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Cong Liu<sup>1</sup>, Georg Fischer<sup>2</sup>, Francisco Hita Garcia<sup>2</sup>, Seiki Yamane<sup>3</sup>, Qing Liu<sup>4</sup>, Yan Qiong Peng<sup>5</sup>, Evan P. Economo<sup>2</sup>, Benoit Guénard<sup>6</sup>, Naomi E. Pierce<sup>1</sup>

I Department of Organismic and Evolutional Biology, Museum of Comparative Zoology, Harvard University, 26 Oxford Street, Cambridge, MA 02138, USA 2 Biodiversity and Biocomplexity Unit, Okinawa Institute of Science and Technology Graduate University, Onna, Okinawa, Japan 3 Kagoshima University Museum, Korimoto 1-21-30, Kagoshima-shi, Japan 4 School of Resources and Environment, Baoshan University, Baoshan city, Yunnan Province, China 5 CAS Key Laboratory of Tropical Forest Ecology, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Mengla, Yunnan Province, China 6 School of Biological Sciences, The University of Hong Kong, Hong Kong SAR, China

Corresponding author: Cong Liu (cong.liu0514@gmail.com)

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#### Abstract

China's Hengduan Mountain region has been considered one of the most diverse regions in the northern hemisphere. Its stunning topography with many deep valleys and impassable mountain barriers has promoted an astonishing diversification in many groups of organisms including plants, birds, mammals, and amphibians. However, the insect biodiversity in this region is still poorly known. Here, the first checklist of ant species from the Southern Hengduan Mountain region is presented, generated by sampling ant diversity using a wide array of collection methods, including Winkler leaf litter extraction, vegetation beating, and hand collection. 130 species/morphospecies from nine subfamilies and 49 genera were identified. Among them, 17 species from 13 genera represent new records for Yunnan province, and eight species are newly recorded for China. Moreover, we believe 41 novel morphospecies (31% of the total collected taxa) will prove to be new to science. These results highlight the rich ant fauna of this region and strongly sup-

port its status as a biodiversity hotspot. The current ant species checklist for the whole of Yunnan Province was updated by recording 550 named species from 99 genera. Taken together, our results suggest that the Yunnan ant fauna still remains under-sampled, and future sampling will likely yield many more species, among them many undescribed ones.

#### **Keywords**

biodiversity hotspot; checklist; China; Formicidae; Hengduan Mountains; new records; species

#### Introduction

The Hengduan Mountain region, located in the southeastern part of the Qinghai-Tibet Plateau, is one of the 35 recognized biodiversity hotspots in the world (Myers et al. 2000). The unique landscape, geomorphology, microhabitat differentiation and geographic isolation created by tectonic uplift during the last eight million years has promoted an astonishing diversification in many groups of organisms, making this region one of the most diverse temperate regions in the northern hemisphere (Boufford 2014; Price et al 2014; Xing and Ree 2017). For example, it harbors nearly 40 percent of China's vascular plant diversity (ca. 12,000 species), including more than 3,000 endemic species (Boufford 2014). However, aside from the well-documented plants and some vertebrates, the diversity of other groups, especially invertebrates in this region remains largely unknown. Insect taxonomic groups in particular have received limited attention, and our understanding of their diversity in the Hengduan Mountains is extremely fragmented.

Ants are an ecologically dominant component of many ecosystems in terms of their abundance, richness, and ecosystem function (Hölldobler and Wilson 1990). Globally, about 15,600 ant species and subspecies have been described (Bolton 2020), making them the most diverse group of social insects and one of the most diverse families of insects. Despite the fact that ant diversity is mainly concentrated within tropical regions (Dunn et al. 2009; Guénard et al. 2012; Economo et al. 2018), the ant fauna of many other regions is still poorly known, especially in Asia (Guénard et al. 2010). Compiling and curating comprehensive and accurate ant species checklists for these regions is essential not only for insights into ant taxonomy and systematics, but also for long-term monitoring and conservation of these ecosystems (Guénard et al. 2017). The goal of this study is to provide a better understanding of the poorly known ant biodiversity in China's Hengduan Mountains. The ultra-variable topography of this region, ideal for creating numerous vicariance events, combined with its wide range of climatic zones has contributed to the exceptional richness of endemic species inhabiting this area. Nevertheless, the rough topography has also made access and exploration rather challenging in the past. Against the background of extraordinary levels of plant diversity harbored by the Hengduan Mountains, it remains unclear whether or not ants and other insects display similar patterns of high diversity and endemism in this region.

To address this gap, we here present the results of an ant biodiversity survey conducted in the Gaoligong Shan mountains (part of the Hengduan Mountains), Yunnan Province, southwest China undertaken in 2019. Our goal is to present a complete species checklist of ants from the Gaoligong Mountains, including new records, as well as to update the current ant species checklist for the whole of Yunnan Province.

The Gaoligong Shan mountains (lat. 24°560'–28°220'N, long. 98°080'–98°500'E) comprise the western-most part of the Hengduan Mountain Range, and are among the most biodiversity-rich areas in Yunnan (Li et al. 2008; Dumbecher et al. 2011; Lo and Bi 2019). The ant fauna in the Gaoligong Shan mountains remains poorly understood, despite several studies focusing on ant diversity patterns that have recorded 62 ant species from 31 genera (Xu 2001a, b), but lack a comprehensive list of species collected.

Yunnan province is the richest province of China in terms of ant diversity (Guénard and Dunn 2012). The latest ant checklist of Yunnan was compiled almost 10 years ago and consisted of 462 ant species. Since then, new ant inventories have been conducted (e.g. Liu et al. 2015a), as well as new species descriptions (e.g., Guénard et al. 2013; Xu et al. 2014a, b; Liu et al. 2015b; Staab et al. 2018), and the identification of previously dubious records have sensibly modified our understanding of Yunnan's ant diversity and species composition. Therefore, in this study, we also provide an update to the ant species checklist of Yunnan province and discuss future trends.

#### Materials and methods

Ant specimens were collected from natural forests along an elevational gradient on both the eastern and western slopes of the Gaoligong Mountains in July 2019. We sampled leaf litter ants from 16 sites at roughly 150 m elevational intervals from 600 m to 3000 m, following the standardized sampling protocol developed in Liu et al. 2016. At each site, we established a 400 m<sup>2</sup> quadrat (20 m × 20 m) and collected leaf litter samples at the four corners of the quadrat (1 m<sup>2</sup>). We also collected leaf litter within the quadrat to cover a variety of microhabitats. Finally, ants on the ground, lower vegetation, and tree branches were collected both by hand and using a beating sheet. Leaf litter samples were extracted using mini Winkler extractors for 72 hours using the shuffling method described in Guénard and Lucky (2011).

Ant specimens were first placed in 99% ethanol and later sorted into morphospecies and point mounted. Each mounted specimen was assigned a unique Museum of Comparative Zoology, Harvard University (**MCZ**) specimen code and collection labels. Extended depth of field specimen images were taken with a Leica DFC400 digital camera mounted on a Leica M205C stereomicroscope through the Leica Application Suite V4 software in the Ant Room at the MCZ. Specimens were identified to species / morphospecies using available keys, the digital resources on Antwiki (http:// www.antwiki.org) and AntWeb (http://www.antweb.org), as well as reference museum material. All mounted and alcohol-preserved ant specimens are currently deposited in the Ant Room of the MCZ.

Distribution maps of species were generated from records included within the Global Ant Biodiversity Informatics (GABI) database and available at https://antmaps. org (Janicki et al, 2016; Guénard et al. 2017). These maps are based on records reported

at the country level, or at the first administrative division for the larger countries (China, India, Japan). For larger islands that form their own natural biogeographic units like Borneo, Sumatra, New Guinea, the distribution maps used the island boundary instead of political boundaries (see also Guénard et al. 2012).

#### Results

#### Ants of the Hengduan Mountain region

More than 3000 specimens were collected during this survey, and 130 species and morphospecies in 49 genera and nine subfamilies were identified. After identification of 88 valid species from the 130 total collected species, a total of 17 new species records are presented for Yunnan province and eight represent new records for China (see Table 1). The newly recorded species belong to 13 genera from four subfamilies. Moreover, the 41 morphospecies that could not be identified are likely to represent new species.

Within the recent collection, the most speciose ant genus is *Pheidole* with eleven species (8.5% of the total species collected in the survey), followed by *Camponotus* (ten species, 7.7%), and *Polyrhachis* (seven species, 5.4%). Other diverse genera include *Aphaenogaster* (6 species, 4.6%), *Strumigenys* (six species, 4.6%), *Tetramorium* (six species, 4.6%), *Aenictus* (five species, 3.8%), and *Carebara* (five species, 3.8%). More details are presented in Table 2.

Here, we present the list of ant species that were collected in the Gaoligong Shan mountains (Table 1), as well as images for each species (Figs 1–136).

#### Updated ant checklist in Yunnan

The ant species list of Yunnan Province was generated using records from GABI available at https://antmaps.org (Janicki et al. 2016; Guénard et al. 2017). In total, the Yunnan ant fauna is composed of 99 genera and 550 named species and subspecies. Among them, the ant genera *Lasiomyrma*, *Lordomyrma*, and *Prionopelta* are only known from unidentified morphospecies. Through our collection and the records from GABI, we have added 125 species and subspecies to the list of ants of Yunnan since the last ant checklist (Guénard et al. 2012). We also excluded 26 species records from the previous list and explained our rationale in each case (Table 3).

In Yunnan, the most diverse ant genus is *Pheidole* with 42 named species, followed by *Polyrhachis* (33 species), *Camponotus* (30 species), and *Tetramorium* (29 species). Other diverse genera include *Crematogaster* (25 species), and *Strumigenys* (25 species). Although 15 ant genera contain more than ten named species in Yunnan, the majority of ant genera occurring in Yunnan seem to be not particularly diverse. For example, 35 genera are represented by only one species in Yunnan (Table 4).

Species	Figure
Dorylinae	
Aenictus artipus Wilson, 1964	Fig. 1
** Aenictus brevinodus Jaitrong & Yamane, 2011	Fig. 2
Aenictus hodgsoni Forel, 1901	Fig. 3
Aenictus paradentatus Jaitrong, Yamane & Tasen, 2012	Fig. 4
* Aenictus watanasiti Jaitrong & Yamane, 2013	Fig. 5
Cerapachys sulcinodis Emery, 1889	Fig. 6
Cerapachys sp. clm01	Fig. 7
Chrysapace costatus (Bharti & Wachkoo, 2013)	Fig. 8
Dorylus orientalis Westwood, 1835	Figs 9,10
Ooceraea biroi (Forel, 1907)	Fig. 11
Amblyoponinae	
Stigmatomma octodentatum (Xu, 2006)	Fig. 12
Dolichoderinae	
Dolichoderus feae Emery, 1889	Fig. 13
Dolichoderus squamanodus Xu, 2001	Fig. 14
Dolichoderus taprobanae (Smith, 1858)	Fig. 15
Ochetellus glaber (Mayr, 1862)	Fig. 16
Tapinoma melanocephalum (Fabricius, 1793)	Fig. 17
Ectatomminae	115.17
Gnamptogenys guadrutinodules Chen Lattke & Zhou 2017	Fig. 18
Formicinae	119.10
Anophalepis gracilizes (Smith 1857)	Fig. 19
** Camponatus hellus laucadiscus Wheeler 1919	Fig. 20
** Camponotus beibitai Forel 1913	Fig. 20
Camponotus laciselene Wang & Wu 199/	Figs 22 23
Camponolus usiselene wallg & wit, 1994	Fig. 24
Camponotus mitis (Sinthi, 1856)	Eig. 25
Camponolius nuobulensis Iviayi, 1809	Fig. 26
Camponotas sp. clm01	Fig. 20
Camponolas sp. cimoz	Fig. 2/
Camponolas sp. clinios	Fig. 20
Camponolas sp. cinio4	Fig. 29
Camponolas sp. cililo	Fig. 30
Formica cunicularia Lattenie, 1798	Fig. 31
<i>Formica japonica</i> Motschoulsky, 1866	Fig. 32
Lasius obscuratus Stitz, 1950	Fig. 35
Lasius nimalayanus Bingnam, 1903	Fig. 34
Nylanderia bourbonica (Forel, 1886)	Fig. 35
Nylanderia sp. clm01	Fig. 36
Nylanderia sp. clm02	Fig. 3/
Oecophylla smaragdina (Fabricius, 1//5)	Fig. 38
Paraparatrechina sakurae (Ito, 1914)	Fig. 39
Paraparatrechina sp. clmU1	Fig. 40
Paraparatrechina sp. clm02	Fig. 41
Polymachis armata (Le Guillou, 1842)	Fig. 42
Polyrhachts bihamata (Drury, 17/3)	Fig. 43
Polymachis dives Smith, 185/	Fig. 44
Polymachis furcata Smith, 1858	Fig. 45
Polyrhachis halidayi Emery, 1889	Fig. 46
Polyrhachis illaudata Walker, 1859	Fig. 47
Polyrhachis laevigata Smith, 1857	Fig. 48

**Table 1.** List of ant species (Formicidae) in the Gaoligong Shan mountains, Yunnan with their respectiveillustrations. \* New to Yunnan province; \*\*New to China.

Phythesis     Fig. 49       * Prendepis argulariz Zhou. 2001     Fig. 50       * Prendepis funited Williams & LaPolla. 2016     Fig. 51       Prendepis p. clm01     Fig. 52       Prendepis p. clm02     Fig. 53       Prendepis p. clm02     Fig. 53       Prendepis p. clm01     Fig. 54       Prendepis p. clm02     Fig. 55       Prendepis p. clm01     Fig. 56       Aphaemagestre p. clm01     Fig. 56       Aphaemagestre p. clm03     Fig. 58       Aphaemagestre p. clm03     Fig. 60       Aphaemagestre p. clm04     Fig. 61       * Condincombylic linubil Sciert, Okita & Heinze, 2017     Fig. 63       Cardiscond plaine linubil Sciert, Okita & Heinze, 2017     Fig. 63       Cardebard plini (Jecdon, 1851)     Fig. 64       Cardebard plini (Jecdon, 1851)     Fig. 65       Cardebard plini (Jecdon, 1851)     Fig. 66       Cardebard plini (Jecdon, 1974     Fig. 69       Cardebard plinoders p. clm01     Fig. 71       Creatagester sp. clm01     Fig. 73       Cardebard plinoders p. clm01     Fig. 73       Cardebard plinoderoderequadring for forcl, 1911     Fig. 73 </th <th>Species</th> <th>Figure</th>	Species	Figure
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Strumigenys sp. clm02 Fig. 104   Strumigenys sp. clm03 E:~ 105	Strumingenys sp. clm01	Fig. 105
	Strumigenus sp. clm02	Fig. 105

Species	Figure
* Temnothorax striatus Zhou, Huang, Yu & Liu, 2010	Fig. 106
Temnothorax sp. clm01	Fig. 107
Temnothorax sp. clm03	Fig. 108
Tetramorium tonganum Mayr, 1870	Fig. 109
Tetramorium sp. clm01	Fig. 110
Tetramorium sp. clm02	Fig. 111
Tetramorium sp. clm03	Fig. 112
Tetramorium sp. clm04	Fig. 113
<i>Vollenhovia pyrrhoria</i> Wu & Xiao, 1989	Fig. 114
<i>Vollenhovia</i> sp. clm03	Fig. 115
Ponerinae	-
Brachyponera luteipes (Mayr, 1862)	Fig. 116
Ectomomyrmex lobocarenus (Xu, 1995)	Fig. 117
** Ectomomyrmex obtusus Emery, 1900	Fig. 118
Hypoponera sp. clm01	Fig. 119
Hypoponera sp. clm02	Fig. 120
Hypoponera sp. clm03	Fig. 121
Leptogenys birmana Forel, 1900	Fig. 122
Leptogenys kitteli (Mayr, 1870)	Fig. 123
Odontomachus circulus Wang, 1993	Fig. 124
* Odontomachus fulgidus Wang, 1993	Fig. 125
Platythyrea parallela (Smith, 1859)	Fig. 126
Ponera bawana Xu, 2001	Fig. 127
Ponera xantha Xu, 2001	Fig. 128
Proceratinae	
Discothyrea banna Xu, Burwell & Nakamura, 2014	Fig. 129
Discothyrea diana Xu, Burwell & Nakamura, 2014	Fig. 130
Proceratium longigaster Karavaiev, 1935	Fig. 131
Proceratium longmenense Xu, 2006	Fig. 132
Proceratium zhaoi Xu, 2000	Fig. 133
Pseudomyrmecinae	
Tetraponera allaborans (Walker, 1859)	Fig. 134
Tetraponera attenuata Smith, 1877	Fig. 135
Tetraponera protensa Xu & Chai, 2004	Fig. 136

**Table 2.** Number of ant species of per genus collected in this survey as well the total number of each species per genus in Yunnan province.

Genus	Gaoligongshan Mt.	Yunnan	Genus	Gaoligongshan Mt.	Yunnan
Camponotus	10	30	Leptogenys	2	17
Pheidole	8	42	Monomorium	2	6
Polyrhachis	8	32	Odontomachus	2	6
Aphaenogaster	6	10	Ponera	2	14
Strumigenys	6	24	Pristomyrmex	2	4
Tetramorium	5	29	Pseudolasius	2	6
Aenictus	5	19	Vollenhovia	2	3
Carebara	5	19	Anoplolepis	1	1
Prenolepis	4	7	Brachyponera	1	3
Crematogaster	3	25	Cataulacus	1	4
Dolichoderus	3	9	Chrysapace	1	1
Hypoponera	3	7	Dilobocondyla	1	3
Lasius	2	6	Dorylus	1	3
Myrmica	3	12	Gaoligongidris	1	1

Genus	Gaoligongshan Mt.	Yunnan	Genus	Gaoligongshan Mt.	Yunnan
Myrmecina	3	7	Gauromyrmex	1	1
Nylanderia	3	10	Gnamptogenys	1	7
Paraparatrechina	3	2	Lordomyrma	1	1
Proceratium	3	4	Ochetellus	1	1
Temnothorax	3	7	Oecophylla	1	1
Tetraponera	3	12	Ooceraea	1	1
Cardiocondyla	2	4	Platythyrea	1	2
Cerapachys	2	1	Stenamma	1	4
Discothyrea	2	3	Stigmatoma	1	11
Ectomomyrmex	2	8	Tapinoma	1	4
Formica	2	7	Total	130	550

**Table 3.** Ant species records that have been excluded from Yunnan when compared to the previous list. The explanation "Needs verification" usually signifies that the species has never been recorded before in this region and/or is easily mistaken for another species and likely to have been misidentified. "Dubious" means that the record occurrence is highly unlikely given the known species distribution. Notes provide additional references regarding records and/or further information.

Excluded species records	Explanations	Notes
Camponotus aethiops	Needs verification	A Palearctic species with distribution in Asia needs
		confirmation
Camponotus spenceri	Dubious	An Australian species misreported previously
Cardiocondyla nuda	Dubious	Could be C. kagutsuchi, see Seifert 2003
Discothyrea clavicornis	Dubious	A misidentification of D. diana
Discothyrea kamiteta	Dubious	A misidentification of D. banna
Formica fusca	Needs verification	A Palearctic species with distribution in Asia needs confirmation
Hypoponera exoecata	Needs verification	Species with distribution limited to East Asia
Lasius alienus	Dubious	See Seifert 2020
Lasius emarginatus	Dubious	A West Palearctic species with distribution in Asia doubtful
Lasius fuliginosus	Dubious	See Espadaler et al. 2001
Lasius niger	Dubious	See Seifert 1992
Lasius productus	Needs verification	Species with distribution limited to Japan and the Korean
-		Peninsula
Lasius spathepus	Needs verification	Species with distribution limited to Japan, the Korean
		Peninsula and Eastern Russia
Leptogenys yerburyi	Dubious	See Xu and He 2015
Myrmica inezae	Needs verification	See Chen et al. 2016.
Odontoponera transversa	Dubious	See Yamane 2009
Proceratium deelemani	Dubious	Record represented a new species subsequently described in
		Staab et al. 2018.
Proceratium japonicum	Dubious	A misidentification of <i>P. longigaster</i>
Temnothorax melleus	Needs verification	A central Asian species which presence in Yunnan requires
		confirmation
Tetramorium inglebyi	Dubious	An Indian species that is restricted to the Southwest.
Tetramorium globulinode	Dubious	An Afrotropical species incorrectly reported in Asia
Tetramorium khnum	Dubious	An endemic species in the Philippines
Tetramorium melleum	Dubious	A misidentification of T. wroughtonii
Tetraponera aitkenii	Dubious	Phil Ward (Personal communication, 18 August 2015)
Tetraponera nigra	Dubious	Phil Ward (Personal communication, 18 August 2015)
Vollenhovia emeryi	Dubious	See Wetterer et al. 2015

Genus	Native	Exotic	Genus	Native	Exotic
Pheidole	42	0	Solenopsis	2	1
Polyrhachis	32	0	Acanthomyrmex	2	0
Camponotus	30	0	Acropyga	2	0
Tetramorium	28	1	Echinopla	2	0
Crematogaster	25	0	Meranoplus	2	0
Strumigenys	24	1	Myrmoteras	2	0
Aenictus	19	0	Paraparatrechina	2	0
Carebara	19	0	Perissomyrmex	2	0
Leptogenys	17	0	Platythyrea	2	0
Ponera	14	0	Pseudoneoponera	2	0
Tetraponera	12	0	Rhopalomastix	2	0
Myrmica	12	0	Trichomyrmex	0	2
Stigmatomma	11	0	Vollenhovia	2	0
Technomyrmex	11	0	Anoplolepis	1	0
Aphaenogaster	10	0	Buniapone	1	0
Nylanderia	9	1	Centromyrmex	1	0
Dolichoderus	9	0	Cerapachys	1	0
Ectomomyrmex	8	0	Chrysapace	1	0
Lepisiota	8	0	Diacamma	1	0
Colobopsis	7	0	Emeryopone	1	0
Hypoponera	5	2	Erromyrma	1	0
Prenolepis	7	0	Euponera	1	0
Temnothorax	7	0	Gaoligongidris	1	0
Formica	7	0	Gauromyrmex	1	0
Gnamptogenys	7	0	Gesomyrmex	1	0
Myrmecina	7	0	Harpegnathos	1	0
Anochetus	6	0	Iridomyrmex	1	0
Lasius	6	0	Lasiomyrma*	1	0
Odontomachus	6	0	Liometopum	1	0
Pseudolasius	6	0	Lioponera	1	0
Cryptopone	5	0	Lordomyrma*	1	0
Monomorium	5	0	Mesoponera	1	0
Proceratium	4	0	Messor	1	0
Cataulacus	4	0	Myrmicaria	1	0
Plagiolepis	3	1	Mystrium	1	0
Pristomyrmex	4	0	Ochetellus	1	0
Protanilla	4	0	Odontoponera	1	0
Stenamma	4	0	Oecophylla	1	0
Tapinoma	4	0	Ooceraea	1	0
Brachyponera	3	0	Parasyscia	1	0
Cardiocondyla	2	1	Paratrechina	0	1
Chronoxenus	3	0	Philidris	1	0
Dilobocondyla	3	0	Prionopelta*	1	0
Discothyrea	3	0	Probolomyrmex	1	0
Dorylus	3	0	Rotastruma	1	0
Kartidris	3	0	Simopone	1	0
Leptanilla	3	0	Syscia	1	0
Lophomyrmex	3	0	Vombisidris	1	0
Myopias	3	0	Yunodorylus	1	0
Recurvidris	3	0			

**Table 4.** Number of ant species (both native and exotic species) in Yunnan Province. \* Ant genus only known from morphospecies records.



#### Aenictus artipus

**Figure 1.** *Aenictus artipus* worker (MCZ-ENT00763651) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Aenictus brevinodus

**Figure 2.** *Aenictus brevinodus* worker (MCZ-ENT00763491, new to China) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Aenictus hodgsoni

**Figure 3.** *Aenictus hodgsoni* worker (MCZ-ENT00763191) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Aencitus paradentatus

**Figure 4.** *Aenictus paradentatus* worker (MCZ-ENT00763384) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Aenictus watanasiti

**Figure 5.** *Aenictus watanasiti* worker (MCZ-ENT00764608, new to Yunnan) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Cerapachys sulcinodus

**Figure 6.** *Cerapachys sulcinodis* worker (MCZ-ENT00759751) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Cerapachys sp1

**Figure 7.** *Cerapachys* sp. clm01worker (MCZ-ENT00763371) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



#### Chrysapace costatus

**Figure 8.** *Chrysapace costatus* worker (MCZ-ENT00763341) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Dorylus orientalis

**Figure 9.** *Dorylus orientalis* minor worker (MCZ-ENT00760027) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Dorylus orientalis (soldier)

**Figure 10.** *Dorylus orientalis* major worker (MCZ-ENT00760028) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Ooceraea biroi

**Figure 11.** *Ooceraea biroi* worker (MCZ-ENT00759984) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Stigmatoma octoderthatum

**Figure 12.** *Stigmatomma octodentatum* worker (MCZ-ENT00759880) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Dolichoderus feae

**Figure 13.** *Dolichoderus feae* worker (MCZ-ENT00763272) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Dolichoderus squamanodus

**Figure 14.** *Dolichoderus squamanodus* worker (MCZ-ENT00762839) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Dolichoderus taprobanae

**Figure 15.** *Dolichoderus taprobanae* worker (MCZ-ENT00763246) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Ochetellus glaber

**Figure 16.** *Ochetellus glaber* worker (MCZ-ENT00763401) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Tapinoma melanocephalum

**Figure 17.** *Tapinoma melanocephalum* worker (MCZ-ENT00760062) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Gnamptogenys quadrutinodules

**Figure 18.** *Gnamptogenys quadrutinodules* worker (MCZ-ENT00759741) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Anoplolepis gracilipes

**Figure 19.** *Anoplolepis gracilipes* worker (MCZ-ENT00760060) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Camponotus bellus leucodiscus

**Figure 20.** *Camponotus bellus leucodiscus* worker (MCZ-ENT00760068, new to China) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Camponotus keihitoi

**Figure 21.** *Camponotus keihitoi* worker (MCZ-ENT00763692, new to China) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Camponotus lasiselene

**Figure 22.** *Camponotus lasiselene* minor worker (MCZ-ENT00763190) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



Camponotus lasiselene

**Figure 23.** *Camponotus lasiselene* major worker (MCZ-ENT00763247) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Camponotus mitis

**Figure 24.** *Camponotus mitis* worker (MCZ-ENT00763213) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Camponotus nicobarensis

**Figure 25.** *Camponotus nicobarensis* worker (MCZ-ENT00763198) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.


**Figure 26.** *Camponotus* sp. clm01 worker (MCZ-ENT00762843) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



Camponotus sp2

**Figure 27.** *Camponotus* sp. clm02 worker (MCZ-ENT00759861) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



Camponotus sp3

**Figure 28.** *Camponotus* sp. clm03 worker (MCZ-ENT00762821) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



Camponotus sp4

**Figure 29.** *Camponotus* sp. clm04 worker (MCZ-ENT00762978) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



**Figure 30.** *Camponotus* sp. clm05 worker (MCZ-ENT00763312) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



### Formica cunicularia

**Figure 31.** *Formica cunicularia* worker (MCZ-ENT00759967) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Formica japonica

**Figure 32.** *Formica japonica* worker (MCZ-ENT00760066) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Lasius obscuratus

**Figure 33.** *Lasius obscuratus* worker (MCZ-ENT00760025, new to Yunnan) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Lasius himalayanus

**Figure 34.** *Lasius himalayanus* worker (MCZ-ENT00763360, new to Yunnan) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Nylanderia bourbonica

**Figure 35.** *Nylanderia bourbonica* worker (MCZ-ENT00760019) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Nylanderia sp1

**Figure 36.** *Nylanderia* sp. clm01 worker (MCZ-ENT00759776) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## *Nylanderia* sp2

**Figure 37.** *Nylanderia* sp. clm02 worker (MCZ-ENT00759968) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



Oecophylla smaragdina

**Figure 38.** *Oecophylla smaragdina* worker (MCZ-ENT00763551) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Paraparatrechina sakurae

**Figure 39.** *Paraparatrechina sakurae* worker (MCZ-ENT00759953) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Paraparatrechina sp1

**Figure 40.** *Paraparatrechina* sp. clm01 worker (MCZ-ENT00763500) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



0.25 mm

# Paraparatrechina sp2

**Figure 41.** *Paraparatrechina* sp. clm02 worker (MCZ-ENT00763427) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Polyrhachis armata

**Figure 42.** *Polyrhachis armata* worker (MCZ-ENT00763282) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



**Figure 43.** *Polyrhachis bihamata* worker (MCZ-ENT00763176). **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



Polyrhachis dives

**Figure 44.** *Polyrhachis dives* worker (MCZ-ENT00760042). **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Polyrhachis furcata

**Figure 45.** *Polyrhachis furcata* worker (MCZ-ENT00763549) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Polyrhachis halidayi

**Figure 46.** *Polyrhachis halidayi* worker (MCZ-ENT00763195) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Polvrhachis illaudata

**Figure 47.** *Polyrhachis illaudata* worker (MCZ-ENT00760071) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Polychachis laevigata

**Figure 48.** *Polyrhachis laevigata* worker (MCZ-ENT00763568) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Polyrhachis tibialis

**Figure 49.** *Polyrhachis tibialis* worker (MCZ-ENT00763284). **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Prenolepis angularis

**Figure 50.** *Prenolepis angularis* worker (MCZ-ENT00763328, new to Yunnan). **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Prenolepis fustinoda

**Figure 51.** *Prenolepis fustinoda* worker (MCZ-ENT00763200, new to Yunnan) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Prenolepis sp1

**Figure 52.** *Prenolepis* sp. clm01 worker (MCZ-ENT00763220) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.





0.25 mm

# Prenolepis sp2

**Figure 53.** *Prenolepis* sp. clm02 worker (MCZ-ENT00763467) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



### Pseudolasius emeryi

**Figure 54.** *Pseudolasius emeryi* worker (MCZ-ENT00762951) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Pseudolasius silvestrii

**Figure 55.** *Pseudolasius silvestrii* worker (MCZ-ENT00762838) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Aphenogaster feae

**Figure 56.** *Aphaenogaster feae* worker (MCZ-ENT00763554) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map..



**Figure 57.** *Aphaenogaster* sp. clm01 worker (MCZ-ENT00762870) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



Aphaenogaster sp2

**Figure 58.** *Aphaenogaster* sp. clm02 worker (MCZ-ENT00763366) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



Aphaenogaster sp3

**Figure 59.** *Aphaenogaster* sp. clm03 worker (MCZ-ENT00763603) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



Aphenogaster sp4

**Figure 60.** *Aphaenogaster* sp. clm04 worker (MCZ-ENT00764622) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



Aphaenogaster sp5

**Figure 61.** *Aphaenogaster* sp. clm05 worker (MCZ-ENT00762809) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.


#### Cardiocondyla itsukii

**Figure 62.** *Cardiocondyla itsukii* worker (MCZ-ENT00762820, new to Yunnan) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Cardiocondyla sp1

**Figure 63.** *Cardiocondyla* sp. clm01worker (MCZ-ENT00763607) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



#### Carebara acutispina

**Figure 64.** *Carebara affinis* worker (MCZ-ENT00759841) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Carebara affinis

**Figure 65.** *Carebara acutispina* worker (MCZ-ENT00759773) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Carebara altinoda

**Figure 66.** *Carebara altinoda* worker (MCZ-ENT00759928) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Caerbara bihornata

**Figure 67.** *Carebara bihornata* worker (MCZ-ENT00759796) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Carebara sp1

**Figure 68.** *Carebara* sp. clm01 worker (MCZ-ENT00759855) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



# Cataulacus marginatus

**Figure 69.** *Cataulacus marginatus* worker (MCZ-ENT00760045, new to Yunnan) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Crematogaster quadriruga

**Figure 70.** *Crematogaster quadriruga* worker (MCZ-ENT00759778) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Crematogaster sp1

**Figure 71.** *Crematogaster* sp. clm01 worker (MCZ-ENT00762837) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



# Crematogaster sp2

**Figure 72.** *Crematogaster* sp. clm02 worker (MCZ-ENT00762875) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



#### Dilobocondyla eguchii

**Figure 73.** *Dilobocondyla eguchii* worker (MCZ-ENT00763656, new to China) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Gaoligongidris planodorsa

**Figure 74.** *Gaoligongidris planodorsa* worker (MCZ-ENT00759792) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Grauromyrmex sp1

**Figure 75.** *Gauromyrmex* sp. clm01 worker (MCZ-ENT00764656) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Lordomyrma sp1

**Figure 76.** *Lordomyrma* sp. clm01 worker (MCZ-ENT00763514) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Monomorium pharaonis

**Figure 77.** *Monomorium pharaonis* worker (MCZ-ENT00760064) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Monomorium sp1

**Figure 78.** *Monomorium* sp. clm01worker (MCZ-ENT00759771) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



### Myrmica draco

**Figure 79.** *Myrmica draco* worker (MCZ-ENT00759985) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Myrmica pleiorhytida

**Figure 80.** *Myrmica pleiorhytida* worker (MCZ-ENT00759935) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



**Figure 81.** *Myrmica* sp. clm01 worker (MCZ-ENT00763256) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



Myrmecina sp1

**Figure 82.** *Myrmecina* sp. clm01 worker (MCZ-ENT00759959) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



**Figure 83.** *Myrmecina* sp. clm02 worker (MCZ-ENT00759803). **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



**Figure 84.** *Myrmecina* sp. clm03 worker (MCZ-ENT00763515). **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



### Pheidole allani

**Figure 85.** *Pheidole allani* minor worker (MCZ-ENT00759865) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Pheidole allani

**Figure 86.** *Pheidole allani* major worker (MCZ-ENT00759866) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Pheidole fervens

**Figure 87.** *Pheidole fervens* worker (MCZ-ENT00764619) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Pheidole fervida

**Figure 88.** *Pheidole fervida* minor worker (MCZ-ENT00759918) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



**Figure 89.** *Pheidole fervida* major worker (MCZ-ENT00760026) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Pheidole gatesi

**Figure 90.** *Pheidole gatesi* worker (MCZ-ENT00763577) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Pheidole indica

**Figure 91.** *Pheidole indica* worker (MCZ-ENT00762822) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Pheidole magna minor

**Figure 92.** *Pheidole magna* minor worker (MCZ-ENT00759762) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Pheidole magna

**Figure 93.** *Pheidole magna* major worker (MCZ-ENT00759980) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Pheidole nodifera

**Figure 94.** *Pheidole nodifera* worker (MCZ-ENT00759837, new to Yunnan) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Pheidole zoceana

**Figure 95.** *Pheidole zoceana* minor worker (MCZ-ENT00760015) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Pheidole zoceana

**Figure 96.** *Pheidole zoceana* major worker (MCZ-ENT00760016) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Pristomyrmex brevispinosies

**Figure 97.** *Pristomyrmex brevispinosus* worker (MCZ-ENT00763505) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.


### Pristomyrmex hamatus

**Figure 98.** *Pristomyrmex hamatus* worker (MCZ-ENT00763502) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Stenamma wumengense

**Figure 99.** *Stenamma wumengense* worker (MCZ-ENT00762907) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Strumigenys assamensis

**Figure 100.** *Strumigenys assamensis* worker (MCZ-ENT00759885) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Strumigenys strygax

**Figure 101.** *Strumigenys strygax* worker (MCZ-ENT00763507) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Strumigenys taphra

**Figure 102.** *Strumigenys taphra* worker (MCZ-ENT00759758, new to China) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



Strumigenys sp1

**Figure 103.** *Strumigenys* sp. clm01 worker (MCZ-ENT00763511) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



**Figure 104.** *Strumigenys* sp. clm02 worker (MCZ-ENT00759897) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



### Strumigenys sp3

**Figure 105.** *Strumigenys* sp. clm03 worker (MCZ-ENT00759991) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



#### Temnothorax striatus

**Figure 106.** *Temnothorax striatus* worker (MCZ-ENT00759763, new to Yunnan) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



Figure 107. Temnothorax sp. clm01 worker (MCZ-ENT00759977) A mesosoma in profile view B mesosoma in dorsal view **C** head in front view.



Temnothorax sp3

**Figure 108.** *Temnothorax* sp. clm03 worker (MCZ-ENT00763303) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



#### Tetramorium tonganum

**Figure 109.** *Tetramorium tonganum* worker (MCZ-ENT00764651) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Tetramorium sp1

**Figure 110.** *Tetramorium* sp. clm01 worker (MCZ-ENT00759754) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



### Tetramorium sp2

**Figure 111.** *Tetramorium* sp. clm02 worker (MCZ-ENT00763454) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



Tetramorium sp3

**Figure 112.** *Tetramorium* sp. clm03 worker (MCZ-ENT00760040) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



**Figure 113.** *Tetramorium* sp. clm04 worker (MCZ-ENT00759856) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



### Vollenhovia pyrrhoria

**Figure 114.** *Vollenhovia pyrrhoria* worker (MCZ-ENT00759854) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Vollenhovia sp3

**Figure 115.** *Vollenhovia* sp. clm03 worker (MCZ-ENT00764617) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



#### Brachyponera luteipes

**Figure 116.** *Brachyponera luteipes* worker (MCZ-ENT00759752) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Ectomomyrmex lobocarenus

**Figure 117.** *Ectomomyrmex lobocarenus* worker (MCZ-ENT00759748) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Ectomomyrmex obtusus

**Figure 118.** *Ectomomyrmex obtusus* worker (MCZ-ENT00759859, new to China) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Hypoponera sp1

**Figure 119.** *Hypoponera* sp. clm01 worker (MCZ-ENT00759780) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



# *Hypoponera* sp2

**Figure 120.** *Hypoponera* sp. clm02 worker (MCZ-ENT00759849) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



# Hypoponera sp3

**Figure 121.** *Hypoponera* sp. clm03 worker (MCZ-ENT00759808) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view.



## Leptogenys birmana

**Figure 122.** *Leptogenys birmana* worker (MCZ-ENT00763178) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Leptogenys kitteli

**Figure 123.** *Leptogenys kitteli* worker (MCZ-ENT00763321). **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Odontonmachus circulus

**Figure 124.** *Odontomachus circulus* worker (MCZ-ENT00762856). **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Odontomachus fulgidus

**Figure 125.** *Odontomachus fulgidus* worker (MCZ-ENT00760009, new to Yunnan) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Platythyrea parallela

**Figure 126.** *Platythyrea parallela* worker (MCZ-ENT00763657) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



### Ponera bawana

**Figure 127.** *Ponera bawana* worker (MCZ-ENT00759807) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Ponera xantha

**Figure 128.** *Ponera xantha* worker (MCZ-ENT00759845) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



Discothyrea banna

**Figure 129.** *Discothyrea banna* worker (MCZ-ENT00759809) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



Discothyre dina

**Figure 130.** *Discothyrea diana* worker (MCZ-ENT00759806) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



#### Proceratium longigaster

**Figure 131.** *Proceratium longigaster* worker (MCZ-ENT00759931) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Proceratium longmenense

**Figure 132.** *Proceratium longmenense* worker (MCZ-ENT00763325) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



## Proceratium zhaoi

**Figure 133.** *Proceratium zhaoi* worker (MCZ-ENT00759857) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.


# Tetraponera allaborans

**Figure 134.** *Tetraponera allaborans* worker (MCZ-ENT00763523) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Tetraponera attenuata

**Figure 135.** *Tetraponera attenuata* worker (MCZ-ENT00763165) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.



# Tetraponera protensa

**Figure 136.** *Tetraponera protensa* worker (MCZ-ENT00763526) **A** mesosoma in profile view **B** mesosoma in dorsal view **C** head in front view **D** global distribution map.

## Yunnan ant list:

### AMBLYOPONINAE

Mystrium: 1 species

Mystrium camillae Emery, 1989

Prionopelta: 1 species (undescribed)

Prionopelta sp.

Stigmatomma: 11 species

\* Stigmatomma amblyops Karavaiev, 1935
\* Stigmatomma awa (Xu, 2012)
Stigmatomma crenatum (Xu, 2001)
\* Stigmatomma kangba (Xu, 2012)
\* Stigmatomma meilianum (Xu, 2012)
\* Stigmatomma mulanae (Xu, 2000)
Stigmatomma octodentatum (Xu, 2006)
Stigmatomma rothneyi (Forel, 1900)
\* Stigmatomma silvestrii (Wheeler, 1928)
Stigmatomma trilobum (Xu, 2001)

## DOLICHODERINAE

Chronoxenus: 3 species

Chronoxenus myops (Forel, 1895) Chronoxenus walshi (Forel, 1895) Chronoxenus wroughtonii (Forel, 1895)

Dolichoderus: 9 species

Dolichoderus affinis Emery, 1889 Dolichoderus feae Emery, 1889 Dolichoderus incisus Xu, 1995 \* Dolichoderus laotius Santschi, 1920 Dolichoderus moggridgei Forel, 1886 Dolichoderus sagmanotus Xu, 2001 Dolichoderus squamanodus Xu, 2001 Dolichoderus taprobanae (Smith, 1858) Dolichoderus thoracicus (Smith, 1860)

Iridomyrmex: 1 species

Iridomyrmex anceps (Roger, 1863)

Liometopum: 1 species

Liometopum sinense Wheeler, 1921

Ochetellus: 1 species

Ochetellus glaber (Mayr, 1862)

Philidris: 1 species

Philidris laevigata (Emery, 1895)

Tapinoma: 4 species

*Tapinoma geei* Wheeler, 1927 *Tapinoma indicum* Wheeler, 1895 *Tapinoma melanocephalum* (Fabricius, 1793) *Tapinoma wroughtonii* Forel, 1904

Technomyrmex: 11 species

Technomyrmex albipes (Smith, 1861) Technomyrmex antennus Zhou, 2001 Technomyrmex bicolor Emery, 1893 Technomyrmex brunneus Forel, 1895 Technomyrmex elatior Forel, 1902 Technomyrmex horni Forel, 1912 \* Technomyrmex kraepelini Forel, 1905 Technomyrmex obscurior Wheeler, 1928 Technomyrmex pratensis (Smith, 1860) \* Technomyrmex vitiensis Mann, 1921 \* Technomyrmex yamanei Bolton, 2007

# DORYLINAE

Aenictus: 19 species

\* Aenictus artipus Wilson, 1964

Aenictus binghamii Forel, 1900 \* Aenictus brevinodus Jaitrong & Yamane, 2011 Aenictus ceylonicus (Mayr, 1866) Aenictus dentatus Forel, 1911 Aenictus feae Emery, 1889 Aenictus fergusoni Forel, 1901 Aenictus grandis Bingham, 1903 Aenictus hodgsoni Forel, 1901 Aenictus laeviceps (Smith, 1857) \* Aenictus maneerati Jaitrong & Yamane, 2013 \* Aenictus paradentatus Jaitrong & Yamane, 2012 Aenictus piercei Wheeler & Chapman, 1930 Aenictus punensis Forel, 1901 Aenictus shuckardi Forel, 1901 Aenictus thailandianus Terayama & Kubota, 1993 \* Aenictus watanasiti Jaitrong & Yamane, 2013 Aenictus westwoodi Forel, 1901 \* Aenictus yangi Liu, 2015

Cerapachys: 1 species

Cerapachys sulcinodis Emery, 1889

Chrysapace: 1 species

\* Chrysapace costatus (Bharti & Wachkoo, 2013)

Dorylus: 3 species

*Dorylus laevigatus* (Smith, 1857) *Dorylus orientalis* Westwood, 1835 *Dorylus vishnui* Wheeler, 1913

Lioponera: 1 species

Lioponera longitarsus (Mayr, 1879)

Ooceraea: 1 species

Ooceraea biroi (Forel, 1907)

Parasyscia: 1 species

Parasyscia fossulata (Forel, 1895)

\* Simopone yunnanensis Chen, 2015

Syscia: 1 species

Syscia typhla Roger, 1861

Yunodorylus: 1 species

Yunodorylus sexspinus Xu, 2000

#### **ECTATOMMINAE**

#### Gnamptogenys: 6 species

Gnamptogenys bicolor (Emery, 1889) Gnamptogenys coccina Zhou, 2001 \* Gnamptogenys coxalis (Roger, 1860) \* Gnamptogenys quadrutinodules Chen, 2017 Gnamptogenys sichuanensis Lattke, 2004 \* Gnamptogenys sinensis Wu & Xiao, 1987 \* Gnamptogenys treta Lattke, 2004

## FORMICINAE

Acropyga: 2 species

*Acropyga nipponensis* Terayama, 1985 *Acropyga yaeyamensis* Terayama & Hashimoto, 1996

Anoplolepis: 1 species

Anoplolepis gracilipes (Smith, 1857)

Camponotus: 28 species

Camponotus albosparsus Bingham, 1903 Camponotus anningensis Wu & Wang, 1989 Camponotus auratiacus Zhou, 2001 Camponotus barbatus taylori Forel, 1892 \* Camponotus bellus leucodiscus Wheeler, 1919 \* Camponotus binghamii Forel, 1894 Camponotus chongqingensis Wu & Wang, 1989

Camponotus compressus (Fabricius, 1787) Camponotus confucii Forel, 1894 Camponotus cornis Wang & Wu, 1994 \* Camponotus crassisquamis Forel, 1902 Camponotus dolendus Forel, 1892 Camponotus exiguoguttatus Forel, 1886 \* Camponotus fuscivillosus Xiao & Wang, 1989 *Camponotus holosericeus* Emery, 1889 \* Camponotus invidus Forel, 1892 \* Camponotus itoi Forel, 1912 Camponotus japonicus Mayr, 1866 Camponotus jianghuaensis Xiao & Wang, 1989 Camponotus lasiselene Wang & Wu, 1994 Camponotus minus Wang & Wu, 1994 Camponotus mitis (Smith, 1858) Camponotus nicobarensis Mayr, 1865 Camponotus parius Emery, 1889 Camponotus pseudoirritans Wu & Wang, 1989 Camponotus pseudolendus Wu & Wang, 1989 \* *Camponotus radiatus* Forel, 1892 Camponotus siemsseni Forel, 1901 *Camponotus singularis* (Smith, 1858) Camponotus tonkinus Santschi, 1925 *Camponotus vitiosus* (Smith, 1874)

#### Colobopsis: 7 species

Colobopsis badia (Smith, 1857) \* Colobopsis ceylonica (Emery, 1925) Colobopsis cotesii (Forel, 1893) Colobopsis leonardi (Emery, 1889) Colobopsis politae (Wu & Wang, 1994) Colobopsis rothneyi (Forel, 1893) Colobopsis vitrea (Smithi, 1860)

#### Echinopla: 2 species

\* Echinopla cherapunjiensis Bharti & Gul, 2012

\* Echinopla striata Smith, 1857

#### Formica: 5 species

Formica cunicularia Latreille, 1798

Formica gagatoides Ruzsky, 1904
Formica glabridorsis Santschi, 1925
Formica lemani Bondroit, 1917
Formica japonica Motschoulsky, 1866
Formica sanguinea Latreille, 1798
Formica sinensis Wheeler, 1913

## Gesomyrmex: 1 species

\* Gesomyrmex kalshoveni Wheeler, 1929

Lasius: 6 species

Lasius draco Collingwood, 1982 Lasius flavus (Fabricius, 1782) \* Lasius himalayanus Bingham, 1903 Lasius nipponensis Forel, 1912 \* Lasius obscuratus Stitz, 1930 Lasius sichuense Seifert, 2020

## Lepisiota: 8 species

Lepisiota acuta Xu, 1994 Lepisiota capensis (Mayr, 1862) Lepisiota opaca (Forel, 1892) \* Lepisiota pulchella (Forel, 1892) Lepisiota reticulata Xu, 1994 Lepisiota rothneyi (Forel, 1894) Lepisiota rothneyi wroughtonii (Forel, 1902) Lepisiota xichangensis (Wu & Wang, 1995)

Myrmoteras: 2 species

Myrmoteras binghamii Forel, 1893 Myrmoteras cuneonodus Xu, 1998

Nylanderia: 10 species

Nylanderia birmana (Forel, 1902) Nylanderia bourbonica (Forel, 1886) \* Nylanderia emmae (Forel, 1894) \* Nylanderia flaviabdominis (Wang, 1997) Nylanderia flavipes (Smith, 1874) Nylanderia indica (Forel, 1894) Nylanderia sharpii (Forel, 1899) Nylanderia taylori (Forel, 1894) Nylanderia vividula (Nylander, 1846) (**Exotic**) Nylanderia yerburyi (Forel, 1894)

## Oecophylla: 1 species

Oecophylla smaragdina (Fabricius, 1775)

#### Paraparatrechina: 2 species

\* Paraparatrechina sakurae (Ito, 1914) Paraparatrechina sauteri (Forel, 1913)

Paratrechina: 1 species

Paratrechina longicornis (Latreille, 1802) (Exotic)

#### Plagiolepis: 4 species

Plagiolepis alluaudi Emery, 1894 (**Exotic**) Plagiolepis demangei Santschi, 1920 Plagiolepis exigua Forel, 1894 \* Plagiolepis jerdonii Forel, 1894

#### Polyrhachis: 32 species

Polyrhachis armata (Le Guillou, 1842) Polyrhachis bakana Xu, 1998 Polyrhachis bicolor Smith, 1858 Polyrhachis bihamata (Drury, 1773) Polyrhachis brevicorpa Xu, 2002 Polyrhachis burmanensis Donisthorpe, 1938 Polyrhachis cornihumera Xu, 2002 Polyrhachis cornuhumera Zhou & Huang, 2002 Polyrhachis cyphonota Xu, 1998 Polyrhachis dentihumera Xu, 2002 Polyrhachis dives Smith, 1857 \* Polyrhachis exercita (Walker, 1859) Polyrhachis furcata Smith, 1858 Polyrhachis gibba Emery, 1901 Polyrhachis halidayi Emery, 1889 \* Polyrhachis hippomanes Emery, 1861 Polyrhachis hippomanes ceylonensis Emery, 1893 Polyrhachis illaudata Walker, 1859 Polyrhachis jianghuaensis Wang & Wu, 1991 Polyrhachis laevigata Smith, 1857 Polyrhachis moesta Emery, 1887 Polyrhachis orbihumera Xu, 2002 Polyrhachis paracamponota Wang & Wu, 1991 Polyrhachis proxima Roger, 1863 Polyrhachis pubescens Mayr, 1879 Polyrhachis punctillata Roger, 1863 Polyrhachis rastellata (Latreille, 1802) Polyrhachis rotoccipita Xu, 2002 Polyrhachis rufipes Smith, 1858 Polyrhachis thompsoni Bingham, 1903 Polyrhachis thrinax Roger, 1863 Polyrhachis tibialis Smith, 1858

#### Prenolepis: 7 species

Prenolepis angularis Zhou, 2001 \* Prenolepis fustinoda Williams & LaPolla, 2016 \* Prenolepis mediops Williams & LaPolla, 2016 Prenolepis melanogaster Emery, 1893 Prenolepis naoroji Forel, 1902 \* Prenolepis shanialena Williams & LaPolla, 2016 \* Prenolepis striata Chen & Zhou, 2018

#### Pseudolasius: 6 species

Pseudolasius bidenticlypeus Xu, 1997 Pseudolasius cibdelus Wu & Wang, 1992 Pseudolasius emeryi Forel, 1911 Pseudolasius familiaris (Smith, 1860) Pseudolasius risii Forel, 1894 Pseudolasius silvestrii Wheeler, 1927

#### LEPTANILLINAE

Leptanilla: 3 species

Leptanilla hunanensis Tang, Li & Chen, 1992 Leptanilla kunmingensis Xu & Zhang, 2002 Leptanilla yunnanensis Xu, 2002

Protanilla: 4 species

Protanilla bicolor Xu, 2002 Protanilla concolor Xu, 2002 \* Protanilla furcomandibula Xu, 2002 Protanilla gengma Xu, 2012

## MYRMICINAE

Acanthomyrmex: 2 species

Acanthomyrmex glabfemoralis Zhou & Zheng, 1997 Acanthomyrmex luciolae Emery, 1893

Aphaenogaster: 9 species

Aphaenogaster beccarii Emery, 1887 Aphaenogaster exasperata (Smith, 1921) Aphaenogaster famelica (Smith, 1874) Aphaenogaster feae Emery, 1889 \* Aphaenogaster geei Wheeler, 1921 Aphaenogaster japonica Forel, 1911 Aphaenogaster lepida Wheeler, 1930 Aphaenogaster rothneyi (Forel, 1902) Aphaenogaster schurri (Forel, 1902) Aphaenogaster smythiesii (Forel, 1902)

Cardiocondyla: 3 species

\* Cardiocondyla itsukii Seifert, Okita & Heinze, 2017 (Exotic) Cardiocondyla obscurior Wheeler, 1929 Cardiocondyla wroughtonii (Forel, 1890)

Carebara: 18 species

Carebara acutispina (Xu, 2003) Carebara affinis (Jerdon, 1951) Carebara altinoda (Xu, 2003) Carebara asina (Forel, 1902) Carebara bengalensis (Forel, 1902) Carebara bihornata (Xu, 2003) Carebara curvispina (Xu, 2003) \* Carebara diversa (Jerdon, 1851) \* Carebara jiangxiensis Wu & Wang, 1995 Carebara lignata Westwood, 1840 \* Carebara melasolena (Zhou & Zheng, 1997) Carebara obtusidenta (Xu, 2003) Carebara rectidorsa (Xu, 2003) Carebara reticapita (Xu, 2003) Carebara striata (Forel, 2003) Carebara taiponica (Wheeler, 1928) Carebara trechideros (Zhou & Zheng, 1997) Carebara wheeleri (Ettershank, 1966)

#### Cataulacus: 4 species

Cataulacus granulatus (Latreille,1802) \* Cataulacus marginatus Bolton, 1974 Cataulacus simoni Emery, 1893 Cataulacus taprobanae Smith, 1853

#### Crematogaster: 25 species

Crematogaster anthracina Smith, 1857 \* Crematogaster artifex Mayr, 1879 Crematogaster binghamii Forel, 1904 Crematogaster biroi Mayr, 1897 \* Crematogaster contemta Mayr, 1879 Crematogaster dalyi Forel, 1902 Crematogaster dohrni Mayr, 1879 Crematogaster ebenina Forel, 1902 Crematogaster ferrarii Emery, 1888 Crematogaster hodgsoni Forel, 1902 \* Crematogaster inflata Smith, 1857 Crematogaster macaoensis Wu & Wang, 1995 Crematogaster matsumurai Forel, 1901 Crematogaster nawai Ito, 1914 Crematogaster osakensis Forel, 1900 Crematogaster politula Forel, 1902 \* Crematogaster quadriruga Forel, 1911 Crematogaster rogenhoferi Mayr, 1879 Crematogaster rothneyi Mayr, 1879 Crematogaster subnuda Mayr, 1879

Crematogaster travancorensis Forel, 1902 Crematogaster treubi Emery, 1896 Crematogaster walshi Forel, 1902 Crematogaster wroughtonii Forel, 1902 Crematogaster zoceensis Santschi, 1925

## Dilobocondyla: 3 species

\* *Dilobocondyla eguchii* Bharti & Kumar, 2013 *Dilobocondyla fouqueti* Santschi, 1910 \* *Dilobocondyla gasteroreticulata* Bharti & Kumar, 2013

Erromyrma: 1 species

Erromyrma latinodis (Mayr, 1872)

Gaoligongidris: 1 species

Gaoligongidris planodorsa Xu, 2012

Gauromyrmex: 1 species

Gauromyrmex acanthinus (Karavaiev, 1935)

Kartidris: 3 species

Kartidris ashima Xu & Zheng, 1995 Kartidris nyos Bolton, 1991 Kartidris sparsipila Xu, 1999

Lasiomyrma: 1 species (undescribed)

Lasiomyrma sp.

Lophomyrmex: 3 species

Lophomyrmex bedoti Emery, 1893 Lophomyrmex birmanus Emery, 1893 Lophomyrmex quadrispinosus (Jerdon, 1851)

Lordomyrma: 1 species (undescribed)

Lordomyrma sp.

## Meranoplus: 2 speices

Meranoplus bicolor (Guérin-Méneville, 1844) Meranoplus laeviventris Emery, 1889

Messor: 1 species

\* Messor aciculatus (Smith, 1874)

## Monomorium: 5 species

Monomorium chinense Santschi, 1925 Monomorium floricola (Jerdon, 1851) \* Monomorium hainanense Wu & Wang, 1995 Monomorium orientale Mayr, 1879 Monomorium pharaonis (Linnaeus, 1758)

## Myrmecina: 5 species

\* Myrmecina asiatica Okido, Ogata & Hosoishsi, 2020
\* Myrmecina asthena Okido, Ogata & Hosoishsi, 2020
Myrmecina curvispina Zhou, Huang & Ma, 2008
Myrmecina guangxiensis Zhou, 2001
\* Myrmecina sinensis Wheeler, 1921
Myrmecina striata Emery, 1889
Myrmecina taiwana Terayama, 1995

#### Myrmica: 11 species

Myrmica curiosa Radchenko, Zhou & Elmes, 2008 Myrmica draco Radchenko, Zhou & Elmes, 2008 \* Myrmica excelsa Kupyanskaya, 1990 \* Myrmica heterorhytida Radchenko & Elmes, 2008 Myrmica margaritae Emery, 1889 Myrmica pleiorhytida Radchenko & Elmes, 2009 Myrmica polyglypta Radchenko & Rigato, 2008 Myrmica ritae Emery, 1889 Myrmica serica Wheeler, 1928 Myrmica sinensis Radchenko, Zhou & Elmes, 2008 Myrmica titanica Mayr, 2001 Myrmica yunnanensis Radchenko & Elmes, 2008

### Myrmicaria: 1 species

Myrmicaria brunnea Saunders, 1842

#### Perissomyrmex: 2 species

Perissomyrmex bidentatus Zhou & Huang, 2006 Perissomyrmex fissus Xu & Wang, 2004

#### Pheidole: 42 species

Pheidole allani Bingham, 1903 Pheidole binghamii Forel, 1902 Pheidole capellinii Emery, 1902 Pheidole constanciae Forel, 1902 Pheidole elongicephala Eguchi, 2008 Pheidole exasperata (Mayr, 1866) Pheidole fervens Smith, 1858 Pheidole fervida Smith, 1874 \* Pheidole fortis Eguchi, 2006 Pheidole gatesi (Wheeler, 1927) \* Pheidole hongkongensis Wheeler, 1928 Pheidole indica Mayr, 1879 \* Pheidole indosinensis Wheeler, 1928 Pheidole jucunda Forel, 1885 \* Pheidole laevicolor Eguchi, 2006 \* Pheidole magna Eguchi, 2006 Pheidole multidens Forel, 1902 Pheidole nietneri Emery, 1901 \* Pheidole nodifera Smith, 1858 Pheidole nodus Smith, 1874 \* *Pheidole ochracea* Eguchi, 2008 \* Pheidole parva Mayr, 1865 Pheidole pieli Santschi, 1925 \* Pheidole plagiaria Smith, 1860 \* Pheidole planifrons Santschi, 1920 \* Pheidole rabo Forel, 1913 Pheidole roberti Forel, 1902 \* Pheidole rugithorax Eguchi, 2008 Pheidole sagei Forel, 1902 \* *Pheidole singaporensis* Özdikmen, 2010 Pheidole sinica (Wu & Wang, 1992) \* Pheidole smythiesii Forel, 1902

Pheidole spathifera Forel, 1902
Pheidole sulcaticeps Roger, 1863
\* Pheidole tandjongensis Forel, 1913
\* Pheidole tjibodana Forel, 1905
\* Pheidole tumida Eguchi, 2008
\* Pheidole vieti Eguchi, 2008
\* Pheidole vulgaris Eguchi, 2006
Pheidole watsoni Forel, 1902
Pheidole yeensis Forel, 1902
\* Pheidole zoceana Santschi, 1925

## Pristomyrmex: 4 species

Pristomyrmex brevispinosus Emery, 1887 Pristomyrmex hamatus Xu & Zhang, 2002 Pristomyrmex punctatus (Smith, 1860) Pristomyrmex sulcatus Emery, 1895

#### Recurvidris: 3 species

\* Recurvidris kemneri (Wheeler, 1954) Recurvidris nuwa Xu & Zheng, 1995 Recurvidris recurvispinosa (Forel, 1890)

## Rhopalomastix: 2 species

\* *Rhopalomastix rothneyi* Forel, 1900 *Rhopalomastix umbracapita* Xu, 1999

#### Rotastruma: 1 species

\* Rotastruma stenoceps Bolton, 1991

## Solenopsis: 3 species

Solenopsis indagatrix Wheeler, 1928 Solenopsis invicta Buren, 1972 (**Exotic**) Solenopsis jacoti Wheeler, 1923

#### Stenamma: 4 species

*Stenamma ailaoense* Liu & Xiu, 2011 *Stenamma gurkhale* DuBois, 1998 \* *Stenamma jeriorum* DuBois, 1998 *Stenamma wumengense* Liu & Xiu, 2011

#### Strumigenys: 24 species

Strumigenys ailaoshana Xu & Zhou, 2004 \* Strumigenys assamensis De Andrade, 1994 Strumigenys dayui (Xu, 2000) \* Strumigenys doriae Emery, 1887 \* Strumigenys dyschima (Bolton, 2000) Strumigenys exilirhina Bolton, 2000 Strumigenys feae Emery, 1895 \* Strumigenys kichijo (Terayama, 1996) \* Strumigenys leptothrix Wheeler, 1929 Strumigenys lewisi Cameron, 1886 \* Strumigenys lyroessa (Roger, 1862) \* Strumigenys membranifera Emery, 1869 (Exotic) \* Strumigenys mitis (Brown, 2000) Strumigenys mutica (Brown, 1949) Strumigenys nanzanensis Lin & Wu, 1996 \* Strumigenys nepalensis De Andrade, 1994 Strumigenys nongba (Xu & Zhou, 2004) \* Strumigenys paraposta Bolton, 2000 \* Strumigenys rallarhina Bolton, 2000 \* Strumigenys sauteri (Forel, 1912) Strumigenys strygax Bolton, 2000 \* Strumigenys sydorata Bolton, 2000 \* Strumigenys taphra (Bolton, 2000) \* Strumigenys tritomea Bolton, 2000 Strumigenys yangi (Xu & Zhou, 2004)

#### Temnothorax: 7 species

Temnothorax angulohumerus Zhou, 2010 Temnothorax congruus (Smith, 1874) Temnothorax hengshanensis (Huang, 2004) Temnothorax nassonovi (Ruzsky, 1895) Temnothorax orchidus Zhou, 2010 Temnothorax striatus Zhou, 2010 Temnothorax wui (Wheeler, 1929)

#### Tetramorium: 29 species

Tetramorium aptum Bolton, 1977

Tetramorium bicarinatum (Nylander, 1846) Tetramorium cardiocarenum Xu & Zheng, 1994 Tetramorium ciliatum Bolton, 1977 Tetramorium crepum Wang & Wu, 1988 Tetramorium cuneinode Bolton, 1977 Tetramorium cyclolobium Xu & Zheng, 1994 \* Tetramorium difficile Bolton, 1977 \* Tetramorium flavipes Emery, 1893 Tetramorium indosinense Wheeler, 1927 Tetramorium insolens (Smith, 1861) Tetramorium kheperra (Bolton, 1976) Tetramorium kraepelini Forel, 1905 Tetramorium lanuginosum Mayr, 1870 Tetramorium laparum Bolton, 1977 Tetramorium nipponense Wheeler, 1928 Tetramorium nursei Bingham, 1903 Tetramorium obtusidens Viehmeyer, 1916 Tetramorium pacificum Mayr, 1870 \* Tetramorium parvispinum (Emery, 1893) \* Tetramorium polymorphum Yamane & Jaitrong, 2011 Tetramorium repletum Wang & Xiao, 1988 Tetramorium simillimum (Smith, 1851) (Exotic) Tetramorium smithi Mayr, 1879 \* Tetramorium tonganum Mayr, 1870 Tetramorium walshi (Forel, 1890) \* Tetramorium wroughtonii (Forel, 1902) Tetramorium yerburyi Forel, 1902 Tetramorium yulongense Xu & Zheng, 1994

#### Trichomyrmex: 2 species

*Trichomyrmex destructor* (Jerdon, 1851) (**Exotic**) *Trichomyrmex mayri* (Forel, 1902) (**Exotic**)

#### Vollenhovia: 2 species

\* Vollenhovia lucimandibula Wang, 2005 Vollenhovia pyrrhoria Wu & Xiao, 1989

#### Vombisidris: 1 species

\* Vombisidris tibeta Xu & Yu, 2012

## PONERINAE

Anochetus: 6 species

Anochetus graeffei Mayr, 1870 \* Anochetus madaraszi Mayr, 1897 Anochetus mixtus Radchenko, 1993 \* Anochetus myops Emery, 1893 Anochetus risii Forel, 1900 Anochetus subcoecus Forel, 1912

Brachyponera: 2 species

Brachyponera brevidorsa Xu, 1994 \* Brachyponera chinensis (Emery, 1895) Brachyponera luteipes (Mayr, 1862)

Buniapone: 1 species

Buniapone amblyops (Emery, 1887)

Centromyrmex: 1 species

Centromyrmex feae (Emery, 1889)

Cryptopone: 5 species

Cryptopone gigas Wu & Wang, 1995 Cryptopone recticlypea Xu, 1998 \* Cryptopone sauteri (Wheeler, 1906) Cryptopone taivanae (Forel, 1930) Cryptopone testacea Emery, 1893

Diacamma: 1 species

\* Diacamma rugosum (Le Guillou, 1842)

#### Ectomomyrmex: 8 species

*Ectomomyrmex annamitus* (André, 1892) *Ectomomyrmex astutus* (Smith, 1858) *Ectomomyrmex javanus* Mayr, 1867 *Ectomomyrmex leeuwenhoeki* (Forel, 1886) *Ectomomyrmex lobocarenus* (Xu, 1995) \* Ectomomyrmex obtusus Emery, 1900 Ectomomyrmex sauteri (Forel, 1912) Ectomomyrmex zhengi (Xu, 1995)

Emeryopone: 1 species

Emeryopone melaina Xu, 1998

Euponera: 1 species

Euponera pilosior (Wheeler, 1928)

Harpegnathos: 1 species

Harpegnathos venator (Smith, 1858)

Hypoponera: 7 species

Hypoponera ceylonensis (Mayr, 1897)
Hypoponera confinis (Roger, 1860)
\* Hypoponera ergatandria (Forel, 1893) (Exotic)
Hypoponera nippona (Santschi, 1937)
Hypoponera punctatissima (Roger, 1859) (Exotic)
Hypoponera sauteri Onoyama, 1989
Hypoponera truncata (Smith, 1860)

## Leptogenys: 17 species

Leptogenys binghamii Forel, 1900 Leptogenys birmana Forel, 1900 Leptogenys chinensis (Mayr, 1870) Leptogenys crassicornis Emery, 1895 \* Leptogenys davydovi Karavaiev, 1935 Leptogenys diminuta (Smith, 1857) \* Leptogenys kitteli (Mayr, 1870) \* Leptogenys kraepelini Forel, 1905 Leptogenys laozii Xu, 2000 Leptogenys lucidula Emery, 1895 Leptogenys mengzii Xu, 2000 Leptogenys pangui Xu, 2000 \* Leptogenys peuqueti (André, 1887) \* Leptogenys processionalis (Jerdon, 1851) \* Leptogenys rufida Zhou, 2012 \* Leptogenys sunzii Xu, 2015

Leptogenys zhuangzii Xu, 2000

Mesoponera: 1 species

Mesoponera melanaria (Emery, 1893)

## Myopias: 3 species

*Myopias conicara* Xu, 1998 \* *Myopias daia* Xu, 2014 \* *Myopias hania* Xu, 2012

## Odontomachus: 6 species

Odontomachus circulus Wang, 1993 \* Odontomachus fulgidus Wang, 1993 Odontomachus granatus Wang, 1993 Odontomachus monticola Emery, 1892 Odontomachus rixosus Smith, 1857 Odontomachus tensus Wang, 1993

#### Odontoponera: 1 species

\* Odontoponera denticulata (Smith, 1858)

Platythyrea: 2 species

*Platythyrea clypeata* Forel, 1911 \* *Platythyrea parallela* (Smith, 1859)

Ponera: 14 species

Ponera alisana Terayama, 1986 Ponera baka Xu, 2001 Ponera bawana Xu, 2001 \* Ponera chiponensis Terayama, 1986 Ponera diodonta Xu, 2001 Ponera longlina Xu, 2001 Ponera menglana Xu, 2001 Ponera nangongshana Xu, 2001 \* Ponera paedericera Zhou, 2001 Ponera pentodontos Xu, 2001 Ponera pianmana Xu, 2001 Ponera scabra Wheeler, 1928 *Ponera sinensis* Wheeler,1928 *Ponera xantha* Xu, 2001

Pseudoneoponera: 2 species

*Pseudoneoponera bispinosa* (Smith, 1858) *Pseudoneoponera rufipes* (Jerdon, 1851)

## PROCERATIINAE

Discothyrea: 3 species

\* Discothyrea banna Xu, 2014 \* Discothyrea diana Xu, 2014 Discothyrea sauteri Forel, 1912

Probolomyrmex: 1 species

Probolomyrmex longiscapus Xu & Zeng, 2000

Proceratium: 4 species

Proceratium longigaster Karavaiev, 1935 Proceratium longmenense Xu, 2006 \* Proceratium shohei Staab, 2018 Proceratium zhaoi Xu, 2000

## PSEUDOMYRMECINAE

Tetraponera: 12 species

Tetraponera allaborans (Walker, 1859) Tetraponera amargina Xu & Chai, 2004 Tetraponera attenuata Smith, 1877 Tetraponera binghami (Forel, 1902) Tetraponera concava Xu & Chai, 2004 Tetraponera convexa Xu & Chai, 2004 Tetraponera furcata Xu & Chai, 2004 Tetraponera microcarpa Wu & Wang, 1990 Tetraponera nitida (Smith, 1860) Tetraponera notabilis Ward, 2001 Tetraponera protensa Xu & Chai, 2004 Tetraponera rufonigra (Jerdon, 1851)

## Discussion

#### Ants in the Hengduan Mountain region

Field inventories and data synthesis efforts are essential for our understanding of ant diversity in 'hotspots' that harbor most of Earth's biodiversity. Our study represents new survey data from an understudied region. We produce the first ant species checklist from China's Hengduan Mountains (130 species).

A majority of the ant species were only collected below 1500 m, consistent with the strong effect of elevation on ant diversity observed elsewhere (Suppl. material 1, Fig. S1). This also suggests that future sampling in low elevation areas may increase species detection. For example, the number of *Strumigenys* species recovered in this survey is relatively low compared to the overall richness of this genus. This could be because we have relatively few collection events at low elevations where many of these species are known to occur. Indeed, all six *Strumigenys* species were collected below 1000 m from only three independent Winkler sampling sites.

Many of the new records in our collection such as *Aenictus brevinodus*, *Camponotus bellus leucodiscus*, *Cataulacus marginatus*, *Crematogaster quadriruga*, *Dilobocondyla eguchii*, *Gnamptogenys quadrutinodules*, and *Strumigenys taphra* represent the northern-most records of their known distributional ranges. Species records such as *Aenictus brevinodus*, *Camponotus bellus leucodiscus*, *Camponotus keihitoi*, *Cataulacus marginatus*, *Gnamptogenys quadrutinodules*, and *Strumigenys taphra* how a disjunction from the rest of their known distributions. It is unclear whether those records represent true biogeographic disjunctions, or sampling / taxonomic artifacts. Another potential reason could be that they were collected in the past, but have not been reported due to the lack of taxonomic infrastructure and species check lists from this region (Guénard et al. 2017). Additional inventories of ant diversity and taxonomic treatments are needed to answer these questions.

Despite the comparatively small area of China's Hengduan Mountains that we explored for this inventory of myrmecofauna, we were able to collect 130 species, which accounts for more than 24 % of the total number of ant species (N = 550) for Yunnan province. Among them, more than 10% of the ant species that were collected in this survey represent new records for Yunnan province. Moreover, there are still more than 41 morphospecies (32% of the total collected) that we believe are undescribed and new to science. To date, three *Myrmecina* species (Figs 82–84) and one *Gauromyrmex* species (Fig. 75) are undergoing taxonomic revision, and species descriptions are being prepared.

Our sampling of the full ant diversity of the Hengduan mountain region is still relatively limited. For example, we only had one sampling site per elevation, which is insufficient to cover the complex topology of the Hengduan Mountains. We also only used leaf litter extraction and hand collection, which is unlikely to recover complete ant assemblages. The incorporation of additional sampling techniques into our methodology, such as pitfall trapping, soil baiting, twig sampling, light trapping and canopy fogging, will cover more strata and lifestyles, and thus significantly increase our rate of species discovery. Overall, our results highlight how little was previously known about the ant fauna in this region and emphasize the need for further collecting in order to better understand the hidden ant biodiversity in China's Hengduan Mountains, and Yunnan Province overall.

## Ants in Yunnan

If the total species richness of ants in Yunnan, with 550 species, is still an underestimate of the full species numbers, the exceptional diversity of genera encountered in this region needs to be highlighted. With 99 genera, Yunnan generic diversity is only matched globally by a few regions in South East Asia, and Queensland, Australia. A major difference with other Asian regions lies in the composition of the genera retrieved and their origin. For instance, genera found in Borneo, Sumatra, Java, Vietnam, Thailand, Peninsular Malaysia are almost exclusively derived from tropical, Oriental origins. In contrast, the geographic location and topography of Yunnan province has promoted an intermixing of taxa from several biogeographic regions: the Oriental realm from the south, the Palearctic realm from the northwest, and the Sino-Japanese realm from the northeast. As a result, the composition of the Yunnan ant fauna includes both tropical, subtropical, and temperate elements. Such intermixed communities are evident even at a small scale. For instance, during previous fieldwork conducted in the Gaoligongshan Mountains in 2015 by two of the authors (BG and CL), for which specimens were unfortunately lost, the coexistence of tropical (*Dorylus*, Ectomomyrmex), subtropical (Temnothorax) and temperate genera (Formica, Lasius) was observed on a hillside at an elevation of about 1900 m on an ~ 250 m<sup>2</sup> patch of grassland. Interestingly, while this area exhibited a transition where fauna from distinctly different origins coexisted along a thin band of altitude, at lower elevations, tropical genera were dominant and at higher elevations, temperate genera became dominant. Overall, this generated an unexpectedly diverse faunal composition, with such mixed communities contemplated by Wheeler (1915) to explain the generic composition and diversity of fossil ants observed in Baltic amber. Possibly, the ant composition of genera now retrieved within Yunnan might represent the remains of a once more widespread assemblage found within Asia and Europe during the Miocene (Guénard et al. 2015). This highlights the specific nature of the Yunnan ant fauna and its importance in studying ant biogeography within Asia. It also serves as an excellent example of the formation and stability of ant community assemblages over time. Other neighboring regions such as Myanmar, Bhutan, Nepal or northeast India are likely to exhibit similar features, but to this point, the myrmecological exploration of these regions has been largely fragmentary (Guénard et al. 2010, 2012).

The diversity of Yunnan ants is also remarkable for particular ant genera for which their global peak of diversity is encountered in the region. While it is important to note that the global diversity of specific genera as well as their overall taxonomic descriptions remain incomplete, seven genera present their highest currently known global diversity in Yunnan (*Cryptopone*: 5 species, *Ectomomyrmex*: 8 species, *Kartidris*: 3 species, *Perissomyrmex*: 2 species, *Ponera*: 14 species, *Prenolepis*: 7 species, *Stigmatomma*: 11 species), while six others are remarkable by the level of global diversity there, among

the highest observed globally (*Aenictus*: 19 species, *Carebara*: 19 species, *Dilobocondyla*: 3 species, *Myrmecina*: 7 species, *Proceratium*: 4 species, *Recurvidris*: 3 species).

In conclusion, the important topographic variation, with mountain ranges aligned along a north-south axis combined with the presence of multiple climatic zones, including tropical rainforest in the lowland areas of the southern part of Yunnan create a diversity of microhabitats for supporting a diverse ant fauna. Moreover, the geographic position of Yunnan at the confluence of three biogeographic realms may promote ant diversity in the region. The collection of these 16 new ant records for Yunnan together with our previous discovery of 40 new ant records for Yunnan (Liu et al. 2015a) suggest that the true ant diversity in Yunnan is significantly higher. Moreover, the species diversity of some ant genera in nearby regions (based on data from GABI) also suggests that some ant genera sampled will ultimately be much more diverse in Yunnan (Guénard et al. 2017). For example, Hong Kong has recorded a similar diversity of Strumigenys species while having an area nearly 350 times smaller and a much less diverse topography compare to Yunnan (Tang et al. 2019), perhaps because leaf litter extraction has not been widely used for sampling ants in Yunnan. Thus, our survey to date indicates that further intensive sampling focused on different ecological strata (arboreal, leaf litter, subterranean) and combining various methods of extraction in both tropical and mountain habitats should yield many additional records and new species discovery in this region.

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# Supplementary material I

# Figure S1. Ant species richness pattern along an elevational gradient in the Hengduan Mountains

Authors: Cong Liu, Georg Fischer, Francisco Hita Garcia, Seiki Yamane, Qing Liu, Yan Qiong Peng, Evan P. Economo, Benoit Guénard, Naomi E. Pierce Data type: Image

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