

A Preliminary Checklist of Ants from Bhutan

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ABSTRACT. Current knowledge on the ant fauna of Bhutan is poor, 55 species of Formicidae belonging to 20 genera are listed in various online databases. As result from a detailed study along an elevational gradient in the south of the country we report about 51 species and 21 genera new to the species list of Bhutan. In our study in Mendrelgang gewog of Tsirang district, ants were collected for one month during the month of January (2019) using the methods of baiting, Winkler extraction of leaf litter and hand picking aided by aspirator. This work brings the total number of the known ant fauna of Bhutan to 103 species and 39 genera. The number of new discoveries is expected to increase in future, since many of the high biodiversity areas of the country are still unexplored.

Keywords Ant fauna, New records and Taxonomy

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INTRODUCTION

Bhutan is a small, non-coastal country in Eastern Himalayas with a total area of 38,394 sq. km positioned on the southern slope of the Eastern Himalayas (NBSAP 2014). It forms the ecotone between the two biogeographic realms of Palearctic and Indomalaya, thereby supporting huge biodiversity from both areas. It is among the biodiversity hotspots in the world and has a substan-

tial forest cover of 70.46% of the total land area (LCMP 2010). Bhutan is well known for its rich biodiversity and efficient environmental conservation (Banerjee & Bandopadhyay, 2016). However, less efforts have been applied to the exploration of the splendid biodiversity, especially to the ant fauna of the country. Knowledge in the field of myrmecology and publications from the country are scarce. Thus, Bhutan provides huge opportunities to discover and document its ant fauna.

Table 1. Preliminary species list for the Formicidae of Bhutan. Given are species names and their occurrences in web databases AntMaps, AntWeb and AntWiki as well as the species presented in the current study.

Subfamily	Genus	Species	Ant Map	Ant Web	Ant Wiki	Present Study	Remarks	
Amblyoponinae	<i>Stigmatomma</i>	<i>Stigmatomma kangba</i> (Xu, Z. & Chu, 2012)	0	0	0	1	N.R	
Dolichoderinae	<i>Dolichoderus</i>	<i>Dolichoderus affinis</i> Emery, 1889	0	0	0	1	N.R	
	<i>Phildris</i>	<i>Phildris laevigata</i> (Emery, 1895)	1	0	0	1	N.R	
	<i>Tapinoma</i>	<i>Tapinoma indicum</i> Forel, 1895	0	0	0	1	N.R	
Dorylinae	<i>Dorylus</i>	<i>Dorylus orientalis</i> Westwood, 1835	0	1	0	0		
Ectatomminae	<i>Gnamptogenys</i>	<i>Gnamptogenys binghamii</i> (Forel,1990)	0	0	0	1	N.R	
Formicinae	<i>Camponotus</i>	<i>Camponotus barbatus</i> Roger, 1863	0	0	0	1	N.R	
		<i>Camponotus mitis</i> (Smith, 1858)	0	0	0	1	N.R	
		<i>Camponotus nicobarensis</i> Mayr, 1865	0	0	0	1	N.R	
		<i>Camponotus oblongus</i> (Smith,1858)	1	0	0	0		
		<i>Camponotus parvus</i> Emery, 1889	0	0	0	1	N.R	
		<i>Camponotus wasmanni</i> Emery, 1893	0	0	0	1	N.R	
	<i>Formica</i>	<i>Formica candida</i> Smith, 1878	1	0	0	0		
	<i>Lasius</i>	<i>Lasius alienoflavus</i> Bingham, 1903	1	0	0	0		
		<i>Lasius crinitus</i> (Smith, 1858)	1	0	0	0		
		<i>Lasius draco</i> Collingwood, 1982	1	1	1	0		
		<i>Lasius magnus</i> Seifert, 1992	1	1	1	1		
	<i>Lepisiota</i>	<i>Lepisiota</i> sp.	0	0	0	1	N.R	
	<i>Nylanderia</i>	<i>Nylanderia taylora</i> (Forel, 1894)	0	0	0	1	N.R	
	<i>Oecophylla</i>	<i>Oecophylla smaragdina</i> (Fabricius, 1775)	0	0	0	1	N.R	
	<i>Polyrhachis</i>	<i>Polyrhachis bicolor</i> Smith, 1858	0	0	0	1	N.R	
		<i>Polyrhachis dives</i> Smith, 1857	0	0	0	1	N.R	
		<i>Polyrhachis hauxwelli</i> Bingham, 1903	0	0	0	1	N.R	
		<i>Polyrhachis hippomanes</i> Smith, 1861	0	0	0	1	N.R	
		<i>Polyrhachis illaudata</i> Walker, 1859	0	0	0	1	N.R	
		<i>Polyrhachis laevigata</i> Smith, 1857	1	0	0	0		
		<i>Polyrhachis punctillata</i> Roger, 1863	0	0	0	1	N.R	
		<i>Polyrhachis rastellata</i> (Latreille, 1802)	0	0	0	1	N.R	
		<i>Polyrhachis sculpturata</i> Smith, 1860	0	0	0	1	N.R	
<i>Polyrhachis striata</i> Mayr, 1862		0	0	0	1	N.R		
<i>Polyrhachis thompsoni</i> Bingham, 1903		0	0	0	1	N.R		
<i>Pseudolasius</i>		<i>Pseudolasius familiaris</i> (Smith, 1860)	0	0	0	1	N.R	
Myrmicinae		<i>Aphaenogaster</i>	<i>Aphaenogaster feae</i> (Emery, 1889)	0	0	0	1	N.R
			<i>Calyptomyrmex</i>	<i>Calyptomyrmex friederikae</i> Kutter, 1976	1	1	1	0
		<i>Calyptomyrmex wittmeri</i> Baroni Urbani, 1975	1	1	1	0		
	<i>Cardiocondyla</i>	<i>Cardiocondyla itsukii</i> Seifert et al., 2017	1	0	1	0		
		<i>Cardiocondyla kagutsuchi</i> Terayama, 1999	1	0	0	0		
		<i>Cardiocondyla obscurior</i> Wheeler, 1929	1	0	0	0		
		<i>Cardiocondyla wroughtonii</i> (Forel, 1890)	1	0	0	0		
	<i>Carebara</i>	<i>Carebara affinis</i> (Jerdon, 1851)	0	0	0	1	N.R	
	<i>Crematogaster</i>	<i>Crematogaster aberrans</i> Forel, 1892	1	0	0	0		

	<i>Crematogaster dohrni</i> Mayr, 1879	0	0	0	1	N.R
<i>Lophomyrmex</i>	<i>Lophomyrmex bedoti</i> Emery, 1893	0	0	0	1	N.R
	<i>Lophomyrmex birmanus</i> Emery, 1893	0	0	0	1	N.R
	<i>Lophomyrmex quadrispinosus</i> (Jerdon, 1851)	0	0	0	1	N.R
	<i>Lordomyrma bhutanensis</i> (Baroni Urbani, 1977)	1	1	1	0	
<i>Mayriella</i>	<i>Mayriella transfuga</i> Baroni Urbani, 1977	1	1	1	0	
	<i>Mayriella warchalowskii</i> Boroweic, 2007	1	1	0	0	
<i>Meranoplus</i>	<i>Meranoplus bicolor</i> Guérin-Méneville, 1844	1	0	1	0	
	<i>Meranoplus rothneyi</i> Forel, 1902	1	0	1	0	
<i>Monomorium</i>	<i>Monomorium floricola</i> (Jerdon, 1851)	0	0	0	1	N.R
<i>Myrmica</i>	<i>Myrmica aimonissabaudiae</i> Menozzi, 1939	1	0	1	0	
	<i>Myrmica collingwoodi</i> Radchenko & Elmes, 1998	1	1	1	0	
	<i>Myrmica indica</i> Weber, 1950	1	0	1	0	
	<i>Myrmica pachei</i> Forel, 1906	1	1	0	0	
	<i>Myrmica rugosa</i> Mayr, 1865	1	1	1	0	
	<i>Myrmica rpestris</i> Forel, 1902	1	0	1	0	
	<i>Myrmica villosa</i> Radchenko & Elmes, 1999	1	1	1	0	
	<i>Myrmica weberi</i> Elmes & Radchenko, 2009	1	0	1	0	
<i>Perissomyrmex</i>	<i>Perissomyrmex monticola</i> Baroni Urbani & De-Andrade, 1993	1	1	1	0	
<i>Pheidole</i>	<i>Pheidole jucunda</i> Forel, 1885	0	0	0	1	N.R
	<i>Pheidole parva</i> Mayr, 1865	0	0	0	1	N.R
	<i>Pheidole smythiesii</i> Forel, 1902	0	0	0	1	N.R
	<i>Pheidole woodmasoni</i> Forel, 1885	0	0	0	1	N.R
<i>Strumigenys</i>	<i>Strumigenys caniophanoides</i> De Andrade, 2007	1	1	1	0	
	<i>Strumigenys dohertyi</i> Emery, 1897	1	0	1	0	
	<i>Strumigenys exilirhina</i> Bolton, 2000	1	0	1	0	
	<i>Strumigenys kichijo</i> (Terayama et al., 1996)	1	0	1	0	
	<i>Strumigenys lyroessa</i> (Roger, 1862)	1	1	1	0	
	<i>Strumigenys membranifera</i> Emery, 1869	0	0	1	0	
	<i>Strumigenys nannosobek</i> (Bolton, 2000)	1	1	1	0	
	<i>Strumigenys nanzanensis</i> Lin & Wu, 1996	1	0	1	0	
	<i>Strumigenys uberyx</i> Bolton, 2000	1	1	1	0	
	<i>Strumigenys virgila</i> Bolton, 2000	1	0	1	0	
<i>Tetramorium</i>	<i>Tetramorium bicarinatum</i> (Nylander, 1846)	0	0	1	0	
	<i>Tetramorium christiei</i> Forel, 1902	1	0	0	0	
	<i>Tetramorium difficile</i> Bolton, 1977	1	0	0	0	
	<i>Tetramorium indicum</i> Forel, 1913	1	0	0	0	
	<i>Tetramorium lanuginosum</i> Mayr, 1870	1	0	0	0	
	<i>Tetramorium nipponense</i> Wheeler, 1928	1	0	0	0	
	<i>Tetramorium smithi</i> Mayr, 1879	1	0	0	0	
	<i>Tetramorium urbanii</i> Bolton, 1977	1	1	1	0	
	<i>Tetramorium wroughtonii</i> (Forel, 1902)	0	0	0	1	N.R
<i>Trichomyrmex</i>	<i>Trichomyrmex destructor</i> (Jerdon, 1851)	0	0	0	1	N.R

Ponerinae	<i>Anochetus</i>	<i>Anochetus madaraszii</i> Mayr, 1897	0	0	0	1	N.R.
		<i>Anochetus risii</i> Forel, 1900	0	0	0	1	N.R.
		<i>Anochetus validus</i> Bharti & Wachkoo, 2013	0	0	0	1	N.R.
	<i>Brachyponera</i>	<i>Brachyponera jerdonii</i> (Forel, 1900)	0	0	0	1	N.R.
	<i>Diacamma</i>	<i>Diacamma rugosum</i> (Le Guillou, 1842)	0	0	0	1	N.R.
	<i>Ectomyrmex</i>	<i>Ectomyrmex astutus</i> (Smith, 1858)	0	0	0	1	N.R.
		<i>Ectomyrmex javanus</i> Mayr, 1867	0	0	0	1	N.R.
		<i>Ectomyrmex leeuwenhoekii</i> (Forel, 1886)	0	0	0	1	N.R.
	<i>Harpegnathos</i>	<i>Harpegnathos venator</i> (Smith, 1858)	0	0	0	1	N.R.
	<i>Leptogenys</i>	<i>Leptogenys assamensis</i> Forel, 1900	0	0	0	1	N.R.
		<i>Leptogenys kitteli</i> (Mayr, 1870)	0	0	0	1	N.R.
		<i>Leptogenys lucidula</i> Emery, 1895	0	0	0	1	N.R.
		<i>Leptogenys peuqueti</i> (Andre, 1887)	0	0	0	1	N.R.
	Proceratiinae	<i>Discothyrea</i>	<i>Discothyrea stumperi</i> Baroni Urbani, 1977	1	1	1	0
<i>Proceratium</i>		<i>Proceratium williamsi</i> Mathew & Tiwari, 2000	1	1	1	0	
Pseudomyrmecinae	<i>Tetraoponera</i>	<i>Tetraoponera allaborans</i> (Walker, 1859)	1	1	0	0	
		<i>Tetraoponera binghami</i> (Forel, 1902)	1	0	0	0	
		<i>Tetraoponera modesta</i> (Smith, 1860)	0	0	0	1	N.R.
		<i>Tetraoponera rufonigra</i> (Jerdon, 1851)	1	0	1	1	

Table 2. Transects along with the elevation and coordinates.

Transect ID	Elevation	Coordinates of transect			
		Start of Transect		End of Transect	
		Latitude	Longitude	Latitude	Longitude
01	700	26.96607°N	90.10003°E	26.96457°N	90.09745°E
02	900	26.96195°N	90.1021°E	26.96002°N	90.09635°E
03	1400	26.95708°N	90.13518°E	26.95123°N	90.13343°E
04	1600	26.95518°N	90.14152°E	26.94936°N	90.13715°E
05	2100	26.96425°N	90.14575°E	26.96908°N	90.14683°E
06	2300	26.97138°N	90.14572°E	26.97469°N	90.14519°E

Three important online platforms summarize taxonomic information on Bhutanese ants; however, they result in diverse lists of species recorded from the country. According to AntWiki (2020) 32 species belonging to 13 genera from five subfamilies of ants were recorded from Bhutan. AntWeb listed 24 species from 14 genera (Antweb.org, 2020), while AntMaps had the most comprehensive list with 49 species from 17 genera (AntMaps.org, 2020; Janicki et al, 2016)). Although lists overlapped in their main parts, each of them also provided unique species. Com-

binning all the information we counted 55 species from 20 genera of Formicidae currently known for Bhutan.

Those ant specimens were mainly collected during the basal expedition in 1970s (Baroni Urbani, 1977a; Baroni Urbani 1977b; Baroni Urbani & De Andrade 1993; Baroni Urbani et al., 1973). Since that time little efforts had been made to enlarge the species list of Bhutan. Therefore, we designed a study that should give a broader overview on the ants of the country. During this research we explored the Mendrelgang Gewog

region of Tsirang district, where the elevation ranges from 700 m asl to 2300 m asl. The lower altitude region is covered by warm broadleaved forest, while cool broadleaved forest coats the upper regions. The whole study area was characterized into three habitat areas of Forest (Warm and Cool broadleaved forests), Agriculture area (Cultivated as well as Fallow land) and Built up

areas (Houses, roads, infrastructures). A list of new records of 51 species of ants and 21 ant genera is provided in the present article together with a preliminary list of the ants of Bhutan. The number of new records for the country is expected to increase in future, since many of the high biodiversity areas in Bhutan are still unexplored.

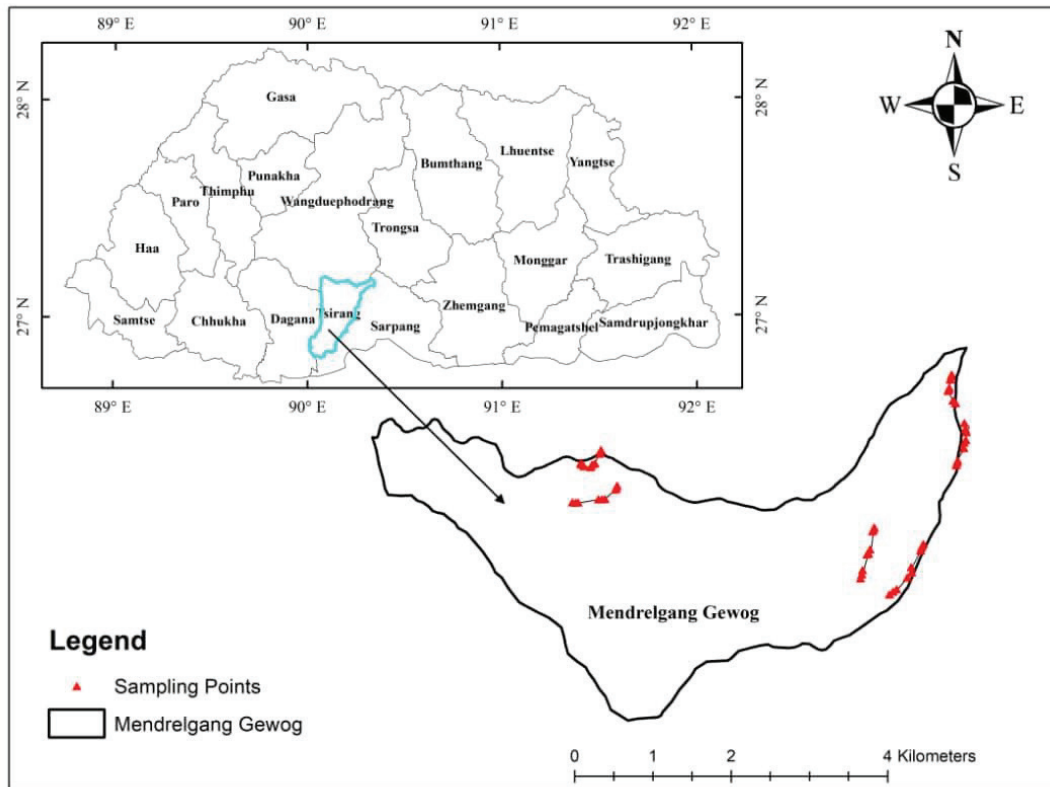


Fig. 1. Map showing the collection sites. Map depicting the transects of the collection sites.

MATERIAL AND METHODS

The ants were sampled in Mendrelgang Gewog region of Tsirang district along an elevational gradient (700- 2300 m asl, Fig. 1) extensively for the period of one month (January of 2019) using systematic random sampling. In total there were 54 sampling plots from 18 sampling areas from six elevational transects (700 m asl; 900 m asl; 1400 m asl; 1600 m asl; 2100 m asl; 2300 m asl). The coordinates for the start and end of the six

elevational transects are reflected in Table 2. Ant specimens were collected by baiting, Winkler extraction, hand picking and with the help of aspirator. The methods of Winkler extraction and baiting was used in the forested areas and agriculture areas. Hand picking along with the aspirator was applied in all habitats. The collected specimens were preserved in 90% alcohol and mounted on triangles as per standard procedure in ant taxonomy. The taxonomic analysis was conducted on a Nikon SMZ 1500 stereo zoom microscope.

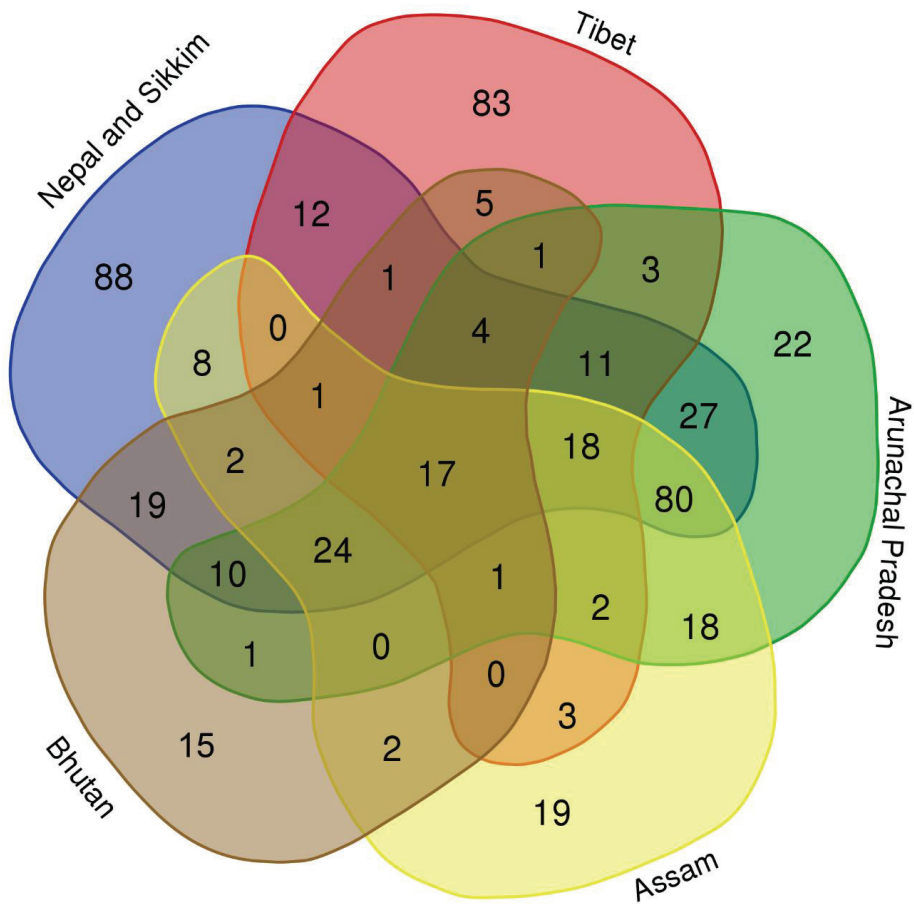


Fig. 2. Venn diagram of species overlap among Bhutan and its neighboring countries: Nepal and Sikkim (India), Tibet (China), Arunachal Pradesh (India), and Assam (India). In the electronic appendix A1, we give further information on ant species lists of these states with intersections and species names. The information of this figure was compiled from AntMaps (2020), species lists of Nepal and Sikkim were united for better overview in the final picture. The complete species numbers of the states were 323 (Nepal & Sikkim), 162 (Tibet), 239 (Arunachal Pradesh), 195 (Assam) and 103 (Bhutan).

In total, 1811 specimens were checked and sorted up to morphospecies. Most of the morphospecies were identified up to species level. Keys for adjacent regions and taxonomic analyses of different ant genera used in the present study were as follows: Bharti & Wachkoo (2013), Bingham (1903), Bolton (1994, 2003), Chen *et al.*, 2019 and Xu & Chu (2012). Voucher specimens were all deposited in College of Natural Resources, Lobesa, Bhutan. A detailed ecological assessment of our samples is in preparation (Karma *et al.* in prep.).

To assess the potential species number in Bhutan and identify further potential species of the country we checked the species lists of the neighboring countries and states, viz. Nepal, Sikkim, Tibet, Arunachal Pradesh and Nepal (Ant-Maps, 2020) and compared them with our species list. We united the lists of Sikkim and Nepal and produced a Venn diagram of five lists using the online tool provided by the Department of Bioinformatics of the University of Ghent (<http://bioinformatics.psb.ugent.be/webtools/Venn/>).

RESULTS

During the course of study, we found 51 ant species new to Bhutan. Our collecting efforts also resulted in the addition of 21 ant genera new to Bhutan: The list of new records is given below, while the comprehensive checklist of the ants of Bhutan is given in the Electronic Appendix (Appendix A1).

1. *Anochetus madaraszii* Mayr, 1897

Materials examined: 2 Workers: Tsirang, Mendrelgang, ID3, 26.96562°N, 90.09985°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned Agriculture land; Tsirang, Mendrelgang, ID9, 26.96457°N, 90.09745°E, 700m, 17.I.2019, K.C. Dendup, CNR, Warm broadleaved forest.

Remarks: This genus is reported from Bhutan for the first time.

2. *Anochetus risii* Forel, 1900

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID12, 26.96586°N, 90.09992°E, 900m, 18.I.2019, K.C. Dendup, CNR, Warm broadleaved forest.

3. *Anochetus validus* Bharti & Wachkoo, 2013

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID14, 26.96035°N, 90.10015°E, 900m, 19.I.2019, K.C. Dendup, CNR, Agriculture land.

4. *Aphaenogaster feae* Emery, 1889

Materials examined: 2 Workers: Tsirang, Mendrelgang, ID10, 26.96195°N, 90.1021°E, 900m, 18.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID41, 26.96687°N, 90.14678°E, 2100m, 28.I.2019, K.C. Dendup, CNR, Cool broadleaved forest.

Remarks: This genus is reported from Bhutan for the first time.

5. *Brachyponera jerdonii* (Forel, 1900)

Materials examined: 12 Workers: Tsirang, Mendrelgang, ID8, 26.96438°N, 90.09747°E, 700m, 17.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID10, 26.96195°N, 90.1021°E, 900m, 18.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrel-

gang, ID19, 26.95708°N, 90.13518°E, 1400m, 21.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID30, 26.95438°N, 90.14118°E, 1600m, 24.I.2019, K.C. Dendup, CNR, Cool broadleaved forest; Tsirang, Mendrelgang, ID31, 26.9525°N, 90.13995°E, 1600m, 25.I.2019, K.C. Dendup, CNR, Cool broadleaved forest; Tsirang, Mendrelgang, ID32, 26.95192°N, 90.14003°E, 1600m, 25.I.2019, K.C. Dendup, CNR, Built up area; Tsirang, Mendrelgang, ID33, 26.95132°N, 90.13943°E, 1600m, 25.I.2019, K.C. Dendup, CNR, Built up area; Tsirang, Mendrelgang, ID34, 26.94996°N, 90.13806°E, 1600m, 26.I.2019, K.C. Dendup, CNR, Cool broadleaved forest; Tsirang, Mendrelgang, ID35, 26.94968°N, 90.13762°E, 1600m, 26.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID40, 26.96623°N, 90.14677°E, 2100m, 28.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID42, 26.96712°N, 90.147°E, 2100m, 28.I.2019, K.C. Dendup, CNR, Cool broadleaved forest; Tsirang, Mendrelgang, ID43, 26.96803°N, 90.14708°E, 2100m, 29.I.2019, K.C. Dendup, CNR, Cool broadleaved forest.

Remarks: This genus is reported from Bhutan for the first time.

6. *Camponotus barbatus* Roger, 1863

Materials examined: 7 Workers; Tsirang, Mendrelgang, ID3, 26.96562°N, 90.09985°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned Agriculture land; Tsirang, Mendrelgang, ID11, 26.96168°N, 90.102°E, 900m, 18.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID18, 26.96002°N, 90.09635°E, 1400m, 21.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID19, 26.95708°N, 90.13518°E, 1400m, 21.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID23, 26.95408°N, 90.13445°E, 1600m, 26.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID24, 26.95397°N, 90.13425°E, 1600m, 26.I.2019, K.C. Dendup, CNR, Cool broadleaved forest; Tsirang, Mendrelgang, ID38, 26.96457°N, 90.14588°E, 2100m, 27.I.2019, K.C. Dendup, CNR, Agriculture land.

7. *Camponotus mitis* (Smith, 1858)

Materials examined: 6 Workers; Tsirang, Mendrelgang, ID3, 26.96562°N, 90.09985°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned Agriculture; Tsirang, Mendrelgang, ID11, 26.96168°N, 90.102°E, 900m, 18.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID13, 26.9604°N, 90.10053°E, 900m, 19.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID30, 26.95438°N, 90.14118°E, 1600m, 24.I.2019, K.C. Dendup, CNR, Cool broadleaved forest; Tsirang, Mendrelgang, ID31, 26.9525°N, 90.13995°E, 1600m, 25.I.2019, K.C. Dendup, CNR, Cool broadleaved forest; Tsirang, Mendrelgang, ID32, 26.95192°N, 90.14003°E, 1600m, 25.I.2019, K.C. Dendup, CNR, Built up area .

8. *Camponotus nicobarensis* Mayr, 1865

Materials examined: 4 Workers: Tsirang, Mendrelgang, ID4, 26.9645°N, 90.09925°E, 700m, 16.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID13, 26.9604°N, 90.10053°E, 900m, 19.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID15, 26.96037°N, 90.0997°E, 900m, 19.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID18, 26.96002°N, 90.09635°E, 900m, 20.I.2019, K.C. Dendup, CNR, Warm broadleaved forest.

9. *Camponotus parius* Emery, 1889

Materials examined: 2 Workers: Tsirang, Mendrelgang, ID1, 26.96607°N, 90.10003°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned Agriculture land; Tsirang, Mendrelgang, ID16, 26.96000°N, 90.09708°E, 900m, 20.I.2019, K.C. Dendup, CNR, Warm broadleaved forest.

10. *Camponotus wasmanni* Emery, 1893

Materials examined: 1 Worker; Tsirang, Mendrelgang, ID19, 26.95708°N, 90.13518°E, 1400m, 21.I.2019, K.C. Dendup, CNR, Agriculture land.

11. *Carebara affinis* (Jerdon, 1851)

Materials examined: 1 Worker, Tsirang, Mendrelgang, ID26, 26.95167°N, 90.13358°E, 1400m, 23.I.2019, K.C. Dendup, CNR, Agriculture land.

Remarks: This genus is reported from Bhutan for the first time.

12. *Crematogaster dohrni* Mayr, 1879

Materials examined: 3 Workers: Tsirang, Mendrelgang, ID37, 26.96425°N, 90.14575°E, 2100m, 27.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID40, 26.96623°N, 90.14677°E, 2100m, 28.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID43, 26.96803°N, 90.14708°E, 2100m, 29.I.2019, K.C. Dendup, CNR, Cool broadleaved forest.

13. *Diacamma rugosum* (Le Guillou, 1842)

Materials examined: 2 Workers: Tsirang, Mendrelgang, ID1, 26.96607°N, 90.10003°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned agriculture land; Tsirang, Mendrelgang, ID15, 26.96037°N, 90.0997°E, 900m, 19.I.2019, K.C. Dendup, CNR, Agriculture land.

Remarks: This genus is reported from Bhutan for the first time.

14. *Dolichoderus affinis* Emery, 1889

Materials examined: 3 Workers: Tsirang, Mendrelgang, ID32, 26.95192°N, 90.14003°E, 1600m, 25.I.2019, K.C. Dendup, CNR, Built up area; Tsirang, Mendrelgang, ID33, 26.95132°N, 90.13943°E, 1600m, 25.I.2019, K.C. Dendup, CNR, Built up area; Tsirang, Mendrelgang, ID34, 26.94996°N, 90.13806°E, 1600m, 26.I.2019, K.C. Dendup, CNR, Cool broadleaved forest.

Remarks: This genus is reported from Bhutan for the first time.

15. *Ectomyrmex astutus* (Smith, 1858)

Materials examined: 3 Workers: Tsirang, Mendrelgang, ID6, 26.96405°N, 90.0987°E, 700m, 16.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID8, 26.96438°N, 90.09747°E, 700m, 17.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID20, 26.95685°N, 90.1351°E, 1400m, 21.I.2019, K.C. Dendup, CNR, Built up area .

Remarks: This genus is reported from Bhutan for the first time.

16. *Ectomyrmex javanus* Mayr, 1867

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID15, 26.96037°N, 90.0997°E, 900m, 19.I.2019, K.C. Dendup, CNR, Agriculture land.

17. *Ectomyrmex leeuwenhoekii* (Forel, 1886)

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID10, 26.96195°N, 90.1021°E, 900m, 18.I.2019, K.C. Dendup, CNR, Warm broadleaved forest.

18. *Gnamptogenys binghamii* (Forel, 1990)

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID6, 26.96405°N, 90.0987°E, 700m, 16.I.2019, K.C. Dendup, CNR, Warm broadleaved forest.

Remarks: This genus is reported from Bhutan for the first time.

19. *Harpegnathos venator* (Smith, 1858)

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID3, 26.96562°N, 90.09985°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned agriculture land.

Distribution: Bangladesh, Borneo, China, India, Indonesia, Laos, Malaysia, Thailand and Vietnam.

Remarks: This genus is reported from Bhutan for the first time.

20. *Lepisiota* sp.

Materials examined: 2 Workers: Tsirang, Mendrelgang, ID1, 26.96607°N, 90.10003°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned agriculture land ; Tsirang, Mendrelgang, ID22, 26.95455°N, 90.13463°E, 1400m, 22.I.2019, K.C. Dendup, CNR, Built up area .

Remarks: The genus is reported first time from Bhutan.

21. *Leptogenys assamensis* Forel, 1900

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID5, 26.96438°N, 90.93223°E, 700m, 16.I.2019, K.C. Dendup, CNR, Warm broadleaved forest.

Remarks: The genus is reported from Bhutan for the first time.

22. *Leptogenys kitteli* (Mayr, 1870)

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID3, 26.96562°N, 90.09985°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned agriculture land.

23. *Leptogenys lucidula* Emery, 1895

Materials examined: 3 Workers: Tsirang, Mendrelgang, ID2, 26.96586°N, 90.09992°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned agriculture land; Tsirang, Mendrelgang, ID25, 26.95217°N, 90.13369°E, 1400m, 23.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID30, 26.95438°N, 90.14118°E, 1600m, 24.I.2019, K.C. Dendup, CNR, Cool broadleaved forest.

24. *Leptogenys peuqueti* (Andre, 1887)

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID43, 26.96803°N, 90.14708°E, 2300m, 29.I.2019, K.C. Dendup, CNR, Cool broadleaved forest.

25. *Lophomyrmex bedoti* Emery, 1893

Materials examined: 5 Workers: Tsirang, Mendrelgang, ID1, 26.96607°N, 90.10003°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned agriculture land; Tsirang, Mendrelgang, ID4, 26.9645°N, 90.09925°E, 700m, 16.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID9, 26.96457°N, 90.09745°E, 700m, 17.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID10, 26.96195°N, 90.1021°E, 900m, 18.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID11, 26.96168°N, 90.102°E, 900m, 18.I.2019, K.C. Dendup, CNR, Warm broadleaved forest.

Remarks: The genus is reported from Bhutan for the first time.

26. *Lophomyrmex birmanus* Emery, 1893

Materials examined: 3 Workers: Tsirang, Mendrelgang, ID2, 26.96586°N, 90.09992°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned Agriculture land; Tsirang, Mendrelgang, ID7, 26.96417°N, 90.09785°E, 700m, 17.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID16, 26.96000°N, 90.09708°E, 900m, 20.I.2019, K.C. Dendup, CNR, Warm broadleaved forest

27. *Lophomyrmex quadrispinosus* (Jerdon, 1851)

Materials examined: 2 Workers: Tsirang, Mendrelgang, ID27, 26.95123°N, 90.13343°E, 1400m, 23.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID35, 26.94968°N, 90.13762°E, 1600m, 26.I.2019, K.C. Dendup, CNR, Agriculture land.

28. *Monomorium floricola* (Jerdon, 1851)

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID2, 26.96586°N, 90.09992°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned agriculture land.

Remarks: This genus is reported from Bhutan for the first time.

29. *Nylanderia taylori* (Forel, 1894)

Materials examined: 4 Workers: Tsirang, Mendrelgang, ID1, 26.96607°N, 90.10003°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned agriculture land; Tsirang, Mendrelgang, ID4, 26.9645°N, 90.09925°E, 700m, 16.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID23, 26.95408°N, 90.13445°E, 1400m, 22.I.2019, K.C. Dendup, CNR, Built up area; Tsirang, Mendrelgang, ID39, 26.9648°N, 90.14597°E, 2100m, 27.I.2019, K.C. Dendup, CNR, Agriculture land.

Remarks: This genus is reported from Bhutan for the first time.

30. *Oecophylla smaragdina* (Fabricius, 1775)

Materials examined: 2 Workers: Tsirang, Mendrelgang, ID5, 26.96438°N, 90.93223°E, 700m, 16.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID10, 26.96195°N, 90.1021°E, 900m, 18.I.2019, K.C. Dendup, CNR, Warm broadleaved forest.

Remarks: This genus is reported from Bhutan for the first time.

31. *Pheidole jucunda* Forel, 1885

Materials examined: 5 Workers: Tsirang, Mendrelgang, ID2, 26.96586°N, 90.09992°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned agriculture land; Tsirang, Mendrelgang, ID6, 26.96405°N, 90.0987°E, 700m, 16.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID16, 26.96000°N,

90.09708°E, 900m, 20.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID22, 26.95455°N, 90.13463°E, 1400m, 22.I.2019, K.C. Dendup, CNR, Built up area; Tsirang, Mendrelgang, ID41, 26.96687°N, 90.14678°E, 2100m, 28.I.2019, K.C. Dendup, CNR, Cool broadleaved forest.

Remarks: This genus is reported from Bhutan for the first time.

32. *Pheidole parva* Mayr, 1865

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID4, 26.9645°N, 90.09925°E, 700m, 16.I.2019, K.C. Dendup, CNR, Warm broadleaved forest.

33. *Pheidole smythiesii* Forel, 1902

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID28, 26.95518°N, 90.14152°E, 1600m, 24.I.2019, K.C. Dendup, CNR, Cool broadleaved forest.

34. *Pheidole woodmasoni* Forel, 1885

Materials examined: 4 Workers: Tsirang, Mendrelgang, ID1, 26.96607°N, 90.10003°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned agriculture land; Tsirang, Mendrelgang, ID3, 26.96562°N, 90.09985°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned agriculture land; Tsirang, Mendrelgang, ID8, 26.96438°N, 90.09747°E, 700m, 17.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID17, 26.95995°N, 90.09675°E, 900m, 20.I.2019, K.C. Dendup, CNR, Built up area (Construction work area).

35. *Philidris laevigata* (Emery, 1895)

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID17, 26.95995°N, 90.09675°E, 900m, 20.I.2019, K.C. Dendup, CNR, Built up area (Construction work area).

Remarks: This genus is reported from Bhutan for the first time.

36. *Polyrhachis bicolor* Smith, 1858

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID6, 26.96405°N, 90.0987°E, 700m, 16.I.2019, K.C. Dendup, CNR, Warm broadleaved forest.

37. *Polyrhachis dives* Smith, 1857

Materials examined: 2 Workers: Tsirang, Mendrelgang, ID26, 26.95167°N, 90.13358°E, 1400m, 23.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID28, 26.95518°N, 90.14152°E, 1600m, 24.I.2019, K.C. Dendup, CNR, Cool broadleaved forest.

38. *Polyrhachis hauxwelli* Bingham, 1903

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID36, 26.94936°N, 90.13715°E, 1600m, 26.I.2019, K.C. Dendup, CNR, Cool broadleaved forest.

39. *Polyrhachis hippomanes* Smith, 1861

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID18, 26.96002°N, 90.09635°E, 900m, 20.I.2019, K.C. Dendup, CNR, Warm broadleaved forest.

Distribution: China, India and Sri Lanka.

40. *Polyrhachis illaudata* Walker, 1859

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID21, 26.95663°N, 90.13498°E, 1400m, 21.I.2019, K.C. Dendup, CNR, Agriculture land.

41. *Polyrhachis punctillata* Roger, 1863

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID27, 26.95123°N, 90.13343°E, 1400m, 23.I.2019, K.C. Dendup, CNR, Agriculture land.

42. *Polyrhachis rastellata* (Latreille, 1802)

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID11, 26.96168°N, 90.102°E, 900m, 18.I.2019, K.C. Dendup, CNR, Warm broadleaved forest.

43. *Polyrhachis sculpturata* Smith, 1860

Materials examined: 3 Workers: Tsirang, Mendrelgang, ID7, 26.96417°N, 90.09785°E, 700m, 17.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID9, 26.96457°N, 90.09745°E, 700m, 17.I.2019, K.C. Dendup, CNR, Warm broadleaved forest; Tsirang, Mendrelgang, ID20, 26.95685°N, 90.1351°E, 1400m, 21.I.2019, K.C. Dendup, CNR, Built up area .

44. *Polyrhachis striata* Mayr, 1862

Materials examined: 2 Workers: Tsirang, Mendrelgang, ID23, 26.95408°N, 90.13445°E, 1400m, 22.I.2019, K.C. Dendup, CNR, Built up area; Tsirang, Mendrelgang, ID26, 26.95167°N, 90.13358°E, 1400m, 23.I.2019, K.C. Dendup, CNR, Agriculture land.

45. *Polyrhachis thompsoni* Bingham, 1903

Materials examined: 3 Workers: Tsirang, Mendrelgang, ID25, 26.95217°N, 90.13369°E, 1400m, 23.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID29, 26.95482°N, 90.14132°E, 1600m, 24.I.2019, K.C. Dendup, CNR, Cool broadleaved forest; Tsirang, Mendrelgang, ID34, 26.94996°N, 90.13806°E, 1600m, 26.I.2019, K.C. Dendup, CNR, Cool broadleaved forest.

46. *Pseudolasius familiaris* (Smith, 1860)

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID38, 26.96457°N, 90.14588°E, 2100m, 27.I.2019, K.C. Dendup, CNR, Agriculture land.

Remarks: This genus is reported from Bhutan for the first time.

47. *Stigmatomma kangba* (Xu, Z. & Chu, 2012)

Materials examined: 1 Worker: Tsirang, Mendrelgang, ID17, 26.95995°N, 90.09675°E, 900m, 20.I.2019, K.C. Dendup, CNR, Built up area (Construction work area).

Remarks: This genus is reported from Bhutan for the first time.

48. *Tapinoma indicum* Forel, 1895

Materials examined: 5 Workers: Tsirang, Mendrelgang, ID1, 26.96607°N, 90.10003°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned Agriculture land; Tsirang, Mendrelgang, ID14, 26.96035°N, 90.10015°E, 900m, 19.I.2019, K.C. Dendup, CNR, Agriculture land; Tsirang, Mendrelgang, ID28, 26.95518°N, 90.14152°E, 1600m, 24.I.2019, K.C. Dendup, CNR, Cool broadleaved forest; Tsirang, Mendrelgang, ID32, 26.95192°N, 90.14003°E, 1600m, 25.I.2019, K.C. Dendup, CNR, Built up area; Tsirang, Mendrelgang, ID35, 26.94968°N, 90.13762°E, 1600m, 26.I.2019, K.C. Dendup, CNR, Agriculture land.

Remarks: This genus is reported from Bhutan for the first time.

49. *Tetramorium wroughtonii* (Forel, 1902)

Material examined: 1 Worker: Tsirang, Mendrelgang, ID19, 26.95708°N, 90.13518°E, 1400m, 21.I.2019, K.C. Dendup, CNR, Agriculture land.

50. *Tetraponera modesta* (Smith, 1860)

Material examined: 1 Worker: Tsirang, Mendrelgang, ID10, 26.96195°N, 90.1021°E, 900m, 18.I.2019, K.C. Dendup, CNR, Warm broad-leaved forest.

51. *Trichomyrmex destructor* (Jerdon, 1851)

Materials examined: 2 Workers: Tsirang, Mendrelgang, ID2, 26.96586°N, 90.09992°E, 700m, 15.I.2019, K.C. Dendup, CNR, Abandoned Agriculture land; Tsirang, Mendrelgang, ID14, 26.96035°N, 90.10015°E, 900m, 19.I.2019, K.C. Dendup, CNR, Agriculture land.

Remarks: This genus is reported from Bhutan for the first time.

DISCUSSION

The checklist we provide here is only preliminary and incomplete. Bhutan is a part of eastern Himalayan biodiversity hotspot and is counted among the 234 globally outstanding eco-regions of the world (Gillison, 2012). The mountainous and rugged terrain rises from 100 meters in south to 7500 meter above sea level in north. Microclimate varies considerably between valleys and within valleys depending on elevation. Bhutan is divided into six agro-ecological zones in correspondence with the certain elevational ranges and climatic conditions: alpine, cool temperate, warm temperate, dry subtropical, humid subtropical, wet subtropical (CBD, 2020). Because of this high environmental heterogeneity 106 species (51 from current study and 55 from online databases) cannot make up the complete checklist of ants as the major proportion of the country's area is unexplored and needs intensive investigation.

In order to address this question further and to evaluate the potential species pool of the region, we compared the species checklists of

Bhutan's neighboring countries (three states from India- Assam, Sikkim, Arunachal Pradesh; Nepal and Tibet from China) with our species list. A total of 500 species was considered (Fig. 2). Seventeen species in the center of the figure occur in all countries, while the numbers at the edge of the diagram give species that are restricted to one area (country, state or merged states), e.g. there were 15 species restricted to Bhutan and not (yet) recorded in any other of these Himalayan states. These include true Bhutan endemics, like *Strumigenys uberyx*, *Myrmica villosa* and *M. collingwoodi* as well as species that are well known from Indian Himalayas, e.g. *Polyrhachis punctillata*, *Harpegnathos venator* (Bharti et al. 2013) and elsewhere. The other fields of the diagram show different intersections of these ant lists. Most interesting are 18 species that occur in all of the other states, but not in Bhutan. These include some widespread Asian species, as well as invasives and tramp species, e.g. *Camponotus rufoglaucus*, *Crematogaster rogenhoferi*, *Anoplolepis gracilipes* and *Tapinoma melanocephalum* (see Electronic Appendix A1). There is a greater probability of finding this aforementioned tramp species in Bhutan as the current sampling area was very small and is not representative. However, these tramp species could also be absent because the country is mainly covered by large undisturbed forested areas, thus differing from the neighboring units, which were subject to greater anthropogenic change and obtain more traffic from outside. Similarly, those species are important that occur both, in the west (Nepal & Sikkim) and east (Arunachal Pradesh) of Bhutan, but are still not listed for the country itself. These 27 species live in a very similar habitat at the same latitude and under similar altitudinal gradients. *Camponotus arrogans*, *Dolichoderus feae* and *Crematogaster buddhae* are among these species. Species that occur in the north (Tibet) and in the south (Assam) of Bhutan, but not in the countryside could be habitat specialists or exhibit a broad environmental niche. They should be also found in Bhutan, as well as all the other altogether 131 species that occur on two opposing or three sides of the country, but not in Bhutan itself. A total of 149 species are thus prone to become new members of the Bhutanese ant species list.

The results of this work will unravel and shed light on the understanding of Bhutanese ant fauna and can be considered to be a significant step forward in discovering new species of ants. Comparing the species lists of the neighboring countries gives a first hint to the species that future studies may exhibit and can lead our research to specific habitats, where those species wait for their discovery.

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