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Cover: A digital art of water birds of Noyyal River and its wetlands in Coimbatore District by Megha A. Kashyap.

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COMMUNICATION

Diversity and abundance of ants from tehsil Salooni of District Chamba, Himachal Pradesh: a research perspective to study ants as bioindicators

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Abstract: This study evaluated the diversity and abundance of ants in Salooni Tehsil, Chamba District, Himachal Pradesh. Thirty species from five subfamilies were reported using different collection modules, including pitfall traps, baits, soil core, leaf litter, manual, and winkler method. Myrmicinae was the most diversified subfamily, with seven genera, while the genus *Camponotus* of the subfamily Formicinae was found to be most abundant with eight species. The study determined that the region is home to two invasive species (*Monomorium pharaonsis* and *Trichomyrmex destructor*). Due to which it is concluded that the area is prone to many anthropogenic activities, and in the near future, these invasive species can replace many native species of the region. This study also compiled functional groups of ants, which include generalised Myrmicinae, opportunists, subordinate Camponotinii, hot climate specialists, cold climate specialists, tropical climate specialists, cryptic species, and specialist predators. The richness of an environment is represented by the diversity of insects. Because ants maintain the stability of ecosystems, it is important to protect their habitats in order to increase biodiversity in the years to come. The data compiled here represents a turning point in the attempt to understand the geographic variety and dispersion of ant species and also the role of ants as bioindicators.

Keywords: Anthropogenic activities, biodiversity, bioindicator, cryptic species, ecosystem, functional group, invasive species, opportunists, specialist predators, tropical climate specialists.

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Author contributions: JSR—Study design and article drafting; MS—field work.

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INTRODUCTION

Ants are one of the most abundant and diverse groups of insects surviving on Earth. Ants exhibit intricate social behaviours and are present in nearly all terrestrial ecosystems, ranging from rainforests to deserts. Ants serve as efficient bioindicators as they are sensitive to environmental changes and are found in various kinds of environments. They react fast to disturbances such as habitat destruction, pollution, or climate change, making them important for monitoring ecosystem health. Ants are categorized as eusocial among social insects because of their traits, which include sharing generational responsibilities within the colony, and cooperative brood care. Ants are identified as three separate castes: male, female (queen), and sterile workers (Wilson 1971).

Ants are classified as members of the Formicidae family and order Hymenoptera. Among all eusocial insects, ants have the highest ecological dominance (Ward et al. 2015). As of now, 22 subfamilies, 505 genera, and 16,856 valid species of ants are recognized globally (Bolton 2025). These are represented by 10 subfamilies distributed across 108 genera and 865 species in India (Bharti 2025). In recent years, many scientists worldwide have studied the ant fauna. Bharti (2008) compiled a comprehensive checklist and taxonomic review of Indian ant fauna from the Himalayan and sub-Himalayan regions. Their findings include 115 ant species out of 202 crossed an altitude of 2,000 metres; 71 species out of these 115 are endemic to Himalaya. Bharti et al. (2016a) provided a comprehensive and critical list of Indian ant species with up-to-date state-wise distribution. Bharti et al. (2016b) conducted research on ants as bioindicators in Shivalik mountains of Himalayas. A total of 181 species spanning across 59 genera were recorded from Shivalik ranges. Bharti et al. (2017) represented one of the most comprehensive surveys of ant fauna in northwestern Shivalik region. In this study, 179 species group taxa were listed for 61 genera belonging to eight subfamilies. A total of 828 valid species and subspecies names belonging to 100 genera were listed from India. Neupane & Subedi (2018) studied the diversity of ants in the winter and summer seasons in the area of Shivapuri–Nagarjun National Park (SNNP). Using various sampling methods, a total of 817 individual ants, belonging to five sub-families, 16 genera, and 23 morphospecies, were reported. Fontanilla et al. (2019) conducted research on taxonomic and functional ant diversity and identified a total of 263 species in southwestern China. Castro et al. (2020) examined three dimensions of the taxonomic (TD) and functional (FD) (α and β) diversities of ants in a mountainous environment. Brassard et al. (2021) investigated high ant diversity in urban areas. Schmidt et al. (2022) conducted research on ant diversity studies in Brazil and suggested that a global perspective on diversity studies may be achieved by recreating their work in different parts of the world. Li et al. (2023) examined ant species diversity in the central and northern parts of the western Sichuan Plateau in China. A total of 22,645 ant specimens representing 40 species grouped in 18 genera and four subfamilies were collected. Laakel et al. (2024) compiled an ant inventory in Bejaia city urban and suburban areas in order to address the demand for further data regarding ant biodiversity in Algeria's urban environment. Rilta & Sharma (2024) conducted research focused on the diversity and abundance of ants from the tehsil Nerwa of Shimla District. A total of 33 species belonging to 22 genera of four subfamilies were collected. Rilta & Narwal (2025) presented research work focused on ant diversity and community composition from north-western Himalayas. A total of 35 species of ants belonging to 22 genera, and five subfamilies were recorded.

Comprehensive and extensive data were collected on the diversity and abundance of ants with the aim to investigate local ant fauna in the study area and the role of ants as bioindicators.

MATERIALS AND METHODS

Study area

Salooni is a tehsil that is located in the district Chamba, which is at an altitude of 1,829 m. The tehsil is surrounded by the Pir Panjal in the north and the Dhaula Dhar ranges in the south. It provides magnificent sights of the gushing river and snow-capped mountains. The study area is located between 32.500–33.000 ^{0}N & 75.750–76.250 ^{0}E. The human population of the area is 81,556, distributed across 576.5 km^{2} (Vaid & Pathania 2024). There is an abundance of flora and fauna in the valley, which highlights its rich biodiversity. This field has not yet been the subject of any prior research.

Collection tours have been conducted to various localities falling in the tehsil Salooni. The sampling was carried out for three months accounting for both the summer and winter seasons. Localities covered during these tours are labelled in the maps (Figure 1).

Sampling method

For collection of material, all protocol proposed by Agosti et al. (2000) have been followed, which includes:

Figure 1. The geographical location of tehsil Salooni, District Chamba, Himachal Pradesh

· Mini Winkler sacs having wire sieve with square holes of 1×1 cm were used to collect ants from leaf litter. Ants were extracted from sifted litter after a period of 48 hours.

· Pitfall traps consisting of test tubes were used. Each test tube was partly filled with 5% ethylene glycol solution, and was buried with the rim flush with the soil surface.

· Arboreal baits were used for sampling of tree ants.

· The soil core method was used for hypogaeic ants, where soil cores, each of 20 × 20 × 15 cm depth, were taken. These were sifted through a hand sieve pan to collect ants.

· Beating vegetation method (to dislodge ants from vegetation onto sheets) was also carried out.

· Light trap, which consisted of a white sheet, and fluorescent bulb was used for the collection of reproductive castes of ants.

· Finally, the ants were also collected by hand picking method, by searching rotten logs, stumps, dead & live branches, twigs, low vegetation, and termite mounds.

Collection preservation and identification

Both morning and evening hours were used to collect ant samples (Gadagkar et al. 1993). The collected material was preserved using 90% alcohol. The ant specimens were then mounted on triangles for research in accordance with accepted practices in ant taxonomy. To aid in identification, their legs were moved ventrally, away from the body, and the mandibles of certain specimens were opened. The ants were then point mounted on triangle "points" on their right side, between the mesocoxa, and metacoxa. Following their separation from debris and mounting, these specimens were appropriately labelled with the following details: Country, state, location, date, method of collection, and ecological data. All the collected material was identified up to species level with the help of Linnaeus (1758), Fabricius (1787), Foerster (1850), Jerdon (1851), Smith (1858), Mayr (1862), Mayr (1879), Emery (1895), Forel

(1902), Bingham (1903), Forel (1904), Donisthorpe (1938), Menozzi (1939) Bolton (1994), Bharti & Wachkoo (2013), Bharti et al. (2016a), Bharti (2024), Bolton (2024), and then compared with the reference collection already hosted in the laboratory.

The taxonomic analysis was conducted on RSMr-10 stereo zoom microscope. Relevant data has been attached to the arranged catalogue of the acquired content. Voucher specimens have been deposited in the Himachal Pradesh University Ant Collection (HPUAC) in Shimla, India.

RESULTS

A total of 646 ant specimens (Figure 3) representing 30 species, belonging to 19 genera of five subfamilies (Figure 2) were collected (Table 1). In this study subfamily Formicinae and Myrmicinae contributed highest in terms of number of species and number of specimens (Figure 4,5). The study also accounts list of two introduced species (Table 2). The ant fauna prevalent in the region is highly diverse. The study also compiled functional groups of ants in this study, which include generalised Myrmicinae, opportunists, subordinate Camponotinii, hot climate specialists, cold climate specialists, tropical climate specialists, cryptic species, and specialist predators (Table 3). The study also mentions the species of ant that has already been reported from higher regions of Himachal Pradesh (Table 4).

DISCUSSION

The primary findings of the study are the various ant species and records of invasive species, importance of the area's diverse biodiversity. Nonetheless, the existence of invasive species also creates a sense of unease that is common among local ants. Monitoring

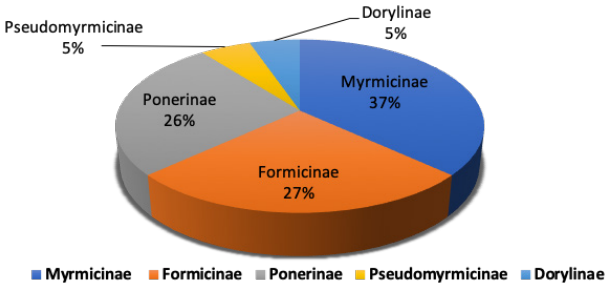

Figure 2. Subfamily representation of 19 ant genera.

Table 1. List of ants collected from tehsil Salooni.

Subfamilies: 5, Genera: 19, Species: 30		
Dorylinae	*Aenictus*	*Aenictus peguensis* (Emery, 1895)
Formicinae	*Camponotus*	*Camponotus albosparsus* Bingham, 1903
		Camponotus arrogans (Smith, 1858)
		Camponotus compressus (Fabricius, 1787)
		Camponotus kattensis Bingham, 1903
		Camponotus nirvanae Forel, 1893
		Camponotus oblongus (Smith, 1858)
		Camponotus opaciventris Mayr, 1879
		Camponotus sp. minor
	Formica	*Formica polyctena* Foerster, 1850
	Lepisiota	*Lapisiota lunaris* (Emery, 1893)
	Polyrhachis	*Polyrhachis menelas* Forel, 1904
	Lasius	*Lasius himalayans* Bingham, 1903
Myrmicinae	*Aphaenogaster*	*Aphaenogaster* JR01
		Aphaenogaster smythiesii Forel, 1902
	Crematogaster	*Crematogaster brunnaea contemta* Mayr, 1879
		Crematogaster sagei Forel, 1902
	Messor	*Messor himalayanus* (Forel, 1902)
	Monomorium	*Monomorium pharaonsis* (Linnaeus, 1758)
	Myrmica	*Myrmica aimonissabaudiae* Menozzi, 1939
		Myrmica smythiesii Forel, 1902
	Pheidole	*Pheidole indica* Mayr, 1879
		Pheidole spathifera aspatha Forel, 1902
	Trichomyrmex	*Trichomyrmex destructor* (Jerdon, 1851)
Ponerinae	*Anochetus*	*Anochetus cryptus* Bharti & Wachkoo, 2013
	Brachyoponera	*Brachyoponera luteipus* (Mayr, 1862)
	Leptogenys	*Leptogenys lucidula* Emery, 1895
	Odontoponera	*Odontoponera denticulata* (Smith, 1858)
	Pseudoneoponera	*Pseudoneoponera rufipes* (Jerdon, 1851)
Pseudomyrmecinae	*Tetraponera*	*Tetraponera rufonigra* (Jerdon, 1851)

Table 2. List of invasive ant species of tehsil Salooni.

Species	Invasive species
Monomorium pharaonsis (Linnaeus, 1758)	Introduced
Trichomyrmex destructor (Jerdon, 1851)	Introduced

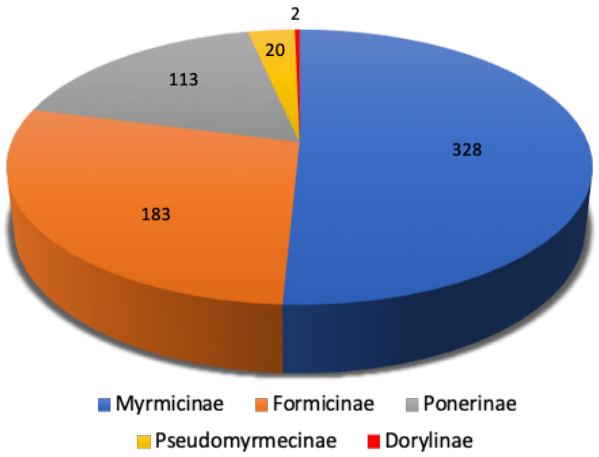

Figure 3. Subfamily representation of 646 ant specimens.

their spread provides valuable information about environmental degradation, particularly in rapidly urbanizing or agriculturally expanding regions (Andersen 1995). An analysis was conducted on the functional group structure of ants inhabiting the area and proposed the ant functional group concept, which shows how ants respond to stressful circumstances and disruptions of environment at a biogeographical scale to identify them as bio-indicators of anthropogenic problems at local scales. The findings of this study reinforce the utility of ants in monitoring environmental changes, particularly in relation to habitat disturbance, pollution and land-use transformation. This approach, which has been in use more recently elsewhere in the world (Andersen 1997), includes the following groups of ants (Table 3). An abundance of ant species has flourished as a result of topographic changes, former climatic regimes, and present-day microclimatic fluctuations. The resulting biodiversity is likely to exhibit a greater level of

Table 3. Different functional groups including their respective genus.

Functional groups	Genus
Generalised Myrmicinae	*Crematogaster*
	Messor
	Monomorium
	Pheidole
Opportunists	*Odontoponera*
	Myrmica
	Lepisiota
	Formica
	Aphaenogaster
Subordinate Camponotini	*Polyrhachis*
	Camponotus
Hot climate specialists	*Monomorium*
Cold climate specialists	*Monomorium*
	Lasius
Tropical climate specialists	*Aenictus*
	Tetraponera
Cryptic species	*Lepisiota*
Specialist predators	*Anochetus*
	Leptogenys

Table 4. List of ant species that has already been reported from higher regions of Himachal Pradesh.

Species name	Location	References
Camponotus albosparsus	Himalayan Region, Nerwa	Bharti (2008), Rilta & Sharma (2024)
Camponotus kattensis	Himalayan region, Nerwa, Shimla	Bharti (2008), Rilta & Sharma (2024), Rilta & Narwal (2025)
Camponotus compressus	Himalayan region, Andretta, Bakhra, Kotla	Bharti (2008), Bharti et al. (2017)
Crematogaster sagei	Himalayan Region, Nerwa, Shimla	Bharti (2008), Rilta & Sharma (2024), Rilta & Narwal (2025)
Monomorium pharaonsis	Himalayan Region, Chanaur, Renuka, Guga, Shivalik region, Nerwa	Bharti (2008), Bharti et al. (2016b), Bharti et al. (2017), Rilta & Sharma (2024)
Leptogenys lucidula	Himalayan Region, Shimla	Bharti (2008), Rilta & Narwal (2025)
Lasius himalayans	Himalayan Region, Shimla	Bharti (2008), Rilta & Narwal (2025)
Messor himalayanus	Himalayan region, Andretta, Bilaspur, Mandi, Nerwa, Shimla	Bharti (2008), Bharti et al. (2017), Rilta and Sharma (2024), Rilta & Narwal (2025)
Myrmica smythiesii	Himalayan region	Bharti (2008)
Myrmica aimonissabaudiae	Himalayan region	Bharti (2008)
Tetraponera rufonigra	Himalayan region	Bharti (2008)
Aphaenogaster cavernicola	Himalayan region	Bharti (2008)
Aphaenogaster smythiesii	Himalayan region, Shimla	Bharti (2008), Rilta & Narwal (2025)
Pheidole indica	Himalayan Region, Una, Terrace, Nerwa, Shimla	Bharti (2008), Bharti et al. (2017), Rilta & Sharma (2024), Rilta & Narwal (2025)

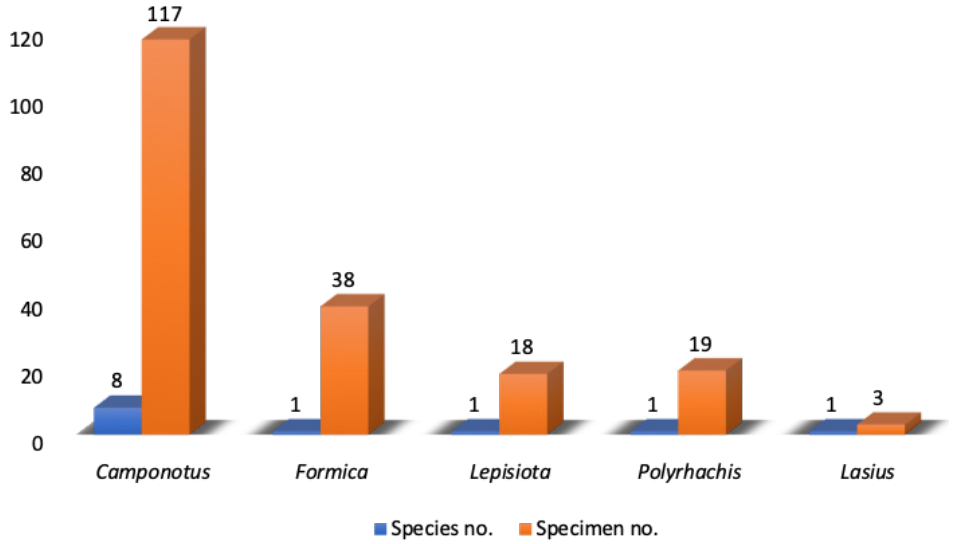

Figure 4. Generic richness of subfamily Formicinae in terms of no. of species and number of specimens collected.

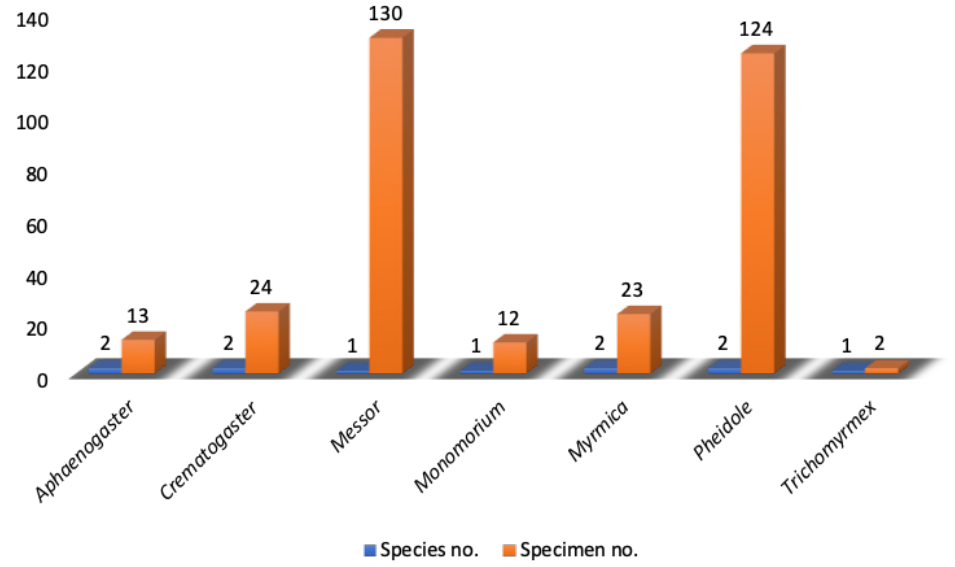

Figure 5. Generic richness of subfamily Myrmicinae in terms of no. of species and number of specimens collected.

specialization and environmental adaptation.

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