

Research Article

Myrmicine ants of Nepal with six new records and updated species list (Hymenoptera: Formicidae: Myrmicinae)

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Abstract

Six ant species from the subfamily Myrmicinae are recorded as new to Nepal, namely *Myrmica rhytida* Radchenko & Elmes, 1999, *Myrmicaria brunnea* Saunders, 1842, *Pheidole nodus* Smith 1874, *Strumigenys godeffroyi* Mayr, 1866, *S. virgila* Bolton, 2000, and *Temnothorax wroughtonii* (Forel, 1904). The type locality, examined materials, worker diagnosis, and global distribution of each newly recorded species are provided, along with images of habitus in profile and head in full-face views. The list of 69 species of Myrmicine ants is provided with their province-specific distribution in Nepal.

Keywords: Checklist, Himalaya, Myrmicine ants, Provincial distribution, *Strumigenys*

1 | Introduction

Ants are the most diversified group of social insects, being the most

common and ecologically dominant insects. Myrmicinae is the most successful of the 16 extant ant subfamilies in terms of ecological diversity and species richness, with 147 genera and 7075 extant species known throughout the world (Bolton 2022). Nepalese Myrmicine ants contain 21 genera and 63 species, making it the most diverse ant subfamily in the country, out of the 56 genera and 147 species of ants known from Nepal (Subedi et al. 2020; Subedi 2021; Subedi et al. 2021a, b, c; Subedi et al. 2022). The subfamily Myrmicinae, first described by Lepeletier de Saint-Fargeau in 1835, belongs to the Formicoid clade. The subfamily is divided into six monophyletic tribes on the basis of molecular phylogenetic studies (Ward et al. 2015). The members of this highly diverse subfamily inhabit all major terrestrial habitats and exhibit wide array of behaviors.

The Myrmicinae workers can be identified by a combination of the following characteristics (see Bolton (1994) for complete diagnosis): clypeus reduced, frontal lobes usually present and expanded laterally covering antennal sockets, eyes usually present, antenna 4–12 segmented, promesonotal suture absent (pronotum and mesonotum fused into a single plate), waist two-segmented (petiole and postpetiole). The five biggest genera, *Pheidole*, *Strumigenys*, *Crematogaster*, *Tetramorium* and *Temnothorax* account for more than half of the species of the subfamily Myrmicinae (Borowiec et al. 2020; Bolton 2022). All of these richly speciose genera have also been found in Nepal (Subedi et al. 2021c). This study reports one species each of *Myrmica*, *Myrmicaria*, *Pheidole*, and *Temnothorax*, and two species of *Strumigenys* as new records for Nepal.

Collingwood (1970) first provided the list of 34 species ants of Nepal which was later updated to 128 ant species, including 63 species of Myrmicinae (Subedi et al. 2020). However, this list is still incomplete. Nepal is predicted to have a high species diversity due to its unique geographical and ecological setting, but despite these efforts, ant fauna of the country is still massively underexplored and majority of species, yet to be known. So, it is presumable that several species exist in Nepal

which may be new to science or new to the country's records.

This paper provides new faunal records of Myrmicine ants for Nepal along with their distribution data and worker diagnosis. It also includes an updated species list of Nepalese Myrmicine ants with their province-specific distribution. We anticipate that our study will be useful in identifying research gaps and so improving future research on Nepalese ants.

2 | Materials and methods

2.1 | Field collection

The specimens used in this study were collected from various locations in Nepal between 2009 and 2020. Selected forests in the eastern, central, and western regions were surveyed during this study, with more concentrated sampling efforts in Shivapuri-Nagarjun National Park and Ranibari Community Forest. Specific collection site locations are provided in materials examined for new species records for the country. Distribution records of previously recorded species, which were also collected and examined during this study, are also provided, but at the provincial level in an updated species list. All collections were made through pitfall trapping, baiting, beating lower vegetation, hand collecting, shifting soil cores, and leaf litters.

2.2 | Morphological examination and data presentation

The specimens were examined with a stereomicroscope (COSLAB MSZ115). Species identifications are based on available identification keys or original descriptions as

indicated in the result section, and the expert suggestions acknowledged below. The specimens were also compared to high-resolution photographs available at www.antweb.org (AntWeb 2022). The morphological terminology mainly follows the pertinent identification keys. For each species, the type locality, junior synonyms, worker diagnosis and additional notes are provided. The province-specific distribution of ants was determined using the specimens collected during this study and the distribution for each species provided by Subedi et al. (2020). The authority, spelling and valid names of the species are updated from Bolton (2022). The photographs were taken using Samsung SM-M625F digital camera. The scale bar in each photograph was created using Fiji, an image processing software based on ImageJ2 (Schindelin et al. 2012). The collected specimens are housed at the Central Department Zoology Museum of Tribhuvan University (CDZMTU).

3 | Results

Six nominal species of the subfamily Myrmicinae are added as new records to Nepal. Type locality of the species, collection localities of examined materials, worker diagnosis, global distribution, and photo images of all newly added species are provided. Further, an updated species list of Nepalese Myrmicine ants along with information on their specific distribution in Nepal's provinces are also provided (Annex Table 1).

3.1 Species accounts

Myrmica rhytida Radchenko & Elmes, 1999 (Figs 1. A, B)

Type locality: Kashmir, India (Radchenko & Elmes 1999).



Figure 1. *Myrmica rhytida* A. habitus in profile view B. head in full-face view

Materials examined: 3 workers (CDZMTU HymF101), Shivapuri peak, Shivapuri-Nagarjun National Park (SNNP), Nepal, 27.82010 N, 85.38528 E, 2732 m, hand collection, 5.XII.2020, I. P. Subedi.

Worker diagnosis: This species may be diagnosed by distinctly coarse rugosity in head dorsum, mesosoma, petiolar node and postpetiole. Mesosoma dorsum is distinctly impressed, and metanotal groove is deep and wide. Petiole is distinctly pedunculate. The species identification is based on species description in Radchenko and Elmes (1999) and key in Radchenko and Elmes (2010). Because of its distinct combination of characteristics, this species has not been placed to any *Myrmica* species group.

Distribution and natural history: This species was previously known from Kashmir, northwest India (Radchenko & Elmes 1999). It is a new record to Nepal. These ants were collected from Shivapuri peak at an altitude of 2732 m beneath the stone. They were previously reported from alpine meadows, nesting in soil, beneath stones, or in logs (Bharti et al. 2016a).

***Myrmicaria brunnea* Saunders, 1842** (Figs 2. A, B)

Type locality: Northern India (Saunders 1842).

Materials examined: 1 worker (CDZMTU HymF102), Gaidakot, Nawalpur district, hand collection, VI. 2009, I. P. Subedi leg.; 2 workers (CDZMTU HymF103), Madhyabindu, Chaliskilo, Nawalpur district, 27.6218 N, 84.05651 E, 198 m, hand collection, 4.X.2020, P. B. Budha leg.

Worker diagnosis: This species belongs to the *M. brunnea* species group. These ants are chestnut-brown in color, body is shiny and covered with long, abundant hairs. They are characterized by short, roughly rounded

head, 7-segmented antennae without distinct club, eyes prominent, short mesosoma, long, triangular propodeal spines, deep metanotal groove, very long petiolar peduncle, long legs and subglobose gaster. The species identification is based upon species description in Bingham (1903).

Distribution and natural history: This species is widely distributed and reported from China, India, Indonesia, Malaysia, Myanmar, Pakistan, the Philippines, Singapore, Thailand, and Vietnam (Janicki et al. 2016; Guénard et al. 2017), and it has now been documented for Nepal for the first time. These ants are seen nesting in soil, typically forming mounds, and can be observed scavenging dead carcasses or tending bugs in gardens and woodlands (Eguchi et al. 2011). During this study, we collected them from Sal forest.

***Pheidole nodus* Smith, 1874** (Figs 3. A, B)

Junior synonyms: *Pheidole nodus flebilis* Santschi, 1937; *P. n. praevoxata* Wheeler, 1929; *P. n. rhombinoda* Mayr, 1879; *Pheidole rhombinoda formosensis* Forel, 1913; *P. r. micantivoentris* Mayr, 1897; *P. r. stella* Forel, 1911; *P. r. taprobanae* Forel, 1902; *Pheidole treubi* Forel, 1905.

Type locality: Hyogo, Japan (Smith 1874).

Materials examined: 3 workers (CDZMTU HymF104), Nagarjun forest, SNNP, 27.74444 N, 85.29417 E, 1400 m, pitfall and hand collection, 9.V.2019, I. P. Subedi leg., 2 workers, idem, pitfall collection, 24.X.2019, I. P. Subedi leg.

Worker diagnosis: *Pheidole nodus* major workers may be diagnosed by the following characteristics (see Eguchi (2008) for full diagnosis): Head bears deep and wide posterior concavity. Head dorsum has long and thick sparse standing hairs and short and thin background



Figure 2. *Myrmicaria brunnea* A. habitus in profile view B. head in full-face view

hairs. The vertex posteriorly and vertexal lobe dorso-laterally are rugoso-reticulate. Subpetiolar process is mostly lacking and postpetiole is massive. The species level identification is based upon species descriptions in Smith (1874) and Eguchi (2008).

Distribution and natural history: This is widely distributed ant species in Manchurian and Oriental regions, and reported from Bangladesh, China, India, Indonesia, Japan, Myanmar, South Korea, Sri Lanka, Thailand, and Vietnam (Janicki et al. 2016; Guénard et al. 2017). It is reported first time for Nepal. During this study, we collected them from the Nagarjun forest, a natural forest in the mid-hill.

***Strumigenys godeffroyi* Mayr, 1866** (Figs 4. A, B)

Junior synonyms: *Strumigenys godeffroyi butteli* Forel, 1913; *S. g. geococci* Calilung, 2000; *S. g. indica* Forel, 1902.

Type locality: Samoa, Upolu Island (Mayr 1866).

Material examined: 1 worker (CDZMTU HymF105), Nagarjun forest, Shivapuri-Nagarjun National Park, Nepal, 27.74583 N, 85.28556 E, 1666 m, pitfall collection, 21.X.2019, I. P. Subedi leg.

Worker diagnosis: This species is a member of the *godeffroyi*-complex in the *S. godeffroyi*-group. It has smooth pleurae and propodeal sides (Bolton 2000) and diagnosed by partly or fully reticulo-punctate mesosoma dorsum. Petiolar node dorsum is finely and densely reticulopunctate, whereas postpetiolar disc is mostly or fully smooth. Body pilosity consists of spatulate, flagellate, stiff and simple hairs. The species identification is based on keys in Bharti & Akbar (2013).

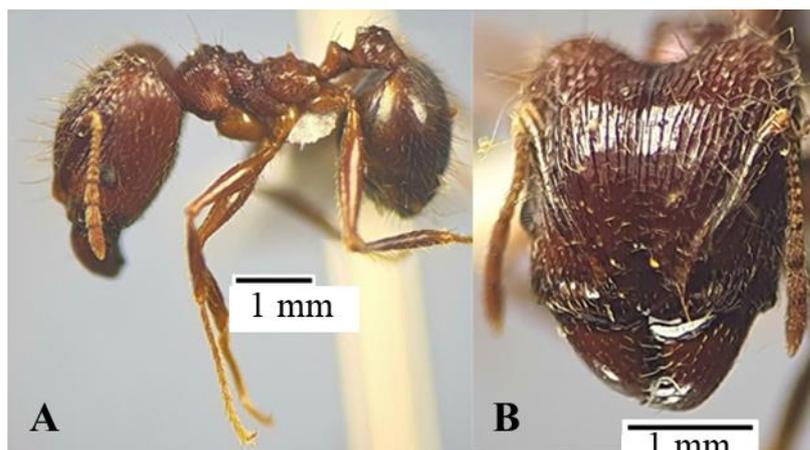


Figure 3. *Pheidole nodus major* A. habitus in profile view B. head in full-face view

Distribution and natural history: *Strumigenys godeffroyi* is a widespread tramp species previously recorded from Australia, India, Pakistan, the Philippines, Myanmar, Vietnam, and in many pacific and Indian ocean islands (Janicki et al. 2016; Guénard et al. 2017). This is the first record for Nepal which was collected by pitfall trapping in Nagarjun forest.

***Strumigenys virgila* Bolton, 2000** (Figs 5. A, B)

Type locality: Siwalik hills, Himanchal Pradesh, India (Bolton 2000).

Materials examined: 2 workers (CDZMTU HymF106), Ranibari Community Forest, Kathmandu district, Central Nepal, 27.72944 N, 85.32056 E, 1310 m, pitfall collection, 19.X.2019, I. P. Subedi leg.

Worker diagnosis: This species is a member of the *signeae*-complex in the *S. godeffroyi*-group (Bolton 2000). It has lamellate propodeal declivity with broadly complex posterior margin. The mandibular apex has an intercalary tooth between apico-dorsal and apico-ventral teeth and 1-2 denticles between intercalary and



Figure 4. *Strumigenys godeffroyi* A. habitus in profile view B. head in full-face view



Figure 5. *Strumigenys virgila* A. habitus in profile view B. head in full-face view

apico-ventral teeth. This species is distinguished from other members of the complex by the presence of intercalary dentition, large lateral spongiform lobe of the petiole, distribution and arrangement of body hairs (Bolton 2000). The species identification is based on keys in Bharti and Akbar (2013).

Distribution and natural history: This species was previously recorded from NW India and Bhutan (Bharti & Akbar 2013; Dendup et al. 2021). It is the first record for Nepal. Almost nothing is previously known about its ecology. The specimens were collected by pitfall trapping during this study, so no direct ecological information is available, however the collection site is a natural urban forest.

Temnothorax wroughtonii (Forel, 1904) (Figs 6. A, B)

Type locality: Liddar valley, Jammu and Kashmir, India (Forel 1904).

Material examined: 1 worker (CDZMTU HymF107), Suidob Shikhar, Dadeldhura district, western Nepal, 29.39526 N, 80.60933 E, 2210 m, hand collection, 11.X.2020, P. B. Budha leg.

Worker diagnosis: The species is characterized by smooth and shiny head, except few striations on frons, between the eyes and frontal edges, 12-segmented antennae with distinct antennal club, metanotal groove distinct, mesosoma finely sculptured and almost smooth, propodeal spines very short, blunt denticles in dorsal view, peduncle of petiole long, petiolar node rounded in profile-view, erect or suberect hair spread all over the body, gaster ovate, smooth and shiny. The species diagnosis is based upon original species description (Forel 1904) and keys (Bharti et al. 2016b; Yusupov et al. 2020). These ants are very close to *T. inermis* but differs by finely sculptured mesosoma in contrast to quite coarse mesosoma in *inermis*, and by the



Figure 6. *Temnothorax wroughtonii* A. habitus in profile view B. head in full-face view

presence of blunt propodeal spines in contrast to unarmed propodeum of *inermis*.

Distribution and natural history: *Temnothorax wroughtonii* was previously known only from NW India and this is a new record for Nepal. This species was collected from *Quercus* forest during this study.

3.2 | Species list of Nepalese Myrmicine ants

The Nepalese ants of the subfamily Myrmicinae contain 21 genera and 69 species. *Myrmica* is the most speciose genus among Nepalese Myrmicine genera, with 16 nominal species, followed by *Strumigenys* with 10 species and *Cardiocondyla* with seven species. Ten of these genera are represented by a single nominal species. The provincial distribution of these ants indicated that Bagmati Province is the most diverse, with 38 known species, followed by Province 1 (25 species) and Gandaki Province (22 species). During this study, we examined 38 Myrmicine ant species from 14 genera. At least nine Myrmicine ants in our collection are likely new to science and will be described in the near future. These undescribed species and morphospecies, however, are not included in the list. The updated species list of Myrmicine ants, along with their provincial distribution is given in the annexed Table 1.

4 | Discussion

Six ant species from five Myrmicine genera have been identified as new for Nepal. *Temnothorax wroughtonii* and *Myrmicaria brunnea* are the only nominal species in these two genera for Nepal. *Myrmica* is the largest genus in Nepal with 16 nominal species, including this new record. Central and Southeast Asia, including the Himalaya, have the greatest diversity of *Myrmica* species, with many endemic species (Radchenko et al. 2007; Bharti 2008; Bharti & Sharma 2013). Additional species reports bring total number of known *Strumigenys* species to 10 and *Pheidole* species to six. *Pheidole* and *Strumigenys* are the second and third most speciose ant genera in the world (Bolton 2022). Apart from *Temnothorax wroughtonii* and *Myrmicaria brunnea*, all newly recorded species, *Myrmica rhytida*, *Pheidole nodus*, *Strumigenys godeffroyi*, and *S. virgila*, were obtained from Shivapuri-Nagarjun National Park or Ranibari Community forest. All of these new records were either collected by pitfall trapping or by hand. *Strumigenys godeffroyi* is a widespread tramp species distributed in Australasia, Indomalaya, Malagasy and Oceania (AntWeb 2022).

The Nepalese Myrmicine ants contain 21 genera and 69 known species. The subfamily Myrmicinae is the largest ant subfamily in Nepal (Subedi et al. 2020), its neighboring countries, India (Bharti et al. 2016) and China (Guenard & Dunn 2012), as well as the entire world (Bolton 2022). With the exception of Province 1, Bagmati and Gandaki, the province-specific distribution of these ants revealed that all other provinces are largely underexplored. Previous collections of Nepalese ants appear to have been limited primarily to trekking routes as sampling locations and to hand collection as collecting methods (Subedi & Budha 2020). Our current surveys were primarily conducted in selected forests in the eastern, central, and western regions, with additional sampling efforts in Shivapuri-Nagarjun National Park and Ranibari Community Forest. As a result, it is not yet possible to present a complete list of Nepalese ant fauna. However, the list gives an overview of Nepal's Myrmicine fauna. Based on the research gap revealed by this study, we emphasize the importance of more ant surveys to catalog the ants of Nepal.

5 | Conclusions

Six ant species of the subfamily Myrmicinae, namely *Myrmica rhytida*, *Myrmicaria brunnea*, *Pheidole nodus*, *Strumigenys godeffroyi*, *S. virgila*, and *Temnothorax wroughtonii* are recorded for the first time from Nepal. *Strumigenys godeffroyi* is a tramp species amongst them. With the addition of these six species, the number of Myrmicine ants known from Nepal reaches to 21 genera and 69 species. The province-specific distribution of these species clearly demonstrated that, with the exception of Province 1, Bagmati and Gandaki, all other provinces are significantly underexplored. More ant surveys are required to catalog the ants of Nepal, where we should expect to find many more species.

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Authors' contributions

Subedi, I. P. conceived the idea, performed field and lab work, and drafted, reviewed, and edited the manuscript. Budha, P. B. performed fieldwork, and

reviewed and edited the manuscript. Yusupov, Z. M., and Bharti, H. reviewed and improved the manuscript. All authors read and approved the manuscript for submission.

Conflicts of interest

Authors declare no conflict of interest.

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Annex Table 1. An updated list of Myrmicine ant species and their distributional records in Nepal

SN	Name of the species	Province 1	Madhesh	Bagmati	Gandaki	Lumbini	Karnali	Far-West
1	<i>Aphaenogaster beesoni</i> Donisthorpe, 1933							*
2	<i>Aphaenogaster pachei</i> (Forel, 1906)	*		*				
3	<i>Aphaenogaster prudens</i> (Forel, 1902)	*						
4	<i>Aphaenogaster smythiesii</i> (Forel, 1902)			*				
5	<i>Cardiocondyla emeryi</i> Forel, 1881			*				
6	<i>Cardiocondyla itsukii</i> Seifert, Okita & Heinze, 2017				*			
7	<i>Cardiocondyla kagutsuchi</i> Terayama, 1999			*	*			
8	<i>Cardiocondyla mauritanica</i> Forel, 1890				*			
9	<i>Cardiocondyla minutior</i> Forel, 1899			*				
10	<i>Cardiocondyla obscurior</i> Wheeler, 1929				*			
11	<i>Cardiocondyla wroughtonii</i> (Forel, 1890)				*			
12	<i>Carebara affinis</i> (Jerdon, 1851)						*	
13	<i>Carebara bengalensis</i> (Forel, 1902)			*				
14	<i>Carebara diversa</i> (Jerdon, 1851)				*			
15	<i>Carebara lignata</i> Westwood, 1840			*				
16	<i>Cataulacus granulatus</i> (Latreille, 1802)				*			
17	<i>Crematogaster binghamii</i> Forel, 1904			*				
18	<i>Crematogaster flava</i> Forel, 1886							
19	<i>Crematogaster himalayana</i> Forel, 1902							
20	<i>Lophomyrmex ambiguus</i> Rigato, 1994	*			*			
21	<i>Lordomyrma bhutanensis</i> (Baroni Urbani, 1977)							
22	<i>Mayriella transfuga</i> Baroni Urbani, 1977			*				
23	<i>Meranoplus bicolor</i> Guerin-Meneville, 1844		*	*	*			
24	<i>Meranoplus nepalensis</i> Schödl, 1998	*		*				
25	<i>Meranoplus rothmeyeri</i> Forel, 1902	*						
26	<i>Monomorium sahlbergi</i> Emery, 1898		*	*				
27	<i>Monomorium pharaonis</i> (Linnaeus, 1758)			*	*			
28	<i>Myrmica aimonissabaudiae</i> Menozzi, 1939			*	*			
29	<i>Myrmica alperti</i> Elmes and Radchenko, 2009	*						
30	<i>Myrmica bactriana</i> Ruzsky, 1915	*		*				
31	<i>Myrmica boltoni</i> Radchenko and Elmes, 1998	*		*	*			
32	<i>Myrmica brancuccii</i> Radchenko, Elmes & Collingwood, 2009	*			*			
33	<i>Myrmica hecate</i> Weber, 1947			*	*			
34	<i>Myrmica indica</i> Weber, 1950	*		*				
35	<i>Myrmica kozlovi</i> Ruzsky, 1915	*		*				
36	<i>Myrmica martensi</i> Radchenko & Elmes, 1998			*				
37	<i>Myrmica pachei</i> Forel, 1906	*						
38	<i>Myrmica rhytida</i> Radchenko & Elmes, 1999			*				
39	<i>Myrmica ritae</i> Emery, 1889				*			
40	<i>Myrmica rugosa</i> Mayr, 1865				*			
41	<i>Myrmica rupestris</i> Forel, 1902	*		*	*			
42	<i>Myrmica smythiesii</i> Forel, 1902	*		*				
43	<i>Myrmica weberi</i> Elmes and Radchenko, 2009	*						
44	<i>Myrmicaria brunnea</i> Saunders, 1842				*			
45	<i>Perissomyrmex monticola</i> De Andrade, 1993	*						
46	<i>Pheidole indica</i> Mayr, 1879			*				
47	<i>Pheidole jucunda</i> Forel, 1885	*		*				
48	<i>Pheidole nodus</i> Smith 1874			*				
49	<i>Pheidole parva</i> Mayr, 1865							
50	<i>Pheidole sagei</i> Forel, 1902	*		*				
51	<i>Pheidole smythiesii</i> Forel, 1902			*	*			
52	<i>Pristomyrmex sulcatus</i> Emery, 1895	*						
53	<i>Recurvidris recurvispinosa</i> (Forel, 1890)			*				
54	<i>Stenammina gurkhale</i> DuBois, 1998			*				

55	<i>Strumigenys buddhista</i> De Andrade, 2007			*
56	<i>Strumigenys caniophanoides</i> De Andrade, 2007	*		
57	<i>Strumigenys exilirhina</i> Bolton, 2000	*		*
58	<i>Strumigenys godeffroyi</i> Mayr 1866			*
59	<i>Strumigenys hemisobek</i> Bolton, 2000	*		
60	<i>Strumigenys hindu</i> De Andrade, 2007			*
61	<i>Strumigenys membranifera</i> Emery, 1869			
62	<i>Strumigenys nepalensis</i> De Andrade, 1994		*	*
63	<i>Strumigenys podarge</i> Bolton, 2000			*
64	<i>Strumigenys virgila</i> Bolton, 2000			*
65	<i>Temnothorax wroughtonii</i> (Forel, 1904)			*
66	<i>Tetramorium bicarinatum</i> (Nylander, 1846)			*
67	<i>Tetramorium difficile</i> Bolton, 1977	*		
68	<i>Tetramorium lanuginosum</i> Mayr, 1870	*	*	*
69	<i>Trichomyrmex destructor</i> (Jerdon, 1851)	*		*