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Research Article

Diversity and abundance of Subterranean Termites in South India

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ABSTRACT

The abundance and diversity of subterranean termites was studied in the states of Andhra Pradesh, Keralae, Karnataka and Tamilnadu. Fifteen species of termites belonging to subfamilies Apicotermitinae, Kalotermitidae, Macrotermitinae and Nasutitermitinae, were recorded. The fungus growing termites (Macrotermitinae) accounted for 66.66% abundance, across the states. The Apicotermitinae (soil feeders) and Kalotermitidae (dry wood termites) registered 6.62% each and the dry wood termites (Nasutitermitinae) recorded 20.1% abundance. Among the different species of termites, Odontermes obesus, was more predominant (15.62%) than others. The cropping pattern, soil type and topography predisposed the abundance and diversity of termites.

Keywords: *Abundance, Cropping pattern, Diversity, Macrotermitinae.*

INTRODUCTION

Termites (Isoptera) are considered as the most abundant invertebrates and represent up to 95% of soil insect biomass show an elaborated morphology and complex behaviour (Wang, et al., 2009) Termites are the serious pests of agricultural and horticultural crops that mainly destroy the roots and above ground parts and feed on paper, wood and timber (Murthy, et al., 2015). They are classified in about 280 genera, and over 2800 species within 14 subfamilies (Eggleton & Tayasu, 2001). In India about 300 species within seven families have been reported (Kumar & Pardeshi, 2011). Termites are often referred as "ecosystem engineers" (Jouquet et al., 2006, & Ali, et al., 2013) as they play a vital role in recycling of plant materials and wood, modifying and improving the soil condition and composition, and providing food for other animals (Ackerman et al. 2009, & Sugimoto et al., 2000). Termites are also considered as potent catalysts due to their role involved in converting lignocellulose into biofuels (Deivendran, 2013) and contribute to gas exchange, nitrogen fixation, and soil stability and quality (Bignell 2000, & Hemachandra et al., 2010).

Termites are abundant throughout the tropics, subtropics and the temperate regions of the world.

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The subterranean termites which are of economic importance (Wang et al., 2009) to agriculture are mostly found in temperate climates. The population density and biomass determines the extent and dimension of their function in an ecosystem (Evans et al., 2011). The composition in a given region is predisposed by the habitat disturbance and ecological factors (Jones & Eggleton 2000, Pardeshi & Prusty 2010, & Luke et al., 2014). Loss in biodiversity and degradation of natural habitats due to climate change and human interference in natural ecosystem has necessitated the need to have an inventory of species richness in an ecosystem.

The information on species diversity, relative abundance of termites in different agro-ecological regions of South India has not been adequately addressed. It is imperative to understand the species distribution in different regions, so to develop a strategy for their management and conservation in wild habitats to maintain the ecological balance.

MATERIALS AND METHODS

Study area:

Surveys were carried out in the southern states of India, viz., Andhra Pradesh, Karnataka, Kerala and Tamilnadu in different locations. The geographical co-ordinates in the different locations considered for study ranged from 10.52-17.89 ^{0}N, 74.29 - 83.2 ^{0}E. The study area comprised of different cropping patterns and soil types **(Table 1).**

Collection and identification of termite samples

Termite specimens (Soldiers and workers) were collected from the various locations listed in Table 1 by adopting the belt transect method (Eggleton et al. 1997, Davies et al., 2003, & Anantharaju et al., 2014). Collections were made at three months intervals from August 2016 to July, 2018. The sampling also included the micro habitat (mounds, leaf litter, stump, tree bark, tree logs, bamboo fencing and vegetation) apart from the crop canopy.

Contiguous sections of thetransect, measured 10 sq. m each. The collected specimens were taken to the laboratory at the Division of Molecular Entomology, NBAIR-ICAR Bangalore, The labeled specimens were preserved in 75% (v/v) ethyl alcohol.

Taxonomical identification of these specimens was done at the Division of Entomology Indian Agricultural Research Institute, New Delhi, Institute of Wood Science Technology Bangalore, and Centre for Insect taxonomy, University of Agricultural Sciences, Bangalore, by using the keys of Roonwal and Chottani (1989), Chottani (1997) and Kalleshwaraswamy et al. (2013).

RESULTS AND DISCUSSION

Study area

The study area comprised of four South Indian states, viz., Andhra Pradesh, Karnataka, Kerala and Tamilnadu. The states are characterized with varied cropping pattern, soil type and geography (Table 1). The plantation crops (arecanut, coconut, cocoa, coffee, pepper, tea and rubber) predominate in the state of Kerala, while Karnataka has more diversified pattern with maize, millets, pulses arecanut and vegetables. The type of soil in the states varied from red loamy, alluvial soils, sandy loams, red laterite and silty loam. The geographical co-ordinates ranged from 10.52-15.51 ^{0}N, 70.58-83.2 ^{0}E

Species distribution and abundance

The population of termites were collected from different geographical locations in the country from the four states of South India - Andhra Pradesh, Karnataka, Kerala and Tamilnadu. The locations surveyed are indicated in **Table 2**.

The distribution of subterranean termites in the different states indicated occurrence of fifteen species in the locations surveyed. The collected termites belonged to the subfamilies Macrotermitinae, Nasutitermitinae Apicotermitinae and Kalotermitidae. The Species belonging to sub family Macrotermitinae, outnumbered the others in abundance. Ten species of Macrotermitinae, three species of Nasutitermitinae and one each of Apicotermitinae and Kalotermitidae. Among the macrotermitinae, *Odontermes obesus* registered 15.62% abundance followed

by *Odontotermes holmgren* (13.24%) and *Odontotermes longignathus* (10.21%) and *O. gurdaspurensis* (10.04%), in the various locations (Table 2), while *Hypotermes makhamensis*, *Hypotermes xenotermitis* and *Microtermes obesi* accounted for low occurrence (1.72% each). *Dicuspiditermes Krishna* registered the least abundance (1.31%). The species *Euhamitermes hamatus* and *Neotermes koshunensis* under the subfamilies, Apicotermitinae and Kalotermitidae , respectively recorded 6.62% each. The Nasutitermitinids, *Nasutitermes exitiosus* and *Nasutitermes octopilis*, registered 11.62 and 6.66% abundance, respectively. **(Fig1).**

The taxonomic composition of termites and their abundance revealed occurrence of species diversity with respect to the area and the cropping pattern. Our observations in the present study are corroborative with the earlier reports of diversity of termite species reported by several earlier workers. Earlier, Twenty five species of termites around 22,400 km2 in three states: Tamil Nadu 400 km2 , Karnataka 13,000 km2 and Kerala 9,000 km2 were sampled in a study conducted to assess the economic damage caused to forest trees and ecological habitat by termites (Roonwal & Bose, 1978). Twelve termite species were identified in the Western Ghats, South India to understand impact of human disturbance on pristine ecosystem (Basu et al., 1996). A survey by Rao et al. (2012) to investigate diversity of termites and their damage to living trees of forest region of Bhadrachlam forest (1, 44,603 ha) in Andhra Pradesh revealed greater distribution of Macrotermitinae. in the area (Odontotermes brunneus (Hagen), Odontotermes feae (Wasmann), Odontotermes guptai (Roonwal and Bose), Odontotermes indicus (Thakur), Odontotermes obesus (Rambur), Odontotermes redemanni (Wasmann) and Odontotermes wallonensis (Wasmann). Similarly, Varma and Swaran (2007), Vidyashree et al. (2018 and 2018a) and Shanbhag and Sundarai (2013) reported their occurrence in the western ghats of Karnataka. Anantharaju et al. (2014) spotted ten species of termites belonging to eight genera and three families in Northeastern Puducherry. Parween, et al. (2016) found thirteen species of termite in the states of Uttar Pradesh, Rajasthan and Haryana and reported the maximum occurrence of Odontotermes obesus (Macrotermitinae) in these regions.

The percentage distribution of termites across the different states indicated that the fungus growing termites, Macrotermitinae, outnumbered the other groups with 66.66% occurrence followed by the exclusive soil feeders, subfamily Apicotermitinae and the dry wood termites, Kalotermitidae which accounted for 6.62% each. The wood feeding termites (sub family Nasutitermitinae) occurred to the extent of 20.01 % across the different states (**Table 3 and Fig. 2)**

The landscapes located in sub-tropical and low humid temperate region (N 300, 12.57 - 12.97 N and 75.72 - 778.05 E) with a broad altitude range (2322 - 2479 msl) facilitated the diversity of termites in different habitats. The correlation between altitude and diversity of woodfeeding termites in South East Asia was stated by Inoue et al (2006) that Subfamily Macrotermitinae showed increasing abundance with the increasing altitude. On the contrary, the abundance of Subfamily Nasutitermitinae decreased with the increasing altitude.

The significance of changes in altitude and low temperatures on the abundance and diversity of species richness must be correlated, probably, the low temperatures at high altitudes might limit the development of termites. The soil content decreases as the altitude gets higher, poor soil nutrient, high CaCO3 and pH, do not afford a favorable habitat for many species of termites which depend on soil substrate, as source of nutrient for community development (Pratiknyo & Setyowati 2020).

The natural vegetation and the cropping pattern might have contributed to greater diversity of termite fauna in the region. Most termite assemblages having a more diverse range of food resources with the varying cropping pattern (e.g., wood, soil, and

leaf litter) and soil type for nesting strategies (mound, arboreal nests, and nests of wood) as reported by Dawes (2010). Soil parameters, vegetation and microclimate strongly modify the termite communities as opined by Basu et al. (1996). Land use patterns had an observable impact on the termite species composition and abundance Previous studies by Blanchart and Julka (1997) and Ferry (1992) suggested that increased anthropogenic activity in the region adversely affected the soil macrofauna and diversity, while Menon and Bawa (1997) opined conversion of forest land in to cultivation land with coffee and areca plantations

Assessment of species diversity and abundance, would provide information on planning strategies for the conservation of their natural enemies, habitat management, and formulate pest management strategies.

Table 1: Characteristics of the study area

State	Location	Geographical Co-ordinates	Cropping pattern	Soil type
Andhra Pradesh	**Anakapalle**	17 .38. N, 83.2 E	Pigeon pea, Sugarcane, Groundnut , millets	Red laterite, Sandy loam
	Samarlakota	17 .5 N, 82.2 E	Millets, Sugarcane, Pulses, cotton	Alluvial, Sandy loam
	Tirupathi	13.65 N, 79.42 E	Groundnut, millets, pulses	Red sandy loam
Kerala	**Kannur**	11.8 N, 75.32 E	Arecanut, Coconut,Paddy, Pepper, Tapioca	Red laterite, Sandy loan
	Thrissur	10.52 N, 76. 2 E	Arecanut, Banana, Coconut Paddy, Pepper, Vegetables	Alluvial, Red laterite, Sandy loam
	Sultan Betheri Wayanad	11.67 N, 76.28 E	Arecanut, Coconut, Coffee, Cardamom, Rubber, Pepper and Vegetables	Alluvial soil, Red laterite soil, Silty loam
Karnataka	**Malanad region** (Agumbe, Chikmagalur,Sringeri Sirsi ,Shimoga Thirthahalli)	12.57 -13.52 N., 75.72 -75.22 E	Millets, maize, pulses. Arecanut, cocoa, sugarcane, coffee, cardamom and spices	Red laterite, Red Sandy, Silty clay
	Bangalore, Mysore	12.97 N., 77.57 E	Rice, Small millets, Maize, Groundnut, sorghum, Sugarcane, castor and vegetables	Red laterite and red loamy
	Chintamani	13.40 N., 78.05 E	Rice, Small millets, Maize, Groundnut, sorghum, pulses, sunflower, fruit crops and vegetables	Red loamy, Red sandy
	Belgaum	15.51 N., 74.29 E	Jowra, Maize, Paddy, Wheat, Bajra, Pulses, groundnut, sunflower, sugarcane, cotton, tobacco	Deep black soil, Red loamy. Laerite
Tamilnadu	**Gudalur**	11.59 N., 76.50 E	Coffee, Tea, Paddy, Vegetables, Spices	Lateritic soil, Red sandy soil, Red loam, black soil, Alluvial and Colluvial soil.
	Coimbatore	11.16 N., 76.58 E	Banana, Coconut, cotton, Oilseeds, Pulses, Millets, Vegetables, Sugarcane	Red calcareous Soil, Black Soil, Red non-calcareous, Alluvial and Colluvial ...
	Ooty	11.41 N., 70.58 E	Potato, Cabbage, Carrot, Cauliflower, peaches, pears, plums and strawberries Vegetables, Coconut	Lateritic soil, Red sandy soil, Red loam, black soil, Alluvial and Colluvial soil.
	Theni	15.51 N., 77. 79 E	Banana, Chillies, Sugarcane, Paddy, Oilseeds, Vegetables, millets	Red spoil, Black soil, Brown soil
	Valparai	15.51 N., 74.29 E	Coffee, Tea, Cardamom, Coconut, pulses, vegetables, millets	Red Sandy, Sandy Loam, Clay Loam

Table 2: Relative abundance of Termites in various locations in Southern states

Sl. No	Subfamily	Species	Relative Abundance (%)	State (Location)
1	Macrotermitinae	*Odontermes obesus*	15.62	Tamilnadu (Coimbatore, Gudalur, Oooty, Valparai, Theni, Dindigul) Andhra Pradesh (Anakapalle, Samarlakota, Tirupathi. Horsely hills) Karnataka Bangalore
		O. gurdaspurensis	10.04	Karnataka (Bangalore,Bagalkot, Chikkaballapur, Chintamani, Hubli, Mysore)
		Odontotermes longignathus	10.21	Karnataka (Bangalore , Belgaum, Chikamagalur, Udupi, Mangalore) Kerala (Thrissur, Kohzikode,)
		Odontotermes – wallonesis	8.31	Karnataka Thirthahalli, Chikmagalur, Bagalkot, Belgaum)
		Odontotermes Holmgren	13.24	**Karnataka** (Belgaum, Mudhigere, Sirsi) Kerala (Kannur, Wayanad)
		Microtermes mycophagus	2.78	**Karnataka** (Bangalore Sringeri, Shivamoga, Thirthahalli,Sirsi) **Kerala** (Sultan Betheri, Thrissur, Kannur)
		Hypotermes makhamensis	1.72	Karnataka (Mysore, Mandya, Gudalur) Kerala (Thrissur, Wayanad)
		Dicuspiditermes Krishna	1.31	Karnataka (Mudhigere, Sringeri, Sirsi)
		Microtermes obesi	1.72	**Karnataka** (Udupi. Mangalore, Bagalkot)
		Hypotermes xenotermitis	1.72	Tamilnadu (Uddanpatti, Dindigul, Ooty)
2.	Nasutitermitinae	*Nasuitermes* sp.	1.72	Karnataka (Sirsi, Sringeri Shivamoga)
		Nasutitermes octopilis	6.66	Tamilnadu **(**Ooty, Theni,Dindigul)
		Nasutitermes exitiosus	11.62	
3	Apicotermitinae	*Euhamitermes hamatus*	6.62	Karnataka (Bangalore, Chikkaballapur, Doddaballapur)
4	Kalotermitidae	*Neotermes koshunensis*	6.62	Tamilnadu (Dindigul, Theni, Ottanchatram)

Table 3: Percentage of Termites in South Indian states

S. No.	Subfamily	Abundance (%)
1	Macrotermitinae	66.66
2.	Nasutitermitinae	20.10
3	Apicotermitinae	6.62
4	Kalotermitidae	6.62

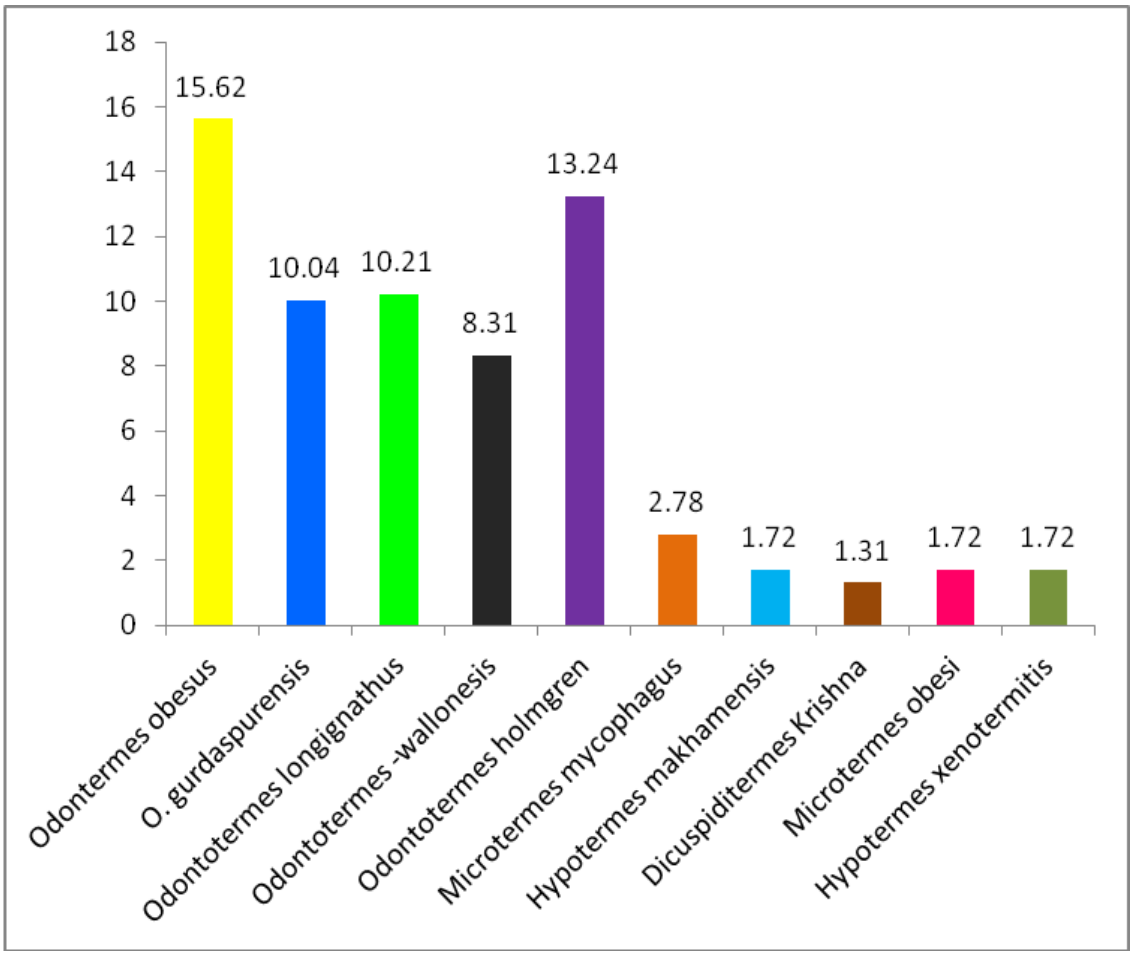

Fig. 1: Percenatege occurrence of more prevalent Termites of subfamily Macrotermitinae in the states of South India

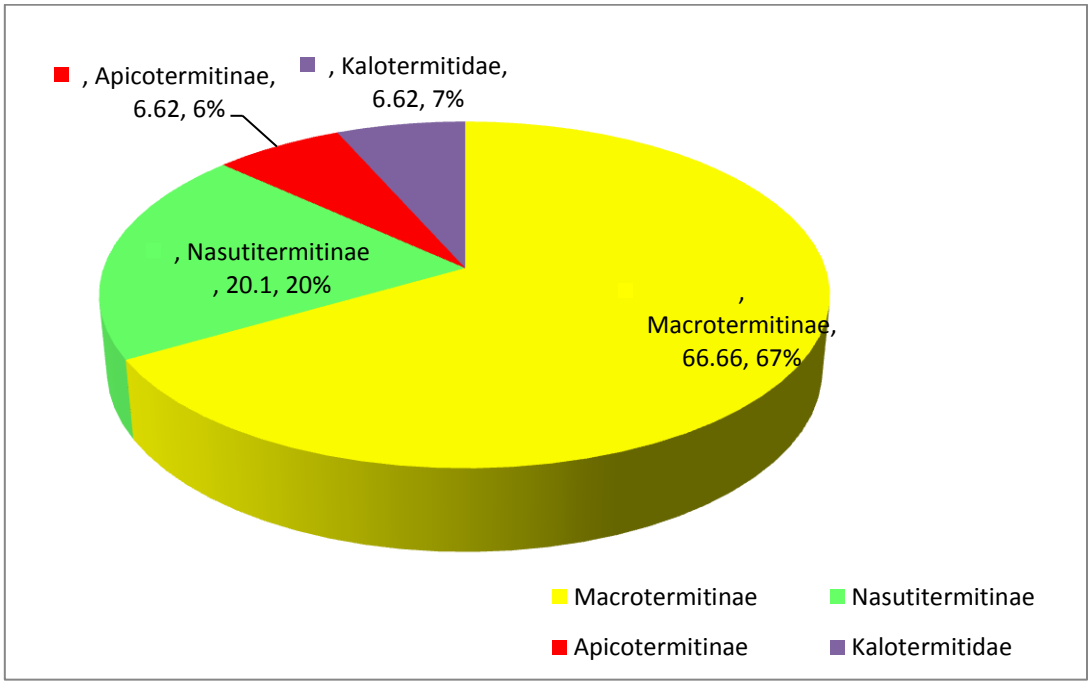

Fig 2. Percentage abundance of major termite sub families across the states

CONCLUSION

The study on diversity and abundance of subterranean termites in the states of Andhra Pradesh, Kerala, Karnataka and Tamilnadu revealed that species of sub family Marcrotermitinae, the fungus growing termites, occurred in greater abundance than others. The soil type, cropping pattern and topography influenced the diversity.

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