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Species Composition of Termites in Coastal Karnataka

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Abstract: Coastal regions have a different climate than inlands; hence may contribute to variation in the diversity of organisms they possess. Termite fauna of coastal Karnataka is understudied. Hence the present investigation was carried out to know the species composition of termites of coastal Karnataka, which includes three districts viz., Udupi, Dakshina Kannada and Uttara Kannada. Soldier caste was used for morphological identification. A total of 29 species belonging to 11 genera and six subfamilies under two families viz., Termitidae and Rhinotermitidae, were recorded. Termitidae was the most dominant family, with 25 species belonging to nine genera. Among subfamilies, Termitinae and Macrotermitinae contributed the highest number of species (nine), followed by Nasutitermitinae (four) and Apicotermitinae (three). Genus *Odontotermes* of subfamily Macrotermitinae was frequently collected and composed of highest number of species (eight).

Keywords: Coastal Karnataka, Termite, Termitidae, *Odontotermes*, Macrotermitinae, Apicotermitinae, Composition, New record

Social insects are one of the most important ecological components of ecosystems. They are among the world's most successful species invading new habitats (Scaduto et al 2012). Among these, termites form a major proportion of the soil macrofauna and highly successful group of insects. They are a marvelous group of social insects with highly evolved organization, caste system and division of labor. They are an ecologically important order with high abundance and biomass in tropical ecosystems (Donovan et al 2000). They play a major role as both destructive pests on economic plants and as beneficial decomposers in natural ecosystems, depending on the species composition of the local communities. Termites belong to the infraorder Isoptera within the order Blattodea and include more than 3500 species described around the world. Termites can be divided into two groups on the basis of habitat; wood dwelling (Kalotermitidae , Archotermopsidae and Stolotermitidae) and subterranean(Rhinotermitidae , Mastotermitidae, Hodotermitidae , Stylotermitidae and Termitidae) (Krishna et al 2013). In India, about 337 species of termites were reported (Paul et al 2018). In southern India, a total of 132 species from five families were reported, of which Termitidae is the dominant family consisting of 101 species from 27 genera and four subfamilies. The regional termite diversity of Karnataka has recently been enriched by the addition of a two new species viz., *Neotermes viraktamathi* (Ranjith et al 2022a) and *Ceylonitermellus sahyadriensis* (Ranjith et al 2022b). Of the 132 species recorded from south India, 60 species belonging to five genera are endemic to the southern region, and the Termitinae was the subfamily with the greatest degree of endemism (Ranjith and Kalleshwaraswamy, 2021). An area-wide distribution may shed more light on conservation. Termites are ubiquitously found in many parts with high diversity, especially in tropical and subtropical regions. Role of termites in different biological processes is very limited regardless of their importance in agriculture and hence it is very essential to understand their biology and ecology, which relies on accurate species identification to a greater extent (Singla et al 2013). Termites are also becoming invasive and hence, thorough identification and regional survey are required (Kalleshwaraswamy 2023). With these points in view, a study was taken up to understand the diversity of termites of coastal Karnataka.

MATERIAL AND METHODS

The study was carried out in three coastal districts of Karnataka viz., Udupi, Dakshina Kannada and Uttara Kannada, which covers a total area of 18,730 km2 with 320 km coastline popularly known as Karavali. This coastline stretches along the eastern shore of the Arabian Sea. The region lies between 12º27' and 15º32' latitude and 74º00' and 75º12' longitudes (ENVIS 2021). The termites were collected in a plastic vial containing 80 per cent ethyl alcohol and brought to the laboratory. The collected specimens were then cleaned with 80 per cent alcohol to eliminate all dirt and debris associated with them using the forceps and camel hairbrush. Then they transferred to a permanent glass vial of 5 ml capacity containing 80 per cent ethyl alcohol and preserved in the Department of Agricultural Entomology,

Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India. Measurements of different body parts are required for species-level identification. For accurate measurement, the alcohol preserved specimens were kept straight and then measured. A special arena/platform was prepared in order to stretch the specimen properly and taken the measurements using an ocular micrometer.

The morphological characters of soldiers are highly variable from species to species for example, the length, shape and size of the mandible, head, labrum, postmentum, pronotum, fontanelle, antennal segments and number of tarsi. Hence these characters were observed. Samples of soldier caste were picked up randomly from the labelled vial. Measurements like the length of head without mandibles, width of head at the base of mandibles (as in case of *Coptotermes*), maximum width of head, length of left mandible, tooth distance of left mandible from the tip, length and width of the labrum, length and width of pronotum, length of postmentum, maximum and minimum width of postmentum were taken. In case of the subfamily Nasutitermitinae of Termitidae, head length along with rostrum, head length without rostrum, length of rostrum and head bulge length were noted, since they differ from other subfamilies or families with respect to head character. For soldierless Apicotermitinae, workers were used for identification. Head length to tip of the labrum, head length to base of the mandible, head width, post clypeus length, post clypeus width, pronotum length, pronotum width, diameter of mid dorsal spot were measured. The observations and measurements were recorded with the help of a stereo-zoom microscope (ZEISS Stemi508) at magnification between 10 to 50X. Measurements were taken with the help of calibrated ocular micrometer (0-10 divisions) and values were converted into mm using the correction factor of the ocular micrometer for each magnification. Soldier specimens of all the species collected were identified to species level using the keys or descriptions as mentioned by Roonwal and Chhotani (1989), Chhotani (1997) and Kalleshwaraswamy et al (2013). Photographs of the collected specimens were taken using Leica M205C microscope attached with a DFC450 camera.

RESULTS AND DISCUSSION

The survey conducted during the investigation period (2019-2021) yielded 172 samples of termites in which 145 were identified till species level and the rest 27 contained only workers or imagoes, which were unable to be identified down to the species level. The taxonomic study indicated the presence of 29 species belonging to 11 genera under six subfamilies belonging to two families viz., Rhinotermitidae Froggatt and Termitidae Latreille. Most of the samples collected were of Termitidae (88.28%) whereas samples of Rhinotermitidae were scarcely collected with 11.72% (Table 1). One new record from Karnataka indicates the need for intensive survey and collections from unobserved habitats like aerial nests, underneath the boulders, logs, leaf litters etc. In terms of species richness also, Termitidae was the most dominant with the highest number of species (25), whereas Rhinotermitidae recorded only four species. This variability in abundance is due to various factors. Most vital among these are climate suitability, availability of food and interactions with other organisms. Family Termitidae is considered as the most evolved group of termites is mainly due to the lack of symbiotic cellulolytic protists in their gut region (Ohkuma 2003). Some of them are mound builders and adapted to various climatic conditions and food habits, which act as key factors for their success (Vidyashree and Kalleshwaraswamy 2018). Among the seven termite families, Termitidae is the largest family covering almost 85 per cent of the known species. It represents approximately 70 per cent of the species in the order Isoptera and is distributed throughout the world (Kambhampati and Eggleton 2000). Termitidae has the maximum number of species (2021) compared to Rhinotermitidae (349) in the world (Constantino and Acioli 2006), which may potentially be the reason for this area's highest level of species diversity.

Rhinotermitidae was represented by two subfamilies viz., Coptotermitinae Holmgren and Heterotermitinae Forgatt. Four species belonging to two different genera (*Coptotermes* and *Heterotermes*) were recorded within this family. Species from subfamily Heterotermitinae Forgatt were frequently collected (11.03%) than Coptotermitinae Holmgren (0.69%). Out of three species collected from Heterotermitinae, *H. indicola* (Wasmann) (Fig. 3) and *H. malabaricus* Snyder (Fig. 4) were represented highest with 4.83% each, followed by *H. balwanti* Mathur and Chhotani (1.38%) (Fig. 5). In Coptotermitinae single species, *C. kishori* Roonwal and Chhotani (Fig. 6) was collected with 0.69 per cent of total samples. Termitidae was comprised of four subfamilies viz., Nasutitermitinae Hare, Termitinae Latreille, Apicotermitinae Grasse and Noirot and Macrotermitinae Kemner. From this family, a total of 25 species belonging to 9 genera were recorded from various locations of coastal Karnataka. The subfamily Macrotermitinae was frequently encountered with 33.10 per cent of total samples, followed by Termitinae (32.41%), Nasutitermitinae (20%) and Apicotermitinae (2.76%) (Table 1).

Nasutitermitinae was the third frequently encountered subfamily during the survey with 20 per cent. It had four

Table 1. Species composition of termites collected from coastal Karnataka

Species	Percentage
Rhinotermitidae	11.72
Heterotermitinae	11.03
Heterotermes balwanti Mathur and Chhotani	1.38
Heterotermes indicola (Wasmann)	4.83
Heterotermes malabaricus Snyder	4.83
Coptotermitinae	0.69
Coptotermes kishori Roonwal and Chhotani	0.69
Termitidae	88.28
Nasutitermitinae	20.00
Trinervitermes biformis (Wasmann)	5.517
Nasutitermes anamalaiensis Snyder	2.76
Nasutitermes brunneus Snyder	4.138
Nasutitermes kali Roonwal and Chhotani	7.59
Termitinae	32.41
Microcerotermes beesoni Snyder	0.69
Microcerotermes cameroni Snyder	2.07
Microcerotermes fletcheri Holmgren and Holmgren	3.44
Microcerotermes pakistanicus Akhtar	17.93
Dicuspiditermes gravelyi Silvestri	2.76
Dicuspiditermes incola Wasmann	0.69
Pseudocapritermes fletcheri Holmgren and Holmgren	2.07
Pseudocapritermes kunjepu Mathew	0.69
Labiocapritermes distortus (Silvestri)	2.07+-
Apicotermitinae	2.76
Speculitermes cyclops Wasmann	1.38
Speculitermes sinhalensis Roonwal and Sen-Sarma	0.69
Speculitermes dharwarensis Akhtar	0.69
Macrotermitinae	33.10
Microtermes obesi Holmgren	4.14
Odontotermes adampurensis Akhtar	0.69
Odontotermes anamallensis Holmgren and Holmgren	4.14
Odontotermes assmuthi Holmgren	3.44
Odontotermes bellahunisensis Holmgren and Holmgren	9.65
Odontotermes guptai Roonwal and Bose	0.69
Odontotermes obesus (Rambur)	6.20
Odontotermes vaishno Bose	1.38
Odontotermes yadevi Thakur	2.76
Total	100

species belonging to two genera (*Nasutitermes* Dudley and *Trinervitermes* Holmgren). When species composition within the subfamily was compared, it revealed that *Nasutitermes* was frequently encountered genus with 72.41 per cent, followed by *Trinervitermes* with 27.59 per cent (Fig. 1). The comparison of individual species of Nasutitermitinae realized that *N. kali* Roonwal and Chhotani (Fig. 7) was frequently collected species (7.59%) followed by *T. biformis* (Wasmann)

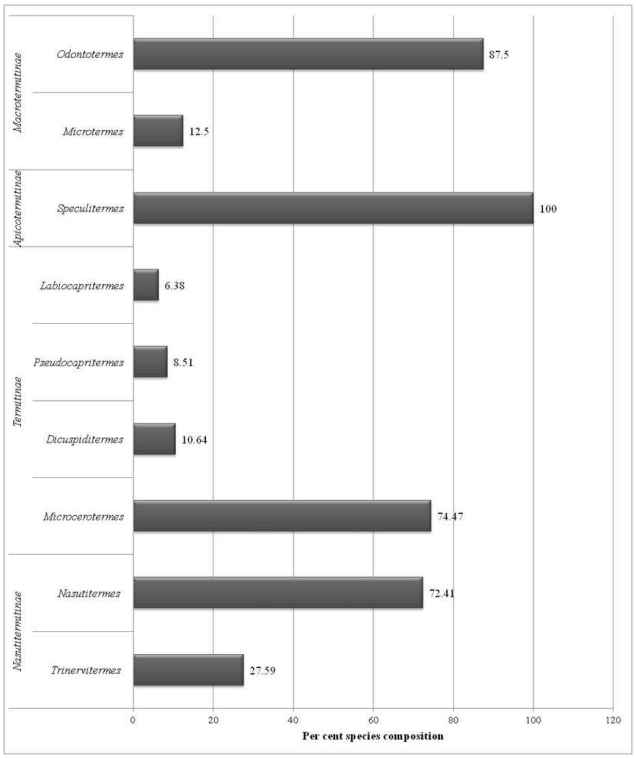

Fig. 1. Per cent composition of species within subfamilies of Termitidae

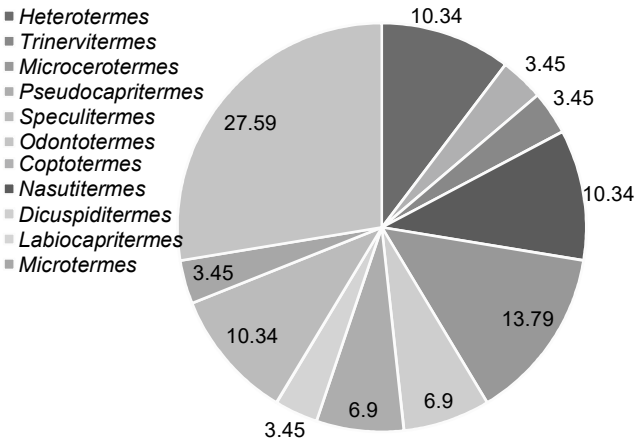

Fig. 2. Per cent species composition of termites collected from coastal Karnataka

(5.52%) (Fig. 8) and *N. brunneus* Snyder (4.14%) (Fig. 9). *N. anamalaiensis* Snyder (2.76%) (Fig. 10) was the sparsely collected species with 2.76 per cent of the total samples collected (Table 1). In Nasutitermitinae, *Nasutitermes* is the most evolved and well-represented genus, having the greatest species diversity. Termitinae was the most diverse subfamily represented by 9 species belonging to four genera. The collection of this subfamily comprised of four species of *Microcerotermes* Silvestri, two species each of *Dicuspiditermes* Krishna and *Pseudocapritermes* Kemner, single species of *Labiocapritermes* Krishna. *Microcerotermes* was the species rich genus under Termitinae. Genus composition within Termitinae indicated that the genus *Microcerotermes* was the frequently collected with 74.41 per cent followed by *Dicuspiditermes* (10.64% of Termitinae) and *Pseudocapritermes* (8.51%). The genus *Labiocapritermes* was least encountered with 6.38 per cent (Fig. 1). Among total species of termites collected within subfamily Termitinae, *Microcerotermes pakistanicus* Akhtar (Fig. 11) was the dominant species collected with 17.93 per cent of the total samples, followed by *M. fletcheri* Holmgren and Holmgren (3.44%)(Fig. 12), *D. gravelyi* Silvestri (Fig. 13) (2.76%), *M. cameroni* Snyder (Fig. 14), *P. fletcheri* Holmgren and Holmgren (Fig. 15) and *L. distortus* (Silvestri) (Fig. 16) each with 2.07 per cent of the total samples. Whereas *M. beesoni* Snyder (Fig. 17), *D. incola* Wasmann (Fig. 18) and *P. kunjepu* Amina and Rajmohana (Fig. 19) were the least encountered with 0.69 per cent of the total samples (Table 1). *P. kunjepu* was the first record from Karnataka. This generic diversity of Termitinae is corroborated with the findings of Ranjith and Kalleshwaraswamy (2021).

Apicotermitinae was represented by single genus *Speculitermes* Wasmann with three species viz., *S. cyclops* Wasmann (Fig. 20), *S. dharwarensis* Roonwal and Chhotani (Fig. 21), *S. sinhalensis* Roonwal and Sen-Sarma (Fig. 22). When individual species collected within Apicotermitinae was compared with total samples revealed that *S. cyclops* was frequently collected sample with 1.38 per cent of the total samples followed by *S. sinhalensis* and *S. dharwarensis*, each with 0.69 percent of the total samples (Table 1). In termites, species identification is majorly based on soldier caste, but most of the genus in this subfamily is soldierless; hence they received less attention. There is a possibility that many common species from this subfamily are not yet described in this region. Therefore intensive survey and identification may yield more species from this subfamily.

Macrotermitinae was the most frequently encountered subfamily during the survey with 33.10 per cent. It was represented by two genera, namely *Odontotermes* Holmgren and *Microtermes* Wasman. The genus *Odontotermes* was the species rich under the subfamily Macrotermitinae with eight species. The genus *Microtermes* was represented by only one species i.e., *M. obesi* (Holmgren) (Fig. 23). Species composition within Macrotermitinae revealed that *Odontotermes* comprised of 87.50 per cent of termite samples collected and *Microtermes* was the least collected (12.50%) (Fig. 1). Comparison of the individual *Odontotermes* species with overall sample revealed that the species *O. bellahunisensis* Holmgren and Holmgren (Fig. 24) was frequently collected species (9.65%) followed by *O. obesus* (Rambur) (Fig. 25) (6.20%), *O. anamallensis* Holmgren and Holmgren (Fig. 26) (4.14%), *O. assmuthi* Holmgren (Fig. 27) (3.44%), *O. yadevi* Thakur (Fig. 28) (2.76%) and *O. vaishno* Bose (Fig. 29) (1.38%). *O. guptai* Roonwal and Bose (Fig. 30) and *O. adampurensis* Akhtar (Fig. 31) were the least encountered species, each represented by 0.69 per cent of the total samples (Table 1).

Analysis on the species diversity of the termites collected

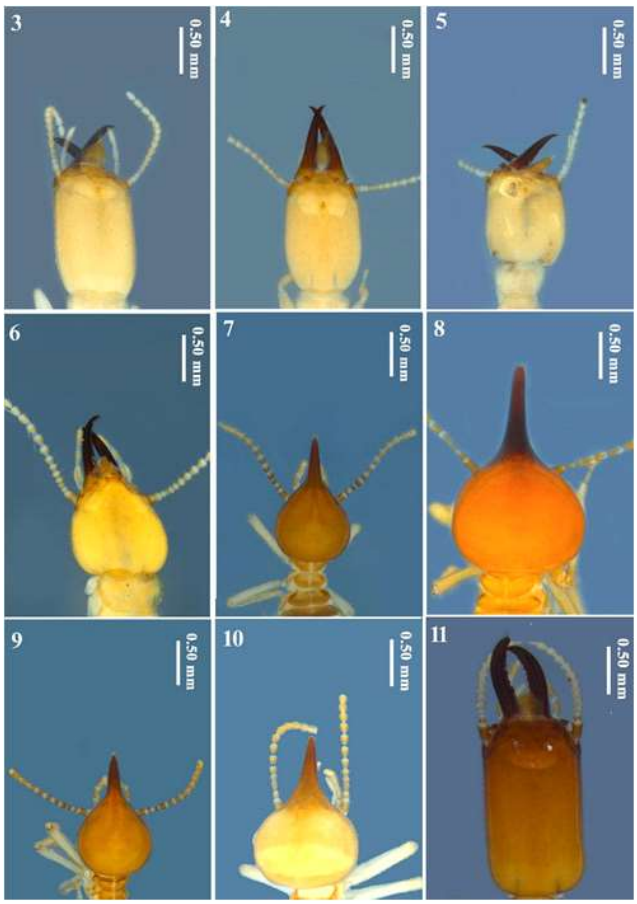

Fig. 3-11. 3. *H. indicola* (Wasmann) 4. *H. malabaricus* Snyder 5. *H. balwanti* Mathur and Chhotani 6. *C. kishori* Roonwal and Chhotani 7. *N. kali* Roonwal and Chhotani 8. *T. biformis* (Wasmann) 9. *N. brunneus* Snyder 10. *N. anamalaiensis* Snyder 11. *Microcerotermes pakistanicus* Akhtar

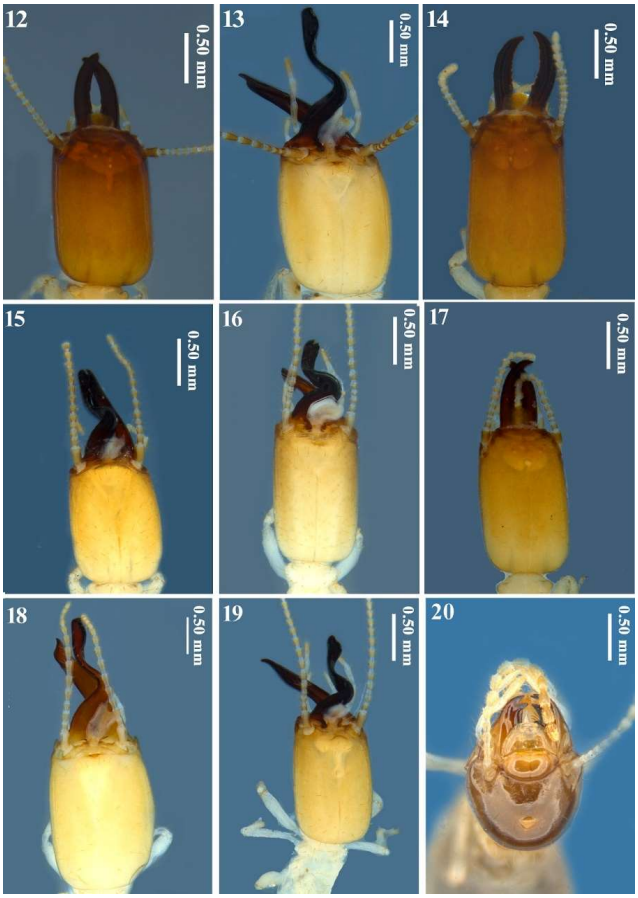

Fig. 12-20. 12. *M. fletcheri* Holmgren and Holmgren 13. *D. gravelyi* Silvestri 14. *M. cameroni* Snyder 15. *P. fletcheri* Holmgren and Holmgren 16. *L. distortus* (Silvestri) 17. *M. beesoni* Snyder 18. *D. incola* Wasmann 19. *P. kunjepu* Amina and Rajmohana 20. *S. cyclops* Wasmann

Fig. 30-31. 30. *O. guptai* Roonwal and Bose 31. *O. adampurensis* Akhtar

during the survey indicated that a total of 27.59 per cent of the termite species falls under the genus *Odontotermes*, followed by *Microcerotermes* (13.79%), *Heterotermes*, *Nasutitermes* and *Speculitermes* each with 10.34 per cent (Fig 2). In the present study, *Odontotermes* was the majorly collected, most

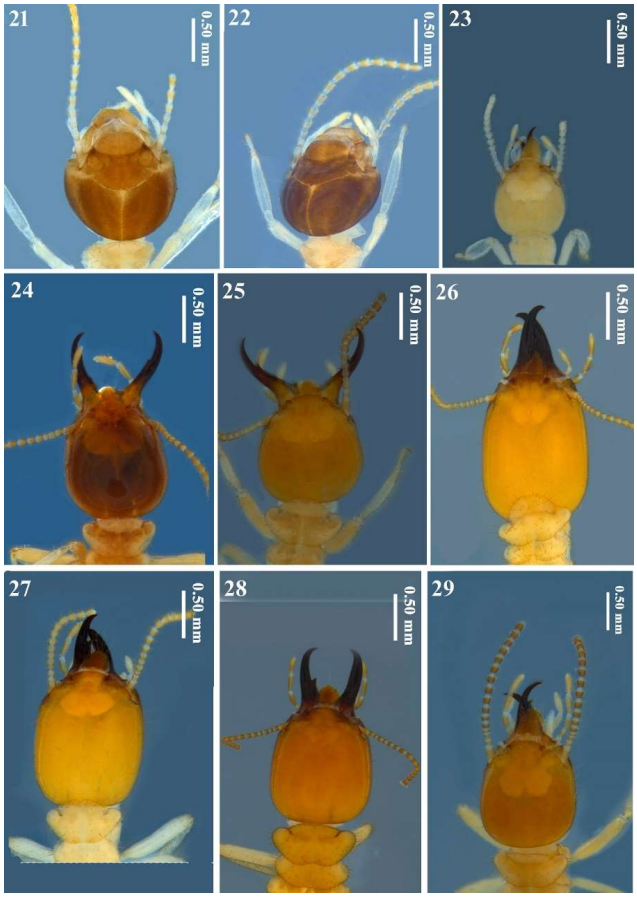

Fig. 21-29. 21. *S. dharwarensis* Roonwal and Chhotani 22. *S. sinhalensis* Roonwal and Sen-Sarma 23. *M. obesi* (Holmgren) 24. *O. bellahunisensis* Holmgren and Holmgren 25. *O. obesus* (Rambur) 26. *O. anamallensis* Holmgren and Holmgren 27. *O. assmuthi* Holmgren 28. *O. yadevi* Thakur 29. *O. vaishno* Bose

diverse and species rich genus of the Macrotermitinae. Similar findings were recorded by Rao et al. (2012) at the Bhadrachalam region of Khammam district of Telangana and Arumugam et al (2020) in Berembun forest reserve, Malaysia. Termites are found in every type of soil. They have both positive and negative effects on the environment. They are the chief decomposers in the ecosystem. By recycling organic materials, modifying soil conditions and improving soil composition and fertility, they serve a critical role. On the contrary to this, they act as destructive insect pests of agricultural, ornamental crops, dry wood, furniture etc. Thus, proper identification and understanding of the species composition in a particular area is essential. Further, molecular identification is suggested for any discrepancies in species delimitation (Vidyashree et al 2018).

CONCLUSION

The study documented termites from costal Karnataka

comprising of 29 species belonging to 11 genera under six subfamilies of two families. Termitidae was the most dominant family, with 25 species belonging to nine genera. The documented species in this study may serve as base for understanding termite species presence and conservation decision making in this region.

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AUTHORS CONTRIBUTION

BS, CMK and MR surveyed for termites. CMK designed the research and interpreted the results. BS and KJM wrote the manuscript and analyzed the data. All authors read and approved the final manuscript.

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