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A Preliminary Study on Soil Modification by Termites in the Eastern Part of Palakkad Gap, Western Ghats, Kerala, India

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Abstract: This study investigates the ecological and edaphic significance of termite mounds along the eastern boundary of the Palakkad Gap, Western Ghats, Kerala, India. Morphometric analysis revealed substantial spatial variability in mound size, indicating site-specific environmental control. Termite mounds supported higher plant and faunal diversity compared to surrounding areas, functioning as key microhabitats. Soil analyses showed consistent enrichment of macro (N, P, K) and micronutrients (Fe, Mn, Zn) in termite mound soils relative to adjacent soils, confirming their role as nutrient hotspots. Overall, the findings demonstrate that termite mounds enhance soil fertility, biodiversity, and landscape heterogeneity, underscoring their importance as ecosystem engineering structures in dry forest environments.

Keywords: Termite mounds, Palakkad Gap, Ecosystem engineers, Western Ghats

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Introduction

Termites are eusocial "ecosystem engineers" that build conspicuous mounds and profoundly modify soil structure and function (Dangerfield *et al.*, 1998; Jouquet *et al.*, 2016a). Of the 3176 known species, about 2976 are extinct, with 1150 species reported from the Oriental region (Constantino, 2020). Higher termites, which represents 75% of modern species diversity, exploit diverse food resources including wood, litter, soil and dung (Krishna *et al.*, 2013; Jouquet *et al.*, 2016a). Although globally distributed except Antarctica, only about 10% are pests, while most species play key ecological roles in tropical and subtropical ecosystems (Ahmed and Pradhan, 2018).

Termites spend their entire life within soil, continuously tunneling and constructing mounds

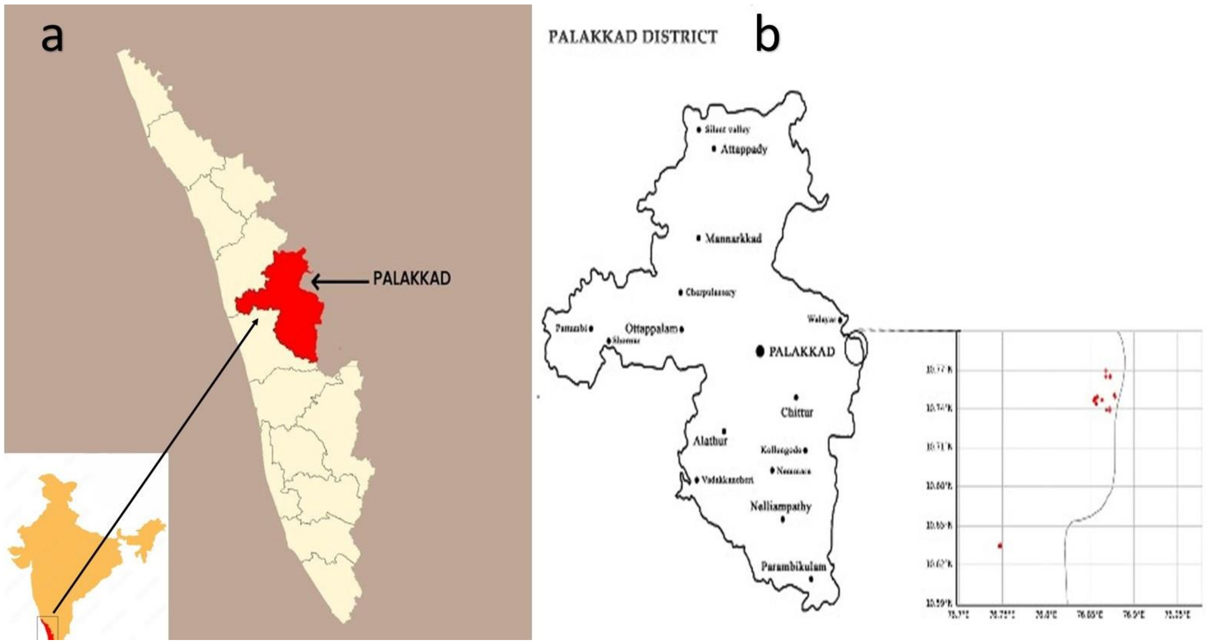

Fig. 1: Study Area: (a) Map showing Palakkad gap, and (b) Map showing study sites.

using fine soil particles bound with saliva and fecal material, leading to marked changes in soil structure (Holt and Lepage, 2000). Mound construction generally increases bulk density and reduces porosity, whereas subterranean galleries enhance porosity and water movement. By transporting clay-rich subsoil to the surface, termites can enrich upper soil layers with nutrients and organic matter (Jouquet *et al.*, 2011). However, termite impacts on soil chemistry remain poorly documented in Asia, and outer mound surfaces are less studied than internal mound soils. Therefore, this study investigates termite-induced alterations by comparing outer mound soil with adjacent surface soils to better understand their influence on soil profile development.

Materials and Methods

Study site and data collection

Soil samples were collected from the eastern boundary of Palakkad Gap, which shares its boundary with Coimbatore, Tamil Nadu, India. The eastern boundary is the driest part of the Palakkad gap, which starts from Chittur (Fig. 1). The major ecosystem found in the eastern part is an agrarian type, with mostly rice. Other than rice are groundnut, millet, corn, pulses, and vegetables. As it shares a boundary with Tamil Nadu, the people residing here follow Tamil culture. Total area sampled was 900 sq. km. The study was conducted from September 2019 to June 2020.

Termite mound survey

Fifteen mounds were sampled, of which ten active mounds were selected for soil sampling. Termites were sampled using the standard belt transect method (2 m wide; 40-50 m long) following Jones and Eggleton (2000). Soil was collected from mound surfaces and from adjacent soils located 5 m away. For each mound, morphometric parameters (height, basal diameter, and shape), GPS coordinates, and associated vegetation and fauna were recorded.

Termite species collection

The termites were collected from termites' mounds followed by its separation from debris. By using wet camel hair brush, termites were then

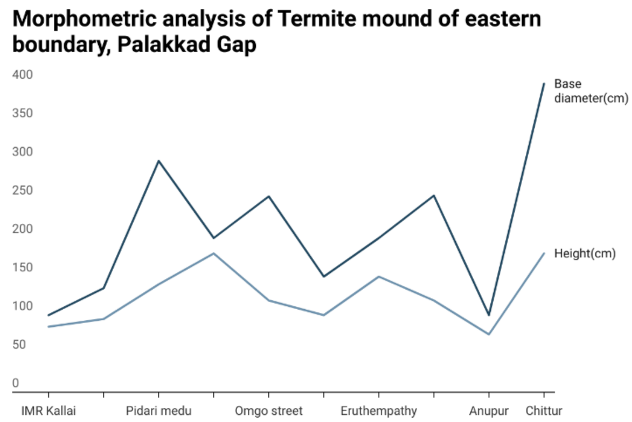

Fig. 2: Morphometric analysis of termite mound.

transferred into a 2 ml polypropylene vial having 80% alcohol for preservation and subsequent identification.

Soil Chemical Analyses

A total of twenty soil samples were collected from the study area. Ten soil samples were taken directly from termite mounds, and another ten soil samples were collected from soil, 5 m apart from each termite mounds, which were treated as control soil/ adjacent soil sample (ADS). Soil sampling was carried out using standard procedures with an auger, and the samples were securely sealed in airtight 1 kg plastic bags. All samples were subsequently analyzed for soil analysis for pH, Macro elements [Nitrogen (Kg/hec), Phosphorous (Kg/hec), Potassium (Kg/hec)]; and Microelements [Copper (ppm), Iron (ppm), Zinc (ppm), Manganese (ppm)].

Macro elements

Analysis was performed for available Phosphorous for alkaline soil by Olsen's Method (Olsen and Sommers, 1982); Bray's No. 1 method for acidic soil; exchangeable Potassium by Neutral ammonium acetate (Atkinson *et al*., 1958) and available Nitrogen by Alkaline Permanganate Method (Subbiah and Asija, 1956).

Microelements

Microelement's analysis was conducted to determine the exchangeable cations in soils--exchangeable Calcium by neutral ammonium acetate (Doll *et al*., 1973) and Iron, Manganese, Zinc and Copper by DTPA soil test (Lindsay and Norvell, 1978).

Results

Termite Mound Survey

The area covered during the survey was 900 sq. km. Most of the survey was done by random selection. As it is not a closed type of area, most of the area was with human habitants or in agricultural fields with crops. Thus, taking a transect was not possible most of the time. Thus, the service road was considered as a transect and surveyed for nearly 40-50 m on both sides of the road. During the survey, only active termite mounds were selected for the study; most of them are either inactive or termites are unavailable for collection, and some mounds were treated as holy, thus unavailable for collection. Morphometric analysis of termite mounds is given in Figure 2 and Table 1. The graph shows clear spatial variation in the termite mounds across the eastern boundary of the Palakkad Gap. Base diameter varies more sharply than height, indicating irregular termite mound geometry. The largest termite mounds occur at Chittur and Pidari medu, while Anupur has the smallest structures. Overall, mound dimensions appear to be influenced by local site conditions rather than showing any uniform growth pattern. The total height of the termite mound from base to top, and the basal diameter of each mound were recorded, shape

Table 1: Morphometric details of termite mounds

S. No.	Termite mound	Length (cm)	Base diameter (cm)	Shape	Location
1	IMR Kallai	85	100	Conical lenticular	76˚52'22.28" E 10˚45'53.78" N
2	IMR Kallai	95	135	Conical lenticular	76˚52'22.28" E 10˚45'53.78" N
3	Pidari medu	140	300	Big conical	76˚51'49.48" E 10˚44'48.86" N
4	Pidari medu	180	200	Dome shape	76˚51'49.48" E 10˚44'48.86" N
5	Omgo street	119	254	Big dome	76˚51'28.66" E 10˚44'56.12" N
6	Omgo street	100	150	Small dome	76˚51'28.66" E 10˚44'56.12" N
7	Eruthempathy	150	200	Conical	76˚52'22.28" E 10˚45'53.78" N
8	Anupur	119	255	Small castle	76˚51'22.4" E 10˚44'40.15" N
9	Anupur	75	100	Small Hillock	76˚51'22.4" E 10˚44'40.15" N
10	Chittur	180	400	Big Conical	76˚44'53.90" E 10˚38'03.88" N

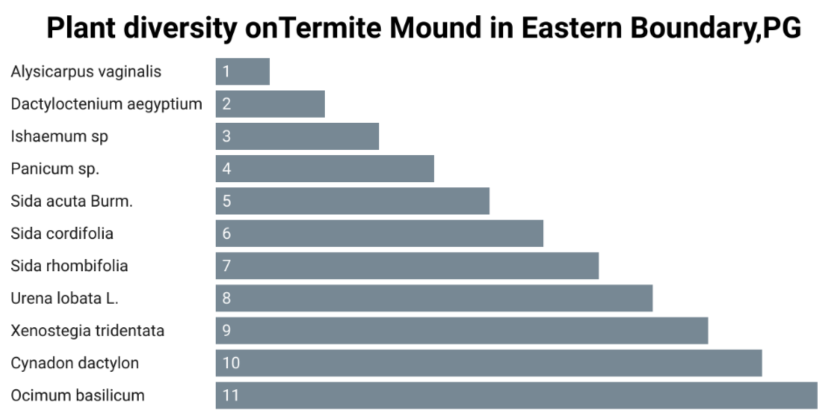

Fig. 3: Floral diversity recorded from and near termite mounds.

was also noted (Table 1). Plant details are included in Figure 3. The termite mounds in Palakkad Gap support 11 plant species, reflecting good vegetation diversity. Dominant species include *Ocimum basilicum*, *Cynodon dactylon*, *Xenostegia tridentata*, and *Urena lobata* L., while *Alysicarpus vaginalis* and *Dactyloctenium aegyptium* are at least represented. This indicates that termite mounds provide a favourable microhabitat that promotes plant establishment and diversity.

The faunal survey of the termite mounds (Fig. 4) revealed notable species richness. Insects were the most abundant group, followed by lizards, skinks, and ants, indicating that termite mounds function as important microhabitats and refuges for both invertebrates and small vertebrates. Lower occurrences of spiders, millipedes, and centipedes suggest selective habitat suitability. Overall, the data highlight the ecological significance of termite mounds in supporting diverse faunal communities.

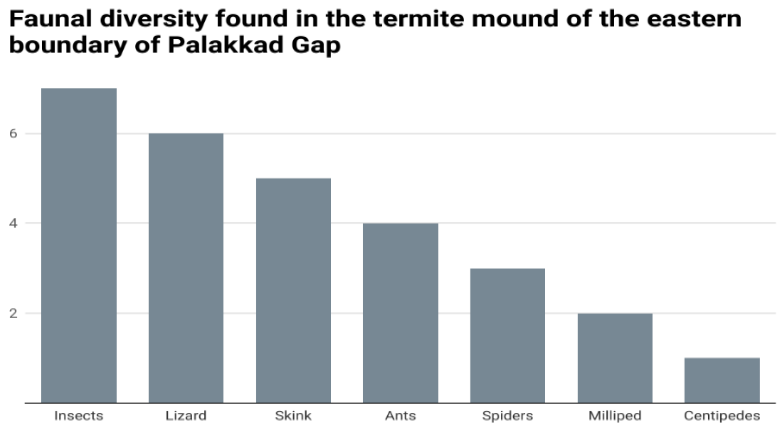

Fig. 4: Fauna collected around the mound.

Table 2: (a) Soil Chemical Analysis of Termite Mound Soil Soil; and (b) Chemical Analysis of Control.

(a)

Soil chemical analysis of Termite mound soil of eastern boundary, Palakkad Gap

Place	N	P	K	Cu	Fe	Zn	Mn
Pidari medu	251	171	666	2	132	6	24
Pidari medu	240	186	675	3	18	3	39
Eruthempathy	250	190	558	2	34	4	45
Omgo street	163	117	628	5	46	5	36
Omgo street	275	125	635	5	25	3	35
IMR Kallai	250	323	525	3	22	3	29
IMR Kallai	252	315	548	4	23	3	25
Anupur	290	350	527	2	24	3	26
Anupur	300	366	642	3	40	3	35
Chittur	320	96	211	3	225	1	43

(b)

Soil chemical analysis of Control soil of eastern boundary, Palakkad Gap

Place	N	P	K	Cu	Fe	Zn	Mn
Pidari medu	226	132	569	4	132	2	43
Pidari medu	210	150	550	4	46	3	48
Eruthempathy	163	175	515	2	36	5	78
Omgo street	164	98	373	5	84	2	50
Omgo street	200	100	376	5	45	3	50
IMR Kallai	250	246	205	3	29	2	40
IMR Kallai	201	265	201	3	39	2	35
Anupur	191	300	347	3	39	3	42
Anupur	250	324	375	3	46	3	53
Chittur	251	66	174	4	354	1	54

Termite species collection

The most common encountered genera were of *Odontotermes obesus* (9 mounds), and *Coptotermes sp.* found in one mound. Species-level identification is not complete. Odontoterms are mainly soil termites and known as fungus-growing termites, belonging to the family Termitidae (Krishna *et al*., 1969). *Coptotermes* sp. belongs to the family Rhinotermitidae and is an economically destructive pest (Thompson, 1985).

Soil chemical analyses

The results of the chemical analyses of termite mounds (TMS) and adjacent soil (ADS) are given in Table 2. The pH of termite mound soil is higher compared to adjacent soil (Fig. 5). Total N (Kg/hec) and K(Kg/hec) are higher in the termite mound. P (Kg/hec) is significantly higher in the termite mound. Termite mound soils show clear nutrient enrichment compared to adjacent soils. Nitrogen, Phosphorous, and Potassium are generally higher in mound samples, with particularly elevated values at Chittur, IMR Kallai, and Pidari Medu. This pattern confirms that termite mounds function as nutrient hotspots, improving soil fertility relative to surrounding areas. There were no significant changes in microelements (Cu, Zn, Fe, Mn) between the two sites. The micronutrient levels show clear enrichment in termite mound soils compared to adjacent soils. Fe and Mn are notably higher at Anupur and Chittur, while Zn shows a strong peak at Pidari Medu. Cu remains comparatively low with minor variation. Overall, termite mounds act

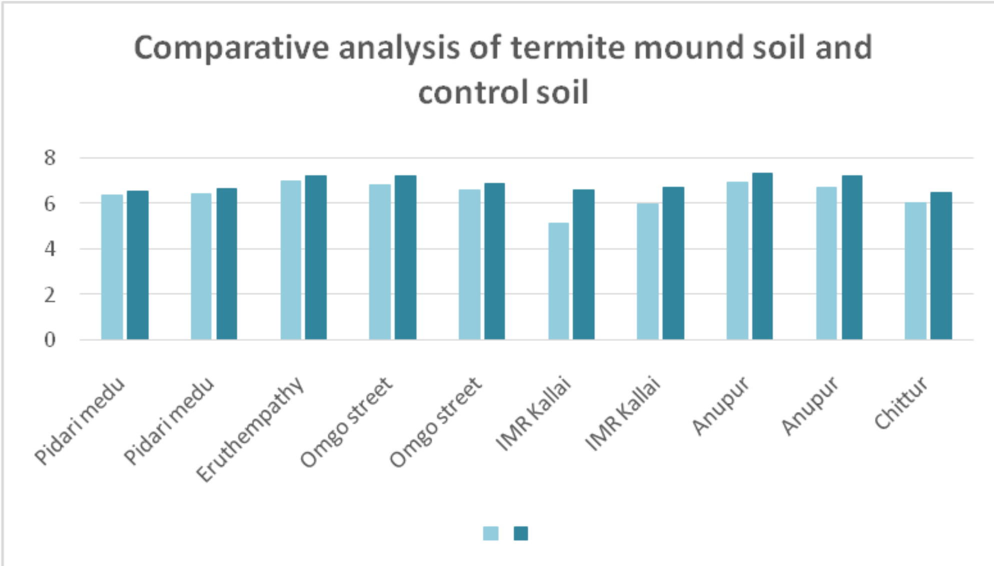

Fig. 5: Soil pH of Termite mound soil (TMS) and Adjacent soil (ADS).

as micronutrient-rich hotspots.

Discussion

Soil sustains enormous biological life, supports plant productivity, and acts as a major carbon reservoir, yet global quality is rapidly declining due to loss of organic matter, intensive agriculture, and chemical inputs, leading to reduced fertility, declining insect biomass, and increasing desertification risks (Savci, 2012). Within this context, termite mounds function as important microecosystems rather than simple soil accumulations. Along the eastern boundary of the Palakkad Gap, termite mounds exhibit pronounced structural, ecological, and edaphic variability, reflecting environmental heterogeneity and factors such as colony age, soil texture, moisture regime, and disturbance. Larger mounds observed at Chittur and Pidarimedu suggest older, well-established colonies (Dangerfield *et al.*, 1998; Turner, 2006). The associated biological assemblages underline their ecological significance, as mound soils promote higher plant richness and serve as suitable substrates for microbial communities due to elevated nutrients and organic matter (Pringle *et al.*, 2010; Nithyaharani and Kavitha, 2018).

Termite mounds also support diverse faunal communities, including insects, reptiles, arachnids, and myriapods, functioning as refugia and biodiversity hotspots that provide shelter, food resources, and thermal stability (Dangerfield *et al.*, 1998; Bignell and Eggleton, 2000). Chemically, mound soils act as "nutrient-enriched islands" showing enrichment of macro and micronutrients such as Fe, Mn, Zn, improved pH balance, higher clay content, and better water – holding capacity compared with adjacent soils, driven by termite-mediated soil translocation, aggregation, and organic incorporation (Holt and Lapage,2000). In the largely sandy and less fertile soils of the Palakkad Gap, the higher clay, nutrient concentration, and organic carbon in mound soils suggest enhanced fertility and hydrological benefits. While these findings strongly indicate termite-driven improvement of soil profiles, further work with expanded parameters is needed to deepen understanding of their ecological engineering role.

Conclusion

Soil on which all ecosystem thrives is the base of everything. If nutrition has to happen soil should be rich. Plants also get nutrition only when soil is healthy. As we all are aware of civic issues but less being said for soil, which support zillions of lives.

According to UN report 60-80% of agricultural soil has been extinct. 80% of the insect biomass lost in 25-30 yrs from the planet according to Biological Conservation. World Economic forum predicted 30% less food in the next 20-50 yrs. The conditions of some African Countries prove this. In a rainforest, organic content is 70%, and in an agricultural field is 3-7%, but today it is less than .5%. So literally, we are on the verge of desertification across the world. Thus, we need sufficient ecological engineers to restore it. Enhancing biodiversity is the only measure that can bring about a long-term effect. This study justifies the termite as a potential ecological engineer in the Palakkad gap, which is one of the driest and most exploited areas of Palakkad, Kerala. This work is a preliminary work, more research is needed in termite biology to get more insight.

Ethical Statement

No animal or microbes have been used or sacrificed for this study, hence Ethical Approval not required.

Author Contributions

Each author has contributed equally to the study's planning, analysis, writing, and editing. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

The authors declare no conflicts of interest.

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