up to the highland which involves high mountain peaks, long spurs, extensive ravines, dense forests and tangled jungles.The normal annual temperature in Palakkad is 27.8°C | 82.0°F and in a year, the rainfall is 2135 mm. The sampling blocks of the district is rich in termite mound which is ecologically very sensitive and economically important for soil fertility. A survey was carried out to analyze and document the distribution of the termite species in various land use patterns.

Field survey: A field survey was conducted at various sampling blocks of Palakkad district. Termite mound in different transect was documented. In each section the collectors searched the microhabitats which are common sites for termites: from surface soil to above 50 cm deep; accumulations of litter and humus at the base of trees; inside the dead logs, tree stumps, branches and twigs; the soil within and beneath rotten logs, all subterranean mounds, carton sheeting and runways on vegetation and arboreal nests up to a height of three meter above the ground level.

The procedure was intended to offer a flexible approach to the sampling, whereby the collectors used their experience to search and locate as many sample species of termite in available mounds. Samples from each termite population encountered were collected. All castes were collected, but priority was given for finding soldiers and workers. Samples were put in grease proof paper bags and these bags were taken to the laboratory where each one was opened and the termites present were placed in vials labeled with the section number and preserved with 100% ethanol for later identification. Termite identification was done at the Department of Entomology, University of Agricultural and Horticultural Sciences (UAHS), Shivamogga, Karnataka, India where the samples were sent.

Determination of diversity: The number of species encountered was used as an indicator of relative abundance of species within each habitat. Richness (number of species) and abundance (number of individuals) were assessed. Termite species richness was calculated using Shannon's diversity index (H), Simpson's diversity index (D). The Shannon index explains the abundance of species, while the Simpson index (D) is less sensitive to species richness but more sensitive to the most abundant species.

Relative abundance is the proportion of a species in an ecosystem or sample of a community. The relative abundance (p_i) of each species was expressed as

$$P_i = n_i / N * 100$$

Where n_i is the number of individuals of the same species and N is the total number of individuals for all species.

Shannon diversity index is an informative statistic index, which means it assumes all species are represented in a sample and they are randomly sampled.

$$H = -\Sigma_{i=1}^{S} p_i \ln p_i$$

In the Shannon index, p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), ln is the natural log, Σ is the sum of the calculations, and s is the number of species.

The Simpson index is a dominance index because it gives more weight to common or dominant species. In this case, a few rare species with only a few representatives will not affect the diversity.

$$D = \frac{1}{\sum_{i=1}^{S} p_i^2}$$

In the Simpson index, p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), Σ is still the sum of the calculations, and s is the number of species.

Simpson's index of diversity= D

Simpson's Reciprocal Index = 1/D

RESULTS AND DISCUSSION

Profile of the experimental sites: The research was undertaken in the various blocks of Palakkad district of Kerala, India. The geographical locations of various blocks in Palakkad district (Table 1). Sampling was carried out in different land use patterns *viz*., barren, cultivated land in the plains and forest of tropical and subtropical region of Palakkad district. The plains recorded the elevations ranging from 70m at Mathur to 232m at Kava-Aanakkal. The land use pattern varied from barren land to cultivated land in plain and forest area which reflected the species richness and distribution of termite in various habitats. The mound area forms a part of species biodiversity which is ecologically very important for agricultural production and soil fertility.The most dominant species recorded in various sampling sites were *Odontotermes obesus.*

Species composition and abundance: Fifty (50)

Table 1. Survey of termite in various blocks of Palakkad district

Sampling blocks	Name of the block	Latitude	Longitude	Altitude (m)	Habitat	Termite species
P1	Venoli road Puthur	10.47' 4.737" N	76.40'28.919" E	98	Mound	*Odontotermes globicola*
P2	Kutupatha	10.46' 27.84" N	76.39'22.499" E	86	Mound	*Ododntotermes wallonensis*
P3	Chandranagar	10.46'20.721" N	76.40'41.63" E	98	Mound	*Ododntotermes wallonesis*
P 4	Erattiyal	10.45' 4.433" N	76.41'59.577" E	98	Mound	*Odontotermes ceylonicus*
P 5	Prime college	10.45' 7.296" N	76.42'5.024" E	98	Subterranean	*Odontotermes vaishno*
P 6	Nellepilli	10.43' 47.1" N	76.47'5.28" E	120	Damp wood	*Odontotermes ceylonicus*
P 7	Mundur	10.50' 7.596" N	76.34'19.516" E	105	Damp teak	*Odontotermes ceylonicus*
P 8	Kongad	10.51'14.835" N	76.31'39.421" E	101	Wet news paper	*Odontotermes anamallensis*
P9	Kottayi	10.45'40.557" N	76.32'35.061" E	73	Subterranean	*Ododntotermes obesus*
P10	Mathur	10.44'12.814" N	76.34'45.122" E	70	Subterranean	*Ododntotermes obesus*
P11	Thenkurissi	10.42' 6.014" N	76.37'55.80" E	93	Subterranean	*Odontotermes bellahunisensis*
P12	Kuthannur east	10.43' 2.895" N	76.32'39.901" E	70	Mound	*Odontotermes wallonensis*
P13	Mithunampallam	10.44' 9.604" N	76.42'22.319" E	94	Dry wood	*Odontotermes globicola*
P14	Chittur	10.41' 4.494" N	76.43'38.314" E	116	Dry wood	*Odontotermes yadevi*
P15	Pattanchery	10.39' 0.35" N	76.44'15.895" E	118	Dry wood	*Odontotermes horni*
P16	Chittur-Vannamadai road	10.40' 3.815" N	76.46'32.501" E	134	Damp wood	*Odontotermes anamallensis*
P17	Kalvakulam	10.47' 5.984" N	76.40'31.372" E	95	Damp wood	*Odontotermes ceylonicus*
P18	Mankavu	10.46' 6.626" N	76.39'43.691" E	86	Dry wood	*Odontotermes anamallensis*
P19	Kalpathi	10.47' 7.273" N	76.38'48.321" E	86	Damp wood + soil	*Odontotermes globicola*
P20	Manjakulam	10.46' 1.973" N	76.38'58.257" E	86	Subterranean	*Heterotermes malabaricus*
P21	Palakkad-Malampuzha Road	10.47' 7.609" N	76.39'39.499" E	86	Mound	*Odontotermes bellahunisensis*
P22	Tharekkad	10.46' 7.419" N	76.39'3.506" E	86	Subterranean	*Odontotermes bellahunisensis*
PW 23	Malampuzha bypass	10.49' 7.963" N	76.41'10.305" E	95	Damp wood	*Odontotermes ceylonicus*
PW 24	Kava-Aanakkal	10.50' 9.586" N	76.43'47.812" E	232	Small mound + tree	*Odontotermes globicola*
PW 25	Malampul reservoir road	10.51' 9.354" N	76.39'41.856" E	138	Subterranean in teak	*Odontotermes obesus*
PW 26	Asuru home, kava Aanaikkal	10.51' 5.699" N	76.42'38.29" E	232	Small mound	*Odontotermes vaishno*
PW 27	GTW Higher Secondary School, Kava	10.51' 2.982" N	76.41'58.43" E	114	Small mound	*Odontotermes vaishno*
PW 28	Akamalavanam	10.51' 4.086" N	76.40'51.611" E	114	Small mound	*Odontotermes brunneus*

Cont...

Table 1. Survey of termite in various blocks of Palakkad district

Sampling blocks	Name of the block	Latitude	Longitude	Altitude (m)	Habitat	Termite species
PW 29	Malampuzha Reservoir Road	10.49' 1.347" N	76.40'52.692" E	95	Projection in teak tree	*Odontotermes obesus*
PW 30	Malampuzha Reservoir Road	10.50' 3.805" N	76.40'39.097" E	114	Small horizontal subterranean	*Odontotermes obesus*
PW 31	Kava-Aanakkal	10.52' 24.9" N	76.39'40.697" E	138	Mound	*Odontotermes obesus*
PW 32	Kava-Aanakkal	10.52' 15.19" N	76.39'50.276" E	138	Damp wood	*Odontotermes obesus*
PW 33	Olavakkode	10.52' 5.48" N	76.39'21.54" E	138	Small mound	*Odontotermes obesus*
PW 34	Malampuzha Kanjikode route 1	10.48' 0.617" N	76.42'57.833" E	117	Big mound	*Odontotermes bellahunisensis*
PW 35	Malampuzha Kanjikode bypass route 2	10.48' 52.469" N	76.41'56.576" E	95	Wood and plastic bottom	*Odontotermes anamallensis*
P36	Manjakulam	10.46' 26.475" N	76.39'10.86" E	86	Mound	*Odontotermes obesus*
P37	Kannara street	10.46' 21.39" N	76.39'22.95" E	86	Small mound	*Odontotermes obesus*
P38	Kenathuparambu road	10.45' 46.102" N	76.39'40.292" E	86	Small mound	*Odontotermes obesus*
P39	Kunnathumedu	10.45' 6.068" N	76.39'58.136" E	86	Dry palm leaf	*Odontotermes bellahunisensis*
P40	St. Sebastian School, Kodunbu	10.45' 33.05" N	76.41'12.912" E	98	Dry coconut flower waste	*Odontotermes redemanni*
P41	Govt Polytechnic College	10.45' 0.031" N	76.41'33.769" E	98	Small mound on palm root	*Odontotermes obesus*
P42	Kalmandapam	10.46' 7.591" N	76.40'28.381" E	98	Small mound	*Odontotermes obesus*
P43	Salem-Kochi-Kanniyakumari highway	10.46' 2.225" N	76.41'35.931" E	98	Small projection under tree	*Odontotermes bellahunisensis*
P44	Devaki nandhanam home stay	10.45' 9.693" N	76.41'31.606" E	98	Small projection under tree	*Odontotermes obesus*
P45	Palakkad-Chittur Road	10.44' 0.533" N	76.41'37.785" E	94	Damp wood (rubber)	*Odontotermes bellahunisensis*
P46	Nellikad	10.45' 2.997" N	76.42'2.968" E	98	Damp wood (rubber)	*Odontotermes anamallensis*
P47	Prime College Palakkad	10.45' 19.39" N	76.42'10.384" E	98	Damp wood (palm)	*Odontotermes yadevi*
P48	Palakkad - Polachi Road	10.45' 43.37" N	76.42'6.676" E	98	Damp wood (coconut)	*Odontotermes vaishno*
P49	Primary health center - Kudumbu	10.45' 28.8" N	76.41'4.144" E	98	Damp wood (rubber)	*Odontotermes anamallensis*
P50	Kallingal	0.45' 16.885" N	76.41'1.918" E	98	Damp wood (coconut)	*Odontotermes anamallensis*

N= Number of individuals; RA= Relative abundance

Table 2. Taxonomic composition, species composition and relative abundance of different species of Termites in Palakkad

Termitidae /Rhinotermitidae.	Sub family	N	n/N	p_i	p_i^2	ln p_i	p_i ln p_i	RA
Odontotermes globicola	Macrotermitinae	4	4/50	0.08	0.0064	-2.525	-0.202	8
Ododntotermes wallonensis	Macrotermitinae	3	3/50	0.06	0.0036	-2.813	-0.168	6
Odontotermes vaishno	Macrotermitinae	4	4/50	0.08	0.0064	-2.525	-0.202	8
Odontotermes ceylonicus	Macrotermitinae	5	5/50	0.1	0.01	-2.302	-0.230	10
Odontotermes anamallensis	Macrotermitinae	7	7/50	0.14	0.0196	-1.966	-0.275	14
Ododntotermes obesus	Macrotermitinae	14	14/50	0.28	0.0754	-1.272	-0.356	28
Odontotermes bellahunisensis	Macrotermitinae	7	7/50	0.14	0.0196	-1.966	-0.275	14
Odontotermes yadevi	Macrotermitinae	2	2/50	0.04	0.0016	-3.218	-0.128	4
Odontotermes horni	Macrotermitinae	1	1/50	0.02	0.0004	-3.912	-0.001	2
Heterotermes malabaricus	Heterotermitinae	1	1/50	0.02	0.0004	-3.912	-0.001	2
Odontotermes redemanni	Macrotermitinae	1	1/50	0.02	0.0004	-3.912	-0.001	2
Odontotermes brunneus	Macrotermitinae	1	1/50	0.02	0.0004	-3.912	-0.001	2
Total		50			0.1442		1.84	100

individuals were collected in July 2020 from two different sub families of termite's species. The majority of the individuals (Table 2) belonged to sub family Macrotermitinae with relative abundance 28%.The most dominant species recorded in various sampling sites were *Odontotermes obesus* with relative abundance 28%, *Odontotermes bellahunisensis* with relative abundance 14%, *Odontotermes anamallensis* with relative abundance 14%, *Odontotermes ceylonicus* with relative abundance 10%.Among the species identified, 49 samples representing single family Termitidae and one from Rhinotermitidae. Termitidae are the largest group dominating the order Isoptera with over 80 % of the genera and 74 % of the species which include the most advanced and diverse group with a wide variety of social specializations (Edwards and Mill 1986, Breznak 1982). Nearly all identified termite species are detritivorous (Gudeta et al 2010, Sileshi et al 2010).

The biodiversity of termite recorded a notable variation in the sampling blocks with a greater number of species abundance in open pasture land and the termite mound distribution showed a striking variation in the different habitats with different land use patterns (Table 1). Higher termites were recorded in all fifty sampling blocks. Biodiversity of termite species in Palakkad district revealed that there a greater number of subterranean mounds colonized by *O. obesus* in the sampled blocks which maintain fungal comb as symbiotic association in their mounds. The richness in species diversity recorded in hilly forest blocks was similar in natural ecosystem of tropical region. The poor diversity of other species recorded during the survey could be explained by the degradation of habitat, vegetation types, microclimate fragile ecosystem along with changes in the physico chemical components.

Species diversity: Species diversity was calculated for the seven transects using the Shannon Index of Diversity and Simpson's index of diversity. The mean Shannon diversity of termites in Palakkad was 1.84 which is moderately diverse. In the Simpson index of individuals of one particular species D= 0.87. This diversity can be explained by the availability of moisture particularly climate of that region, which can serve both as food and habitat for termites.

CONCLUSION

There is variation in the abundance and diversity of termite in Palakkad district of Kerala. High abundance of active *Odontotermes obesus* species in the moist tropical regions in and around the Malampuzha region of the sampling blocks. All termites were listed as detritivorous. The baseline data generated from this study will be useful for monitoring the presence of dominant species in Palakkad district and their habitat distribution will helpful to analyse key role of termites in understanding the decomposition process important in the functioning of tropical ecosystem.

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