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DIVERSITY OF GROUND-DWELLING ANTS (HYMENOPTERA: FORMICIDAE) IN PHULCHOWKI HILL, LALITPUR, NEPAL

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ABSTRACT

The study assesses the diversity of ground-dwelling ants (Hymenoptera: Formicidae) in Phulchowki Hill, Lalitpur, Nepal focusing their species richness altitudinally and seasonally. Ants were sampled from June 2018 to February 2019 using pitfall traps, bait traps and hand collection methods covering an altitudinal range from 1500 m to 2700 m in five selected sites (1500 m, 1800 m, 2100 m, 2400 m, and 2700 m). A total of 1443 specimens representing four subfamilies, 12 genera and 18 morphospecies were collected. Formicinae (57.58%) was recorded as the most abundant subfamily followed by Myrmicinae (38.53%), Ponerinae (2.21%) and Pseudomyrmicinae (1.66%). *Camponotus* was the most speciose (4 morphospecies) genus and was most abundant in all seasons. The highest Similarity index (0.667) was recorded between the first and second sites among five sites. Species richness (16), Shannon diversity index (1.504) and abundance (631) were the highest in autumn. Similarly, species richness (12), Shannon diversity index (1.399) and species evenness (0.563) were recorded highest at 2100 m altitude, while species abundance (519) was maximum at 1500 m.

Keywords: altitudinal gradient - ant genera - *Camponotus* - formicinae - pitfall traps

INTRODUCTION

Ants (Hymenoptera: Formicidae) are the vital component of biomass and diversity in terrestrial ecosystem (Holldobler & Wilson, 1990) constituting about 15% of the total animal biomass in Central Amazonian

rainforest (Fitttkau & Klinge, 1973). They are the key indicator species in monitoring conservation and management programs due to their quick response to habitat quality and relatively easy sampling and identification (Brown, 2000; Andersen *et al.*, 2002; Will & Landis, 2018). Ants play an important role in predation (Youngs, 1983), decomposition (Eubanks *et al.*, 2019), and secondary seed dispersal (Bottcher, 2016). Ants are the ecosystem engineers and they influence invertebrate, plant and soil microbial diversity (Subedi, 2016; Will & Landis, 2018).

Ants are the social insects evolving since the Cretaceous period. There are 17 valid subfamilies, 337 genera and 13851 valid species of ants in the world (Bolton, 2020). Myrmicinae, Formicinae, Ponerinae and Dolichoderinae are four major subfamilies of ants constituting about 87% of the described ant species in the World (Guenard, 2013).

Suspended litter in the forest can provide a greater availability of foraging and nesting sites, thus, ground dwelling ants should occur at both higher densities and species numbers (McGlynn *et al.*, 2009; Queiroz *et al.*, 2013; Macedo-Reis *et al.*, 2019). Environmental factors are key drivers for high taxonomic and functional diversity of ground-dwelling ants in continuous forests (Santos *et al.*, 2019). Different sampling methods have been used to collect ant fauna and they vary in their efficacy and selectivity in capturing ant species (Bestelmeyer *et al.*, 2000). A large percentage of the ground dwelling fauna can be captured using a combination of methods (Olson, 1991; Fisher, 1999; Bestelmeyer *et al.*, 2000). Thus, studies generally use two or more methods for collection of ants to produce better results (Subedi & Budha, 2020).

Little is known about the diversity and distribution patterns of ants in Nepal. Collingwood (1970) published the first comprehensive list of Nepalese ants with 34 species. Thapa (2015) listed 44 named species of ants of Nepal. The data on Nepalese ants are also available in different web-based resources such as, 51 named species (AntWeb, 2020), and 86 species/subspecies (AntWiki, 2020). Recent updates of Nepalese ants include 128 species, 48 genera and eight subfamilies representing 0.9% of the global ant diversity (Subedi *et al.*, 2020). However, ant distribution patterns in Nepal cannot be generalized based upon few collections and limited published literature (Subedi & Budha, 2020). This paper aims to explore the diversity of ground-dwelling ants in Phulchowki Hill, Lalitpur, Nepal focusing their species richness altitudinally and seasonally.

MATERIALS AND METHODS

Study area

Phulchowki Hill lies in Lalitpur district between 27°34" N and 85°24" E within the elevational range from 1500 m to 2700 m. The Hill is located within the subtropical mountain to temperate mountain climate. Field survey was conducted during rainy (June–July) and autumn (September–October) seasons of 2018 and winter (January–February) season of 2019 in five selected sites, namely, site A (1500 m), site B (1800 m), site C (2100 m), site D (2400 m) and site E (2700 m). Three distinct types of evergreen broad-leaved forests, namely, mixed *Schima-Castanopsis* forest (1400 m – 1800 m), oak-laurel forest (1800 m – 2400 m) and evergreen oak forest (above 2000 m) characterize the vegetation of Phulchowki Hill.

Sampling methods

Ants were collected by using pitfall traps, bait traps, and hand collection methods. In each site, 10 pitfall and 10 bait traps were kept parallelly in linear series. The distance between the adjacent traps was maintained at 10 m. Each pitfall trap was made by a plastic cup with 12 cm depth and eight cm diameter, buried at ground level. Each trap was filled one-third with detergent water. Samples were collected after 48 hrs. Each bait trap was made by keeping 0.25 gm sugar and butter in a 10 cm by 10 cm plain paper. The baits were exposed for 30 minutes. Ants were searched under stones, logs and moss for opportunistic hand collection. All collected specimens were preserved in 70% ethanol.

Specimen processing, identification and analysis

The preserved specimens were first sorted by morphospecies in the laboratory of Amrit Campus. The required number of sorted specimens were pin mounted. Ants were identified using standard taxonomic keys for generic level identification (Bingham, 1903; Bolton, 1994). They were observed under a stereo-zoom trinocular microscope and photographed by using a Samsung digital camera. Collected specimens were deposited at the Department of Zoology, Amrit Campus. Statistical analysis was done using MS Excel 2007 to calculate Shannon diversity index, Evenness index and Sorenson index.

RESULTS AND DISCUSSIONS

Altogether 1443 individual ants were collected; representing four subfamilies (Formicinae, Myrmicinae, Ponerinae and Pseudomyrmecinae), 12 genera (*Camponotus, Lepisiota, Paratrechina, Polyrhachis, Prenolepis, Aphaenogaster, Crematogaster, Monomorium, Pheidole, Brachypone*ra, *Leptogenys* and *Tetraponera*) and 18 morphospecies through 300 trap samples and opportunistic hand collection. Formicinae was recorded as the most abundant subfamily with 831 individuals collected and Pseudomyrmicinae as the least abundant with 24 individuals (Figure 1). Neupane and Subedi (2018) also reported Formicinae and Myrmicinae as the most abundant subfamilies from the Muhan Pokhari area of Shivapuri-Nagarjun national park.

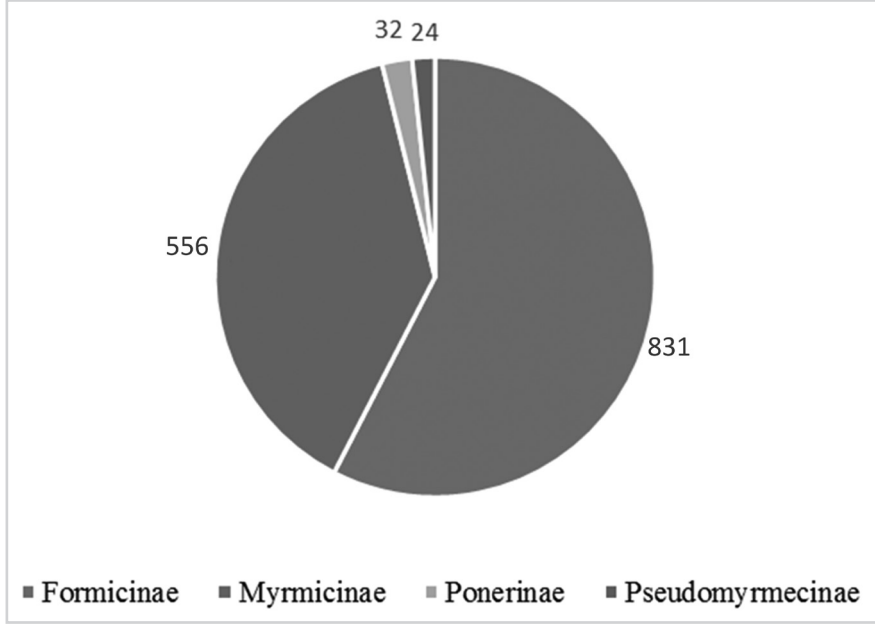

Figure 1: Subfamily-wise abundance of ants in Phulchowki Hill

Seasonal diversity of ants

Two subfamilies, three genera and five morphospecies; four subfamilies, 12 genera and 16 morphospecies and three subfamilies, five genera and 10 morphospecies were collected during rainy, autumn and winter seasons respectively. Maximum species richness (16) was recorded during autumn as compared to rainy (5) and winter (10) seasons. Similarly,

Shannon index of species richness (H`) was recorded as the highest during autumn season (1.504) followed by winter (1.456) and rainy (0.998). The highest number of individual ants were collected in autumn (631) followed by winter (565) and rainy (274) seasons. The highest Sorensen similarity coefficient was found between site A and site B (0.667) followed by site D and E (0.545). The lowest Sorensen similarity coefficient was between site B and C (0.117). Thus, it can be concluded that there was moderate similarity between sites A and B and slight similarity between sites D and E and strong dissimilarity between sites B and C. Bharti *et al.* (2009) recorded maximum species richness of ants during summer in Punjab Siwalik. Higher abundance and richness of ant species were recorded in the dry period (summer and spring) than in the rainy period (winter and autumn) of the year in Moroccan Argan forest (Keroumi *et al.*, 2012). Species richness was higher in the dry season, whereas the composition of ant assemblages did not change between seasons in a secondary tropical dry forest (Marques *et al.*, 2017). De Souza *et al.* (2020) found fewer ant species and less occurrence during the rainy season but the assemblage composition was more heterogeneous during rainy season compared to same locations during dry season in Amazon rainforest. Tchoudjin *et al.* (2020) revealed that the dry season is richer and more diverse than the rainy season and the season significantly influences the diversity of litter ants.

Species richness

The most speciose genus was *Camponotus* (4 morphospecies) followed by *Crematogaster* (2), *Lepisiota* (2), and *Pheidole* (2). The genera *Paratrechina, Prenolepis, Polyrhachis, Aphaenogaster, Monomorium, Leptogenys, Tetraponera* and *Brachyponera* were represented each by a single species. *Camponotus* was the most frequently encountered ant in almost all sites. Globally, *Camponotus*, *Pheidole* and *Crematogaster* are amongst the most prevalent genera (Wilson, 1976; Ryder Wilkie *et al.*, 2010; Bolton, 2020). Almost 93.9% of the total samples belong to *Camponotus, Aphaenogaster, Crematogaster* and *Lepisiota* in the study area. Myrmicine ants occur in a variety of habitats due their potential to adopt in varying environmental conditions e.g., *Pheidole* nests in soil while *Crematogaster* nests on dead wood (Anderson *et al*., 2002). In the study, Formicinae and Myrmicinae represented above 86% of total ants which resembles more or less with the dominance of these subfamilies (92.81%) recorded from Jammu Kashmir Himalaya I from altitudinal range of 1000 m – 2000 m (Bharti & Sharma, 2013). Ponerinae is more specific about niche and food

habitats, nesting in soil and even rotten logs and feeding on wide-range of food resources. Pseudomyrmecinae in this study was represented by single genus *Tetraponera.*

Altitudinal diversity

Twelve morphospecies of ants were collected from site C, seven from site D, five from site B, four each from site A and E. Similarly, Shannon diversity index of species richness (H`) was maximum in site C (1.399) followed by site E (1.167), site D (1.055), site B (1.026) and site A (0.7920). The result indicated that the species richness was highest in the mid-elevation. Light penetration was also better in the mid-elevation area. The results resemble the mid-elevation peak recorded in the altitudinal diversity study (550 m – 2600 m) conducted in the primary forest of Mount Kinabalu (Bruhl *et al.*, 1999). Similarly, ant diversity in Wayanad region of Western Ghats in Kerala, Southern India showed the highest abundance and species richness in mid-elevation (Sabu *et al*., 2008). Subedi and Budha (2020) concluded mid-elevation peak as the commonest species richness pattern in their global scale review. The finding of ant species diversity, species richness and abundance along an elevation gradient in Jammu Kashmir Himalayas also showed a mid-elevation peak (Bharti *et al.*, 2013). The likelihood of many species from lower and higher elevation overlaps at mid elevation which provides the most suitable environment for ants (Fisher, 1996). Species richness at mid-elevation might be due to optimum conditions and availability of prey resources.

CONCLUSION

This study reported four subfamilies, 12 genera and 18 morphospecies of ants from Phulchowki Hill, Lalitpur, Nepal. Formicinae was recorded as the most abundant subfamily followed by Myrmicinae in the study area. Maximum species richness (16) was recorded during autumn as compared to rainy (5) and winter (10) seasons. The mid-elevation peak has been found as the species richness pattern in the study area. Extensive survey in the study area may add more ant species and will further elaborate the distribution pattern of ants.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

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