

Ecology and conservation of ant communities in the Alappuzha coast, Kerala, India

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ABSTRACT: The diversity, composition, and ecological significance of ant communities across three distinct coastal habitats - vegetated dunes, coconut groves, and disturbed sandy patches along the Alappuzha coast of Kerala were studied. A total of 21 ant species from 16 genera and 5 subfamilies were identified. Species richness and Shannon diversity were highest in vegetated dunes (17 species; $H' = 2.97$; $1-D = 0.91$), followed by coconut groves (14 species; $H' = 2.54$; $1-D = 0.84$) and disturbed sandy patches (11 species; $H' = 1.98$; $1-D = 0.74$). Soil organic matter and moisture content showed strong positive correlations with ant abundance and diversity. Field observations and seed removal experiments revealed that ants contribute significantly to seed dispersal, soil turnover, and nutrient cycling. The findings highlight the sensitivity of coastal ant assemblages to habitat conditions and their potential as bioindicators for monitoring and conserving coastal ecosystems.

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KEY WORDS: Bioindicators, seed dispersal, soil parameters. diversity indices, species richness

INTRODUCTION

Ants (Hymenoptera, Formicidae) are among the most ecologically dominant and functionally diverse insect groups on Earth, performing as ecosystem engineers (Bagyaraj *et al.*, 2016) influencing soil aeration, nutrient cycling, seed dispersal, and regulation of arthropod populations and act as bioindicators (Philpott *et al.*, 2010; Chowdhury *et al.*, 2023). Despite their ecological importance, studies on coastal ant communities in India are scarce. Most research has focused on forest and agricultural ecosystems (Bharti and Sharma, 2009). Coastal and insular ant communities have been examined in Australia (Lach and Thomas, 2008), Brazil (Fetiosa *et al.*, 2022; Chen *et al.*, 2015),

and the Gulf of Mexico. However, studies on coastal ant fauna in India are limited, and little is known about species-habitat associations, diversity patterns, and interactions with soil and vegetation in these coastal ecosystems. The coastal region of Alappuzha, Kerala, with its sandy beaches, dunes, lagoons, and estuarine backwaters, presents mosaic microhabitats shaped by tidal influences, monsoon climate, and human activities (Praveen and Kunnampalli, 2024). The varied landforms of Alappuzha produce diverse soil and vegetation conditions that influence ant community composition and nesting patterns. This microhabitat diversity often affects species distribution and functional roles, as ants tend to associate with specific substrates and vegetation types (Wills, 2018). This

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study addresses the gap by assessing species composition, habitat-linked diversity, and soil-faunal associations of ants across three contrasting habitats: vegetated dunes, coconut groves, and disturbed sandy patches along the Alappuzha coast of Kerala, India.

MATERIALS AND METHODS

The study was conducted along the Alappuzha coast (9.49.4927° N; 76.3178° E). Sampling was conducted between March and June 2024. Three representative habitat type - vegetated dunes, coconut groves, and disturbed sandy patches located approximately 100m within the seashore were selected for ant sampling. Ants were collected using a combination of standardized pitfall traps, bait traps, and hand collection methods (Bestelmeyer, 2000) to ensure comprehensive sampling of both ground-dwelling and foraging species. Collected specimens were preserved in 70 per cent ethanol and identified to species level using standard taxonomic keys (Bingham, 1903; Bolton, 1994; Bharti, 2016) and regional keys and the identifications were subsequently confirmed by Dr. Kalesh Sadasivasan, Research Associate, Travancore Nature History Society. Field observations and experimental approaches were employed to assess the ecological roles of ants in the coastal habitats. Standardized seed-removal experiments were conducted to evaluate ants' contributions to seed dispersal and soil turnover. Experimental plots (1m X 1m) were established within each habitat type, and marked seeds were placed at fixed intervals. The rate and pattern of seed removal were recorded at 2-h intervals over a 24-h period, following protocols adapted from (Gómez *et al.*, 2003; Andersen and Majer, 2004).

Soil samples were collected from each trap location for physicochemical analysis. Organic matter was estimated using Walkley and Black method (Walkley and Black, 1934). Soil moisture was determined by the gravimetric method; and pH was measured in a soil–water suspension using a calibrated digital pH meter. Diversity indices such as Shannon–Wiener (H') and Simpson's ($1-D$) were calculated to assess species richness and evenness across habitats (Magurran, 2013).

Statistical analyses, including one-way ANOVA, were performed to test differences in ant diversity among habitats, and Pearson's correlation was used to evaluate the relationships between soil parameters and ant diversity (Zar, 1999). Direct field observations were made to record behavioral interactions of ants with other invertebrates, focusing on trophic associations, predatory activities, and mutualistic relationships such as tending of Hemipterans or association with aphids. Opportunistic observations were also included to capture rare or infrequent behavioral events (Hölldobler and Wilson, 1990). For conservation assessment, potential threats to ant populations, including habitat disturbance, vegetation clearance, litter removal, and anthropogenic pressures such as tourism and waste accumulation, were identified through systematic field inspection and informal interviews with local residents. Each species was evaluated according to the IUCN Red List Criteria (2012) to determine its conservation status and potential vulnerability within the coastal ecosystem. Inter-specific interactions between ants and other animals (birds, reptiles, and arthropods) were observed to elucidate their ecological relationships and the role of ants in maintaining coastal trophic networks. Data from these observations provided qualitative insight into the functional importance of ants across the studied habitats.

RESULTS AND DISCUSSION

A total of 1,950 samples representing 21 species, 16 genera, and five subfamilies were recorded across the three coastal habitats of Alappuzha (Table 1). Species richness was highest in vegetated dunes (17 species), followed by coconut groves (14) and disturbed sandy patches (11). The dominant genera *Camponotus* (28%), *Paratrechina* (24%), and *Solenopsis* (18%) together accounted for over 70 per cent of the total samples. A survey conducted on the ant diversity in the University of Kerala Campus also revealed a total of 64 species across six subfamilies. Species belonging to the Myrmicinae dominated (51.5%) followed by Formicinae (20.6%), Ponerinae (13.2%), Dolichoderinae (4.4%), Pseudomyrmicinae (4.4%) and Dorylinae (1.5%) (Antony *et al.*, 2021).

Diversity indices revealed significant habitat variation, with the Shannon–Wiener index (H') being highest in vegetated dunes (2.97) and lowest in disturbed patches (1.98). Similarly, Simpson's index ($1-D$) indicated greater evenness in vegetated dunes (0.91) than in disturbed patches (0.74), signifying reduced dominance in more stable habitats. The ponerine ant *Diacamma rugosum* (Le Guillou, 1842) was confined to vegetated dunes, whereas *Anoplolepis gracilipes* (Smith, 1857) and *P. longicornis* (Latreille, 1802) were restricted to disturbed habitats, indicating their tolerance to habitat modification. Anas *et al.* (2021) conducted a study on Macrohymenopteran diversity in Thrissur (Thommana Kole wetland), identifying Formicinae as the species-rich subfamily of ants.

Soil parameters also varied significantly among habitats. Soil organic matter and moisture were highest in vegetated dunes (0.8 and 12%) and lowest in disturbed patches (0.3 and 6%). A strong positive correlation ($r = 0.74$) existed between soil organic matter and species richness (Fig. 1), whereas soil pH (6.9–7.1) showed no significant effect ($r = 0.12$, $p > 0.05$). Ant abundance differed significantly among habitats (ANOVA, $F_{2,27} = 7.11$, $p < 0.01$), being greatest in vegetated dunes (60 ± 8 individuals/trap) and least in disturbed patches (30 ± 5 individuals/trap), implying higher heterogeneity and resource availability in stable habitats.

Functional observations and seed removal experiments highlighted the ecological significance of ants in coastal systems. Seed removal rates (Table 2) were highest in vegetated dunes (68%), moderate in coconut groves (52%), and lowest in disturbed patches (35%). The principal seed-transporting species *Meranoplus bicolor* (Guerin-Meneville, 1884) and *S. geminata* (Fabricius, 1804) facilitated secondary seed dispersal and soil turnover, enhancing nutrient cycling and microhabitat formation.

Trophic interactions were diverse (Table 3). Predatory activity by *Odontomachus similimus* and *Tetramorium smithi* Mayr, 1879 regulated invertebrate populations, while scavenging by *Camponotus parius* Emery, 1889, *C. rufoglaucus*

Table 1. Ant species recorded in the Alappuzha coastal habitats

No.	Subfamily/ Species
Formicinae	
1	<i>Oecophylla smaragdina</i> (Fabricius, 1793)
2	<i>Paratrechina longicornis</i> (Latreille, 1802)
3	<i>Camponotus parius</i> Emery, 1889
4	<i>Camponotus rufoglaucus</i> (Jerdon, 1851)
5	<i>Anoplolepis gracilipes</i> (Smith, 1857)
Ponerinae	
6	<i>Diacamma rugosum</i> (Le Guillou, 1842)
7	<i>Diacamma ceylonense</i> Emery, 1897
8	<i>Odontomachus similimus</i> Smith, 1858
Myrmicinae	
9	<i>Crematogaster hodgsoni</i> Forel, 1902
10	<i>Crematogaster subnuda</i> Mayr, 1879
11	<i>Tetramorium smithi</i> Mayr, 1879
12	<i>Tetramorium indicum</i> (Forel, 1902)
13	<i>Tetramorium salvatum</i> Forel, 1902
14	<i>Meranoplus bicolor</i> (Guerin-Meneville, 1884)
15	<i>Trichomyrmex destructor</i> (Jerdon, 1851)
16	<i>Pheidole sharpi</i> Forel, 1902
17	<i>Solenopsis geminata</i> (Fabricius, 1804)
Dolichoderinae	
18	<i>Tapinoma melanocephalum</i> (Fabricius, 1793)
19	<i>Technomyrmex albipes</i> (Smith, 1861)
20	<i>Dolichoderus taprobanae</i> (Smith, 1858)
Pseudomyrmicinae	
21	<i>Tetraponera allaborans</i> (Walker, 1859)

(Jerdon, 1851) and *P. longicornis* accelerated organic matter decomposition. Mutualistic associations involving *Technomyrmex albipes* (Smith, 1861) and *C. rufoglaucus* with

Table 2. Seed removal rates (SRR) and seed – transporting ants across coastal habitats

Habitat	SRR (%)	Dominant species	Note on seed fate
Vegetated dunes	68	<i>Meranoplus bicolor</i> , <i>Camponotus compressus</i> , <i>Solenopsis geminata</i>	Transported to nests or buried in soil
Coconut groves	52	<i>Meranoplus bicolor</i> , <i>S. geminata</i>	Partial burial and redistribution
Disturbed sandy patches	35	Opportunistic species (<i>S. geminata</i> , others)	Limited seed dispersal and soil incorporation

[Seed removal rates (SRR) were calculated as the percentage of seeds removed from the experimental plots within 24 hours of deployment]

Table 3. Functional roles and observed behaviors of key ant species, across Alappuzha coastal habitats

Ant species	Functional role	Behavior/interaction	Habitat preference
<i>Meranoplus bicolor</i>	Seed disperser, soil aerator	Transporting seeds, soil-nesting, organic matter redistribution	Dunes, groves
<i>Solenopsis geminata</i>	Seed disperser, scavenger	Seed burial, scavenging, soil turnover	All habitats
<i>Pheidole sharpi</i>	Soil aerator, seed disperser	Soil nesting, seed movement, nutrient cycling	Dunes, dead wood remaining's
<i>Odontomachus similimus</i>	Predator	Preying on termites and dipteran larvae	Dunes
<i>Tetramorium smithi</i>	Predator	Termite and larval predation	Dunes
<i>Camponotus parius</i>	Scavenger, pest regulator	Removing dead insects and plant debris	Groves, dunes
<i>C. rufoglaucus</i>	Mutualist	Protects Hemipterans for honeydew	Dunes, Groves
<i>Technomyrmex albipes</i>	Mutualist	Tending sap-sucking Hemipterans	Dense plant cover
<i>Paratrechina longicornis</i>	Scavenger	Accelerates decomposition	Disturbed sandy patches

hemipterans on *Spinifex littoreus* (Burm.f.) Merr. and *Cocos nucifera* L. reflected complex ant–plant–insect networks.

Habitat-specific behavioral adaptations indicated that vegetated dunes supported complex nesting and multi-species coexistence, whereas disturbed sandy patches were dominated by opportunistic and invasive taxa, underscoring the sensitivity of ant assemblages to anthropogenic disturbance. Local knowledge corroborated these patterns. 82 per cent of respondents recognised ants as beneficial for soil fertility and pest regulation, while 18 per cent reported nuisance species (*S. geminata* and *Anoplolepis gracilipes*).

Interactions between ants and vertebrates, such as the Indian Common Myna *Acridotheres tristis*

(Linnaeus 1766), the Greater Racket-tailed Drongo *Dicrurus paradiseus* (Linnaeus, 1766), and the skink *Lankascincus fallax* (Peters, 1860), revealed the integration of ants into the broader coastal trophic web. Nest mounds and litter turnover further supported detritivorous and edaphic fauna, enhancing overall biodiversity.

These findings indicate that ant diversity and ecological functioning are closely linked to habitat stability and soil quality. The dense vegetation and higher organic matter in vegetated dunes provided favourable nesting sites and microclimatic buffering, consistent with earlier reports from tropical systems (Parr and Bishop, 2022). In contrast, the simplified communities in disturbed patches, dominated by *P. longicornis* and *A. gracilipes*, mirror patterns from other degraded landscapes (Bharti and Sharma,

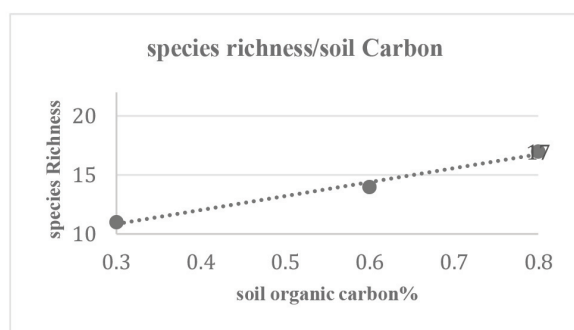


Fig. 1 Correlation between soil organic carbon content and species richness

2009; Wetterer, 2005). The observed positive association between organic matter and species richness supports previous evidence that nutrient-rich soils enhance foraging opportunities and colony establishment (Culliney, 2013).

The exclusive occurrence of *Diacamma rugosum* in vegetated dunes suggests sensitivity to disturbance and dependence on stable microhabitats (Gadagkar *et al.*, 1989). Such species serve as indicators of habitat quality and restoration potential. Overall, the study confirms that ants act as ecosystem engineers in coastal dune systems, facilitating processes such as seed dispersal, soil modification, predation, and mutualism that maintain ecosystem stability (Hölldobler and Wilson, 1990).

Comparative studies from tropical coasts (Floren, 2014; Antony *et al.*, 2021) similarly report that structurally intact dunes harbour more resilient ant assemblages. The decline in diversity along the disturbance gradient observed in Alappuzha aligns with global trends, reaffirming the value of ants as bioindicators of ecosystem integrity. Protecting the structural and ecological stability of vegetated dunes is essential for sustaining native ant populations and the key ecosystem functions they regulate. Conservation strategies should prioritise minimising anthropogenic disturbances and restoring degraded dune habitats to enhance the resilience and ecological stability of the Alappuzha coast.

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REFERENCES

- Anas P.P.M., Prakash A.S., Bijoy C and Mohamed H.E.S. (2021) Macrohymenopteran diversity in Thommana Kole wetland, Thrissur, India. *ENTOMON* 46(3): 273–276
- Andersen A.N. and Majer J.D. (2004) Ants show the way Down Under: Invertebrates as bioindicators in land management. *Frontiers in Ecology and the Environment* 2(6): 291–298.
- Antony A.K., George M.E. and Prasad G. (2021) Diversity of ants (Hymenoptera: Formicidae) in the University of Kerala Campus, Thiruvananthapuram, India. *ENTOMON* 46(4): 349–356.
- Bagyaraj D.J., Nethravathi C.J. and Nitin K.S. (2016) Soil biodiversity and arthropods: Role in soil fertility. *Economic and Ecological Significance of Arthropods in Diversified Ecosystems: Sustaining Regulatory Mechanisms*: 17–51.
- Bestelmeyer B.T., Agosti D., Alonso L.E., Brandão C.R. F., Brown W.L., Delabie J.H.C. and Silvestre R. (2000) Field techniques for the study of ground-dwelling ants: an overview, description, and evaluation. *Ants: Standard Methods for Measuring and Monitoring Biodiversity* 9(1): 122–144.
- Bharti H. and Sharma Y.P. (2009) Diversity and abundance of ants along an elevational gradient in Jammu-Kashmir Himalaya-I. *Halteres* 1(1): 10–24.
- Bharti H., Guénard B., Bharti M. and Economo E.P. (2016) An updated checklist of the ants of India with their specific distributions in Indian states (Hymenoptera: Formicidae). *ZooKeys* 551(1): 1–83.
- Bingham C.T. (1903) The fauna of British India, including Ceylon and Burma. Hymenoptera: Ants and cuckoo wasps. 506pp.
- Bolton B. (1994) Identification guide to the ant genera of the world. Harvard University Press, Cambridge, MA. 222pp.
- Chen X., Adams B., Bergeron C., Sabo A. and Hooper-

- Bui L. (2015) Ant community structure and response to disturbances on coastal dunes of Gulf of Mexico. *Journal of Insect Conservation* 19(1): 1–13.
- Chowdhury S., Dubey V.K., Choudhury S., Das A., Jeengar D., Sujatha B. and Kumar V. (2023) Insects as bioindicator: A hidden gem for environmental monitoring. *Frontiers in Environmental Science* 11(1): 1146052.
- Culliney T.W. (2013) Role of arthropods in maintaining soil fertility. *Agriculture* 3(4): 629–659.
- Feitosa R.M., Camacho G.P., Silva T.S., Ulysséa M.A., Ladino N., Oliveira A.M. and Darocha W. (2022) Ants of Brazil: an overview based on 50 years of diversity studies. *Systematics and Biodiversity* 20(1): 1–27.
- Floren A., Wetzel W. and Staab M. (2014) The contribution of canopy species to overall ant diversity (Hymenoptera: Formicidae) in temperate and tropical ecosystems. *Myrmecological News* 19(1): 65–74.
- Gadagkar R., Varma S. and Chandrashekara K. (1989) Ecology and behaviour of *Diacamma rugosum* (Hymenoptera: Formicidae) in southern India. *Journal of Animal Ecology* 58(3): 543–556.
- Gómez C., Pons P. and Bas J. M. (2003) Effects of the Argentine ant *Linepithema humile* on seed dispersal and seedling emergence of *Rhamnus alaternus*. *Ecography* 26(4): 532–538.
- Hölldobler B. and Wilson E.O. (1990) *The Ants*. Harvard University Press, Cambridge, MA. 732pp.
- Lach L. and Thomas M.L. (2008) Invasive ants in Australia: documented and potential ecological consequences. *Australian Journal of Entomology* 47(4): 275–288.
- Magurran A.E. (2013) *Measuring biological diversity*. John Wiley & Sons. pp1–215.
- Parr C.L. and Bishop T.R. (2022) The response of ants to climate change. *Global Change Biology* 28(10): 3188–3205.
- Philpott S.M., Perfecto I., Armbrrecht I. and Parr C.L. (2010) Ant diversity and function in disturbed and changing habitats. *Ant Ecology* 1(1): 137–156.
- Praveen D. and Kunnampalli J. (2024) Evaluating the impacts of anticipated sea level rise, climate change and land use land cover scenarios on the rice crop in Alappuzha, Kerala and strategies to build climate responsive agriculture. *International Journal of Disaster Resilience in the Built Environment* 15(4): 755–775.
- Walkley A. and Black I.A. (1934) An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science* 37(1): 29–38.
- Wetterer J.K. (2005) Worldwide distribution and potential spread of the long-legged ant, *Anoplolepis gracilipes* (Hymenoptera: Formicidae). *Sociobiology* 45(1): 77–97.
- Wills B.D. and Landis D.A. (2018) The role of ants in north temperate grasslands: a review. *Oecologia* 186(2): 323–338.
- Zar J.H. (1999) *Biostatistical analysis*. Prentice-Hall, New Jersey. 620pp.

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