



Ant Diversity of Isolated Land Masses in Ashtamudi Lake Ramsar Site, Kollam, Kerala, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Ashtamudi Lake is one of the three designated Ramsar sites of International importance in Kerala. This wetland has many isolated landmasses, few with human habitation and few without and thus supplements to its uniqueness. This study is an attempt to assess the diversity of ant species in these isolated landmasses and to understand if there is any difference in the distribution of ants in accordance with disturbances due to human habitation. The study was conducted for two years from 2021 to 2023. The study area comprises four isolated land masses - two without human habitation and two with human habitation. Ants were collected using different methods as described

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by Gadagkar et al. [1] and Agosti et al. [2] and preserved in 70% ethyl alcohol [2]. Overall 36 ant species were identified from isolated land masses without human habitation and 33 ant species were identified from isolated land masses with human habitation. Myrmicinae is the richest subfamily in both types of land masses and *Crematogaster* and *Camponotus* are the abundant genera in both kinds of land masses. Nineteen ant species were recorded in common from both kinds of isolated land masses. The Sørensen Similarity index between the two kinds of land masses is 0.55. The difference in the species composition suggests that the two types of isolated land masses provide varied environment which may lead to its unique species diversity.

Keywords: Ashtamudi; formicidae; myrmicinae; crematogaster; sorensen similarity index.

1. INTRODUCTION

Ants are increasingly used for ecological and conservation studies, mostly due to their biological properties. They occupy almost every habitat and geographical locations except for few extreme conditions like those covered with ice throughout the year. Ants perform a myriad of roles in the ecosystem like pollinators, decomposers, aeration of soil; regulate the population of other species by competition and predation etc. demonstrating its importance in the ecosystem [3]. Ecological disturbances are temporary disruptions in the environment resulting from abiotic, biotic, or anthropogenic factors, causing a pronounced change in an ecosystem. Key biological processes like mortality, reproduction, movement, and social behaviour within the populations in an ecosystem can be affected by disturbances. Their sensitivity to environmental perturbation, combined with their functional importance and ease of sampling, makes it ideal taxa for monitoring changes in ecosystems [4]. Moreover, structure and function of ant communities vary between different habitats and in response to disturbance [5].

Ashtamudi is a unique wetland system with its own hydrological system and biodiversity. It harbours different species of mangroves. Hence the site has been included in the Ramsar site list since 2002. But nowadays, threats to the site are increasing due to increasing tourism, oil spillage from the motor boats and industrial developments near the lake [6]. This site has many isolated landmasses in the lake, both with human habitation and without and thus supplements to the uniqueness of the Lake. So far, ant diversity has not been studied in these isolated land masses of Ashtamudi Lake and this is the first attempt to understand the ant species diversity of the study area and to compare the species composition of two types of isolated land masses.

2. MATERIALS AND METHODS

The study was conducted for a period of two years (2021-2023).

2.1 Study Area

Study area included isolated land masses in Ashtamudi Lake (Figs. 1-4). There are two types of land masses in the lake - few with human habitation and few without. Two land masses with human habitation selected are Pathupara (PTP) (8°99'88" N, 76°62'89"E) with an area of 9,961.32 sqm and Pezhumthuruthu (PZT) (8°97'36" N, 76°60'66"E) with an area of 2,34,326.73 sqm. These land masses are found very close to the main land. People residing over there use their own boat to commute to the main land and back. They practice agriculture of Coconut, Yam, Ginger, Yard long bean and Tapioca. Jack fruit tree, mango tree, *Murraya koenigii*, *Moringa oleifera*, breadfruit, plantain, Areca palm, cashew trees are also cultivated by them for household requirements. They also practice poultry farming of ducks and chicken. Pezhumthuruthu is little more big land mass. Along with agriculture and poultry farming, they also rear cattle. The litter cover is less in these areas.

The isolated land masses without habitation are Palliyamthuruthu (PLT) (8°97'55" N, 76°62'15"E) with an area of 15,662.65 sqm and Kakkathuruthu (KT) (8°57'57" N, 76°36'18"E) with an area of 29,655.84 sqm. These isolated land masses are bordered by mangroves. Towards the inner side of these land masses there is dense vegetation including perennial trees like Coconut tree (*Cocos nucifera*), Jackfruit trees (*Artocarpus heterophyllus*), Tamarind trees (*Tamarindus indica*), Acacia (*Racosperma auriculiforme*), Haldu (*Haldina cordifolia*), *Briedelia retusa*, Spotted gliricidia (*Gliricidia sepium*). Along with the trees, lots of bushes of *Chromolaena odorata*, *Mimosa pudica*

and many climbers are also present. The ground has a good litter cover (around 70-80 %) especially in Palliyamthuruthu where *Acacia* is the most abundant tree species. The soil is rich in humus and moist and more clayey towards the shore. Kakkathuruthu has uniform elevation throughout but Palliyamthuruthu has different elevations. The elevated region is dry and with less cover of trees and more of long grasses and bushes while the other areas are thickly covered with trees especially *Acacia mangium*. This tree often sheds its leaves and thus the ground is covered with litter round the year. Most of the collection was done between 9 am to 2 pm and during non rainy season. The climate mostly was sunny, humid and warm.

2.1.1 Ant collection, Identification and data analysis

Ants were collected using different methods like pitfall trap, tray sifting, food bait (both protein and sugar), ground hand collecting, vegetation beating and litter sampling as described by Gadagkar et al. [1] and Agosti et al. [2]. The collected specimens were preserved in 70% ethyl alcohol [2]. Identification of ant species was done with the help of a stereo zoom microscope based on the taxonomic keys of Bingham [7], Bolton [8] and Bolton et al. [9]. Sorensen's similarity index is a measure of similarity between two populations and is calculated based on the number of species in common and total number of species in both sites [10].

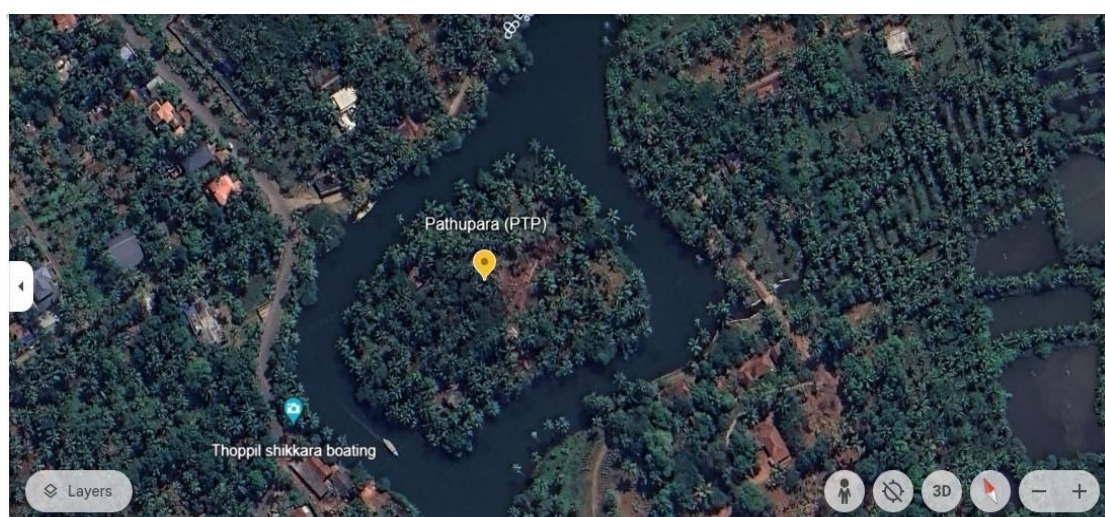


Fig. 1. Survey locality map of Pathupara (PTP)

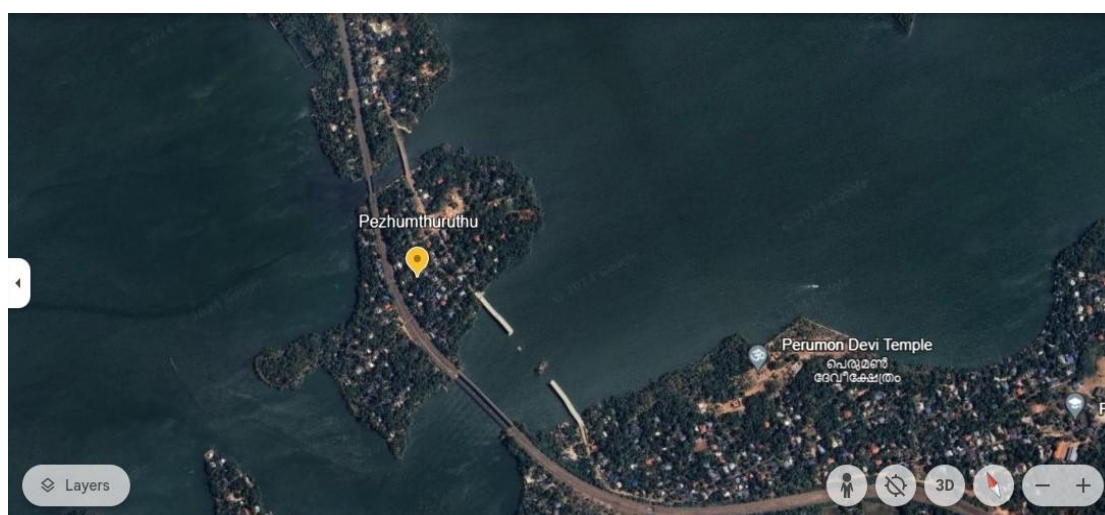


Fig. 2. Survey locality map of Pezhumthuruthu (PZT)

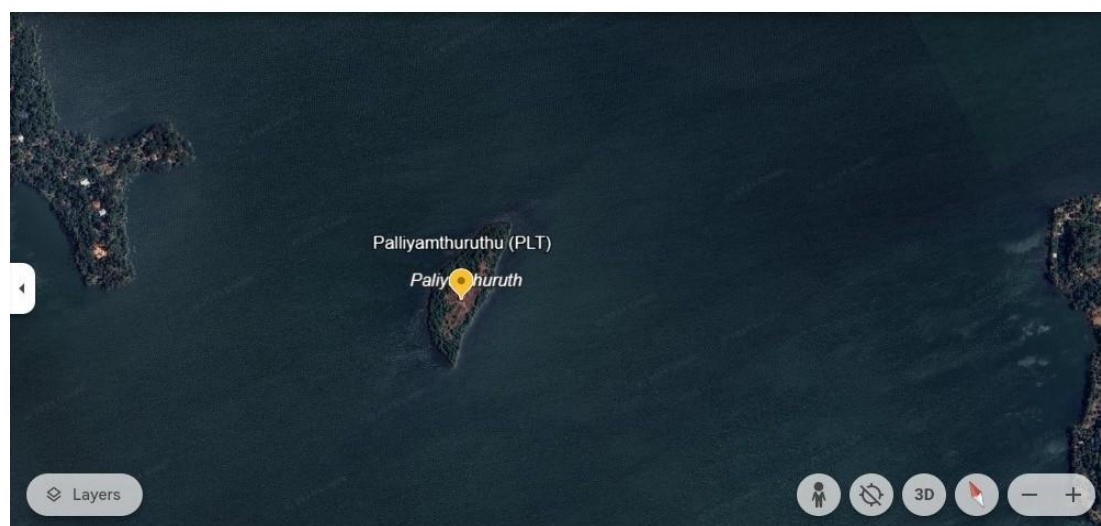


Fig. 3. Survey locality map of Palliyamthuruthu (PLT)

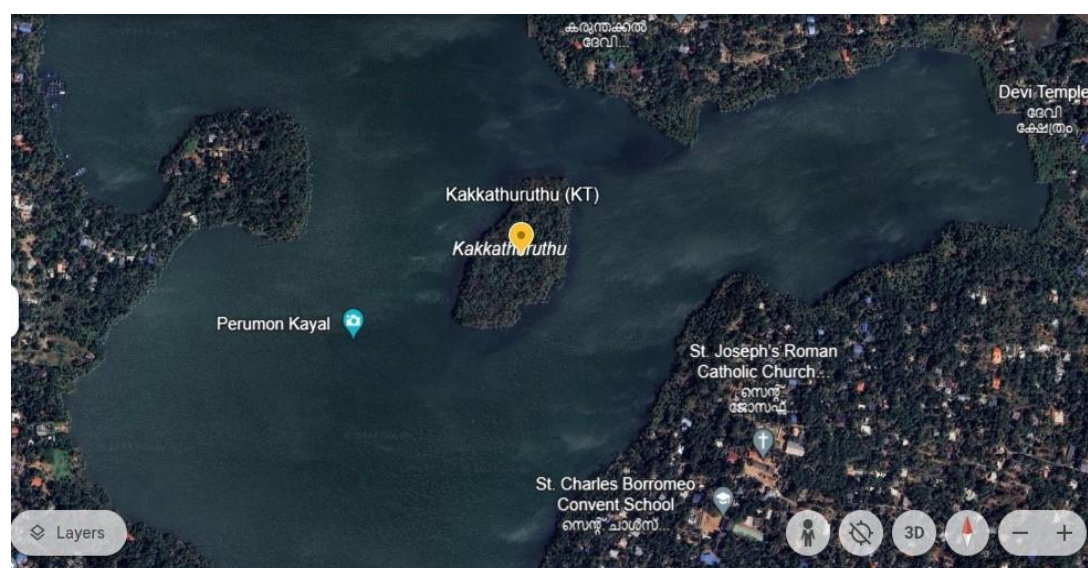


Fig. 4. Survey locality map of and Kakkathuruthu (KT)

3. RESULTS AND DISCUSSION

A total of 50 species placed under 23 genera and 5 subfamilies were recorded from the four isolated land masses studied (Table 1). Myrmicinae was found to be the dominant subfamily with 29 species and 10 genera followed by subfamily Formicinae with 14 species and 7 genera (Fig. 5). Subfamily Ponerinae was represented by 3 species belonging to 3 genera, Dolichoderinae with 2 species belonging to 2 genera and Pseudomyrmecinae with 2 species belonging to one genus. Similar dominating pattern of subfamilies was reported by Rabeesh et al. [11] in the study of diversity of ants in Kuttanad region of Kerala, India. *Crematogaster*

was found to be the most abundant genus with 7 species.

Most of the ants including *Tapinoma*, *Technomyrmex*, *Anoplolepis*, *Camponotus*, *Lepisiota*, *Nylanderia*, *Paratrechina*, *Crematogaster*, *Meranoplus*, *Monomorium* were collected from almost all the methods employed including soil sifting, litter sifting, hand picking, bait, beating sheet etc. Few arboreal species like *Oecophylla*, *Tetraponera nigra* and *Tetraponera nitida* were collected by beating sheet method, bait method and hand picking. Ground dweller ants like *Solenopsis*, *Diacamma*, *Odontomachus*, few species of *Pheidole* were collected by pitfall trap, hand picking and baits.

Table 1. Complete List of ant species recorded from isolated land masses of Ashtamudi Lake with and without human habitation

Sl. No.	Species	Subfamily	With Human Settlement		Without Human Settlement	
			PTP	PZT	KT	PLT
1	<i>Tapinoma melanocephalum</i> (Fabricius, 1793)	Dolichoderinae	√			
2	<i>Technomyrmex albipes</i> (Smith F, 1861)	Dolichoderinae	√	√		
3	<i>Anoplolepis gracilipes</i> (Smith F, 1857)	Formicinae	√	√		
4	<i>Camponotus compressus</i> (Fabricius, 1787)	Formicinae				√
5	<i>Camponotus irritans</i> (Smith F, 1857)	Formicinae	√			√
6	<i>Camponotus parius</i> (Emery, 1889)	Formicinae	√	√	√	
7	<i>Camponotus rufoglaucus</i> (Jerdon, 1851)	Formicinae	√	√	√	√
8	<i>Camponotus sericeus</i> (Fabricius, 1798)	Formicinae				√
9	<i>Camponotus</i> sp	Formicinae	√	√		√
10	<i>Lepisiota</i> sp	Formicinae			√	√
11	<i>Nylanderia bourbonica</i> (Forel, 1886)	Formicinae		√		√
12	<i>Nylanderia taylori</i> (Forel, 1894)	Formicinae	√			√
13	<i>Oecophylla smaragdina</i> (Fabricius, 1775)	Formicinae	√	√	√	√
14	<i>Paratrechina longicornis</i> (Latreille, 1802)	Formicinae	√	√	√	√
15	<i>Polyrhachis scissa</i> (Roger, 1862)	Formicinae			√	
16	<i>Polyrhachis tibialis</i> (Smith, 1858)	Formicinae	√			
17	<i>Cardiocondyla parvinoda</i> (Forel, 1902)	Myrmicinae				√
18	<i>Carebara affinis</i> (Jerdon, 1851)	Myrmicinae	√			
19	<i>Crematogaster anthracina</i> (Smith F, 1857)	Myrmicinae		√		
20	<i>Crematogaster biroi</i> (Mayr, 1897)	Myrmicinae	√			
21	<i>Crematogaster contemta</i> (Mayr, 1879)	Myrmicinae				√
22	<i>Crematogaster dohrni</i> (Mayr, 1879)	Myrmicinae		√		√
23	<i>Crematogaster flava</i> (Forel, 1886)	Myrmicinae		√	√	
24	<i>Crematogaster rothneyi</i> (Mayr, 1879)	Myrmicinae				√
25	<i>Crematogaster</i> sp.	Myrmicinae			√	√
26	<i>Meranoplus bicolor</i> (Guerin-Meneville, 1844)	Myrmicinae	√	√	√	√
27	<i>Monomorium floricola</i> (Jerdon, 1851)	Myrmicinae		√	√	√
28	<i>Monomorium monomorium</i> (Bolton, 1987)	Myrmicinae			√	
29	<i>Monomorium orientale</i> (Mayr, 1879)	Myrmicinae			√	
30	<i>Monomorium pharaonis</i> (Linnaeus, 1758)	Myrmicinae	√			
31	<i>Pheidole constanciae</i> (Forel, 1902)	Myrmicinae				√
32	<i>Pheidole indica</i> (Mayr, 1879)	Myrmicinae			√	√
33	<i>Pheidole</i> sp	Myrmicinae		√	√	√

Sl. No.	Species	Subfamily	With Human Settlement		Without Human Settlement	
			PTP	PZT	KT	PLT
34	<i>Pheidole spathifera aspatha</i> (Forel, 1902)	Myrmicinae	√		√	
35	<i>Pheidole watsoni</i> (Forel, 1902)	Myrmicinae	√	√		
36	<i>Solenopsis geminata</i> (Fabricius, 1804)	Myrmicinae	√	√		
37	<i>Solenopsis nitens</i> (Bingham, 1903)	Myrmicinae				√
38	<i>Strumigenys godeffroyi</i> (Mayr, 1866)	Myrmicinae	√			
39	<i>Tetramorium salvatum</i> (Forel, 1902)	Myrmicinae				√
40	<i>Tetramorium smithi</i> (Mayr, 1879)	Myrmicinae	√		√	√
41	<i>Tetramorium tortuosum</i> (Roger, 1863)	Myrmicinae	√			
42	<i>Tetramorium walshi</i> (Forel, 1890)	Myrmicinae			√	√
43	<i>Trichomyrmex aberrans</i> (Forel, 1902)	Myrmicinae			√	
44	<i>Trichomyrmex destructor</i> (Jerdon, 1851)	Myrmicinae		√	√	√
45	<i>Trichomyrmex glaber</i> (Andre, 1883)	Myrmicinae				√
46	<i>Diacamma ceylonense</i> (Emery, 1897)	Ponerinae	√		√	√
47	<i>Hypoponera confinis</i> (Roger, 1860)	Ponerinae	√			
48	<i>Odontomachus similimus</i> (Smith F, 1858)	Ponerinae	√	√	√	√
49	<i>Tetraponera nigra</i> (Jerdon, 1851)	Pseudomyrmecinae		√	√	
50	<i>Tetraponera nitida</i> (Smith, 1860)	Pseudomyrmecinae		√		
Total			24	20	22	28

Table 2. Exotic Species of Ant recorded from different types of isolated land masses

S No	Species	Subfamily	Isolated Land Masses with Habitataion	Isolated Land Masses without Habitataion
1.	<i>Tapinoma melanocephalum</i> (Fabricius, 1793)	Dolichoderinae	+	-
2.	<i>Technomyrmex albipes</i> (Smith F, 1861)	Dolichoderinae	+	-
3.	<i>Anoplolepis gracilipes</i> (Smith F, 1857)	Formicinae	+	-
4.	<i>Paratrechina longicornis</i> (Latreille, 1802)	Formicinae	+	+
5.	<i>Meranoplus bicolor</i> (Guerin-Meneville, 1844)	Myrmicinae	+	+
6.	<i>Monomorium floricola</i> (Jerdon, 1851)	Myrmicinae	+	+
7.	<i>Monomorium monomorium</i> (Bolton, 1987)	Myrmicinae	-	+
8.	<i>Monomorium pharaonis</i> (Linnaeus, 1758)	Myrmicinae	+	-
9.	<i>Solenopsis geminata</i> (Fabricius, 1804)	Myrmicinae	+	-
10.	<i>Trichomyrmex destructor</i> (Jerdon, 1851)	Myrmicinae	+	+

Ant diversity in isolated land masses without human habitation: A total of 36 species of ants belonging to 17 genera were identified from isolated land masses without human habitation. Myrmicinae was found to be the most abundant subfamily with 21 species and 8 genera followed by subfamily Formicinae represented by 12 species belonging to 6 genera (Table 1). Subfamily Ponerinae was represented by 2 species belonging to 2 genera whereas only one species was recorded from subfamily Pseudomyrmecinae.

Ant diversity in isolated land masses with human habitation: A total of 33 species belonging 21 genera and 5 subfamilies were recorded from the two sites belonging to the category isolated land masses with human habitation. Subfamily Myrmicinae was found to be the most abundant represented by 16 species and 9 genera followed by subfamily Formicinae represented by 10 species belonging to 6 genera. Subfamily Ponerinae was represented by 3 species belonging to 3 genera whereas subfamilies Dolichoderinae and Pseudomyrmecinae were represented by 2 species belonging to 2 genera (Table 1).

Subfamily Myrmicinae was found to be dominant in both types of isolated land masses studied (Fig. 6). *Crematogaster* is the richest genus in the subfamily Myrmicinae with 7 species. Genus *Camponotus* was found to be the richest genus from subfamily Formicinae with 6 species

(Table 1). Sornapriya et al. [12] also reported that *Crematogaster* of Myrmicinae and *Camponotus* of Formicinae were mostly found everywhere in a study on diversity and abundance of Ants in a village of Coimbatore district.

Nineteen species were found common in two different types of isolated land masses studied (Table 1). Sorensen's similarity index of the two types of isolated land masses was calculated and found to be 0.55 which represents a difference in the species composition of these two land masses. Species richness of ants is found to be more in isolated land masses without human habitation than the other especially for ants belonging to subfamily Formicinae and Myrmicinae (Fig. 7). Seventeen species of ants recorded from isolated land masses without human habitation were not reported from the land masses with human habitation (Table 1). The tree cover and vegetation are denser; litter cover was also found to be more in these land masses. Savitha et al. [13] and Graham et al. [14] also reported that species richness increase with the canopy and litter cover of the area. These land masses were less disturbed when compared to the isolated land masses with human habitation where disturbances are mostly caused by travel and trade of materials with main land and other anthropogenic activities. Reduced phylogenetic and functional diversity of ant community due to increased anthropogenic disturbances was also reported by Arnan et al. [15] and Garcia et al. [16].

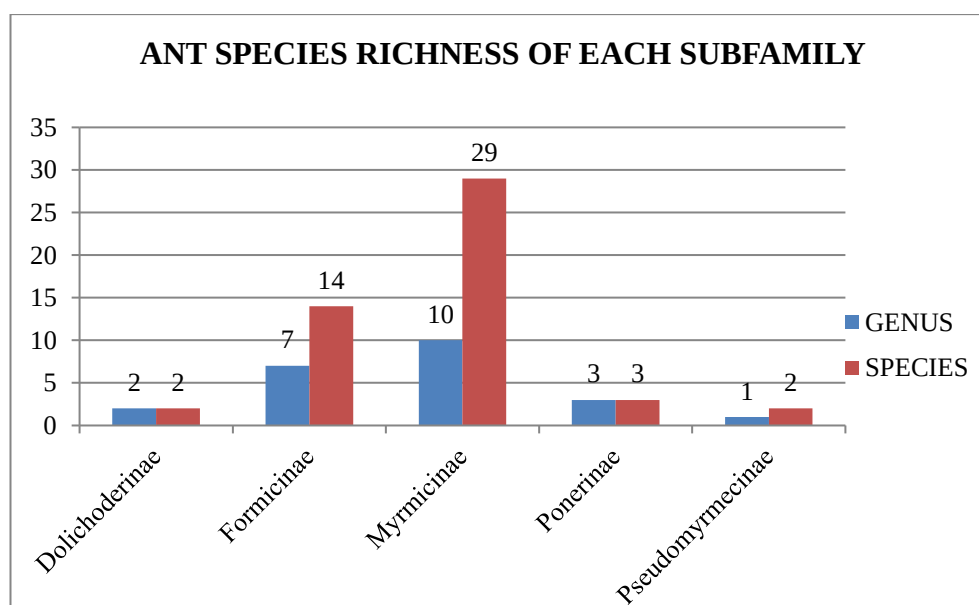


Fig. 5. Total Number of ant genera and species recorded from all the isolated land masses in Ashtamudi Lake

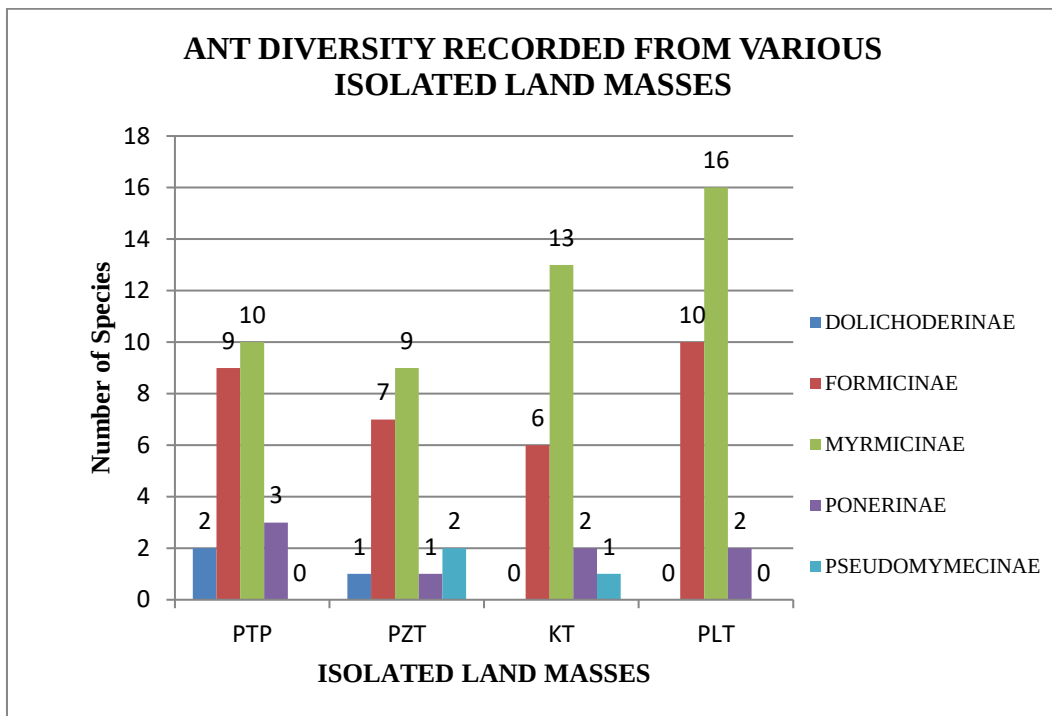


Fig. 6. Subfamily wise representation of ants recorded from four isolated land masses in Ashtamudi Lake

[PTP (Pathupara), PZT (Pezhumthuruthu), KT (Kakkathuruthu) and PLT (Palliyamthuruthu)]

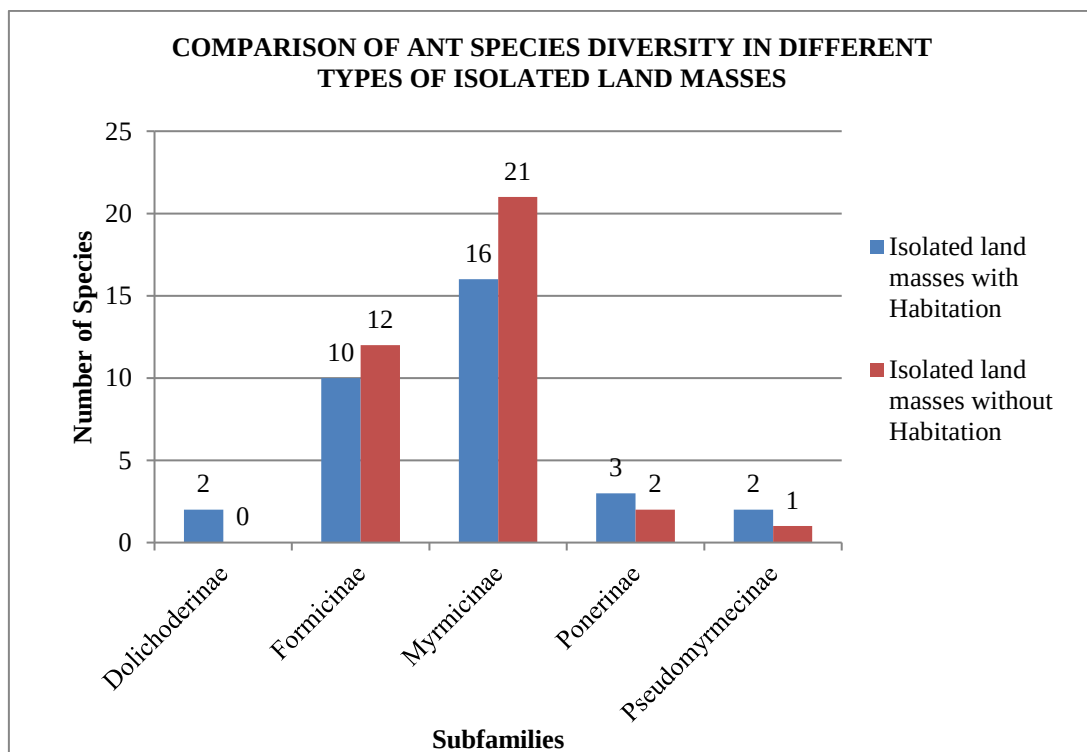


Fig. 7. Comparison of Ant species diversity in different types of isolated land masses in Ashtamudi Lake both with and without human habitation

Isolated land masses with habitation also recorded 14 species which were not recorded from the land masses without habitation (Table 1). Number of exotic species of ants recorded was also more from these isolated land masses compared to the isolated land masses without human habitation. Frequent interaction with the nearby main lands, disturbances and the land usage pattern in the form of agriculture, farming, grazing and associated activities might be the causes for these records.

A total of ten species of exotic ants were recorded from the study area as per the list of exotic ants of Bharti et al. [17] and Dad et al. [18]. Isolated land masses with human habitation recorded 9 of those exotic species while isolated land masses without human habitation recorded only 5 of them (Table 2). Disturbances to the area mainly by anthropogenic activities results in introduction to exotic species [19,20,9,21].

4. CONCLUSION

The study area is included under Ramsar Site of International importance in Kerala. Presence of isolated land masses (both with habitation and without) in this Lake highlights its peculiar geographical pattern. Ants, being ecological indicators can be used to understand the ecology of these land masses. There are differences regarding disturbances and land usage pattern in the two types of the land masses studied. Varied species composition of ants is recorded from the two types of land masses. There are various anthropogenic activities carried out in this lake including construction of bridge, conversion of many isolated land masses into tourist resorts, culture of prawns, *Etroplus*, mussels and other animals. These activities can have significant effects on the biodiversity as whole. A thorough study of this kind can help understanding the present status of the ecosystem and further changes can be evaluated with this background. Apart from natural phenomenon like fluctuations in the inundation pattern, dryness etc. increased anthropogenic activities also have effects in altered species composition of ants. Hence it is suggested to limit such anthropogenic activities and conserve the ecosystem in its natural form. A constant monitoring of the biodiversity of this area, not only for ants but for other organisms too, will help further in understanding the changing patterns of these areas.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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