Preliminary Record on Ants of the Genus *Camponotus* (Hymenoptera: Formicidae) from Khyber Pakhtunkhwa, Pakistan

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Abstract

Ants are one of the most ubiquitous and ecologically significant insects. Camponotus *ants, commonly known as carpenter ants, are a diverse genus of ants found worldwide. Studying the* Camponotus *ants' biodiversity not only provides valuable insights into the evolutionary processes that have shaped these species, but also offers a window into broader ecological and biological principles. Sampling of* Camponotus *worker caste was conducted using multiple techniques like pitfall traps, oral aspirator and handpicks across indoor and outdoor sites in Peshawar and Khyber District, Khyber Pakhtunkhwa, Pakistan. Ants were initially preserved in 90% alcohol in Eppendorf tubes. The preserved specimens were then transported to the Vector Biology and Entomology Laboratory, Institute of Zoological Sciences, University of Peshawar, where they were mounted following the procedure outlined by Bolton (1994). All collected ants were identified using Olympus SD30 stereo microscope and taxonomic keys by Bolton (1994), Bingham (1903), Bharti and Wachkoo (2014), and Shahjeer et al. (2021). They were further verified by comparing images with online resources. Species richness and diversity was statistically analyzed by Margalef and Simpson diversity index. The current study documented eight species and one subspecies of the genus* Camponotus *from Pakistan, including* C. compressus*,* C. oblongus*,* C. sylvaticus basalis*,* C. sericeus*,* C. invidus*,* C. parius*,* C. mitis*,* C. irritans *and the subspecies* C. irritans pallidus*, thus increasing the* Camponotus *fauna of Pakistan to 15 species and 2 subspecies. Notably, two species i.e.,* C. irritans*,* C. mitis *and one subspecies i.e.,* C. irritans pallidus*, are reported for the first time from Pakistan. District Peshawar was observed more diverse and species rich as compared to district Khyber. This baseline study establishes new records for Pakistan, opening avenues for further exploration of its hidden ant diversity.*

Keywords: Ants, Biodiversity, *Camponotus*, New Records, Pakistan.

Introduction

Taxonomically ants are members of the family Formicidae, superfamily Vespoidea and the order Hymenoptera (Majer, 1985; Rasheed et al*.,* 2020). Ants are regarded as a highly complex class of true social insects in terms of morphology and behavior. Worldwide there are approximately 15,000 known species of ants, further classified into 296

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genera and 16 subfamilies (Bolton, 1994; Shahjeer et al., 2021). Ants can be found in a wide range of habitats, ranging from sub-arctic tundra to equatorial rainforests, except for cold and perpetually damp forests. They inhabit areas from the ground surface to the highest points of the tallest trees (Johnson et al., 2013).

Ants of the family Formicidae are classified into several subfamilies, of which Formicinae and Myrmicinae are among the most diverse. A key morphological distinction lies in the petiole: Formicinae possess a single node, whereas Myrmicinae exhibit two nodes. The subfamily Formicinae, comprising approximately 3,000 recorded species, is considered the second most diverse after Myrmicinae. Within Formicinae, the genus *Camponotus* (Hymenoptera: Formicidae) was first described by Gustav *Mayr* in 1861 (Hansen & Klotz, 2005). Within Formicinae *Camponotus* being the most diverse taxa (Wilson, 1976; Ward, 2014) consist of 1058 species, 495 subspecies and 31 fossils species (Bolton, 2012; Bharti and Wachkoo, 2014). Carpenter ants (*Camponotus*) are large ants that are native to many woodland regions of the globe and range in size from 8 to 25 mm. Although they are commonly known as "carpenter ants" due to their habit of nesting in wood, not all members of this genus construct their nests in this manner (Hansen & Klotz, 2005). Carpenter ants can excavate vast networks of subterranean tunnels, with a primary "parent" colony supported by a network of secondary "satellite" colonies (Akre et al., 1994). Members of the *Camponotus* genus are also active participants in various food webs in cerrados and are capable of day and night foraging (Oliveira & Brandao, 1991; Del-Claro & Oliveira, 2000; Yamamoto & Del-Claro, 2008).

The study of myrmecology can provide insight into the diversity, distribution, and behavior of ants, which in turn can have implications for agriculture, ecology, and conservation. It is important to document the ant species present in each region, as they play important roles in many ecosystems, such as seed dispersal, nutrient cycling, and pest control. By exploring the diversity of ants in Peshawar and Khyber districts, our study can contribute to the understanding of the ant fauna of the region and help fill the gaps in knowledge in myrmecology in the region.

Methods

Study Area

The current taxonomic study was conducted in Vector Biology and Entomology Laboratory, Institute of Zoological Sciences, University of Peshawar and collection of specimens were made from the districts of Khyber (35°56′25.8″N, 71°02′59.28″E) and Peshawar (34°0′0″N,

71°45′0″E), in Khyber Pakhtunkhwa province, Pakistan from July 2019 to February 2022. District Peshawar has an area of 1,257 km^2 and is mostly surrounded by mountain ranges with a hot and semi-arid climate. The district lies at a height of 331m above sea level and has a maximum and minimum mean temperature of 25°C to 40°C in summer and 4°C to 18°C in winter, respectively, with an average annual rainfall of 403.83 mm. District Khyber, formerly known as Khyber Agency, was once part of the Federally Administered Tribal Areas and has since been merged into Khyber Pakhtunkhwa. Covering a total area of 2,576 km², approximately 8.22 percent of its land is forested. The district is characterized by an arid, infertile, and rugged mountainous terrain, and it has a population of 986,973.

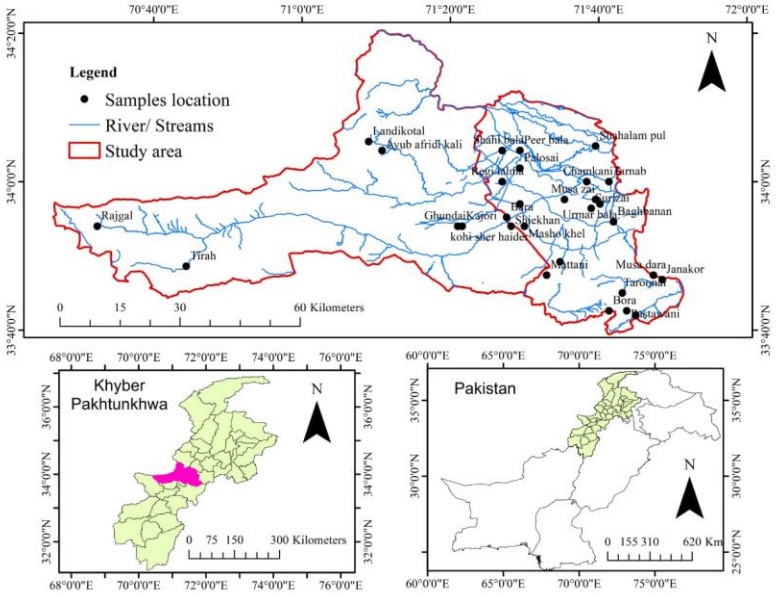


Figure 1: Map showing sampling areas of district Peshawar and district Khyber.

Sampling

Ant specimens of worker caste were collected using multiple sampling techniques, including pitfall traps, oral aspirators, and hand-picking. Employing diverse sampling methods has been shown to enhance the likelihood of capturing a greater diversity of ant species (Longino & Colwell, 1997). To ensure accurate data collection, each specimen was preserved in labelled Eppendorf tubes containing complete collection metadata.

Sampling was conducted across a wide range of habitats, including mountain ranges, agricultural fields, burial grounds, trees, houses, shops, streets, and roadsides. Collections were performed during both daytime and nighttime to maximize the representation of ant species from different ecological niches.

Ant Carnage and Preservation

After the sampling process, ants were killed using Ethyl Acetate and then preserved in 90% ethanol. The ethanol was changed on a regular basis to prevent the decomposition of ants caused by exposure to the chemical content of the cuticle to the preservative solvent (Rasheed et al., 2021). Regular changes of ethanol were also necessary to minimize contamination from soil particles or other debris that may have been introduced during the sampling process.

Mounting

For accurate identification, proper mounting of collected ants was essential. Large specimens were mounted directly by inserting entomological pins through the thorax, while smaller ants were affixed to triangular stiff cards. Prior to mounting, ants were removed from storage tubes, carefully positioned, and allowed to dry. Seccotine glue was applied to the narrow tip of the card, which was then attached between the mesothorax and metathorax, ensuring minimal contact with the body. Finally, an entomological pin was passed through the broad base of the card, and the mounted specimens were placed in insect boxes for subsequent study.

Identification

Ant specimens were examined using a stereo microscope (Olympus SD30) with a magnification range of 10X to 60X. Subfamily and genus identification was carried out using the key described by Bolton (1994), while species-level identification followed the keys of Bingham (1903), Bharti & Wachkoo (2014), and Shahjeer et al. (2021). A Nikon DS-Fi2 camera fitted to the microscope was used to capture images of the specimens. The identifications were further validated by comparing these images with online databases such as AntWeb (www.antweb.org) and AntWiki (www.antwiki.org).

Statistical Analysis

Margalef's index was used to determine species richness as:

$$R = (S - 1)/ \ln(N)$$

while S = total number of species; N = total number of individuals in the sample; In = natural logarithm.

Species Diversity was calculated by Simpson index,

$$D = \Sigma ni(ni-1)/ N(N-1),$$

Where n_i: The number of organisms that belong to species; N: The total number of organisms.

As D nominates dominance, as its values increase diversity will decrease, according to this index 0 represents infinites diversity while 1 indicate no diversity, so a Simpson index of diversity (1-D) was applied. In this case the higher value of Simpson (1-D) indicates high diversity (Rasool et al., 2018).

Simpson Evenness (E) = (1/D×S) was used to calculate the species evenness.

Results

In this study a total of Eight different species of *Camponotus* were identified from the study area (Table 1). Of these, two species (*C. mitis, C. irritans*) and one subspecies (*C. irritans pallidus*) are newly recorded not only from the study area but also from Pakistan, while the rest have already been reported from different parts of the country in previous studies. The most abundant species was found to be *C. compressus* while *C. irritans pallidus* was found least abundant. District Peshawar appeared to be more diverse than District Khyber because of its Simpson's diversity index score of 0.76, while that of District Khyber was 0.70. Furthermore, a Margalef's Index score of R = 1.17 and Simpson's evenness score of E = 4.88 was recorded for District Peshawar as opposed to R = 0.63 and E = 2.10 for District Khyber (Table 2). The comparatively higher values of Margalef's index, Simpson's diversity index, and Simpson's evenness observed in District Peshawar indicate that the *Camponotus* in District Peshawar is more abundant and diverse compared to District Khyber having a higher number of taxa present in an evenly spread distribution. These results indicate that the biodiversity pattern in District Peshawar is much more diverse and stable. With the addition of two new species and one species reported in this study the *Camponotus* fauna of Pakistan has increased to 15 species and 2 subspecies.

Diagnostic Characters of Genus Camponotus

This research focuses on ants of genus *Camponotus*, which hold wider ecological importance as they are among the most abundant and influential ant genera in terrestrial ecosystems. Their worker castes play critical roles in soil aeration, nutrient cycling, seed dispersal, and decomposition processes, thereby contributing to ecosystem productivity

and stability. Their worker caste further categorized in to major and minor workers. Major workers, which can also be called "soldiers" have strong mandibles and hard heads that help them defend against enemies and crush difficult food sources, whereas small workers are tasked with gathering food, tending to eggs and larvae, and maintaining the hive. The body of *Camponotus* ants consist of four main divisions; head, alitrunk, waist and gaster. Worker ants of *Camponotus* genus are large with size ranges from 3 to 16 mm. Most *Camponotus* major workers have large heads in comparison to minor workers with elongated heads. Mandibles more or less triangle shaped; stout and denticulate with 4 to 9 teeth; palps formula 6:4; clypeus trapezoids, mostly carinate, with anterior margins smooth, toothed or notched in middle,; antennae 12 segmented, filiform, frontal region short and wider than long, eyes large, lies above mid line of head, lack ocelli; thorax broad anteriorly and laterally, compressed posteriorly with distinct pro-meso and meso-metanotal grooves; petiole one segmented with scale or node on top; abdomen ovoid; well-developed acidopore in last abdominal segment.

Table 1: Diversity and abundance of species under genus* Camponotus *reported from districts Peshawar and Khyber.

Ants Species & subspecies collected	No. of specimens collected		Percentage of each species
	Peshawar	Khyber	
Camponotus compressus	174	41	41.34%
Camponotus oblongus	37	-	7.11%
Camponotus sericeus	67	18	16.34%
Camponotus invidus	21	-	4.03%
Camponotus parius	54	-	10.38%
*Camponotus irritans**	18	13	5.96%
*Camponotus irritans pallidus**	11	-	2.11%
Camponotus sylvaticus basalis	-	42	8.07%
*Camponotus mitis**	24	-	4.61%

- = not reported,
* = these species have been reported for the first time from Pakistan.

Table 2: Comparison of diversity indices of Ant species belonging to genus* Camponotus *encountered from different locations of districts of Peshawar and Khyber.

District	Margalef's index (R)	Simpson index (D)	Simpson diversity index (1-D)	Simpson Evenness (E) = (1/D×S)
Peshawar	1.17	0.24	0.76	0.52
Khyber	0.63	0.30	0.70	0.48
Overall	1.27	0.23	0.77	0.50

Family: Formicinae

Genus*: Camponotus* Mayr, 1861

Camponotus compressus (Fabricius, 1787) (Figure 2)

Material Examined: District Peshawar (n=174☿); Urmar Bala (33.95N, 71.67E), 11.06.2021, Ahmad Yar 25☿ ; Ghari Musafar Khan (33.96N, 71.66E), 21.08.2020, Farid, 23☿ ; Regi lalma (34.0N, 71.45E), 29.07.2019, Manzoor, 19☿ ; Mattani (33.79N, 71.55E), 26.10.2021, Amir, 05☿ ; Bora water fall (33.7N1, 71.75E), 11.05.2020, Adnan, 15☿ ; Palosai (34.03N, 71.49E), 19.03.2020, Farman, 20☿ ; Surizai (33.94N, 71.65E), 03.05.2021, Imran, 17 ; Masho Khel (33.90N, 71.50E), 09.03.2020, Inam, 23☿ ; Taroonai (33.75N, 71.72E), 13.04.2021, Aimal, 27☿ ; District Khyber (n =41☿); Landikotal (34.09N, 71.15E), 15.10.2019, Farman, 17 ☿ ; Ghundai (33.9N, 71.36E), 17.08.2021, Zakir, 12☿ ; Ayub afridi kali (34.07N, 71.18E), 16.04.2021, Haroon, 12☿ .

Sampling Habitat: The ants were collected from agricultural fields, shops, bare grounds gardens, house, mountains, and pastures.

Distribution: Camponotus compressus has distribution over different regions and has recorded from different countries such as United Arab Emirate (Afrotropical region) Indonesia, Malaysia, Borneo (Indo-Australian region), Bangladesh, India, Pakistan, Sri Lanka (Oriental region), China (Palearctic region).

Remarks: In Pakistan, *Camponotus compressus* was previously reported from Potohar region Punjab. From KP it is reported by Umair et al. (2012), Rasheed et al. (2020) from Charsadda, Shahjeer et al. (2021) from different districts of KP and Khudadad et al. (2021) reported it from Mansehra.

(a) ***(b)*** ***(c)***

Figure 2:* Camponotus compressus*, (a), dorsal view with elongated, narrow thorax, prominent collar (b), lateral view shows elongated legs with prismatic tibiae, abdomen large and heavy broader posteriorly (c). head somewhat triangular.

Camponotus oblongus (Smith, 1858) (Figure 3)

Material Examined: District Peshawar (n=37☿); Musa Zai (33.96N, 71.59E), 15.09.2021, Farid, 10☿ ; Pastwani, (33.7635°N, 71.5919°E) 03.05.2021, Adnan, 05☿ ; Pishtakhra (33.95N, 71.49E), 29.02,2022, Farman, 10☿ , Shahalam Pull (34.08N, 71.66E), 21.07.2020, Farman, 12☿ .

Sampling Habitat: Collection was done from agricultural fields, shops, gardens, streets, and pastures.

Distribution: Camponotus oblongus is recorded from Bangladesh, India, Myanmar, Pakistan, Sri Lanka (Oriental Region). Also from Malaysia, Singapore and Thailand (Indomalayan).

Remarks: Camponotus oblongus was reported by Bingham (1903) from Indo Pak subcontinent. In Pakistan Rasheed et al. (2020, 2021) also reported it from Charsadda and Swabi districts of Khyber Pakhtunkhwa; Shahjeer et al. (2021) reported it from districts Kohat, Mansehra and upper Dir, Khyber Pakhtunkhwa; Umair et al. (2012) reported it from Potohar region, Punjab. Khudadad et al. (2021) recorded it from Mansehra.

Novelty Statement: First time reported from Peshawar district.

(a) ***(b)*** ***(c)***

Figure 3*: Camponotus oblongus, *dorsal view shows the massive, small and wider thorax (a), robust legs with tibia cylinder shaped not prismatic, abdomen large and wide, sparse pubescence (b), head heavy and large, wider anteriorly, conspicuously spherical lateral angles, clypeus with small middle lobe and sub-tectiform (c).

Camponotus sericeus (Fabricius, 1798) (Figure 4)

Material Examined: District Peshawar (67☿); Regi Lalma, (34.008°N, 71.57°E), 20.01.2022, Toheed, 13☿ ; Maryamzai (33.82N, 71.58E), 01.11.2020, Imran, 10☿ ; Shahi Bala (34.07N, 71.45E),

18.09.2019, Farman, 08☿ ; Peer Bala (34.07N, 71.49E), 19.04.2021, Ihsan, 06☿ ; Janakor (33.78N, 71.81E), 16.04.2020, Farman, 12☿ ; Baghbanan (33.91N, 71.70E), 18.03.2021, Farid, 15☿ ; Shiekhan (33.90N, 71.47E), 18.02.2020, Inam, 03☿ ; District Khyber (18☿); Tirah (33.81N, 70.74E), 15.10.2019, Habib, 08☿ ; Kajori (33.90N, 71.36E),15.02.2022, Farman, 06☿ ; Rajgal (33.9 N, 70.54 E), 13.09.2020, Zakir, 04 ☿ .

Sampling Habitat: This species was collected from agricultural fields, bare grounds, mountains, and graveyards.

Distribution: Camponotus sericeus has a distribution record over different countries such as Saudi Arabia, Kenya, Zimbabwe (Afrotropical region), Mauritius (Malagasy region), India, Pakistan, Sri Lanka (Oriental region), Afghanistan, Egypt, Israel (Palearctic region).

Remarks: Camponotus sericeus was first reported by Bingham (1903) from Indo Pak territory. In Pakistan, Umair et al. (2012) reported it from Potohar region, Punjab: Rasheed et al. (2020; 2021) recorded it from district Charsadda, Swabi and Shahjeer et al. (2021) recorded it from different districts of Khyber Pakhtunkhwa; Majeed et al. (2021) recorded it from Faisalabad, Punjab.

Novelty statement: First time reported from district Khyber and Peshawar.

(a) ***(b)*** ***(c)***

Figure 4: **Camponotus sericeus*****. wide and compressed thorax, with scanting pubescence, meso-metanotal joint serrated (a), posteriorly excavated metanotum, pedicle with circular node, legs without prismatic tibia, abdomen wider and globe shaped (b), head broader and bulky, mandible with 5 teeth, clypeus tectiform with medially emarginated fore border(c).***

Camponotus irritans (Smith, 1857) (Figure 5)

Material examined: District Peshawar (18☿); Pastawani (33.71N, 71.73E), 11.07.2021, Farman, 12☿ ; Bora (33.71N, 71.69E), 11.07.2021, Adnan, 06☿ ; District Khyber (13☿); Ghundai (33.9N, 71.36E), 25.10.2020, Zakir, 13 ☿ .

Sampling Habitat: The specimens were collected from Mountains and searched by turning or under stones.

Distribution: Camponotus irritans has prevalence over Borneo, Brunei Darussalam, Malaysia, Singapore (Indo-Australian Region) India, Nicobar Island, Sri Lanka, (Vietnam Oriental Region), China (Palearctic Region).

Remarks: Camponotus irritans was not recorded previously.

Novelty Statement: Reported it as new record for the first time from Pakistan.

(a) ***(b)*** ***(c)***

Figure 5:* Camponotus irritans*, with shiny, elongated and narrow thorax, slight and fine reticulate and punctate, Dorsal (a), legs have finely oblique and short pubescence, tibia not prismatic but compressed, gaster short and narrow than head (b), head is not completely triangular, longer than broad, tectiform, medially raised clypeus (c).

Camponotus irritans pallidus (Smith, 1857) a Subspecies (Figure 6)

Material Examined: District Peshawar (n =11☿); Chamkani (34.00N, 71.64E), 19.04.2021, Farman, 11☿ .

Sampling habitat: The specimens were collected from agricultural fields.

Distribution: Camponotus irritans pallidus was reported from Borneo, Indonesia, Malaysia, Philippines (Indo-Australian Region) Bangladesh, India (Oriental Region).

Remarks: Camponotus irritans pallidus has no previous reports from Pakistan.

Novelty Statement: Reported as new record for the first time from Pakistan.

(a) ***(b)*** ***(c)***

Figure 6*: Camponotus irritans pallidus, *thorax shiny and broad, pronotum broader than meso and metanotun with convex lateral angles (a), legs stout, spined tibia (b), head square shaped comparatively, broader as long, small sub-medial eyes, scape of antenna hardly reach top of head (c).

Camponotus sylvaticus basilis (Smith, 1878) (Figure 7)

Material Examined: District Khyber (n=42☿); Bara (33.92N, 71.46E), 26.07.2021, Haroon, 27☿ ; Tirah (33.81N, 70.74E), 12.05.2020, Farman, 15☿ .

Sampling Habitat: The specimens were collected from Mountains and by searching under stones.

Distribution: Camponotus sylvaticus basilis has distribution in India and Pakistan (oriental region).

Remarks: Camponotus sylvaticus basilis was reported earlier by Eidmann (1942) from Pakistan. The species was collected at high altitudes from mountains of district Khyber.

Novelty Statement: Reported for the first time from district Khyber.

Camponotus mitis (Smith, 1858) (Figure 8)

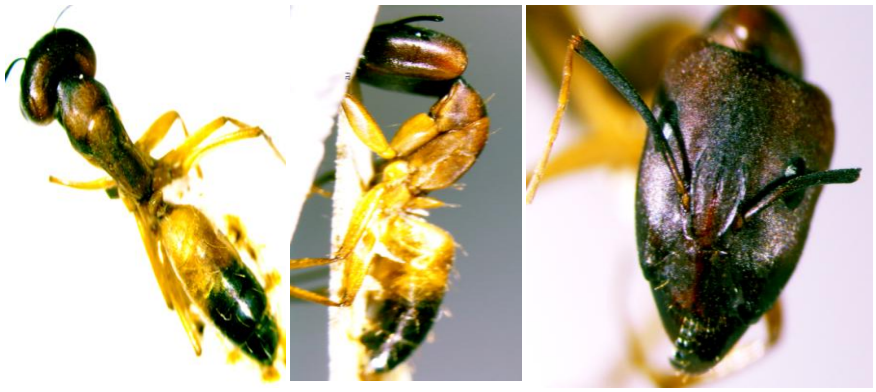
Material Examined: District Peshawar (n=24☿); Ghari Musafar Khan (33.96N, 71.66E), 11.03.2020, Farman, 07☿ ; Urmar Bala (33.95N, 71.67E), 11.03.2020, Shahid Saleem, 08☿ ; Surizai (33.94N, 71.65E), 22.06.2021, Farman, 09☿ .

Sampling Habitat: The specimens were collected from pastures and agricultural fields.

Distribution: Camponotus mitis has distribution records in Singapore (Indo-Australian Region), India, Sri Lanka (Oriental Region), China (Palaearctic Region).

Remarks: Camponotus mitis has no previous record from Pakistan.

Novelty Statement: Reported as new record for the first time from Pakistan.



(a) ***(b)*** ***(c)***

Figure 7:* Camponotus sylvaticus basalis, *thorax elongated, narrow and form a single uniform arch above in profile, pubescence sparse (a), legs with compressed tibia, pubescence flat (b), head slightly rectangular, broader posteriorly as anteriorly, clypeus produced medially in to a lobe, scape of antenna long, from top of head about one-third of its length (c).

Camponotus parius (Emery, 1889) (Figure 9)

Material Examined: District Peshawar (n=54☿); Urmar bala (33.95N, 71.67E), 21.09.2021, Farman, 18☿ ; Chamkani (34.00N, 71.64E), 13.03.2021, Farman, 14☿ ; Tarnab (34.005N, 71.69E), 13.03.2021, Farman, 22☿ .

Sampling Habitat: The samples were collected from pastures and agriculture fields.

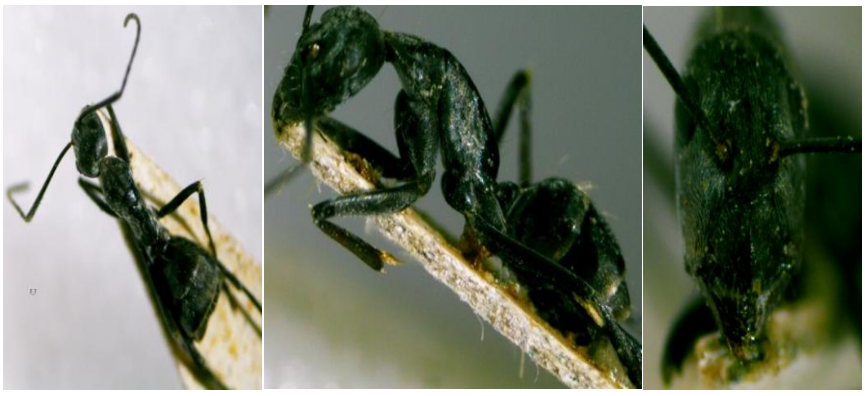
Distribution: Camponotus parius has distribution in different countries such as over Bangladesh, India, Laos, Myanmar, Sri Lanka (Oriental Region), China (Palaearctic Region) and Singapore (Indo-Australian Region).

Remarks: Camponotus parius was earlier reported only by Shahjeer et al. (2021) from district Charsadda Khyber Pakhtunkhwa.

Novelty Statement: First time reported from Peshawar district.

(a) *(b)* *(c)*

Figure 8:* Camponotus mitis*, thorax long and narrow and form uniform arch in profile (a), legs with compressed, spineless tibia (b), distance lies between antennal carina is same to between eyes and antennal carina (c).



(a) *(b)* *(c)*

Figure 9:* Camponotus parius*, elongated and narrow thorax, densely, finely pilose throughout (a), head without beard beneath, long legs, tibia spined, compressed, not prism shaped (b), head elongated, longer than broad, large eyes, clypeus produced, round lateral angles (c).

Camponotus invidus (Forel, 1892) (Figure 10)

Material Examined: District Peshawar (n=21☿); Musa dara (33.79N, 71.79E), 16.06.2021, Adnan, 06☿ ; Janakor (33.78N, 71.81E),

17.08.2021, Farman, 11☿ ; Pastawani (33.71N, 71.73E), 17.08.2020, Farid, 04☿ .

Sampling Habitat: The specimens were collected near water springs, mountains and by turning stones.

Distribution: Camponotus invidus has only prevalence in India, Pakistan (Oriental Region)

Remarks: Camponotus invidus was previously reported by Shahjeer et al. (2021) from Chitral Khyber Pakhtunkhwa.

Novelty Statement: Reported for the first time from district Peshawar.

(a) ***(b)***

Figure 10:* Camponotus invidus*, thorax very convex forming regular arch, pedicel/petiole with flat posterior, front convex, low node, legs usually stout with cylinder shaped tibia(a), head somewhat oval and elongate, sides are straight, not convex, wide clypeus with indistinct middle produced lobe, thick and long antennae (b).

Species identification key after (Bingham, 1903) to species of *Camponotus* reported from Pakistan is as following:

1. a) Thorax viewed from side forming a regular arch……. 2
   b) Regular arch of thorax interrupted by apex of metanotum being truncate……...…..……... 15
   b) Regular arch of the thorax interrupted by the metanotum being raised rounded above and gibbous…….. 16
   d) Regular arch of the thorax interrupted at the meso-metanotal suture by the metanotum forming an angle with the mesonotum; basal portion of metanotum horizontal, flat or slightly concave; apical portion excavate...…….……... 17
2. a) Head, thorax and abdomen black…….…… 3
   b) Head thorax and abdomen pale yellow ….. *Camponotus invidus*

c) Head thorax and abdomen never all black or all yellow…….. 8

3. a) Tibia of the legs prismatic…… 4
   b) Tibia of the legs compressed but not prismatic…… 7
4. a) Abdomen covered with long recumbent yellowish hair…….. 5
   b) Covered with sparse erect hairs……..……..…... 6
5. a) Gastral pubescence relatively short and sparse……*C. aterrimus*
   b) Gastral pubescence relatively long and abundant…*C. japonicus*
6. a) Tibia of the legs with spines beneath, abdomen covered with sparse errect hairs, major worker length 11-16 mm and minor worker head posteriorly narrow but not constricted to form collar……...… *C. compressus*
   b) Tibia of the legs with spines beneath, abdomen covered with sparse erect hairs, major worker length 17-21 mm and minor worker head posteriorly constricted to form collar……. *C. angusticollis*
7. Abdomen with a fine thin yellow sericeous pubescence, length of major worker over 9 mm…….. *C. parius*
8. a) Tibia cylindrical……... 9
   b) Tibia compressed……...…… 11
9. a) Tibia covered with long erect hairs…..... *C. buddhae*
   b) Tibia covered with widely spaced, adpressed hair……. 10
10. a) Tibia with a few spines on apical third of tibia beneath..*C. oblongus*

b) Tibia without spines, Medial lobe of clypeus with its anterior margin transverse, major worker over 8 mm in length and 6 teeth, minor worder over 6 mm in length with 5 teeth……..… *C. variegatus*

11. a) Tibia with spines beneath, Head and abdomen black or dark castaneous red, thorax yellow, wholly or in part..……....12
    b) Tibia without spines beneath, head thorax and abdomen sparsely punctured, shining, not opaque, head and abdomen fuscous brown or black in minor worker head sometimes yellow), thorax honey yellow……..……..… 13
12. a) Medial lobe of clypeus long rectangular, the lateral angles acute, head only as broader posteriorly as in front……..… *C. sylvaticus basalis*
13. a) Medial lobe of clypeus long rectangular, the lateral angles acute, head only as broader posteriorly as in front…… *C. sylvaticus paradichrous*
    b) Medial lobe short not much pronounced, lateral angles rounded…….. *C. irritans*

14. a) Distance between the antennal carinae equal to distance between eyes and antennal carinae……..…….... *C. mitis*
    b) Distance between the antennal carinae distinctly greater than between eyes and antennal carinae…….... *C. irritans pallidus*
15. Clypeus anteriorly not emarginated in middle, scape cylindrical, larger species, with size of major worker more than 10 mm and minor worker 7 mm, clypeus subcarinate, trapeziform and with a subcrenulate anterior border……. *C. Socrates*
16. Anterior angles of pronotum rounded, not dentate, length under 9mm……..... *C. confucii*
17. Tibia of legs spinous beneath, length 6-10mm; node of pedicel thick, globose…… *C. sericeus*

Discussion

The current investigation represents an initial attempt to explore the diversity of ant fauna in the Khyber and Peshawar districts of Khyber Pakhtunkhwa. Since the inception of Pakistan, district Khyber has remained unexplored in taxonomic studies of ants, while only limited research has been conducted on the ant fauna of Peshawar district. So, the basic objective of the research was to explore the untouched and unexplored diversity of ant fauna in districts Khyber and Peshawar. Our findings report eight species of genus *Camponotus* such as *C. compressus, C. oblongus, C. sylvaticus basalis C. sericeus, C. invidus, C. Parius, C. irritans, C. irritans pallidus, C. sylvaticus basalis* and *C. mitis*. Out of these identified species, two species *i.e., C. mitis*, *C. irritans*, and a subspecies C. *irritans pallidus* are reported for the first time from Pakistan (Table 1). According to the data provided on ant wiki of Pakistan (accessed on January 25, 2026), *C. angusticollis* (Rasheed et al. 2021), *C. aterrimus, C. japonicus, C. buddhae, C. variegatus dulcis, C. sylvaticus paradichorous, C. Socrates and C. confucii* has already been reported from Pakistan thus total number of *Camponotus* species reported was 11 species and 2 subspecies and our study contribution has carried this number to 15 species and 2 subspecies.

From zoogeographical perspectives, Pakistan falls into the Oriental region but also lies at the border of the Palearctic region (Rafi et al., 2010). In this regard, the districts of Peshawar and Khyber share borders with Afghanistan which belong to the Palearctic region, acting as an ecotonal link between both zoogeographical regions (Shahjeer et al., 2021). As a result, this geographical location leads to significant resemblance in species diversity with Palearctic fauna. For instance, the blow fly *Wohlfahrtia magnifica* belonging to Diptera: Sarcophagidae family and considered an endemic species in the Palearctic region was

found in the mountains of the Peshawar valley, highlighting the significance of the Palearctic-Oriental ecotone in this region (Ahmad et al., 2020). Likewise, our study includes ants such as *Camponotus parius* and *C. mitis* also recorded in China, and *C. sericeus* described from Afghanistan. All of these findings strengthen our understanding that the ants of Khyber Pakhtunkhwa have transitional biogeography as their geographical area overlaps with the Oriental-Palearctic region.

Bingham (1903) conducted a thorough study on the heterogeneity of this universal group of ants throughout the Indo-Pak subcontinent, Ceylon, and Burma; it was the most extensive study on the variety of ants that had ever been done prior to the establishment of Pakistan. However, after the partition of India and Pakistan, very few works have been published on ants in Pakistan. For example, Umair et al. (2012), Rasheed et al. (2020), Rasheed et al. (2021), Khudadad et al. (2021), Shahjeer et al. (2021), and Majeed et al. (2021) conducted few studies in some areas of Pakistan. Our data match with previous studies. In particular, *C. compressus, C. oblongus*, and *C. sericeus* were recorded by Rasheed et al. (2020, 2021), Shahjeer et al. (2021), and Umair et al. (2012). In a similar vein, *C. invidus* was identified by Shahjeer et al. (2021), whereas *C. parius* has only been reported from district Charsadda, Khyber Pakhtunkhwa, by Shahjeer et al. (2021). The congruence of our results with previous studies not only confirms the accuracy of our study but also shows how knowledge about ant diversity is gradually increasing in Pakistan.

The distribution of *Camponotus* ants' species can be seen in Table 1, which shows that each ant genus has a unique distribution pattern within the studied districts. The *Camponotus invidus, C. mitis, C. irritans pallidus, C. parius,* and *C. oblongus* species were only observed in the district of Peshawar, while *C. sylvaticus basilis* was only found in the district of Khyber. On the other hand, the *C. irritans*, *C. compressus*, and *C. sericeus* were identified in both districts, indicating their better ecological adaptations. Out of these species, *C. compressus* is the most dominant, while *C. irritans pallidus* is the rarest one. This variation in abundance highlights the heterogeneity of ant assemblages in the region.

Our study revealed that Peshawar district supports a richer and more diverse ant fauna compared to Khyber. Diversity indices were notably higher in Peshawar (1–D = 0.76, R = 1.17, E = 4.88), reflecting the district heterogeneous landscape that includes arid and semi-arid zones, aquatic habitats, sandy soils, cultivated fields, rural and urban settlements, and mountainous terrain. In contrast, Khyber is largely hilly with limited agricultural activity, offering fewer ecological niches. Such variation in habitat and resource availability is a well-recognized driver of ant diversity (Mokam et al. 2014; Pacheco & Vasconcelos, 2012; Cabra-

García et al., 2012). The ecological complexity of Peshawar therefore explains its higher abundance and richness, consistent with global findings that link environmental heterogeneity to species diversity (Garcia et al., 2014; Williams & Newbold, 2020). Importantly, the addition of new records for Pakistan highlights the presence of an exceptionally unexplored ant fauna in this region.

Conclusion

The current study reports eight species and one subspecies of the genus *Camponotus* ants from both district Peshawar and Khyber. District Peshawar was detected to be more diverse and species richer as compared to Khyber. This work also presents an identification key for *Camponotus* from Pakistan, which not only provides a checklist of species occurring in Pakistan but also give a comprehensive identification key. Our study gives indication that this area has greater potential and further properly managed study is required to unearth this hidden fauna of ants. Investigation of other genera will also add to the knowledge of ant fauna of this ecologically diverse region. A comprehensive study is required to fully explore the ant fauna of Pakistan in order to fill the gaps regarding the knowledge of species occurring in Pakistan.

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Credit authorship contribution statement Authors Contribution Statements

Ahmad Yar and Farman Ullah Khan made ants collection, identification and writing the manuscript, whereas Syed Basit Rasheed supervised, designed, confirmed the identified specimens, statistical analysis of data, editing and finalizing the manuscript.

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