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Comparative Study of Ant Abundance in Disturbed and Undisturbed Areas of Patna Zoo, an Urban Environment

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Annotation: Zoo in the urban area are increasingly recognized not only for their social and economic benefits but also for their potential to conserve biodiversity. In addition to conservation of biodiversity, zoo reconnect people with nature and create habitat for a wealth of organisms (Goddard s., 2010). Moreover, some of these organism acts as ecosystem monitor and contribute valuable eco- system services such as pollination, decomposition, pest control, aeration in soil and nutrient cycling.

Despite their modest size, urban insects like ants may be quite important to the biodiversity of zoo. This study, conducted in the fast-growing Indian city of Patna, evaluates the distribution, variety, and quantity of ants in tropical urban zoo. Pitfall traps and manual collecting were used in the study of the Patna Zoo. In both the damaged and undisturbed areas of the zoo, we counted a lot of ants. We discovered a variety of ant species, and the number of ant species we saw was strongly correlated with the number of types of trees and shrubs.

The variety and quantity of ant species were also impacted by zoo management techniques. As a result, areas with less aggressive weeding techniques and a higher percentage of undisturbed space compared to disturbed area showed higher insect counts.

In this study, we examined the impact of disturbance on ant diversity and richness in zoo. Specifically, we evaluated how factors such as soil texture, tillage practices, and proximity to natural habitats influence ant diversity.

Keywords: biodiversity conservation; urbanization, ant abundance.

Introduction

Ants are ubiquitous and present in nearly every aspect of the terrestrial ecosystem. Ants are important, and this is widely acknowledged. Ants are gregarious insects that inhabit small, naturally occurring cavities with a few dozen predatory ants or in highly organised colonies with millions of individuals occupying enormous areas.

Ants carry out crucial ecological tasks include preserving the ecosystem's natural equilibrium and serving as a sign of environmental changes in the region they inhabit. Ants are ideal organisms for assessing both biodiversity and habitat quality due to their diverse species, which engage in a variety of ecosystem functions as ecological engineers (Uno *et al*., 2010; Pacheco *et al*., 2013). Along with other soil-dwelling fauna, ground-nesting ants play a pivotal role in enhancing soil structure by improving moisture retention, water infiltration, aeration, and the incorporation of organic matter (Lal, 1988). The potential for biodiversity is contingent upon the availability of resources, the degree of disturbance within zoo, and the surrounding habitats' ability to function as a reservoir or additional resource. Tillage intensity, in particular, has an immediate impact on zoo biodiversity; heavy tilling has been demonstrated to reduce diversity. As societies progress toward urbanization, cities play an increasingly significant role in determining the distribution and patterns of biodiversity. Cities offer heterogeneous environments for biodiversity, marked by frequent, intense, and dense human-nature interactions. As a result, human land use has a long-term influence on urban ecosystems, with changes in urban green spaces being directly associated with cities' decreased resilience.

Ants are important markers for tracking how urbanization affects biodiversity because they react quickly to changes in the quantity and quality of their habitat as well as to altered management techniques related to urban growth. In urban environments, ants are crucial for pollination, soil aeration, organic matter breakdown, and nutrient cycling. Even so, little is known about the distribution of arthropod taxa—like ants and butterflies—in urban contexts, despite their abundance there. Large green areas, such remnant forests, have historically been the subject of the majority of studies on urban biodiversity. However, new research has shown that community gardens may support abundant biodiversity even in highly crowded urban settings.

Unlike forests, zoo are primarily managed at the individual level. As a result, they can vary significantly in structure, composition, and biodiversity, which are further shaped by their socio-economic and cultural backgrounds.

In addition to bees, wasps, ichneumons, and sawflies, ants are members of the order Hymenoptera, of family Formicidae, and the super family Vespoidea. Ants are holometabolous insects that go through four developmental phases, including the egg, larva, pupa, and adult. The division of the adults into castes for reproduction and non-reproduction is crucial. Ants require necessary proteins, lipids, carbohydrates, and amino acids for their biological processes during the developmental phases. In insects, carbohydrates can be found as glycogen and free sugars. Different ant species have different eating habits, such as herbivorous, omnivorous, and carnivorous.

However, certain ant species eat the honeydew that some insects and aphids leave on plants.

Various ant populations can be easily found thriving on a wide range of both living and non-living things, from the tasty sweet stuff kept in our kitchens to the agricultural fields. The ants have also been classified as Formicides, members of the family Formicidae, due to their superior ability to metabolise sugar molecules and produce strong formic acid. Foragers often store food, discard, and other organic trash, which builds up into an ant colony. Determining the soil microbial communities within the nests is the result of this type of modification. An important part of recycling organic materials is played by microorganisms. This causes the ant colony soil to alter in both its chemical and physical characteristics. In alkaline soils, the ant lowers pH, and in acidic soils, it raises pH. Nest size and ant population density determine the extent of soil change. Because of their dense colonies' microbially rich surroundings, ants may be more susceptible to infection and disease transmission.

Role in Nutrient Decomposition

Ants, especially leaf-cutter ants, harvest vast quantities of plant material, which they use as a substrate to cultivate fungi. The fungi decompose the plant material, breaking down complex organic compounds into simpler forms that ants can digest. This process facilitates the recycling of nutrients, particularly carbon, nitrogen, and phosphorus, back into the soil.

The process by which ants give nutrients to plants is known as myrmecotrophy. The most extensive research has been done on plant species that have domatia, which are internal hollow chambers that can host ant colonies. Several investigations have discovered evidence of both epiphytic and ground-dwelling species' nutrition absorption through the domatia's internal walls.

Ants that live in the soil leave waste behind in and around their nests, which enriches the surrounding soil with organic matter and mineral nutrients. Ant nest soil has been shown to have higher nutrient cycling rates and a greater number of standing stocks of various soil components, including phosphorus, ammonium, and nitrate, than the surrounding soil.

Like their domatia-dwelling close companions, soil-dwelling ants can provide soil-rooted plants with nourishment through their waste products. For instance, the label was found in the tissues of plants growing close to the ants' waste piles after N-labelled food was given to two kinds of leaf-cutting ants. (Sternberg *et al.* 2007). Furthermore, a number of observational studies have linked the naturally occurring but unique nitrogen content of ant nest soils to the plant tissues that are growing close to ant nests. (Farji-Brener & Ghermandi 2008;Wagner & Jones 2006). In comparison to conspecifics growing away from the nest's influence, a variety of plant species have shown increased growth rates and seed production when they are close to ant nests. (Dean & Yeaton 1993; Whitford 1988; Rissing 1986; Andersen 1988; Farji-Brener & Ghermandi 2008; Brown & Human 1997; Wagner 1997; Wagner & Jones 2006).

Impact on Soil Structure:

The constant movement of ants and the deposition of organic waste materials (e.g., spent fungal substrates, dead ants) enrich the soil with organic matter. This activity improves soil structure, enhancing its water retention capacity, aeration, and fertility, which benefits plant growth.

Formation of Microhabitats

Creation of Fungal Gardens:

The fungal gardens cultivated by ants create unique microhabitats that support a variety of other organisms, including bacteria, mites, and other insects. These microhabitats contribute to local biodiversity and can influence the composition of microbial communities in the soil.

Burrowing and Soil Mixing:

The burrowing activities of ants mix the soil layers, influencing soil stratification and promoting the distribution of nutrients. This bioturbation can enhance seed germination and root penetration, impacting plant community dynamics.

Interactions with Plants

Mutualistic Relationships with Plants:

In some cases, ants protect plants from herbivores and competing vegetation. The nutrients returned to the soil by ant activity can also promote plant growth. Some plants have evolved specific adaptations to attract and house ants, such as providing food rewards or shelter, which in turn helps in their defense and nutrient acquisition.

Seed Dispersal:

Certain ant species are involved in myrmecochory, the dispersal of seeds with elaiosomes (nutrient-rich appendages). The ants collect these seeds, consume the elaiosomes, and discard the seeds in nutrient-rich waste areas, which can enhance seedling establishment and growth.

Impact on Community Dynamics and Ecosystem Structure

Influence on Plant Community Composition:

The activities of fungus-growing ants can influence plant community composition by selectively harvesting certain plant species, thereby reducing competition for other plants. This selective pressure can shape plant species distributions and abundance in an ecosystem.

Role in Food Webs

The ants themselves and the fungi they cultivate are integral components of the food web. They provide a food source for various predators and parasites, linking them to other trophic levels in the ecosystem. This complex network of interactions can stabilize or destabilize community dynamics, depending on the balance of these relationships.

Responses to Environmental Changes

Climate Change and Habitat Alteration:

Changes in climate conditions, such as temperature and humidity, can affect the growth and maintenance of fungal gardens, impacting the survival and distribution of fungus-growing ants. Habitat alteration, such as deforestation or urbanization, can disrupt these mutualistic relationships, leading to broader ecological consequences.

Materials and methods

Study area

Sanjay Gandhi Biological Park, Patna, is one of the most beautiful and progressive zoos in India. In 1969, the park was first created as a botanical garden. The garden was established on over 34 acres (14 ha) of land from the Governor House campus, which was donated by Sri Nityanand Kanungo, the then-governor of Bihar. In order to assist the park grow, the Revenue Department gave the Forest Department 60.75 acres (24.58 ha) in 1972, and Public Works added 58.2 acres (23.6 ha) to this. The park, which was once a botanical garden, now has over 300 different kinds of trees, herbs, and shrubs. A medical plant nursery, an orchid house, a fern house, a glass house, and a rose garden are among the plant exhibits. The park's aquarium generates the most income, surpassing even the general entry price. The snake house contains 32 snakes of five different types, and the tank contains roughly 35 different species of fish. The geographical co-ordinates of the zoo are 25°35′57.57 north latitude and 85°5′55.64 east longitude. The majority of the zoo's inhabitants reside in expansive, open moated areas that are encircled by native flora, giving them a realistic atmosphere and habitat.

Sampling methods

Pitfall traps, various hand collection techniques as well as scented traps are used to collect ants. Five random quadrants of 20 m x 20 m were chosen. The pit fall traps were made up of half litre plastic bottles with an opening of 12 cm in diameter, all buried at ground level. The bottles contained a mixture of 25 ml ethanol and glycerol. The traps were set during the dusk hours and the samples were collected after 48 hours. In the scented traps 25 ml of sugarcane was added instead of glycerol along with ethanol. 30 minutes were given for hand collection to collect the representative individuals found in the quadrat.

Collected ants were first sorted, then washed and then finally preserved in 70% alcohol. They were put in different containers and then identified. Ants obtained from undisturbed areas and disturbed areas were calculated for abundance

Results and Discussion

A total of 20 ant species belonging to 14 genera and 6 subfamilies were found. Myrmicinae with 7 species dominated the community, followed by Formicinae with 6 species, Pseudomyrmecinae with 3 species, Ponirinae with 2 species, Dorylinae with 1 species and finally with Dolichoderinae also with one species.

3 ant species were common in both undisturbed and disturbed areas, whereas majority (almost 80%) of the species were reserved to the undisturbed territory. Ant species like Meranoplus bicolor, Anochetus graffei and Polyrhachis tibialis were found exclusively in the undisturbed area. Leptogenys chenisis were found solely in disturbed areas. However, the number of ants collected from disturbed areas was less than that of the number of ants collected from undisturbed areas. Subfamily Dolichoderinae, Dorylinae, and Ponirinae though the number of ants collected varied, had almost similar number of species in both areas. Therefore, the species compositon and abundance from both habitats varied significantly.

After analysis it was concluded that the species richness and abundance of disturbed areas was much lower compared to the species abundance found in undisturbed areas. The reason for this difference can be attributed by various factors which include habitat destruction and disturbance caused by anthropogenic activities. A negative effect is seen on the ant diversity due to fragmentation of forest areas. It is seen that habitat with abundant trees, canopy cover and litter content provide a positive and thriving habitat for ants. It provides nesting, hiding places and foraging grounds. Such habitat complexity and heterogeneity are the reason the number of ants is more in undisturbed areas as compared to disturbed areas.

Conclusion

Community gardens have the potential to serve as habitats for a diverse range of ants and other organisms. Soil texture and the level of disturbance are likely the most significant factors influencing ant diversity, with heavy clay soils and higher levels of disturbance leading to a reduction in species diversity. However, minimizing disturbance outside garden plots and maximizing proximity to wooded areas may enhance ant activity within gardens, as ants can disperse into these areas from surrounding habitats.

The species richness of the disturbed area was found to be 16 and the species richness of the undisturbed area was 19 almost greater by 3 points.

The above data is indicative of the fact that undisturbed areas harbour a greater abundance of ant species as compared to disturbed areas. Ants act as indicators, indicating the alterations caused in a particular environment by reacting and responding to the changes immediately. Disturbed sites can be further studied for the extent of disturbance caused, its type, changes in soil parameters like physicochemical properties, pH, moisture content, nutrient concentration, exotic flora and fauna, etc.

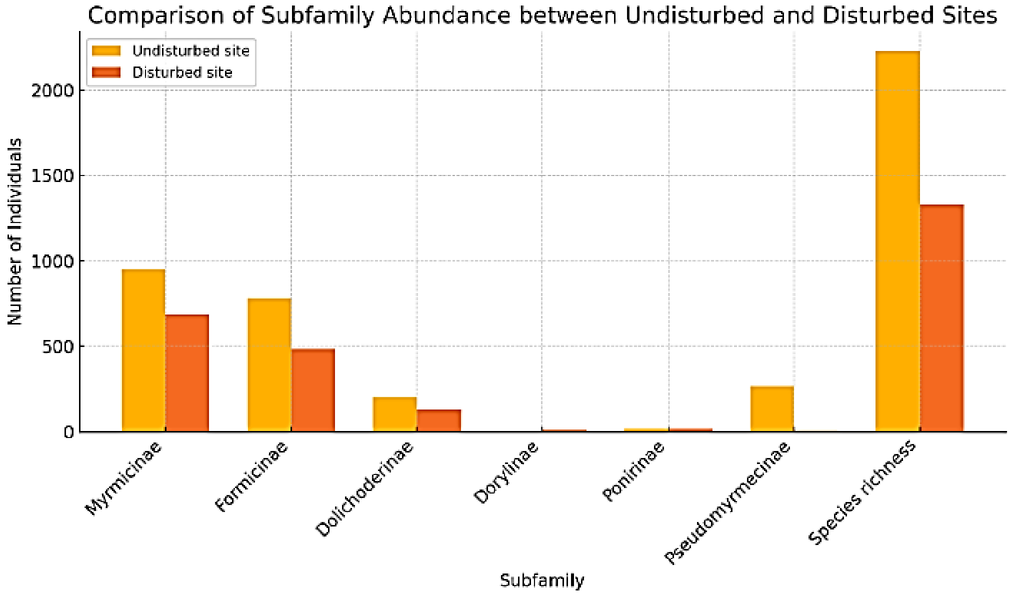
Relative abundance = Pi x 100 = Ni / N x 100

Where, Pi = i^th number of individuals of species.

Ni = number of one species in a sample.

Subfamily	Undisturbed site (no. of individuals)	Disturbed site (no. of individuals)
Myrmicinae,	7 (951)	6(686)
Formicinae	6(779)	5(486)
Dolichoderinae	1(204)	1(127)
Dorylinae	1(3)	1(10)
Ponirinae	1(18)	1(17)
Pseudomyrmecinae	3(267)	2(6)
Species richness	19(2232)	16(1329)

The species richness was found to be 19 for undisturbed site and 16 for disturbed site.



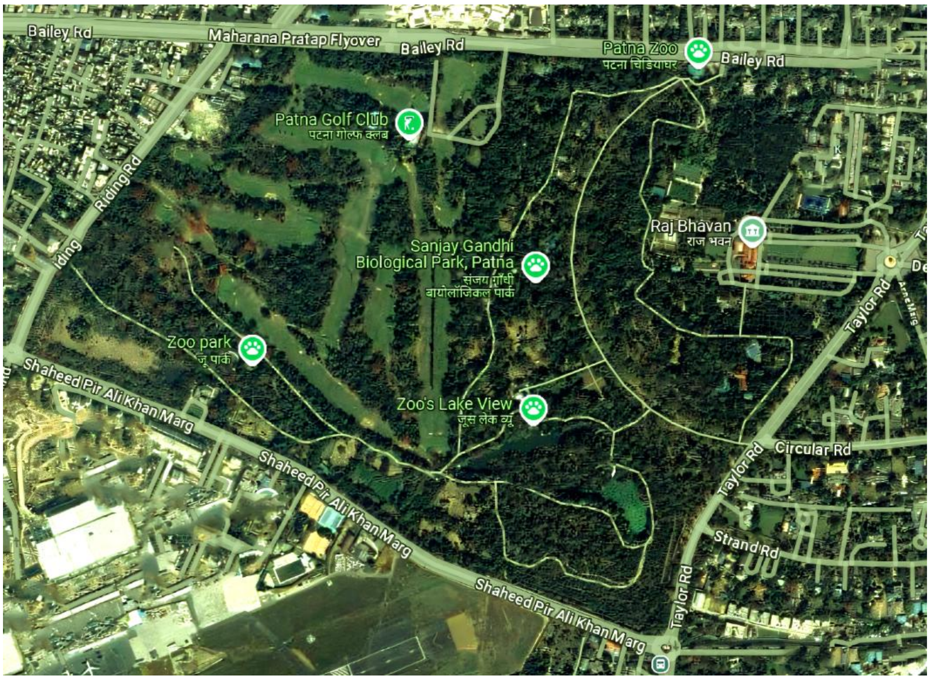


Fig: Patna Zoo

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