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Termite Mounds' Diversity and Distribution: A Study at Jnanabharathi, Bangalore University

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***Abstract*— *Termites work together to modify their surroundings, which in turn influences their behaviour, leading to the building of termite mounds. The study was designed to assess diversity of termite mounds present in the Bangalore University Campus, Bengaluru, India. Observations were made on the occurrence, abundance, evenness and richness of the termite mounds. Mounds were surveyed by field survey and photographic interpretation method during July 2021 to June 2022. Totally 119 mounds were found, out of which 18 are ground level mounds, 42 small mounds, 37 medium mounds and 22 tall mounds. To test its effectiveness and to know about the influence of the mounds on the ecological well-being, termite mounds were identified, compared and interpreted using google earth map and the results were statistically verified.*

***Keywords*— Termites, Mounds, Diversity Index, Richness index and Evenness index.**

I. INTRODUCTION

Termites being eusocial insects are spread widely in sub-tropics and tropics specially playing key role as decomposers and engineers of soil [13, 16]. Termite are having very soft cuticle, they do not sustain in cold regions, their nests are formed by uniform thermal envelope with very hard outer shell for protection from predators and desiccation [33]. Termites feed on various kinds of organic matter such as dead organic materials, wood, cardboard, paper etc [15]. Thus, they contribute much to nutrient cycle and community structuring in any ecosystem [32]. Along with ants and earthworms, the termites play a major role in increasing porosity of soil and creates tunnels which are called mounds. mounds are solid but porous walls made from soil and termite faeces acting as niche for various microorganisms and fauna providing protection against changing environment [10, 20, 27, 34].

The degree of termite contribution for the spatial heterogeneity in an ecosystem is attached with the mounds' spatial distribution per unit area and its size and number. The spatial distribution of mounds is still the concept of debate as emphasized by findings from various ecosystems [5, 18, 19, 22, 30, 35]. Earlier studies of mounds are uneven, focusing on species classification [1] nest building and foraging activities [2] nutrient cycling [17] and termite-herbivore interactions [39]. However, understanding the spatial distribution of termite mounds can be a key component in predicting habitat utilisation and forage for herbivores [11, 12, 24]. Hence the present study was undertaken.

II. METHODOLOGY

The present study was carried out in Jnanabharathi campus (13º 05" N and 77º 34" E) at an altitude of 924 meters above the mean sea level with annual rainfall range of 530 mm to 1375 mm (mean 916 mm) spread to an area about 4.5 sq.km (1100 acres), situated on the elevated plateau at the western side of Bangalore, Karnataka, India. The study area is divided into site 1 (North) and site 2 (South) and is partially inhabited (Fig 1). The major part being un-inhabited, possesses wide range of vegetation from scrubby jungle, wild to cultivated trees with fauna such as insects, toads, reptiles, rodents and birds with a high population of termites and snakes.

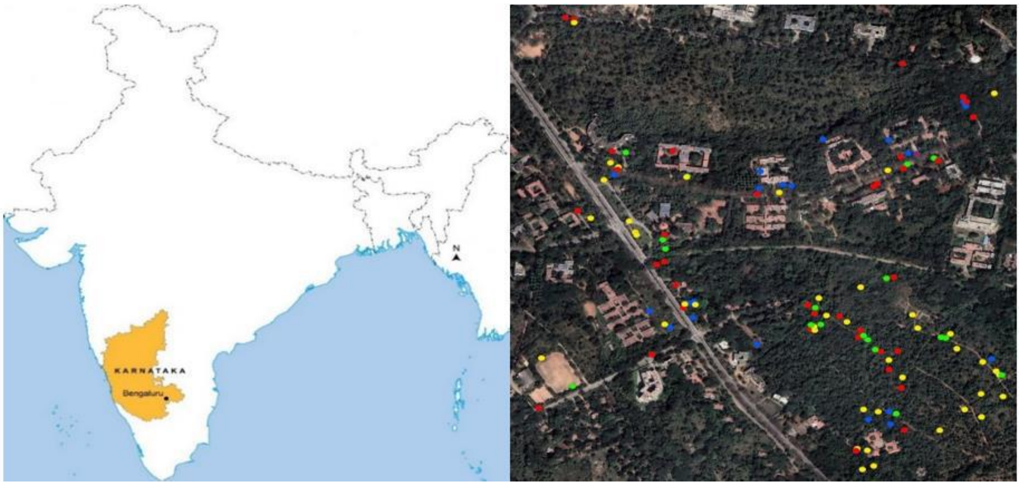

Fig.1: Jnanabharathi campus - Study area (Google map).

The mounds were identified and located in the study area using global positioning system (GPS) and photographic interpretation. Field survey was done during July 2021 to June 2022 for the spatial distribution of different sized mounds on google earth pro with GPS recordings of each mound and the same were photographed for further reference. Data comparison of the mounds between field reality and photography interpretation was performed by comparing the marked point corresponding to the location of mound identified in the field as well as in the image. Mounds were classified based on considering four standard heights, ground level mound (0 to 1 feet) (Fig 2A), small mound (1 to 3 feet) (Fig 2B), medium mound (3 to 7 feet) (Fig 2C) and tall mounds (7 feet and above) (Fig 2D).

Fig.2: Mounds classification based standard heights

The below mentioned statistical equations were used to compute the mounds' diversity, richness and evenness in the study area [25].

Shannon -Wiener diversity index (H') [36] was used to calculate mounds' diversity index:

$$H' = -\sum_{i=1}^{s} \left(P_i * Ln\,(P_i\,)\right)$$

where $P_i = S / N$

S = Number of individuals of one mound type

N = Total number of all individuals in the sample

Ln = Natural logarithm

Margalef's species richness index (d') [21] was adopted to measure mounds' richness index:

$$d' = \frac{(S-1)}{Ln(N)}$$

where S = Total number of mounds

N = Total number of individuals in the sample

Ln = Natural logarithm

Pielou's species evenness index (J') [28] was used to analyse the mounds' evenness index:

$$J' = \frac{H'}{Ln(S)}$$

where H' = Shannon -Wiener diversity index

S = Total number of species in the sample

Ln = Natural logarithm

III. RESULTS AND DISCUSSION

In the present study, out of a total of 119 mounds recorded (Fig 3), 18 (15%) are ground level mounds, 42 (35%) small mounds, 37 (31%) medium mounds and 22 (19%) tall mounds. Out of the 119 mounds identified, 48 (40.34%) mounds were at site 1(North) and 71 (59.66%) mounds were at site 2 (South). Site 1 with 48 mounds (Fig 6) had 6 (12.5%) ground level mounds, 12 (25.0%) small mounds, 18 (37.5%) medium sized mounds, 12 (25.0%) tall mounds (Fig 4) and Site 2 with 71 mounds (Fig 6) had 12 (25.0%) ground level mounds, 30 (62.5%) small mounds, 19 (39.6%) medium level and 10 (20.8%) large mounds (Fig 5). Significantly lower number of mounds were found in site 1 when compared to site 2, this could be attributed to the different human activities taking place decreasing the assemblage of the termite [9, 31].

Forest sites are routinely harvested to satisfy the diverse demands of the expanding human population. As a result, the physical complexity of these habitats is reduced, which lowers the variety and availability of ideal nesting and feeding sites and alters the microclimate. Termite microhabitats such as rotting tree stumps, dead logs, humus soil, etc., will frequently diminish from heavily populated areas. The succession of alates in creating new colonies is therefore thought to be reduced as a result of decreasing biodiversity brought on by human activity [7, 8, 14]. In addition to disrupting termites' natural adversaries, this change in microhabitat could make them pests rather than just a necessary component of the food chain. This is one of the main effects of this kind of habitat damage, both at micro and macro level. Despite agricultural intensification, which results in a trend that is less visible in forests, it is undoubtedly attributable to the establishment of numerous colonies [14].

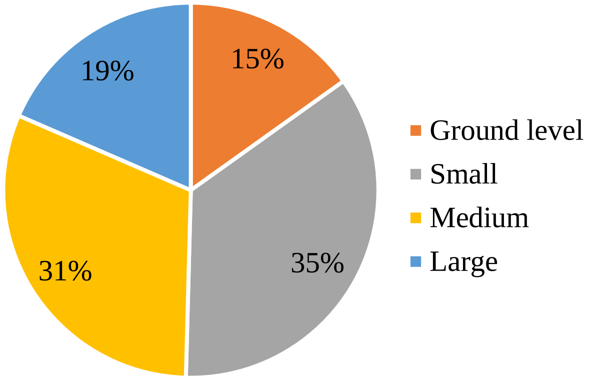

Fig.3: Percentage of different sized mounds in the study site.

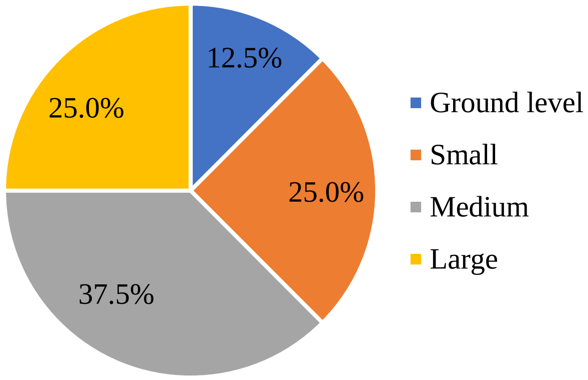

Fig.4: Percentage of different sized mounds at site 1.

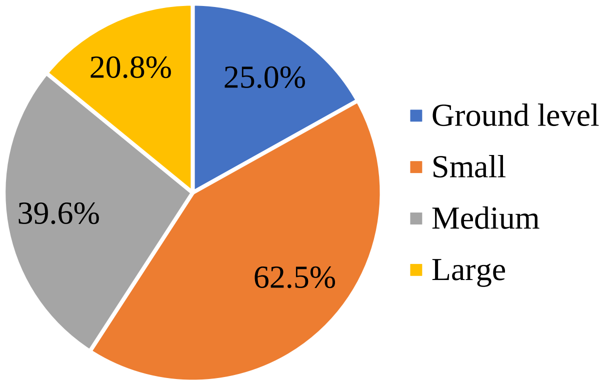

Fig.5: Percentage of different sized mounds at site 2.

Diversity index in site 1 and site 2 is found to be 1.32 and 1.29 respectively whereas the overall diversity index in the study area is 1.33. The mound diversity between the sites in the study area was not significantly different [26]. The result falls between 1.29 and 1.33. In comparison to site 2, diversity was generally greater at site 1 which had open spaces. This might be due to the denseness of the forest, which made sampling challenging, or the ecosystem's potential control over the termite population. This might be explained by the fact that these locations are found in a less dry region with moderate rainfall. Resources and microclimate conditions may not be a constraint to termite variety in such a setting [31]. The high diversity in site 1 could be due to availability of higher resources from human made structures and decreased number of predators.

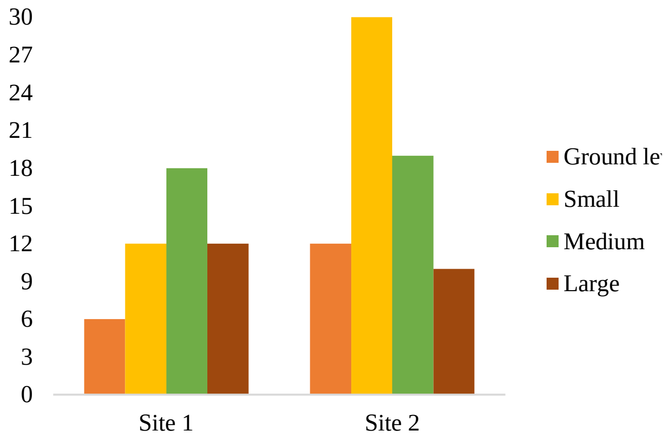

Fig.6: Total number of different sized mounds in the study site.

Richness index assessed at site 1 is 11.37, out of which 1.29 ground level mounds, 2.84 small mounds, 4.39 medium mounds and 2.84 tall mounds, while site 2 has richness index of 15.72 of which 2.58 ground level mounds, 6.80 small mounds, 4.22 medium mounds and 2.11 tall mounds. Over all the richness index of the study area is 24.06, out of which 3.56 ground level mounds, 8.58 small mounds, 7.53 medium mounds and 4.39 tall mounds. The existence or absence of a species in an ecological niche, as well as the richness or abundance there, are indicators of the ecosystem's biological and ecological diversity. Termites are not an exception to this criterion. We may also infer from this study that where there is substantial human activity, termite variety is more abundant, this might be caused by sufficient resources being available and a drop in natural predators and biodiversity is lost only in areas of high human interference. The information at hand also points to human meddling as the cause of the sparse vegetation in the site 1 area, which has diminished natural termite control. Because there are fewer natural nutrients available and predators, termites will infest man-made structures. Due to the destruction of microhabitat, termite biomass and richness are reduced. Due to the minimal level of human influence in the site 2 area, termite biomass and richness are controlled by nature [31].

Evenness index estimated at site 1 is 0.953, site 2 is 0.933 and for the overall study area it is measured to be 0.958. The resource ratio theory, according to Tilman [37, 38], predicts that more species will coexist at low resource levels because individuals perceive the environment as being more spatially diverse, which results in more niches and higher species evenness. Several elements, including fire [6, 7], rainfall [3, 4] and temperature are known to affect the richness, diversity, and evenness of mounds [23, 29]. The loss in mound diversity on this environment is further exacerbated by the absence of soil feeders. Therefore, geology could have an indirect effect on the diversity through soil conditions.

IV. CONCLUSION

The diversity of mound is subjected to change in the pattern of ecosystem, such study would help in understanding the ecological well-being. The kind of species, ecological conditions, clay availability and the degree of termite disturbance in the environment shall influence the morphological variations. Soil nutrients build up in termite mounds and their turnover becomes an essential part to the ecosystem. The present study provides a baseline data on the diversity and spatial distribution of the mounds and helps in taking up mitigation measures to conserve such areas. Isolating the year effect, as discussed in the methodological parts of the article, could help uncover anthropogenic effects on termite presence across time when employing termite mounds as anthropogenic bio-indicators.

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