



Survey and morphological identification of termites (Insecta: Isoptera) in Dandakaranya forest, Bhadrachalam region, Telangana state. India

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Abstract

Termites (Insecta: Isoptera) occupy an essential niche in forests. They help decompose leaves beneath the ground and aerate the soil for roots. At the same time, however, their potential as pests requires a detailed knowledge of both diversity and distribution among them. Consequently, this project focused on surveys and morphological identification of termite species in the Dandakaranya forest, Bhadrachalam area, Indian state of Telangana. Employing the Standardized Transect Sampling Method and manual methods for selection, we carried out a comprehensive investigation to determine the composition of termites in this region. The survey in question turned up a diverse termite fauna with seven species. Each of these was painstakingly collected, preserved and identified in the laboratory, against morphological characteristics of the species. The species so identified are valuable new data for regional biodiversity documentation; and also add to our understanding of termite distribution in the Dandakaranya forest. The findings underscore the ecological importance of termites in this forest ecosystem, and necessitate continued monitoring as well as preservation measures. These results also lay a foundation for future research into termite ecology, behaviour and impact on forest health. More research might look at interactions between termite species and other forest organisms; what changes they undergo in response to environmental alteration. This research provides a first step towards larger-scale assessments of biodiversity, thus contributing to the general period end conservation work for forest ecosystems.

Keywords: Termite diversity, isoptera, forest ecosystem, morphological identification, species distribution

Introduction

The survey and morphological identification of termites in the Dandakaranya forest: Bhadrachalam region, Telangana state, India, will involve many methodologies from previous research and their insights on termiticides. Termite as society has significant roles and impacts should be accurately identified for its diversity holism of termites in similar studies, such as those conducted in southern Hunan Province and Kurukshetra in India for example, researchers have used methods including continuous random hand-picking and line transect combined with morphological identification with the aid of known keys and molecular techniques for phylogenetic analysis [4]. Indices of diversity such as Shannon, Simpson, and Margalef have been applied to assess species richness and diversity levels. Results have shown significant variations from one season or area to another [6]. In the case of non-native species, it is very important to monitor them so as not to introduce them inadvertently. We intercepted *Coptotermes* species termites in imported wood that would be fatal for local ecosystems and structures if they arrived here without control [7]. Molecular phylogenetic studies using mitochondrial genes like COI, COII, NDI, and 12SrRNA often prove effective in resolving species relationships and validating morphological identifications [8]. In anthropogenic environments, such as university campuses, the existence of termites has reminded us of the need for proper management plans so that buildings can avoid suffering structural harm [9]. By adopting these various methodologies, the survey of termite species in Dandakaranya forest should be able to identify and grasp the terms diversity, which is crucial conditions for conservation efforts in this region. Moreover, all of this morphological-molecular accord will provide a robust framework for registering and cataloging termite fauna in

Bhadrachalam region. That would fill in a piece as yet lacking in our overall knowledge about termite diversity throughout India [10]. Termite identification hinges on a variety of morphological features involving different castes, e.g., soldiers, workers, and reproductives. Particular attention must be paid to some of the following for soldiers: their heads, mandibles, antennae, legs. Determining factors include specific measurements such as the length from head to tip of mandible, and dimensions in relation to antennal segments and leg parts that are essential for distinguishing species [1] [2]. In addition, the mandibles figure prominently in morphological rustication, helping to close species together within genera [3]. Furthermore, we use features of the external genitalia, especially the medisternite, basivalvae or spermathecal opening, to identify female species in various termite families [4]. Workers are identified on the basis chiefly of their gut, mandibles, legs and notas. An enumeration is given of certain characteristic features from different families and subfamilies, especially in the Neotropical region [5]. It is known that with morphometric analysis, e.g. the maximum width of postmentum, species in the genus *Coptotermes* can be correctly differentiated from one another. [6] Moreover, the presence of certain micromorphological features in the nest, such as pellets, microstructure and sinuous bands of faecal origin, can provide additional testament to termite species as well as their heritage [7]. High-quality samples of a large representative number of specimens from all castes, especially soldiers, are essential to accurate identification [8]. Barcoding mitochondrial DNA (e.g. COII, COI, NDI, 12SrRNA genes) complements morphological methods by providing insights into phylogeny and revealing new species assignments [9] [10]. In short, a combination of meticulous morphological examination and molecular analysis is

necessary for precise termite identification--and understanding their taxonomy and phylogeny.

Materials and Methods

1. Study Sites

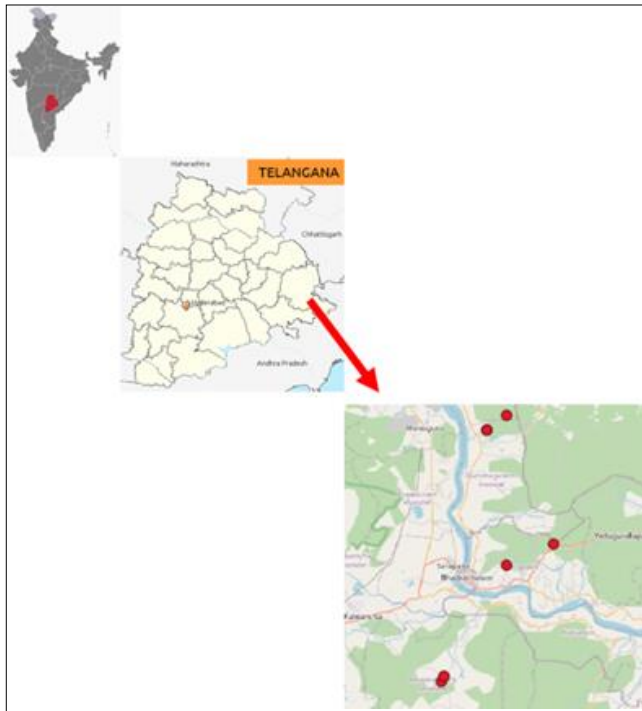


Fig 1: Six distinct locations in Dandakaranya forest of the Bhadrachalam

Six distinct locations within the Dandakaranya forest of the Bhadrachalam Region in the state of Telangana, India (Figure 1), were examined, with each site representing unique habitats. These sites exhibit varying flora. The Dandakaranya forest in the Bhadrachalam Region of Telangana, India is situated at latitudes 17.67°N and longitudes 80.89°E. The minimum temperature is 29°C, reaching a maximum of 41°C. The area receives 13.9mm of precipitation with a humidity level of 61%, a Dew Point of 25°C, Wind speed of 9km/h, and a Pressure of 1005mbar.

2. Termite Survey

The focus of this research was on termites found in the Dandakaranya forest of the Bhadrachalam Region, where samples were obtained following standardized transect sampling procedures. Geographical coordinates were recorded using a GPS device to map the distribution of termite specimens. These specimens should encompass all castes within the colony, including alates, workers, soldiers, nymphs, and imago.

3. The Standardized Transect Sampling Method

The method outlined by [14] for standardized transect sampling was employed to collect termite specimens. A belt transects measuring 100 meters in length and 2 meters in width was utilized, divided into 20 contiguous sections (each 5 × 2 meters) and sequentially numbered. Within each section, two collectors spent 30 minutes searching for termites (resulting in 1 hour of collection per section) in common termite habitats such as surface soil samples, litter and hummus accumulations, dead logs, subterranean nests, and arboreal nests. Collectors exercised their judgment during the search and prioritized sampling soldiers and workers. Specimens were preserved in vials filled with 70% ethanol, with each vial labeled according to the termite's location of discovery.

4. Determination of Termite Species

Identification of termite species was conducted based on key characteristics of soldiers. Each specimen was individually placed in a vial containing 90% ethanol. Soldiers were examined using a stereomicroscope STEMI 2000 with a phototube camera ERC 5S (Olympus, USA), and species were determined using Roonwal and Chottani keys.

Results and Discussion

Observations on the external morphology of termite specimens in the laboratory showed the existence of seven species, which are joined in subfamily Macrotermitinae and family Termitidae. To see the morphological characteristics and morphometric measurements of each species of termite that is found are described as follows:

Table 1: Different types Species with their measurements

Measurments	Name of the species							
	<i>O.obesus</i>	<i>O.bellahunensi Holmgren&Holmgren</i>	<i>O.brunneus</i>	<i>O.vaishno Bose</i>	<i>Macrotermes convulsionarius</i>	<i>O.adampurensis Akhtar</i>	<i>O.globicola</i>	
H.L	1.25	1.20	1.52	1.10	4.26	1.10	0.96	
H. W	1.10	1.12	1.30	0.92	3.89	0.96	0.86	
H. INDEX	0.84	0.90	0.79	—	0.89	0.880	0.89	
A.S	16	17	17	16	17	15	15	
M.L	0.92	0.65	0.96	0.65	2.30	0.66	0.62	
M.Index	0.64	0.56	0.58	0.60	0.50	0.58	0.67	
T. D	0.28	0.20	0.36	0.24	—	0.20	0.14	
T.Index	0.36	0.29	0.34	0.32	—	0.292	0.23	
Posl	0.82	0.66	0.98	0.60	3.00	0.66	0.52	
Posw	0.52	0.47	0.58	0.42	1.16	0.48	0.38	
P.L	0.52	0.42	—	0.42	1.36	0.40	0.42	
P.W	0.96	0.72	—	0.67	2.70	0.68	0.62	

H.L=Head length.Excluding mandibles; H. W=Max.Head Width; H.Index=Head Index=H.W/HL A.S=Antennal segments M.L= Mandible Length; M.I=Mandible

Index=M.L/H.L=Mandible length/head length T.D=Tooth distance; T.index=Tooth distance/mandible length. Posl=

Postmentum Length, Posw=Postmentum width, P.L=Pronotum length; P.W=Pronotum width.

Table 2: Species with their location

S.No	Name of the species	Location of identification	Identified on	Latitude	Longitude
1	<i>Odontotermes obesus</i>	Kamalapur	Casearia graveolens(chilla),	17.48115°	80.848055°
		Bhadradri kothagudem	Borasus flabellifer(Toddy)	17.490557°	80.852722°
		Puligundala	Borasus flabellifer(Toddy)	17.690835°	80.965912°
2	<i>Odontotermes bellahunensis Holmgren&Holmgren</i>	Bhadradri kothagudem	Terminella alata heyne(maddi),dry wood	17.490591°	80.852714°
3	<i>Odontotermes brunneus</i>	Pedabandirevu	Techtona grandis	17.934413°	80.930242°
4	<i>Odontotermes vishno Bose</i>	Pedabandirevu	Techtona grandis	17.934413°	80.930242°
5	<i>Macrotermes convulsionarius</i>	Puligundala	Sand mounds	17.960835°	80.965912°
6	<i>Odontotermes adampurensis Akhtar</i>	pedabandirevu	Cattle dung,Azadirachta indica	17.934426°	80.930195°
7	<i>Odontotermes globicola</i>	burguvai	Casearia graveolens(chilla),	17.72894°	81.050876°

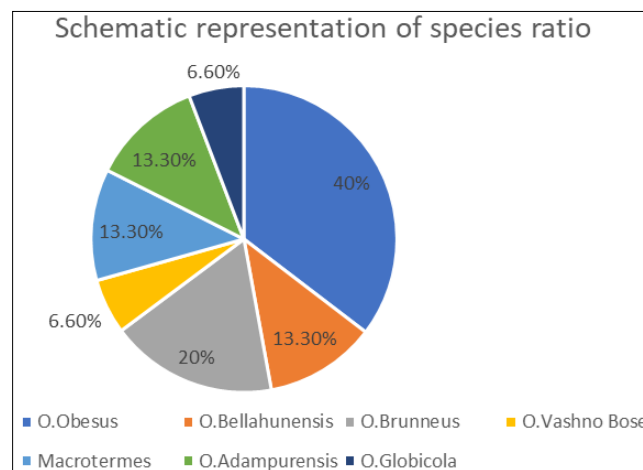


Fig 2: Schematic diagram shows ratio of different species from selected areas

1. Species1.Odontotermes obesus (Rambur, 1842)

The species *Odontotermes obesus* (Rambur,1842) is belongs to the family Termitidae with subfamily Macrotermitinae. Diagnosis, measurements, and distribution of the soldier of

Odontotermes obesus (Rambur,1842) (figure3.1) were described as follows:

Odontotermes obesus (Rambur,1842) has the following characteristics.



Fig 3: *Odontotermes obesus* (Rambur,1842)

(A). Dorsal view ;(B). Head length Mandible length, (C). Anal segments, (D). Pronotum Length (E). Tarsi

Measurements(mm)

HL:1.25, HW:1.10, H. index=0.84; A. S:16; ML:0.92; M. Index:0.64; T. D:0.28; T. Index:0.36; PosL: 0.82; mPosW: 0.52; PL: 0.52; PW: 0.96.

Diagnosis: Head: oval-shaped, head sparsely and body moderately hairy; head capsule pale yellow to castaneous brown. Antennae: pale yellow to yellowish brown, darker distally. Mandibles: light brown to deep reddish brown, long, slender, sabre-shaped. Left mandible with a sharp,prominent tooth at distal,right mandible with a minute tooth a little below level of tooth on left mandible. Body pale yellow to pale brownish. Labrum: Tongue-shaped. Total body length is 4.0 to 6.0.

Habitats: This species is found in kamalapur location of Dandakaranya forest of Bhadrachalam Region, Telangana state, India.And lives on Casearia graveolens (chilla) trees, toddy plant, dry wood.

Species 2: *Odontotermes bellahunensis* Holmgren&Holmgren
Measurements(mm): HL:1.20, mHW:1.12, H. index:0.90; A.S:17,ML:0.65,M.Index:0.56,T.D:0.20,T.Index:0.29,PosL: 0.66, mPosW: 0.47; PL: 0.42; PW: 0.72.

Diagnosis: Head: Broadly oval, broadest posteriorly and narrowed in front; head Sparsely and body fairly densely hairy, Head capsule pale yellowish brown to dark castaneous brown. Antennae: yellowish brownish. Darker distally. Mandibles: Reddish brown, paler basally, short, stout, sickle-shaped and strongly incurved distally. Mandibles shorter in comparison to head. Left Mandible with a large pointed tooth at distal third. Labrum-tongue shaped. Yellow to pale brownish. Total body length is 4.0 to 6.0mm.

Habitats: This species is found in Bhadradri kothagudem location of Dandakaranya forest of Bhadrachalam Region, Telangana state, India.And lives on Terminella alata, heyne (maddi) tree, dry wood.



Fig 4: *Odontotermes bellahunensis* Holmgren&Holmgren

Figure 4. Soldier of *Odontotermes bellahunensi* Holmgren & Holmgren sp.2: (a) head, dorsal view; antennal segments, P.L(b)&c parial view, (d)dorsal view, (e) head.

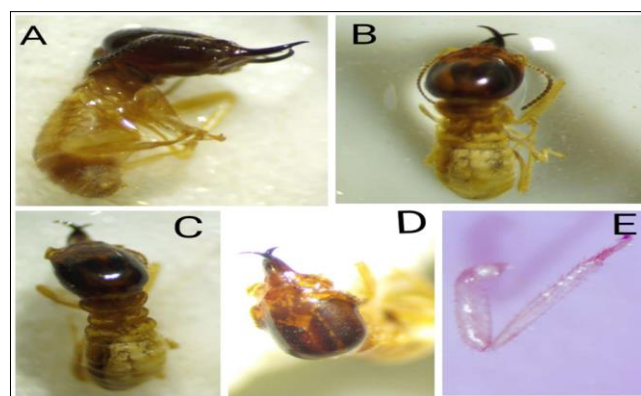
Species 3: *Odontotermes brunners*

Measurements(mm): HL:1.52, mHW:1.30, H. index:0.79; A. S:17, ML:0.96, M. Index:0.58, T. D:0.36, T. Index:0.34, PosL: 0.98, mPosW: 0.58.

Diagnosis: Head: sub rectangularly oval, very slightly converged in front of antennae. Fairly, and body densely hairy, Head capsule pale brown to reddish brown.

Antennae: brown, darker distally. Mandibles: thick, stout and short, strongly incurved anteriorly, shorter than head. left mandible with a large, prominent tooth below distal third. right mandible with a small tooth situated all most at middle Labrum-tongue shaped, with rounded anterior margin. labrum and Body rust yellow. Total body length is 5.0 to 7.0mm.

Habitats: This species is found in Pedabandirevu location of Dandakaranya forest of Bhadrachalam Region, Telangana state, India.And lives on Techtona grandis tree.



(a) Partial view (b) head, dorsal view; (c) pronotum (d)head and mandible(e) Tarsi

Fig 5: *Odontotermes brunners*

Species 4: *Odontotermes vaishno* Bose

Measurements(mm) HL:1.10, mHW:0.92, A. S:16, ML:0.69, M. Index:0.60, T. D:0.24, T. Index:0.32, PosL: 0.60, mPosW: 0.42; PL: 0.42; PW: 0.67.

Diagnosis: Head: Head oval, converging anteriorly a little longer than wide. head and body Sparsely hairy, Head capsule and labrum brownish yellow. Antennae: pale yellow, darker epically Mandibles: dark Reddish brown,

thin slender sabre shaped, very weekly incurved distally.Mandible a little longer than half of head length.Left Mandible with a sharp,laterally directed tooth at distal one third.Right mandible with a minute tooth a little above middle Labrum-tongue shaped.anterior margin broad and rounded.Total body length is 3.8 to 4.10 mm.Habitats: This species is found in pedabandirevu location of Dandakaranya

forest of Bhadrachalam Region, Telangana state, India. And lives on *Tectona grandis* (Teku) tree.



Fig 6: *Odontotermes vaishno* Bose: (a) Dorsal view (b) Partial view; (c) antennal segments (d) head and mandible (e) Pronotum.

Species 5: *Macrotermes convulsionarius*

Measurements(mm): HL:4.26, mHW:3.89, H. index:0.89; A. S:17, ML:2.30, M. Index:0.50, PosL: 3.00, mPosW: 1.16; PL: 1.36; PW: 2.70.

Diagnosis: Head: head capsule large, broadly oval, widest near middle and strongly narrowed in front; head and body very sparsely hairy, Head capsule reddish brown to brownish red. fontanelle small circular, situated at middle of head, eyes pale spots, slightly raised. ocelli indistinct. Mandibles: black. Short, stout, as long as 1/2 head length. Abdomen: pale brown to brown Labrum-oval tongue shaped. with a triangular, hyaline tip. Total body length is 11.0 to 14.0 mm. Habitats: This species is found in puligundala location of Dandakaranya forest of Bhadrachalam Region, Telangana state, India. And lives on soil mounds.

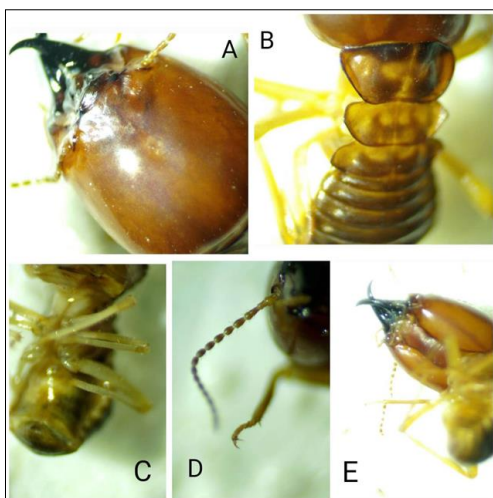


Fig 7: *Macrotermes convulsionarius*: (a)Head (b) Pronotum; (c) Ventral view(d)Tarsi with claw and antennal segments(e) Postmentum.

Species 6: *Odontotermes adampurensis* Akhtar

Measurements(mm): HL:1.10, mHW:0.96, H. index:0.88; A. S:15, ML:0.66, M. Index:0.58, T. D:0.20, T. Index:0.29, PosL: 0.66, mPosW: 0.48; PL: 0.40; PW: 0.68.

Diagnosis: Head: Rectangular oval, sides weakly convex, converging anteriorly. head Sparsely and body fairly pilose hairy, Head capsule pale yellowish to reddish brown. Antennae: uniformly coloured, paler than head. Mandibles: dark Reddish brown, paler basally, Mandibles sabre shaped, weakly incurved distally. Left Mandible with a well-developed tooth at above epical third. right mandible with a small, rudimentary tooth a little lower than corresponding tooth on left mandible Labrum-tongue shaped. sides weakly converging to a rounded tip, with a row of longer bristles on sides and few minute hairs on body Total body length is 4.50 to 5.20 mm. Habitats: This species is found in pedabndirevu location of Dandakaranya forest of Bhadrachalam Region, Telangana state, India. And lives on cattle dung and *azadiractha indica* (Neem) tree.

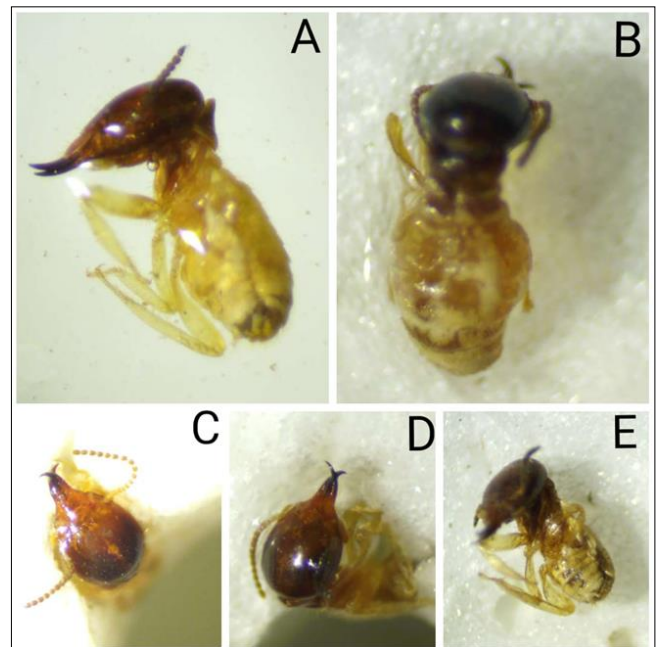


Fig 8: *Odontotermes adampurensis* Akhtar: (a)Partial view (b) Dorsal view and pronotum (c)head and antennal segments (d)head and mandible(e) anal cerci

Species 7: *Odontotermes globicola*

Measurements(mm): HL:0.96, mHW:0.86, H. index:0.89; A. S:15, ML:0.62, M. Index:0.67, T. D:0.14, T. Index:0.23, PosL: 0.52, mPosW: 0.38; PL: 0.42; PW: 0.62.

Diagnosis: Head: Roundly oval, converging anteriorly Head capsule yellowish blue dark golden brown. Head sparsly and body moderately hairy. Antennae: yellowish to brownish. paler than head and paler epically. Mandibles: dark brown, paler basally, mandibles thin, long and slender, straight and weakly in curved near distal end. left mandible with a prominent tooth near tip. Right mandible with a small tooth at about distal third. Labrum-triangular, pointed, in front longer than wide. Body: whitish to pale yellow. Total body length is 3.0 to 4.0 mm.

Habitats: This species is found in buruguvai location of Dandakaranya forest of Bhadrachalam Region, Telangana state, India. And lives on *Casearia graveolens* (chilla) tree.

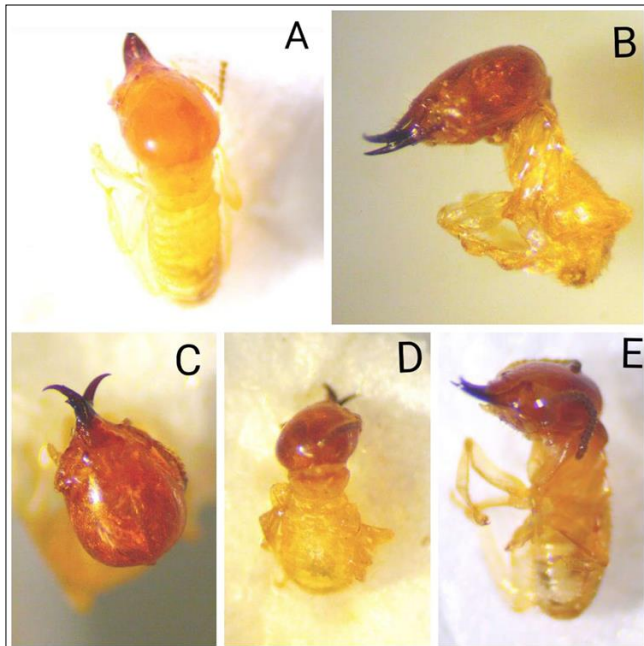


Fig 9: *Odontotermes globicola*: (a) Dorsal view and pronotum (b)Partial view (c)head and mandibles(d) Pronotum (e)Partial view with antennal segments, anal cerci.

The survey and morphological identification of which has brought exciting results. These advancements uncover new aspects to both the biodiversity and ecological roles of termite species living there. Our results emphasize the trend of having many termite species living in the region, expanding our knowledge of their distribution and habitat preferences.

The survey found a number of termite species, showing the rich diversity in the Dandakaranya forest. So if these are the tropical forests to which we must come, India has indeed provided us with a center of termite diversity. Existing surveys already have begun to shape this picture. It is just that the Dandakaranya forest project undertakes this job in more detail and with its own data for comparison.

The habitat preferences of different termite species observed in this study show that they have specific ecological niches within the forest. Some species were predominantly found in decaying wood, others more common in soil or within leaf litter. This diversity in habitat preference is evidence of the many roles termites perform: as decomposers of water and nutrients; suppliers Nitrogen to plants during mineralisation decomposition in soil processes; creators of material through which soil formation can take place Termites are responsible for the decomposition of organic material, adding nutrients to the soil and promoting plant growth, an essential function in maintaining the health of forest ecosystems.

The discoveries concerning the variety of termites in this investigation are of great conservation significance. Knowing which species are present and their ecological functions can help guide forest management practices and preservation strategies. It is necessary to protect termite environments for the sake of ecological balance and anyone that wants its forest resources to last. In light of the mounting dangers of deforestation and climate change, we must incorporate termite conservation into broader environmental strategies.

In spite of the comprehensive nature of this investigation, several hurdles still lay ahead. For example, it was difficult

to get into some parts of the forest; Moreover, if there are seasonal changes in termite behaviour then this might have affected our results. Future studies should aim to conduct annual surveys to take account of seasonal differences and make use of molecular methods for more accurate species identification in conjunction with morphological taxonomic work.

To sum up, researchers have gained a new insight into the diversity of termites and their ecological functions from this study detailed in four parts covering the Dandakaranya forest of Bhadrachalam division. From these findings we can conclude our need for continued research and action on behalf of these essential creatures so often overlooked in favour of more fashionable environmental issues. The integration of detailed taxonomic work with ecological and conservation studies will provide the ring needed to hold this precious teeming biodiversity on place in Dandakaranya.

Conclusion

There were seven species of termites that identified at six different places of Dandakaranya forest of Bhadrachalam Region, Telangana state, India. The following seven species were identified namely, *Odontotermes.obesus*, *Odontotermes.bellahunensiHolmgren&Holmgren*, *Odontotermes. brunneus*, *Odontotermes.vaishno Bose*, *Macrotermes convulsionarius*, *Odontotermes.adampurensis Akhtar*, *Odontotermes.globicola*.

This study revisits termites in Dandakaranya forest and Bhadrachalam region of Telangana state, India, conducting a comprehensive survey of them morphological identification. Our findings demonstrate that termite species richness in this tropical forest ecosystem is extremely high indeed.

In Dandakaranya forest, the termites establish a variety of niches for themselves. From rotten wood to dead leaves, all of these niches play indispensable roles in nutrient cycling, soil formation and organic matter degradation During these sorts of activities termites are a kind of key ecological engineer, contributing to the reproduction of life cycle as well as overall functioning on Earth.

Understanding the diversity and ecological functions of termites in the Dandakaranya forest offers he significant benefits for forest management. It provides a correlation between area plans and projects with the development of workable conservation strategies. For example, if we are going to expect termite populations to move in at some distance from their present location, then we must retain suitable habitat nearby. Likewise protecting termite habitats is needed for maintaining the balance of natural ecology there in the forest and making it more resistant to pressure from deforestation and climate change.

Despite the challenges faced, and these are considerable, there are access issues and possible seasonal fluctuations, this study has laid a foundation for understanding termite diversity in the area. In future work researchers should attempt to overcome these shortcomings with twenty-four hour surveys, and by integrating molecular techniques into species identification methods in order more definitely to assign each name that paper applies.

In conclusion, our study demonstrates that research and conservation efforts are needed to preserve the diverse termite populations in the Dandakaranya forest. By combining detailed taxonomic studies with ecological and

conservation work, we can protect a rich biodiversity area like this forest for future generations as well ensuring its environmental integrity continues.

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