

Review of ants from the genus *Polyrhachis* Smith (Hymenoptera: Formicidae: Formicinae) in Hong Kong and Macau, with notes on their natural history

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ABSTRACT. *Polyrhachis* is one of the most taxonomically and ecologically diverse ant genera in the world. Limited knowledge is, however, available on the species encountered within continental South East Asia, contrasting with the extensive studies conducted on African and Indo-Australian species. Here a contribution of *Polyrhachis* species from Hong Kong and Macau based on specimens collected in the past 30 years, with addition of material from other southeast Chinese provinces is provided. Additionally, new nest collections of *P. dives* Smith allowed a better understanding of its natural history and nest composition. A total of 17 *Polyrhachis* species were identified within Hong Kong and Macau, completed by the descriptions or redescriptions of their worker, males and queen castes, including the novel description of the queen caste of *P. demangei* Santschi. Four new species are discovered and seven species are newly recorded in the regions studied: *P. confusa* sp. nov., *P. fellowesi* sp. nov., *P. hunggeuk* sp. nov., *P. moesta* Emery, 1887, *P. peetersi* sp. nov., *P. punctillata* Roger, 1863, *P. rastellata* Latreille, 1802, and *P. rufipes* Smith, 1858, in Hong Kong; *P. latona* Wheeler, 1909, *P. confusa* sp. nov. and *P. tyrannica* Smith, 1858, in Macau; *P. demangei* in Zhejiang, *P. rufipes* in Hainan and *P. fellowesi* sp. nov. in Guangdong, Guangxi and Zhejiang. A dichotomous key based on the worker caste for the 17 species encountered in Hong Kong and Macau is provided, as well as additional data about their distribution and natural history. Altogether these results highlight the lack of ecological and distribution knowledge on this conspicuous genus of ants and the need for future fieldwork in southeast China.

Keywords taxonomy, distribution, dichotomous key, novel species, new records, *Polyrhachis dives*, southeast China

Zoobank <http://zoobank.org/4861CE85-9A87-4243-A744-F54AF488CFE9>

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INTRODUCTION

Ants are one of the most ecologically crucial and ubiquitous groups of insects (Lach *et al.* 2010), comprising 17 subfamilies, 39 tribes, 337 genera, more than 13,700 species and about 1,900 subspecies (Bolton 2020). *Polyrhachis* Smith 1857, from Camponotini Forel 1878 in the subfamily Formicinae Latreille, is the fourth most diversified ant genus in the world with 783 valid species and subspecies within 13 subgenera (Bolton 2020). With a hypothesized origin in Southeast Asia during the Paleogene period, followed by later dispersal to Australia and Africa (Mezger & Moreau 2016), *Polyrhachis* species are distributed in a wide range of habitats, ranging from tropical rainforests to dry regions (Dorow 1995) or even mangroves (Nielsen 1997), mainly over the tropics to warm temperate regions of the Old World (Rigato 2016). Members of the genus possess a unique set of characters, including for examples, mesosomal and petiolar spines, bright-coloured pubescence, distinct sclerites (Rigato 2016), four- or five-toothed mandibles, a pair of 12-segmented antennae and a round gaster with a large extensive first gastral tergite (Bolton 1973).

Polyrhachis ants are ecologically diverse, acting as predators (Dejean *et al.* 1994) or, for many species as herbivores that feed on honeydew secreted by hemipterans and plant nectar (Degen *et al.* 1986; Dorow & Maschwitz 1990; Pfeiffer *et al.* 2014), with this carbohydrate consumption and pastoralism potential reasons explaining their dominance in tropical ecosystems (Davidson *et al.* 2003). Different species are associated with other organisms in ways including acting as symbiotic partners (Gaume *et al.* 2006; Ramalho *et al.* 2017), targets and models of mimicry (Edmunds 2006), social parasites (Kohriba 1963; Maschwitz *et al.* 2000), hosts of parasitoid wasps (Noyes 2019) and fungi (Shrestha *et al.* 2017; Araújo *et al.* 2018) or preys (Hirosawa *et al.* 2000; Hosoishi *et al.* 2012; Lee *et al.* 2017), and have a variety of adaptive nesting behaviours (Maschwitz *et al.* 2004; Narendra *et al.* 2013a, 2013b). *Polyrhachis* nests, sometimes with fine vegetative materials, larval or spider silk on the walls, can be arboreal, lignicolous, lithocolous, terrestrial, subterranean or even in surprising locations like intertidal mud, colonies of other

ant species (Robson & Kohout 2007) and within pitcher plants (Grafe & Kohout 2013). Their colony structure also varies, where the numbers of nests and queens per colony as well as the presence of cocoons differ for each species (Robson & Kohout 2007).

Described by Smith (1857) using *Polyrhachis bihamata* Drury (1773) as the type species, *Polyrhachis* has never been reviewed thoroughly at the species level outside of Africa (Rigato 2016), even though it has undergone a series of revisions and reclassifications into smaller subgenera (e.g. Mayr 1867; Emery 1898; Wheeler 1911; Forel 1915; Hung 1967, see Dorow 1995 for detail). Kohout in particular has discovered, revised and categorized members of the genus, mainly in Australia, New Guinea and Indonesia, into various species groups for years (e.g. Kohout 2006, 2007, 2008, 2010, 2013a, 2014), updating and providing new information to previous contemporary *Polyrhachis* reviews (e.g. Bolton 1973; Dorow 1995; Bolton *et al.* 2007). Although species found in Africa (e.g. Bolton 1973; Dejean *et al.* 1994; Rigato 2016) and the Indo-Australian region (e.g. Dorow & Maschwitz 1990; Nielsen 1997; Kohout & Mohamed 2008; Kohout 2010) are better known, few studies have been done on *Polyrhachis* ants in continental Southeast Asia (e.g. Hung 1962). Even if there have been more recent studies focusing on their taxonomy (e.g. Zhou & Zheng 1997; Xu 2002; Noon-Anant *et al.* 2009, Terayama 2009) and ecology (e.g. Liefke *et al.* 1998; Noon-Anant *et al.* 2009), most studies usually focused on particular species, for examples, *P. dives* Smith, 1857 (Chen & Tang 1989; Ouyang *et al.* 2009; Su & Li 2009; Fountain & Hughes 2011; Graystock & Hughes 2011), and *P. lamellidens* Smith, 1874 (Hung 1970; Kou *et al.* 2005; Ito *et al.* 2016).

Located within the southeastern part of China, Hong Kong is known for its rich biodiversity despite its small area (Hau *et al.* 2005; Ng *et al.* 2017). It has currently over 10,000 recorded native faunal and floral species (HKU 2002; Janicki *et al.* 2016; Guénard *et al.* 2017; Hong Kong Herbarium 2017; Ng *et al.* 2017; Economo *et al.* 2018; AFCD 2019), although the actual number may be far greater, especially for terrestrial invertebrates, due to research biases (Pyšek *et al.* 2008; Di Marco *et al.* 2017; de Los Ríos *et*

Table 1. The number of the different castes or life stages of *Polyrhachis demangei* in the Lepidopteran pupal case nest (dimensions: 5 cm × 2.1 cm × 3 cm) collected on Lamma Island, Hong Kong. The actual number of ants is likely higher as the nest was disturbed and left behind before being collected. Data kindly provided by E. Jones.

Caste/life stage	dealate queen	alate queen	queen pupa	male pupa	worker pupa	worker	larvae
Number	0	2	3	2	3	51	20

Table 2. The average (\pm standard deviations) number of the different castes or life stages of *Polyrhachis dives* in the 6 nests collected at the Hong Kong Wetland Park. The number of ants in the largest nest (Nest 1) was guesstimated by weight of ants soaked in 75% ethanol, assuming the ratio of different castes in the small portion counted was equal to that of the entity. For comparison, values obtained from a single nest in Iriomote Island, Japan by Hannan & Yamane (2005) are presented here.

Caste/life stage	worker	dealate queen	alate queen	male	larvae	pupal cocoon
Nest 1	10703	230	652	4327	2738	1773
Nest 2	2913	23	0	293	778	1001
Nest 3	4826	19	0	600	2632	321
Nest 4	261	8	16	308	2	0
Nest 5	2212	2	0	30	1387	1474
Nest 6	1589	7	0	478	644	3
Average	3751 \pm 3726	(111 (+263, -111))	(48 (+89, -48))	(1006 (+1638, -1006))	1364 \pm 1115	(606 (+741, -606))
Hannan & Yamane 2005	20083	0	0	10932	26189	17354

al. 2018; Tang *et al.* 2019). This article intends to give a contribution on all *Polyrhachis* species found in Hong Kong and Macau, a nearby city, and a summary of the knowledge on their natural history. Up to now, Hong Kong had eleven recorded *Polyrhachis* species (Guénard & Dunn 2012; Ran & Zhou 2013) and Macau three species (Leong *et al.* 2017). Here, we present a review of *Polyrhachis* species for both regions, increasing the number of species recorded to 17 species and six species respectively, and describe four new species: *Polyrhachis confusa* sp. nov., *Polyrhachis fellowesi* sp. nov., *Polyrhachis hunggeuk* sp. nov. and *Polyrhachis peetersi* sp. nov. In addition, we also provide the first description of the queen of *Polyrhachis demangei* Santschi, 1910, as well as new records for *P. demangei* from Zhejiang, *P. rufipes* Smith, 1858, from Hainan province and *P. fellowesi* sp. nov. from Guangdong, Guangxi and Zhejiang provinces. Moreover, the arboreal nests of *P. dives* are used as an example for providing additional information on the natural history of the species, as they are abundant and easier to ac-

cess compared to those of other species located underground or within dead vegetation (Robson & Kohout 2007).

MATERIALS AND METHODS

Polyrhachis ant species identification

Polyrhachis specimens collected in Hong Kong or Macau and preserved in the collections of the Insect Biodiversity and Biogeography Laboratory (IBBL) and Biological Sciences Museum (BSM), both in The University of Hong Kong, were examined. Other specimens from mainland China in the late 90's and early 2000's were also used when those of certain species sampled from the two regions were insufficient or not available in the two collections. Additional samples collected in the field through hand collection using an insect aspirator specifically for this study were also added to the IBBL collection after mounting. The identity of each *Polyrhachis* ant specimen

Table 3. List of *Polyrhachis* species encountered in southeast China and Taiwan. The newly recorded species and respective regions are marked with an asterisk in the species list and a (N) in the table. +: present; -: absent; ?: dubious/needs verification.

Species	Province/Region										References
	Fujian	Guangdong	Guangxi	Hainan	Hunan	Hong Kong	Jiangxi	Macau	Taiwan	Zhejiang	
<i>P. armata</i> Le Guillou	-	-	+	+	-	-	-	-	-	-	1–3
<i>P. bicolor</i> Smith	-	-	+	-	-	-	-	-	-	-	3
<i>P. bihamata</i>	-	-	+	+	-	-	-	-	-	-	1, 4
<i>P. confusa</i> sp. nov.*	-	-	-	-	-	N	-	N	-	-	This study
<i>P. cornihumera</i> Xu	-	-	+	-	-	-	-	-	-	-	1
<i>P. cyphonota</i> Xu	-	+	-	-	-	-	+	-	-	-	5, 6
<i>P. demangei</i>	+	+	+	+	+	+	-	+	-	N	1, 2, 7, this study
<i>P. dives</i>	+	+	+	+	+	+	+	+	+	+	1, 2, 7
<i>P. fellowesi</i> sp. nov.*	-	N	N	-	-	N	-	-	-	N	This study
<i>P. halidayi</i>	+	+	+	+	-	+	-	-	-	+	1, 2
<i>P. hunggeuk</i> sp. nov.*	-	-	-	-	-	N	-	-	-	-	This study
<i>P. illaudata</i>	+	+	+	+	+	+	+	+	+	+	1, 2, 7
<i>P. jianghuaensis</i> Wang & Wu	-	+	+	-	+	-	-	-	-	+	2
<i>P. lamellidens</i>	+	+	+	-	+	+	-	-	+	+	1
<i>P. latona</i> *	-	+	+	-	-	+	-	N	+	+	1, 2, this study
<i>P. moesta</i> *	-	-	+	-	+	N	+	-	+	+	1, 2, this study
<i>P. murina</i>	-	-	-	-	-	-	-	-	+	-	1, 2
<i>P. paracamponota</i> Wang & Wu	-	+	-	-	-	-	-	-	-	-	This study
<i>P. peetersi</i> sp. nov.*	-	-	-	-	-	N	-	-	-	-	This study
<i>P. proxima</i>	+	+	+	-	+	-	-	-	-	-	1, 2
<i>P. pubescens</i> Mayr	?	+	-	-	-	-	-	-	-	-	2
<i>P. punctillata</i> *	-	+	+	+	-	N	-	-	?	-	2, this study
<i>P. rastellata</i> *	+	+	+	+	+	N	+	-	+	+	1, this study
<i>P. rubigastrica</i>	-	-	+	-	+	-	-	-	-	-	1
<i>P. rufipes</i> *	-	-	-	N	-	N	-	-	-	-	This study
<i>P. shixingensis</i>	-	+	+	+	-	-	-	-	-	+	8
<i>P. tianjingshanensis</i> Quin & Zhou	-	+	-	-	-	-	-	-	-	-	1
<i>P. tyrannica</i> *	-	+	+	+	-	+	-	N	?	-	1, 2, this study
<i>P. vigilans</i>	+	+	+	+	+	+	-	-	+	+	
<i>P. wolfi</i>	-	+	+	+	-	+	-	-	+	-	1
<i>P. zhengi</i> Zhou & Huang	-	-	+	-	-	-	-	-	-	-	
TOTAL	8	19	22	13	10	17	5	6	9	12	

References and numbering used: 1: Guénard & Dunn 2012; 2: Ran & Zhou 2013; 3: Zhang *et al.* 2014; 4: Hua 2006; 5: Zhao 2006; 6: Mezger & Moreau 2016; 7: Leong *et al.* 2017; 8: Kohout 2013b.

was determined based mainly on morphological characters, an approach that is commonly used in taxonomic studies of ants including *Polyrhachis* (e.g. Kohout 2010, 2013a, 2014), with comparison with type specimens accessible on AntWeb performed (CAS 2020) as well as to the different taxonomic descriptions available in literature. Geographical distributions and type descriptions were also considered to identify the *Polyrhachis* specimens, especially when images of type specimens were unavailable.

***Polyrhachis* ant species distribution maps**

The latitude and longitude coordinates of the locations where the *Polyrhachis* specimens were discovered, if available, and high-resolution outlines of Hong Kong and Macau downloaded from the database of Global Administrative Areas (2018) were used to construct distribution maps of *Polyrhachis* ants in the two cities via QGIS version 2.18.15 (2017). To provide precise range maps for each species, geographical coordinates available on AntWeb and from our records were used, while specimens with known sampling locations were assigned with estimated ones.

***Polyrhachis dives* nest structure and associated arthropods**

Six nests of *P. dives* were gathered from the Hong Kong Wetland Park in Tin Shui Wai, New Territories (Fig. 1). The locations of the nests were marked and tree branches attached to them were cut with a tree pruner, or a pole pruner for elevated branches, before they were placed

in large separate zip-zap bags and frozen in a freezer at -22°C for at least one day. Their sizes, shapes and nest materials were recorded, with the number of workers, winged and dealate queens, males, larvae and cocoons counted. For nests with over 10,000 ants, individuals of a known exact number were first randomly selected from a well-mixed throng of ants. The selected portion of ants was then immersed in 75% ethanol to remove anything adhered on their surfaces and was weighed by an electronic balance after being dried. The dry weight of the remaining ants soaked with 75% ethanol was measured by the same balance to estimate the total number of *P. dives* in the nest, with the assumption that the overall proportion of castes was equal to that of the smaller random subset. The presence of other arthropods in the nests was noted, and two queens and two males from each nest were mounted and imaged as part of the IBBL collection, given that the reproductive castes, particularly the males, are poorly known and often undescribed.

***Polyrhachis* measurements**

Multi-focus photographs of the profile, full-face and dorsal views of the specimens were taken using a Leica DFC450 digital microscope camera under 10X to 40X magnifications, which were auto-montaged with minimum smoothing of reflected light and a semi-focused background in a patch size of eight using the softwares LAS V4.5 and Adobe Photoshop. The montaged images were then enhanced with a smooth minimum background of no confidence, maximum soft edges, and maximum sharpening of the whole

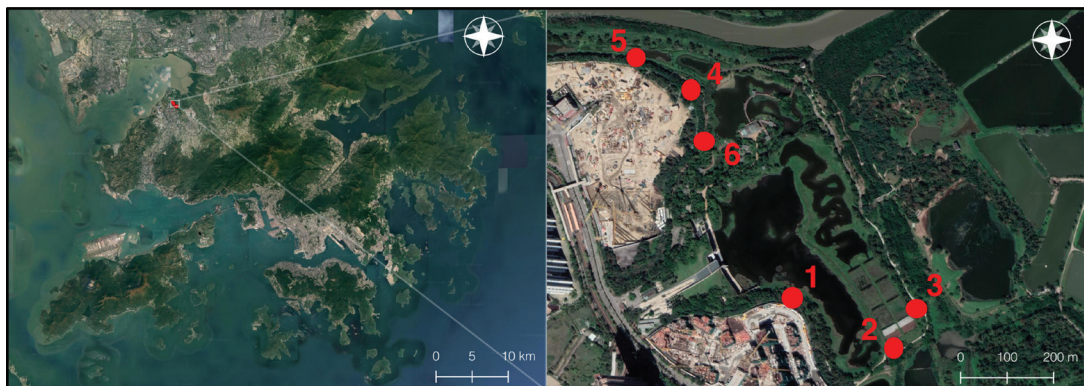


Fig. 1. The locations of the collected nests of *Polyrhachis dives* (modified after Google Satellite Map ©2015).

image. All castes of *Polyrhachis* species identified from specimens in the IBBL and BSM collections were described. Following those of Kohout (2014) with several additions and amendments, 12 morphological features of the specimens (see Fig. 2) were measured in millimeters (mm) using both LAS V4.5 and ImageJ (Schneider *et al.* 2012), and six related indices were calculated respectively based on previous measurements:

- HL (Head Length): the maximum length of the head capsule in full-face view, measured from the anterior clypeal margin to the posterior cephalic margin.
- HW (Head Width): the maximum width of the head in face view, excluding compound eyes.
- EL (Eye Length): the maximum diameter of the eye measured in profile.
- ML (Mandible Length): the straight-line length of the mandible in full-face view, measured from the mandibular apex to the anterior clypeal margin.
- SL (Scape Length): the greatest straight-line length of the scape, excluding the condylar bulb and its distal neck.
- WL (Weber's Length): the diagonal length of the mesosoma, measured from the meeting point of the pronotum and cervical shield to the propodeal lobe in lateral view.
- PW (Pronotal Width): the maximum width of the pronotum in dorsal view, excluding any projecting spine or protuberance.
- PTL (Petiolar Length): the maximum length of the petiole in lateral view, perpendicular to PTH.
- PTW (Petiolar Width): the greatest width of the petiole in dorsal view, including spines when present, with the widest pair used when more than one pair are present.
- PTH (Petiolar Height): the height of the petiole in profile, perpendicular to PTL and measured from the petiolar spiracle to the apex or tangent point of the petiolar spine.
- MTL (Metatibial Length): the maximum length of the tibia of the hind leg.
- CI (Cephalic Index): $HW/HL \times 100$.
- EI (Eye Index): $EL/HW \times 100$.
- MI (Mandible Index): $ML/HL \times 100$.
- SI (Scape Index): $SL/HW \times 100$.

PTI (Petiolar Index): $PTW/PTL \times 100$.

PTHI (Petiolar Height Index): $PTH/PTL \times 100$.

For some measurements, including HW, HL, EL, WL, PW, PTL, PTW and PTH, the specimens were properly placed during the imaging process, so they are not problematic. For other measurements however (e.g. SL, ML, MTL, GL), specific care in the specimens' original position was needed, where the positions of the specimens were adjusted to more appropriate ones to obtain more accurate measurements.

***Polyrhachis* species description and redescription**

Workers (w), queens (q) and males (m) of *Polyrhachis* species that have not been described in the past were described using the morphological traits featured by Kohout (2010, 2013a, 2014), where the description of each caste was categorized into subsections, namely head, mesosoma, metasoma, pilosity, sculpture, colouration as well as forewings and hindwings if present, for better organization. Castes that were described before 1960 or using languages other than English were also redescribed using the IBBL and BSM specimens in order to provide more updated and detailed descriptions. For *Polyrhachis* castes that have been described in detail in other papers since 1970, the original sources were cited for reference instead.

Abbreviations

Unless otherwise specified, the specimens examined were all from IBBL and BSM in The University of Hong Kong, the former including specimens sampled after 2014 and the latter with those collected before 2000. The abbreviations of the other depositories of the *Polyrhachis* type specimens mainly based on Evenhuis (2020) and terms used in this study are listed below:

- CAS California Academy of Sciences, San Francisco, California, USA
- MHNG Muséum d'Histoire Naturelle, Geneva, Switzerland
- MSNG Museo Civico di Storia Naturale "Giuseppe Doria", Genova, Italy
- NHMB Naturhistorisches Museum, Basel,

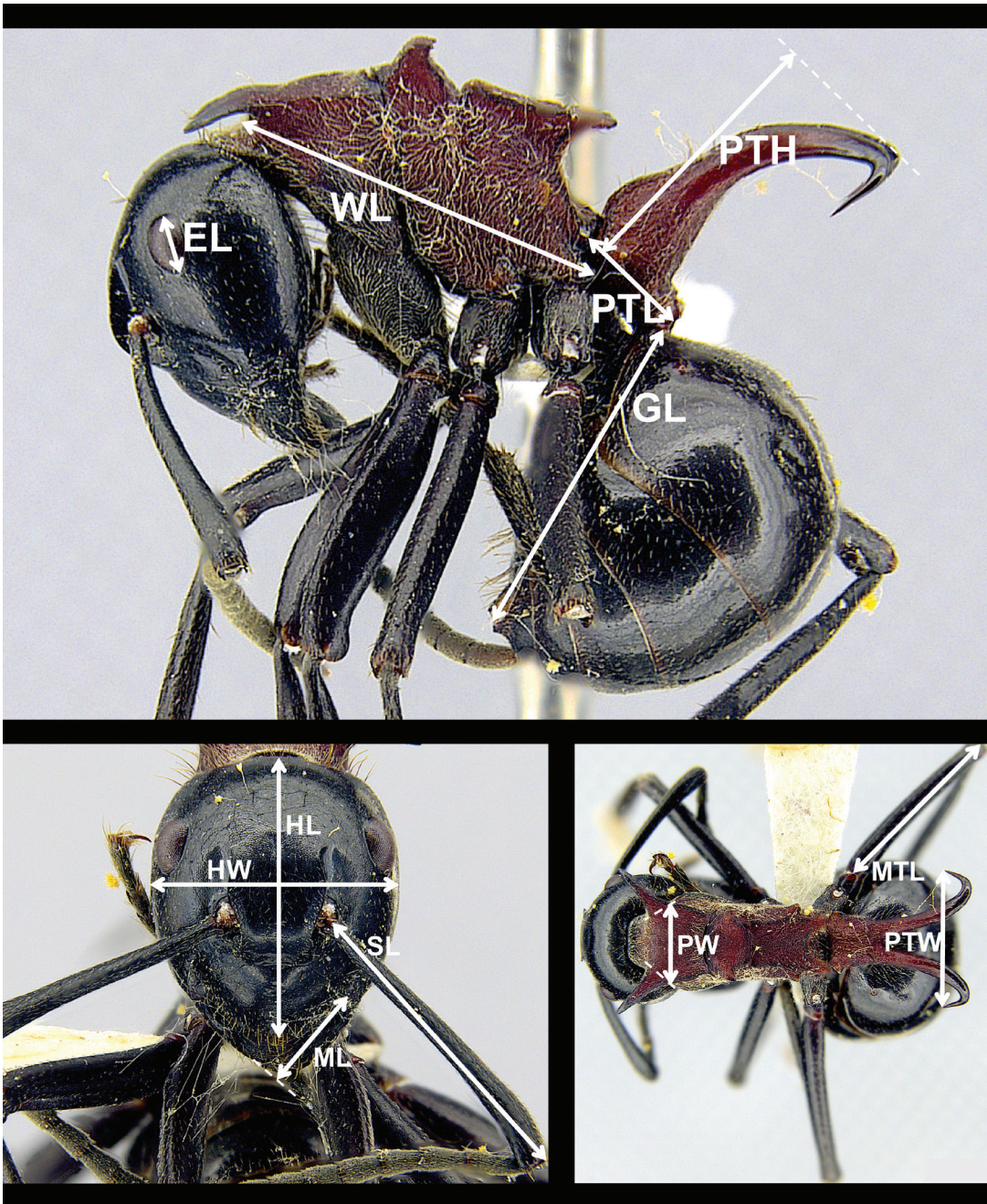


Fig. 2. Morphological features measured in this study. The definition of each abbreviation can be found under the section of *Polyrhachis* ants body measurements.

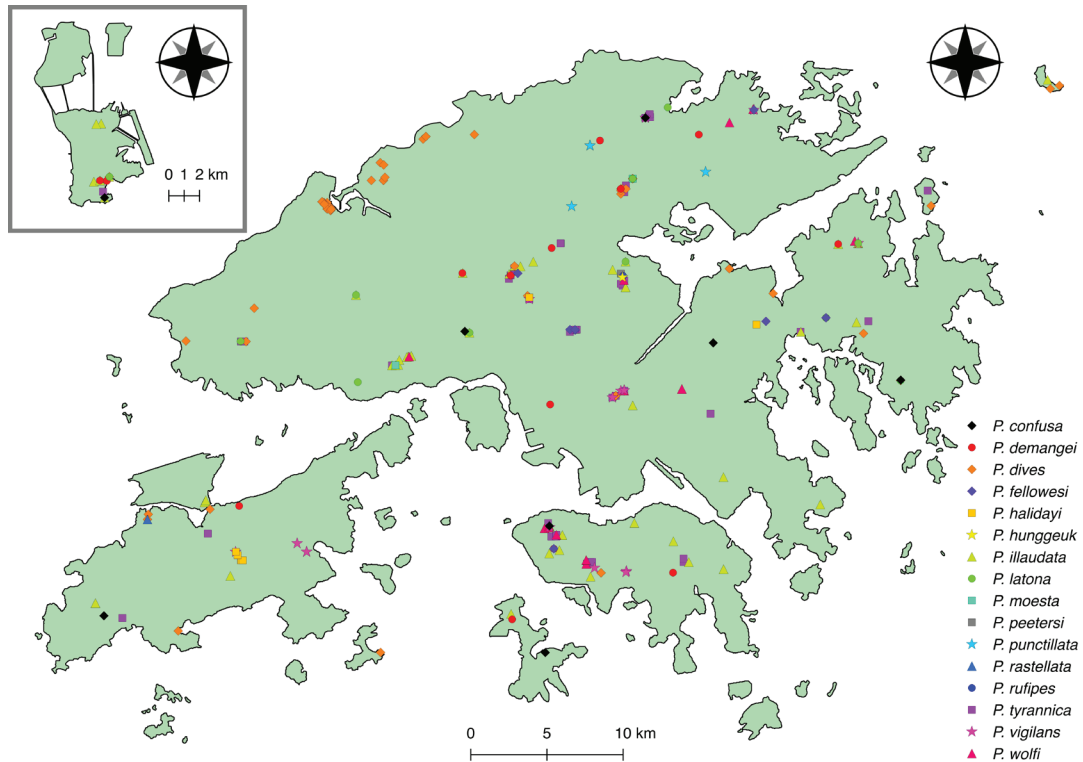


Fig. 3. The distribution of *Polyrhachis* ants in Hong Kong and Macau. *Polyrhachis lamellidens* was only stated to be found in Hong Kong, so the map does not include the species.

	Switzerland
BMNH	The Natural History Museum, London, United Kingdom
NMOK	Kaohsiung City Museum of Natural History, Kaohsiung, Taiwan
SDEI	Senckenberg Deutsches Entomologisches Institut, Müncheberg, Germany
SKYC	Seiki Yamane Collection, Japan
ZMHB	Museum für Naturkunde der Humboldt-Universität, Berlin, Germany
c.	circa

RESULTS

A total of 17 *Polyrhachis* species have been identified from Hong Kong and Macau on the basis of 277 specimens examined from the IBBL and BSM collections, where 240 individuals were collected in Hong Kong, 17 from Macau, and 20 from mainland China. One species belongs to the subgenus *Campomyrma* Wheeler, two to *Cyrto-*

myrma Forel, seven to *Myrma* Billberg, six to *Myrmhopla* Forel, and one to *Polyrhachis* Smith. All 17 species were found to be distributed across Hong Kong, from Hong Kong Island and Kowloon Peninsula to the New Territories, while six of them were also discovered on Coloane Island in Macau (Fig. 3).

Taxonomy

Genus *Polyrhachis* Smith, 1857

Polyrhachis Smith, 1857: 58. Type species: *Formica bihamata* Drury, 1773, by original designation.

Synoptic list of *Polyrhachis* species in Hong Kong and Macau

Polyrhachis confusa sp. nov.

Polyrhachis demangei Santschi, 1910

Polyrhachis dives Smith, 1857

= *Polyrhachis affinis* Smith, 1858

= *Polyrhachis democles* Smith, 1861

= *Polyrhachis mutiliae* Smith, 1861

= *Polyrhachis vicina* Roger, 1863a

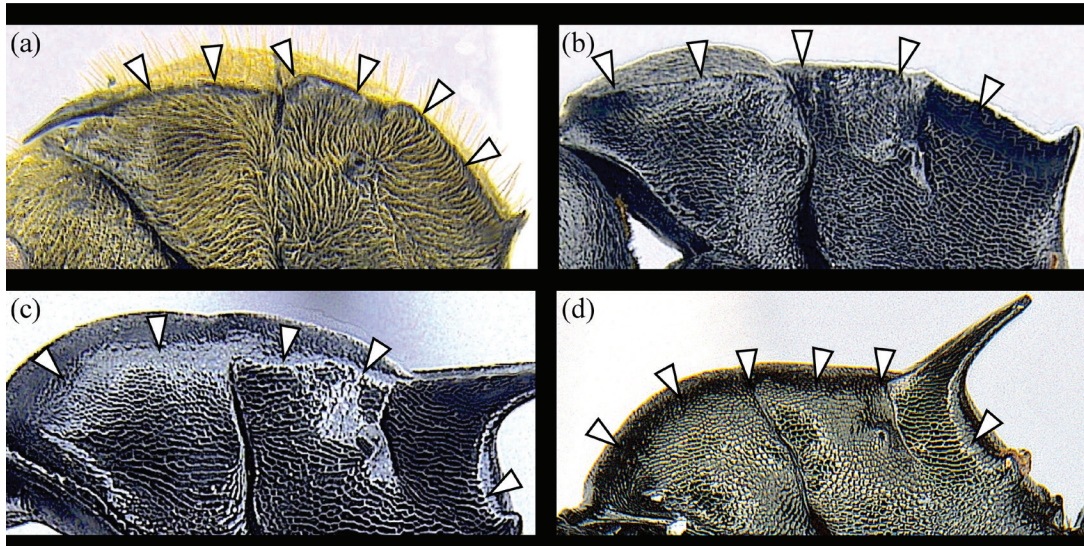


Fig. 4. (a) *Polyrhachis illaudata* worker (ANTWEB1009192), dorsal mesosoma in lateral view; (b) *Polyrhachis halidayi* worker (HNA-01512), dorsal mesosoma in lateral view; (c) *Polyrhachis confusa* worker (FB19152(1)), dorsal mesosoma in lateral view (image kindly provided by F. Brassard); and (d) *Polyrhachis hunggeuk* worker (RHL03201), dorsal mesosoma in lateral view.

- = *Polyrhachis dives euclides* Forel, 1913
- = *Polyrhachis dives siwiensis* Santschi, 1932
- = *Polyrhachis exulans* Clark, 1941
- = *Polyrhachis lucens* Donisthorpe, 1947
- Polyrhachis dives belli* Forel, 1912a [subspecies]
- Polyrhachis dives rectispina* Karavaiev, 1927 [subspecies]
- Polyrhachis fellowesi* sp. nov.
- Polyrhachis halidayi* Emery, 1889
- Polyrhachis hunggeuk* sp. nov.
- Polyrhachis illaudata* Walker, 1859
- = *Polyrhachis mayri* Roger, 1863a
- = *Polyrhachis duodentata* Donisthorpe, 1942
- = *Polyrhachis latispinosa* Donisthorpe, 1942
- Polyrhachis illaudata intermedia* Forel, 1886 [subspecies]
- = *Polyrhachis mayri intermedia* Forel, 1886
- Polyrhachis illaudata pauperata* Emery, 1889 [subspecies]
- = *Polyrhachis mayri pauperata* Emery, 1889
- Polyrhachis illaudata proximomayri* Emery, 1896 [subspecies]
- = *Polyrhachis mayri proximomayri* Emery, 1896
- Polyrhachis lamellidens* Smith, 1874 [previously reported in Hong Kong, currently unknown]
- Polyrhachis latona* Wheeler, 1909
- = *Polyrhachis latona dorsorugosa* Forel, 1913
- Polyrhachis moesta* Emery, 1887
- = *Polyrhachis paromalus tobias* Forel, 1911a
- Polyrhachis peetersi* sp. nov.
- Polyrhachis punctillata* Roger, 1863b
- = *Polyrhachis punctillata fergusonii* Forel, 1902
- = *Polyrhachis punctillata smythiesii* Forel, 1895
- Polyrhachis rastellata* Latreille, 1802
- = *Polyrhachis rastellata ceylonensis* Donisthorpe, 1938
- = *Polyrhachis rastellata aequidens* Santschi, unpublished (CAS 2020)
- = *Polyrhachis rastellata wedda* Santschi, unpublished (CAS 2020)
- Polyrhachis rastellata congener* Santschi, 1928a [subspecies]
- Polyrhachis rufipes* Smith, 1858
- = *Polyrhachis exasperatus* Smith, 1861
- = *Polyrhachis phipsoni* Forel, 1894
- = *Polyrhachis exasperata oblisa* Forel, 1911b
- Polyrhachis tyrannica* Smith, 1858
- Polyrhachis vigilans* Smith, 1858
- = *Polyrhachis pyrgops* Viehmeyer, 1912
- Polyrhachis wolffi* Forel, 1912b

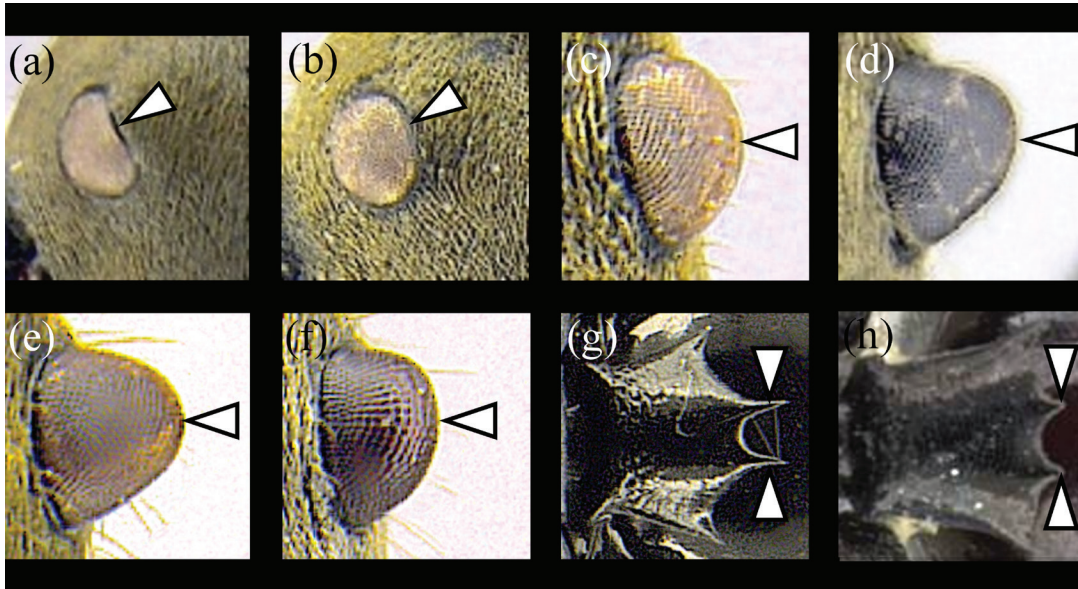


Fig. 5. (a) *Polyrhachis latona* worker (MLT0034), eye in lateral view; (b) *Polyrhachis illaudata* worker (ANTWEB1009192), eye in lateral view; (c) *Polyrhachis illaudata* worker (ANTWEB1009192), eye in full-face view; (d) *Polyrhachis vigilans* worker (WTL0005), eye in full-face view; (e) *Polyrhachis vigilans* worker (ANTWEB1009170), eye in full-face view; (f) *Polyrhachis wolfi* worker (GYOT014), eye in full-face view; (g) *Polyrhachis demangei* worker (WTL0006), petiole in dorsal view; and (h) *Polyrhachis rastellata* worker (CASENT0906784), petiole in dorsal view (photo from AntWeb).

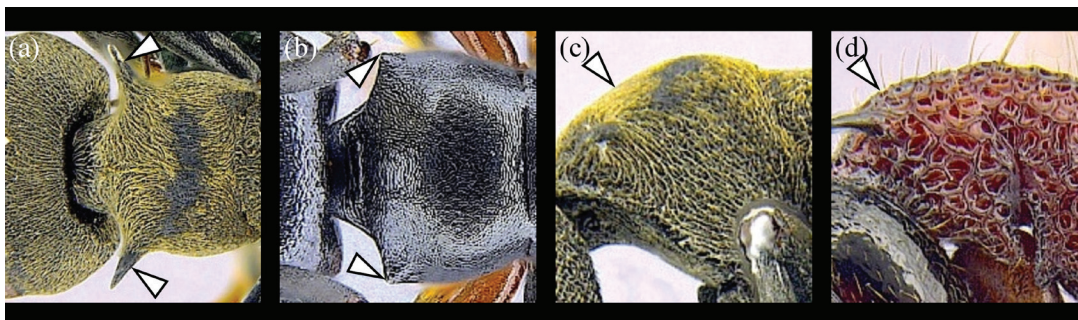


Fig. 6. (a) *Polyrhachis dives* worker (ANTWEB1009175), pronotum in dorsal view; (b) *Polyrhachis confusa* worker (FB19152(1)), pronotum in lateral view (image kindly provided by F. Brassard); (c) *Polyrhachis dives* worker (ANTWEB1009175), pronotum in lateral view; and (d) *Polyrhachis rufipes* worker (BG(2)), pronotum in lateral view.

Key to Hong Kong and Macau *Polyrhachis* species (format inspired by Kohout 2008, 2010)

1. Mesosomal dorsum moderately to significantly laterally marginate (Figs. 4a, b)2
- Mesosomal dorsum laterally weakly marginate or not marginate (Figs. 4c, d)10
2. Head and gaster of the same colour to mesosoma and petiole; mesonotum unarmed; propodeum armed with small upturned teeth; petiolar spines short and straight, or, if long, slightly curved, with an angle less than 90° to the verticle axis3
- Head and gaster of different colours to mesosoma and petiole; mesonotum armed with spines; propodeum armed with blunt spines; petiolar spines long and hook-shaped, with a roughly 180° turn
..... *Polyrhachis lamellidens* Smith

3. Clypeus strongly transverse, with anterior margin medially more or less convex; pronotum armed with spines or teeth; petiolar spines do not conform to shape of gaster in dorsal view; body densely covered by appressed pilosity4
 - Clypeus shield-shaped with anterior margin almost straight; pronotum without spines, anterolateral corner bluntly angled; petiolar spines feebly conform to shape of gaster in dorsal view; body with sparse appressed pubescence*Polyrhachis halidayi* Emery
4. Humeri armed with long spines, petiole armed with short lateral teeth and long dorsal spines5
 - Humeri and petiole armed with only short teeth*Polyrhachis punctillata* Roger
5. With head in profile view posterior margin of eye nearly straight (Fig. 5a)6
 - With head in profile view posterior margin of eye round (Fig. 5b)7
6. TL < 10 mm; with head in full-face view posterior margin shallowly convex; with petiole seen from back dorsal margin convex medially, sometimes forming blunt to distinct median tooth; erected setae on body confined to clypeus, venter and tip of gaster etc.
Polyrhachis latona Wheeler
 - TL ≥ 10 mm; with head in full-face view posterior margin shallowly and roundly convex; with petiole seen from back dorsal margin almost flat; body extensively covered with pale to dark brown erected setae
.....*Polyrhachis fellowesi* sp. nov.
7. Eyes less convex, curvature surface more rounded (Fig. 5c)8
 - Eyes more convex, distinctly narrowed distally (Fig. 5d)9
8. Golden yellow appressed pilosity of normal density distributed over most body surfaces; femora and tibiae black
.....*Polyrhachis illaudata* Walker
 - Pale yellow appressed pilosity of high density distributed over most body surfaces; femora and tibiae dark to very dark red
.....*Polyrhachis tyrannica* Smith
9. TL ≥ 10 mm; CI 84–96; EI 19–21; with head in full-face view eyes strongly protruding laterally, distally strongly narrowed (Fig. 5e); appressed pubescence on gastral tergites golden yellow....*Polyrhachis vigilans* Smith
 - TL < 10 mm; CI 74–85; EI 25–27; with head in full-face view eyes less protruding laterally, where distal outline broadly rounded (Fig. 5f); appressed pubescence on gastral tergites pale to golden yellow
.....*Polyrhachis wolffi* Forel
10. Propodeum unarmed or armed with short denticles; petiole with four short spines ...11
 - Propodeum armed with long slender spines; petiole with two long spines conforming to shape of gaster in dorsal view12
11. Propodeum armed with short denticles; petiolar teeth longer, length of dorsal petiolar teeth around twice that of width (Fig. 5g)
.....*Polyrhachis demangei* Santschi
 - Propodeum unarmed; petiolar teeth shorter, length of dorsal petiolar teeth similar to that of width (Fig. 5h)
.....*Polyrhachis rastellata* Latreille
12. Humeri armed with conspicuous, long and spinose spines (Fig. 6a)13
 - Humeri bluntly angular, at most with small denticles (Fig. 6b)14
13. Pronotum weakly convex in profile (Fig. 6c); pronotal spines straight, tips of propodeal spines curved upwards and outwards; petiole with two to three teeth between spines; body with densely appressed golden pubescence; pronotal dorsum with fine dense punctation that is concealed under dense pubescence; body entirely black
.....*Polyrhachis dives* Smith
 - Pronotum highly convex in profile (Fig. 6d); pronotal and propodeal spines slightly curving downwards; petiole without teeth between spines; body with long golden erected setae; pronotal dorsum coarsely foveolate-reticulate without pubescence; mesosoma and petiole reddish....*Polyrhachis rufipes* Smith
14. SI < 130; mesosoma laterally weakly marginate (Fig. 4c); base of propodeal spines broad*Polyrhachis confusa* sp. nov.
 - SI ≥ 130; mesosoma laterally rounded (Fig. 4d); base of propodeal spines narrower15
15. Petiolar intercalary teeth absent; body dull; coxae and femora dark reddish to pure black16

- Intercalary teeth present in between petiolar spines; body reflective; coxae and femora reddish-brown
..... *Polyrhachis hunggeuk* sp. nov.
- 16. TL < 7 mm; CI > 80; humeri with smaller, bluntly angular protrusions; lateral portion of mesosoma areolate-rugulose; gaster black ...
..... *Polyrhachis moesta* Emery
- TL > 7 mm; CI < 80; humeri armed with larger, sharper denticles; lateral portion of mesosoma irregularly reticulate-rugulose; gaster blackish brown
..... *Polyrhachis peetersi* sp. nov.

***Polyrhachis confusa* sp. nov.**

<http://zoobank.org/718858A4-56B6-4534-A645-3D8DAF46DCD6>

Holotype: HONG KONG: Ling Wui Shan, 22.2283°N 113.87515°E, 323 m, 4.xii.2017, S3-C Winkler leaf litter (*R. Cheung*) (w: LWS S2-R, ANTWEB1016626) (identified as *Polyrhachis* sp. *mucronata* group).

Paratypes: HONG KONG: Northeast New Territories, Sheung Wo Hang, 22.5219°N 114.1945°E, 40 m, F[eng] S[hui] Wood, 20.xi.1996, Winkler or pitfall (*J.R. Fellowes*) (3w: ANTWEB1015821, ANTWEB1015822, ANTWEB1016097) (mistaken as *P. phalerata*); Mui Tsz Lam, 22.38919°N 114.2345°E, 223 m, F[eng] S[hui] Wood, 4.x.2016, Pitfall-T2S5 (*R.H. Lee*) (1w: RHL003309) (mistaken as *P. lucidula*); High Island Reservoir, 22.36726°N 114.3451°E, 59 m, shrubland, 7.vii.2015, W-T1, Winkler (*R.H. Lee*) (1w: RHL02592) (identified as *Polyrhachis mucronata* group); SS BN 12, viii.2017 (*S. Saha*) (1w: Bamboonest colonisation, Aug'16–Aug'17) (mistaken as *P. lucidula*); SS1 site 18, SS7 site 18, vi.2016–viii.2016 (*S. Saha*) (2w, 1q: SRF Colonies, 7 days, 15 days) (mistaken as *P. lucidula*); Lung Fu Shan, 22.2812450°N 114.1378658°E, 143 m, 10.vi.2020 (*T.L. Wong & F. Brassard*) (1w: WTL0026). MACAU: Coloane, Coastal Trail, 22.1144°N 113.56988°E, 112 m, 17.v.2019, HandCol. (*F. Brassard*) (2w: FB19152) (mistaken as *P. lucidula*).

Worker (Figs. 7a–c, 7 measured, holotype cited first): TL c. 6.08, 5.56–6.76; HL 1.42, 1.33–1.57; HW 1.27, 1.17–1.40; EL 0.41, 0.38–0.47; ML 0.55, 0.49–0.56; SL 1.63, 1.47–1.69; WL 1.91, 1.74–2.06; PW 1.00, 0.94–1.12; PTL 0.45, 0.42–0.53; PTW 1.21, 0.98–1.32; PTH 0.54, 0.55–0.66; MTL 1.65, 1.49–1.73; CI 89, 84–94; EI 32, 32–34; MI 39, 33–41; SI 128, 120–129; PTI 269, 232–258; PTHI 121, 115–133.

Description: **Head.** Head longer than broad in full-face view (CI 84–94), broader posteriorly. Lateral margins of head in front of eyes slightly convex, converging towards mandibular bases, behind eyes rounding into curved occipital margin. Eyes located at posterior part of head, large (EI 32–34), facing anterolaterally, moderately convex, exceeding lateral cephalic outline in full-face view. Frontal carinae sinuate with moderately raised margins. Frontal triangle visible but slightly faded. Clypeus with poorly defined median carina; anteriorly straight, posteriorly rounding into relatively impressed basal margin in profile. Anterior clypeal margin slightly emarginate at middle, laterally flanked by acute teeth; posterior margin convex but medially moderately emarginate. Mandibular masticatory border with five teeth, apical tooth longest, subsequent teeth gradually reducing in length. Antennal scape slender and longer than head width (SI 120–129); antennal segments II to XII longer than broad, with segments II and XII slightly longer.

Mesosoma. Mesosoma dorsum weakly marginated laterally. Pronotum massive and moderately convex in profile, in dorsal view subtrapezoidal with anterior part roundly prominent and wider; humeri with reduced, bluntly angular protrusions. Promesonotal suture distinct; mesonotum almost flat in profile view, width narrower than that of pronotum but wider than that of propodeum. Metanotal groove laterally impressed, medially indistinct; propodeal dorsum armed with broad-based spines elevated at near right angle and directing posterolaterally.

Metasoma. Petiole columnar with two horizontal acute dorsal spines that conform to shape of gaster in dorsal view, and two intercalary teeth in between dorsal spines. Anterior face of first gastral tergite straight in lateral view, extensively rounding onto dorsum of segment.

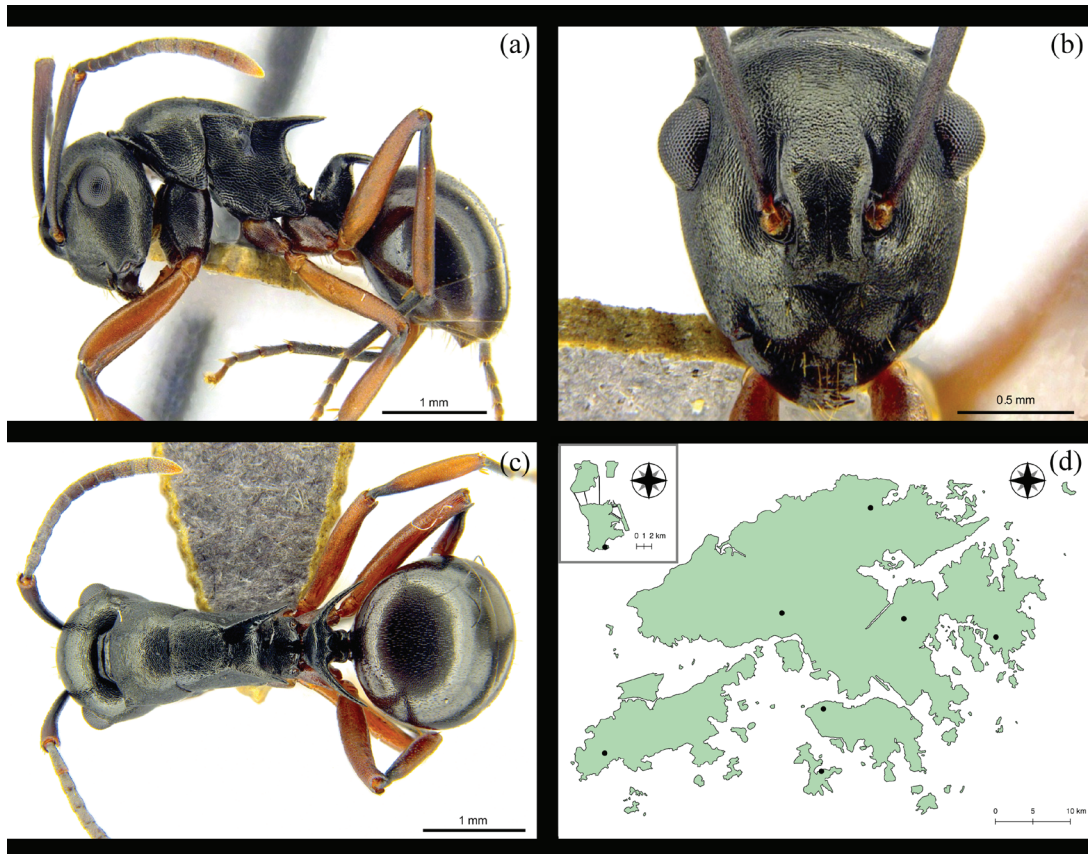


Fig. 7. The (a) profile, (b) full-face and (c) dorsal views of the *Polyrhachis confusa* holotype worker (ANT-WEB1016626), and (d) the species' distribution in Hong Kong and Macau.

Pilosity. Very short (about the length of a single ocellus) pale yellow appressed pubescence distributed sparsely over scapes, legs and gaster, denser on apical funicular segments and tarsi. Anterior and basal clypeal margins and space between frontal carinae with a few anteriorly projecting golden setae. Mandibles at apical borders with a few curved, golden suberected hairs. Dozens of short golden hairs at apical portion of scape. Yellowish brown erected hairs on side of mesosoma in lower portion, tarsi, and around joints of legs. Tuft of short erect golden hairs at tibial spurs and tarsi of forelegs. Ventral gaster with dozens of suberected, posteriorly directed golden hairs.

Sculpture. Mandibles sparsely longitudinally striate with piliferous pits. Head, mesosoma, coxae and petiole irregularly rugose to reticulate. Legs imbricate. Gaster finely shagreened.

Colouration. Body black and reflective; eyes greyish purple to black; condylar bulbs, apical funicular tips, palps and claws yellowish brown; apical funicular segments and gastral tip yellowish to dark reddish brown; coxae of middle and hind legs dark reddish brown to black; femora and tibiae yellowish, reddish or dark brown.

Queen (Fig. 8, paratype queen measured): TL c. 8.12; HL 1.79; HW 1.55; EL 0.61; ML 0.64; SL 1.79; WL 2.70; PW 1.58; PTL 0.58; PTW 1.27; PTH 0.59; MTL 1.92; CI 86; EI 40; MI 36; SI 116; PTI 217; PTHI 101.

Description: Similar to but larger than worker, with the following distinctions: presence of sexual characters, including three ocelli on cephalic dorsum, fully developed mesosoma and wings. Eyes larger (EI 40). Mesoscutum slightly elevated in lateral view, anterior margin rounded

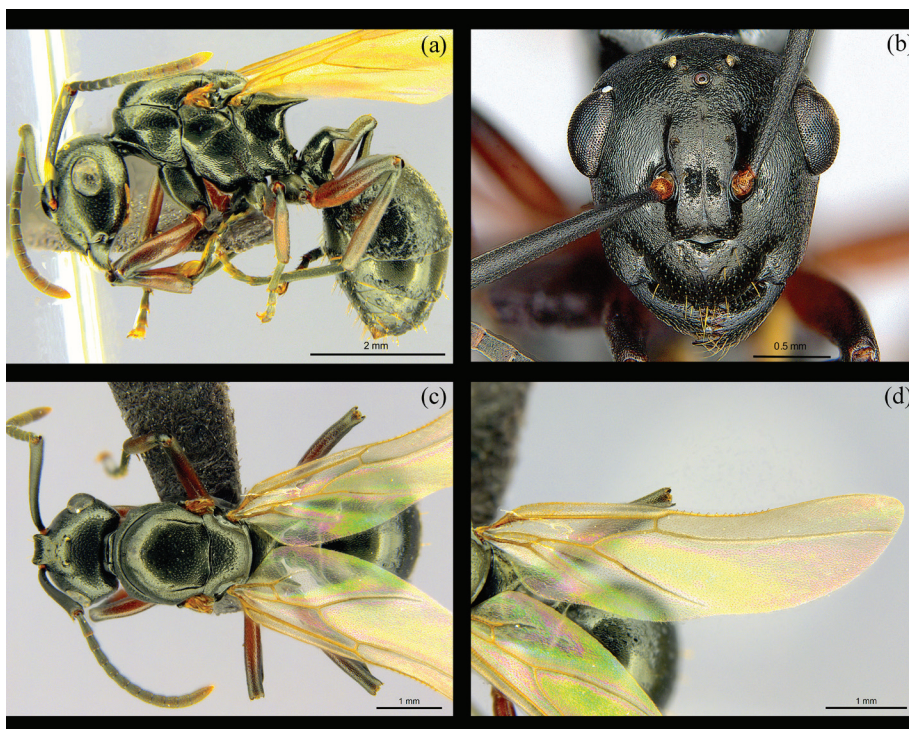


Fig. 8. The (a) profile, (b) full-face and (c) dorsal views and (d) wing of the *Polyrhachis confusa* paratype queen (SS1, site 18(1)).

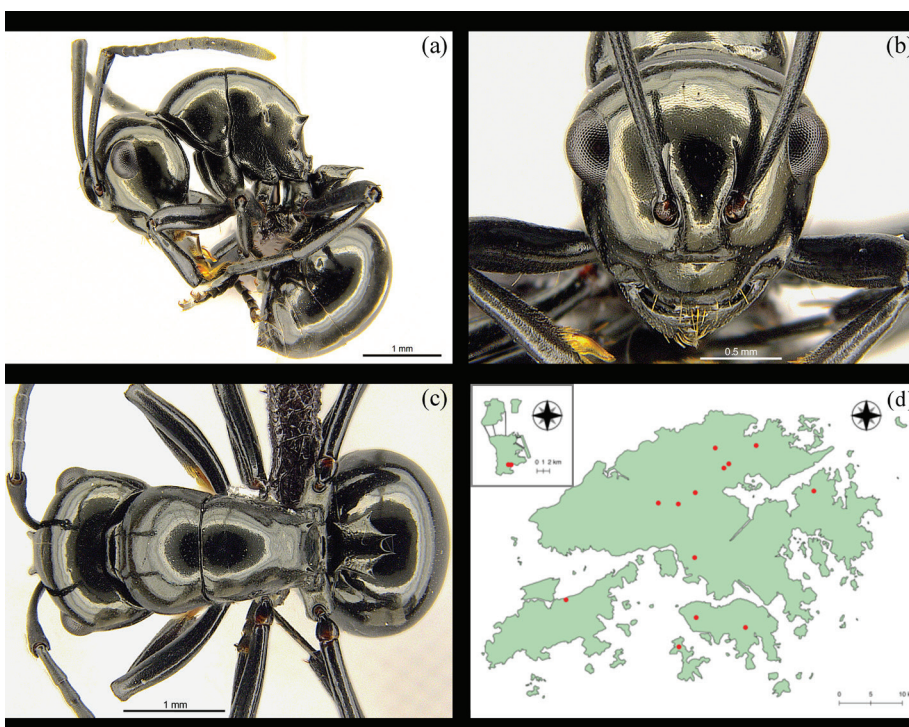


Fig. 9. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis demangei* worker (WTL0006), and (d) the species' distribution in Hong Kong and Macau.

onto flat dorsum in dorsal view; median line short, reaching $2/5$ length of mesoscutum; parapsides flat. Mesoscutellar disc barely convex. Metanotum deeply impressed. Pronotal denticles, propodeal and petiolar spines slightly reduced in size.

Forewing. Forewings of specimen lost.

Hindwing. Costa and subcosta almost parallel, meeting at mid-length of wing before series of distal hamuli. Subparallel radius and horizontal radial sector perpendicular to short vertex radial sector, tips almost reaching margin of wing, to a lesser extent for cubitus tip and midway for anal tip. Media-cubitus subparallel to anal; radial sector-media concave towards basal, part near cubitus semi-parallel to cubitus-anal.

Diagnostic notes. *Polyrhachis confusa* workers possess large eyes, an irregularly rugose to reticulate black reflective body, and petiolar spines conforming to gastral shape in dorsal view. Its laterally weakly marginate mesosoma, broad-based and almost straight propodeal spines help separate it from other members of the *Polyrhachis mucronata* species-group. The ant is similar to *Polyrhachis laevigata* Smith and *Polyrhachis orpheus* Forel, but in the latter two both have an immarginate mesosoma and a petiole lacking intercalary teeth. *Polyrhachis laevigata* also has its eyes facing laterally and propodeal spines very slightly curving downwards, while *P. orpheus* has shorter petiolar spines and a brown to dark brown gaster.

Some of the *P. confusa* specimens have been misidentified as *Polyrhachis phalerata* Menozzi, but the latter has relatively smaller eyes, a duller body with much rougher areolate sculpture and more robust pronotal teeth, propodeal and petiolar spines. Other specimens of *P. confusa* have also been misidentified as *Polyrhachis lucidula* Emery, which is fairly different by having a laterally immarginate mesosoma, long, slender propodeal spines that slightly curve downwards, and a pair of broad petiolar spines conforming to gastral shape in dorsal view. Although *P. lucidula* was said to be present in Shatin, Hong Kong (Wheeler 1928, 1930), this is now suspicious and unlikely due to the lack of known preserved *P. lucidula* specimens collected from Hong Kong as well as the misidentification issues of the *P. confusa* specimens. As a result, *P. lucidula*, de-

scribed from southern Myanmar, is thus removed from the list of Chinese ants as records presented from Fujian (Hua 2006) are likely to represent another misidentification.

Etymology. The specific name refers to the confusions made by previous examiners on the species, where they often mistaken the ant as *P. lucidula* and *P. phalerata*, two fairly different species.

Distribution and natural history. *Polyrhachis confusa* inhabits western Hong Kong Island, the eastern and northern New Territories and western Lantau Island in Hong Kong (Fig. 7d). As the species has previously been misidentified as *P. lucidula* or *P. phalerata*, it is also likely present in the southwestern New Territories and on southern Lamma Island. The ant is also native to Macau, living on southern Coloane Island (Fig. 7d), and our records indicate that this species mainly occupies lowland forest habitats (40–323 m alt.).

The ant seems to be aboreal based on a specimen collected on a leaf and two queenless colony collected from artificial bamboo nests. Both trap nests were placed on tree trunks at a height of about 1.5 m and have been colonized respectively after 7 and 15 days by *P. confusa*. The first nest had an entrance opening of 4.4 mm diameter, a habitable volume of 11.43 cm³ and was colonized by 19 workers and one alate gyne (30.vi.2016), while the second had an entrance of 5.5 mm diameter, a habitable volume of 9.42 cm³ and contained 37 workers and 4 larvae (12.viii.2016). The presence of alate gyne and larvae together with workers may suggest a polydomous structure in *P. confusa* with multiple satellite nests occupied by a single colony. It should be noted, however, that the collection of several workers through pitfall traps and Winkler extractors indicates some activity levels on the ground floor.

Polyrhachis demangei

Polyrhachis rastellata subsp. *demangei* Santschi, 1910: 284, fig. 3. Syntype worker. Type locality: VIETNAM, Hanoi, Tonkin (M. Demange), NHMB (examined via AntWeb). Combination in *P. (Cyrtomyrma)*: Emery, 1925: 208. Raised to species: Donisthorpe, 1938: 264, fig. 14.

Earliest known record: HONG KONG: New Territories, Ko Po orchard, 28.iii.1980, silk nest between longan leaves (*R. Winney*) (1w, NHMUK: ANTC27171) (not examined). **MACAU:** Coloane Island, Hac Sa, 25.vi.1999 (*K. Eguchi*) (1w: ANTWEB1015804) (mistaken as *P. rastellata*); same locality and date (*Sk. Yamane*) (1w, SKYC).

Other material examined: HONG KONG: (*C. Barthelemy*) (1w, M366 Malaise); Pok Fu Lam Country Park, 22.267818°N 114.140483°E, 221 m, 24.vii.2019, beating (*S.P. Yau & C.M. Leong*) (1w: WTL0006); Sha Lo Tung, 22.48°N 114.18°E, 175 m, lowland grassland, mixed/bamboo forest, marsh, 24.iii.1992, pitfall or bait (*J.R. Fellowes*) (1w: ANTWEB1015798); Pak Sha O, 22.44743°N 114.3082°E, 131 m, 17.xi.2017, S1-C Winkler leaf litter (*R. Cheung & M. Pierce*) (1w: ANTWEB1016535); Tung Chung, 22.29306°N

113.95491°E ± 10 m, 27 ± 10 m, ground forager, plantation forest, Hand Collected (*M. Pierce*) (1w: #IAS-0230, ANTWEB1009577); 13.ix.2016 (1q); [The University of] Hong Kong Campus, 11.viii.2015 (*H.M.H. Chan & C. Chan*) (1q: HC); CB00001 (1w: MLT0050); Ping Shan Chai, 22.486°N 114.187°E, 143 m, 13–27.vi.2015, malaise trap (2w: MLT0269, MLT0270); Ping Shan Chai, 22.486°N 114.187°E, 143 m, 15–29.viii.2015, 8.ii–5.iii.2016, malaise trap (3w: MLT0272, MLT0321); Ping Shan Chai, 22.486°N 114.187°E, 143 m, 30.vii.2016–3.ix.2016, M258 Malaise (*C. Barthelemy*) (2w); HK: Lamma Island, Tai Peng Old Village (Family Trail gravesite), 22.226200°N 114.115900°E, 33 m, 25.v.2020, visual, in Lepidopteran pupal case nest (*E. Jones*) (1q: EJ372). **MACAU:** Ka Ho Reservoir, 22.1244°N 113.5672°E, 102 m, 23.viii.2015 (*C.M. Leong*) (1w: Macau Ant Checklist-029). **ZHEJIANG (new record):** Gutianshan, CSP 13,

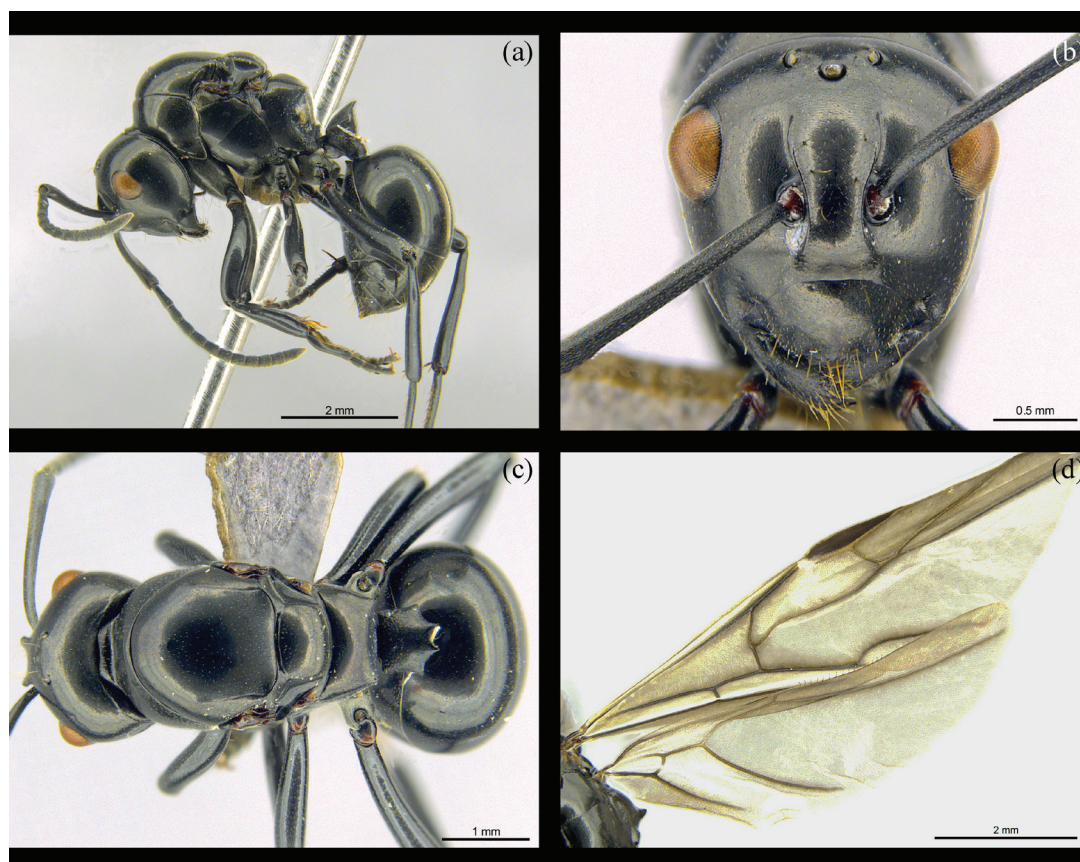


Fig. 10. The (a) profile, (b) full-face and (c) dorsal views and (d) wings of a *Polyrhachis demangei* queen (HC; wings belonging to EJ372).

29.246389°N 118.116111°E, 402 m, 12.v.2012, MS 794, sec(ondary) subtrop(ical) mixed forest, hand col. ground (*Micheal Staab*) (1W); Gutianshan, CSP 22, 29.276944°N 118.090556°E, 617 m, SW 2 (2009), sec(ondary) subtrop(ical) mixed forest, pitfall (*Andreas Schuldt*) (mistaken as *P. debilis*) (1W); Gutianshan, CSP 9, 29.242778°N 118.113333°E, 348 m, 3.v.2012, sec(ondary) subtrop(ical) mixed forest, honey bait on low vegetation (*Micheal Staab*) (1W).

Worker (Figs. 9a–c, 9 non-type workers measured): TL c. 6.29–6.74; HL 1.44–1.59; HW 1.44–1.60; EL 0.43–0.49; ML 0.54–0.63; SL 1.58–1.92; WL 2.02–2.13; PW 1.06–1.24; PTL 0.45–0.63; PTW 0.53–0.68; PTH 0.50–0.59; MTL 1.77–2.28; CI 97–104; EI 28–32; MI 35–41; SI 109–122; PTI 112–133; PTHI 91–117.

Description (Non-type workers described): **Head.** Head about as long as broad in full-face view (CI 97–104), broader posteriorly. Lateral margins of head in front of eyes slightly convex, converging towards mandibular bases, behind eyes rounding into curved occipital margin. Eyes located at posterior part of head, relatively large (EI 28–32), facing anterolaterally; convex, slightly exceeding lateral cephalic outline in full-face view. Frontal carinae sinuate, moderately raised. Frontal triangle indistinct. Clypeus with poorly defined median carina; in profile anteriorly straight, posteriorly rounding into medially impressed basal margin. Anterior clypeal margin arcuate, medially extending as short rectangular process with distinct anterolateral angles; posterior margin mildly convex, median portion almost straight with very shallow median incision. Mandibular masticatory border with five teeth, apical tooth longest, subsequent teeth gradually reducing in length. Antennal scape slender and longer than head width (SI 109–122); antennal segments II to XII longer than broad, with segments II and XII slightly longer.

Mesosoma. Mesosoma not marginate laterally, in profile strongly roundly convex dorsally. In dorsal view pronotum massive, wider and longer than mesonotum, subtrapezoidal, narrowed posteriad, humeri rounded and unarmed. Promesonotal suture distinct. Metanotal groove poorly indicated so that mesonotum and pro-

podeal dorsum almost continuous; propodeum narrower than mesonotum, dorsum posteriorly armed with short, obtusely elevated denticles, their tips curved upwards and outwards.

Metasoma. Petiole node scale-like with four subequal teeth, two broad-based lateral ones projecting laterally and dorsal pair that slightly curve backwards. Anterior face of first gastral tergite straight in lateral view, rounding onto dorsum of segment.

Pilosity. Very short (about the length of a single ocellus) pale yellow pubescence distributed sparsely over most body surfaces, denser on apical funicular segments and tarsi. Anterior clypeal margin, sometimes also basal clypeal margin and dorsal head, with several anteriorly projecting golden setae medially and a few shorter ones fringing margin laterally. Mandibles at masticatory and outer borders with a few curved, golden suberected hairs and shorter appressed ones at base. Dozens of short golden hairs at apical portion of scape. Brown erected hairs present on side of mesosoma in lower portion, tarsi, around joints of legs, and ventrally on petiolar pedicel in front of subpetiolar process. Tuft of golden hairs at tibial spurs and tarsi of forelegs. Apical segments of dorsum and venter of gaster with a number of suberected, posteriorly directed, golden hairs.

Sculpture. Mandibles sparsely longitudinally striate with piliferous pits. Head and mesosoma finely and very superficially reticulate and rather shiny; sides of mesosoma with somewhat coarser sculpture. Gaster finely shagreened.

Colouration. Body black, polished with metallic reflections; scapes, fore coxae and tarsi black or very dark reddish-brown; condylar bulbs dark reddish brown; apical funicular tips and claws yellowish brown; eyes, palps and most of legs, except coxae and tarsi, yellowish brown, light to dark reddish-brown or black.

Queen (Fig. 10, 3 measured, undescribed in the past): TL c. 8.58–9.42; HL 1.81–2.03; HW 1.79–1.97; EL 0.57–0.64; ML 0.75–0.79; SL 2.14–2.35; WL 2.91–3.19; PW 1.77–1.90; PTL 0.64–0.71; PTW 0.67–0.82; PTH 0.57–0.65; MTL 2.33–2.58; CI 97–99; EI 30–32; MI 39–42; SI 112–131; PTI 105–127; PTHI 89–101.

Description: Head. Head almost as long as broad in full-face view (CI 97–99), broader posteriorly. Lateral margins of head in front of eyes slightly convex, converging towards mandibular bases, behind eyes rounding into curved occipital margin. Three ocelli on cephalic dorsum. Eyes located at posterior part of head, relatively large (EI 30–32), facing anterolaterally; convex, slightly exceeding lateral cephalic outline in full-face view. Frontal carinae sinuate, moderately raised. Frontal triangle indistinct. Clypeus with poorly defined median carina; in profile anteriorly straight, posteriorly rounding into medially impressed basal margin. Anterior clypeal margin arcuate, medially extending as short rectangular process with distinct anterolateral angles; posterior margin mildly convex, medially almost flat with very shallow median incision. Mandibular masticatory border with five teeth, apical tooth longest, subsequent teeth gradually reducing in length. Antennal scape slender and longer than head width (SI 112–131); antennal segments II to XII longer than broad, with segments II and XII slightly longer.

Mesosoma. Mesosoma fully developed and not marginate laterally, with wings or scars left by the detached wings. Pronotum in profile with vertical anterior slope so that almost invisible when seen from above; humeri unarmed. Promesonotal suture distinct. With mesosoma in profile view mesonotum greatly convex dorsally, slightly wider than pronotum. Mesoscutum elevated in lateral view, anterior margin rounded onto flat dorsum in dorsal view; median line short, visible in anterior 2/5 of mesoscutum; parapsides roundly slopes to ventral margin of scutum. Mesoscutellar disc shallowly convex dorsally and slightly higher than mesoscutum. Metanotum appears as narrow band, short and much lower than mesoscutellum and propodeum; metapleuron not clearly demarcated from lateral face of propodeum. Propodeal narrower than rest of mesosoma, dorsum rounding into posterior declivity; propodeal spines short, triangular.

Metasoma. Petiole node scale-like with four subequal teeth smaller than those of workers, two broad-based lateral teeth projecting posterolaterally and a pair of dorsal ones slightly curving downwards. Anterior face of first gastral tergite straight in lateral view, rounding onto dorsum of segment.

Forewing. Costa and subcosta almost parallel, meeting at mid-length of wing after series of secondary hamuli and before pterostigma. Vertical radial sector about 45° from subcosta; radial sector-media convex near radius-radial sector, concave near radial sector. Subparallel horizontal radius and horizontal radial sector semi-perpendicular to radius-radial sector, together with outer media branching from radial sector-media tips reaching wing margin; almost reaching wing margin for cubitus tip and to a lesser extent for anal tip. Outer cubitus more inwards than middle cubitus. Inner media almost parallel to cubitus-anal; media-cubitus and anal mostly parallel, perpendicular to cubitus-anal.

Hindwing. Costa, subcosta and media-cubitus almost parallel, with the former two meeting at mid-length of wing before series of distal hamuli. Subparallel horizontal radius and horizontal radial sector perpendicular to short verticle radial sector, tips reaching wing margin; almost for cubitus tip and to a lesser extent for anal tip. Radial sector-media concave towards basal cell, portion near redical sector semi-parallel to subcosta. Anal subparallel to cubitus, perpendicular to convex cubitus-anal.

Pilosity. Very short (about the length of a single ocellus) pale yellow pubescence distributed sparsely over most body surfaces, denser on apical funicular segments and tarsi. Anterior clypeal margin, sometimes also basal clypeal margin and dorsal head, with several anteriorly projecting golden setae medially and a few shorter ones fringing margin laterally. Mandibles at masticatory and outer borders with a few curved, golden suberected hairs and shorter appressed ones at base. Dozens of short golden hairs at apical portion of scape. Brown erected hairs at lower portion of side of mesosoma, tarsi, around joints of legs, and ventrally on petiolar pedicel in front of subpetiolar process. Tuft of golden hairs at tibial spurs and tarsi of forelegs. Apical segments of dorsum and venter of gaster with a number of suberected, posteriorly directed, golden hairs.

Sculpture. Mandibles sparsely longitudinally striate with piliferous pits. Whole body finely reticulate with sides of mesosoma somewhat coarser and sculptured. Gaster finely shagreened.

Colouration. Body black, polished with metallic reflections; scapes, fore coxae and tarsi black or very dark reddish-brown; condylar bulbs dark reddish brown; tips of apical funicular segments and claws yellowish brown; eyes and palps yellowish brown or brown.

Diagnostic notes. In the worker caste *Polyrhachis demangei* is characterized by its rounded, unarmed pronotum, smooth and shiny black body with few hairs, and a pair of small propodeal denticles. It can be distinguished from its sympatric species *Polyrhachis debilis* Emery in the condition of the dorsal petiolar teeth; their bases are combined in *P. demangei* but not in *P. debilis* (Xu 2002). *Polyrhachis rastellata* also highly resembles *P. demangei*, except in lacking the pair of propodeal denticles, having shorter, more robust petiolar teeth, and brightly coloured legs.

Distribution and natural history. *Polyrhachis demangei* can be found on western to central Hong Kong Island, northern Lamma Island, Tung Chung and mainly central and the northern New Territories, as well as southern part of Macau's Coloane Island (Fig. 9d). It is also distributed in northern Vietnam (Santschi 1910, Guénard *et al.* 2017) and southern parts of China, including Guangdong, Guangxi, Hainan (Ran & Zhou 2013), Hunan, Hubei, Fujian (Hua 2006; Guénard & Dunn 2012) and Zhejiang (new record). Our records indicate that this species mainly occupies lowland forest and shrubland habitats in Hong Kong and Macau (27–221 m alt.), while it is found at higher elevation in Zhejiang (up to 348 to 617 m alt.).

This species is known to be preyed by the Chinese pangolin (*Manis pentadactyla* Linnaeus) (Lee *et al.* 2017). It constructs arboreal silk nests primarily built of leaves according to information about a specimen found in Ko Po, Hong Kong and deposited in NHMUK (CAS 2020). The recent collection of a nest collected on Lamma Island, Hong Kong, shows that *P. demangei* can take advantage of a leftover pupal case, which belongs to a large Lepidopteran species from the Saturniidae family, with the colony composed of about 50 individuals (Table 1, Fig. 11) (Jones pers. comm.). The nest was composed of fine plant fibres and attached to a branch, lined with golden silk interiorly and covered by dead leave fragments exteriorly. The species seems to feed on honeydew or sugary food, as the ants inhabiting the pupal case nest survived for weeks by receiving honey-soaked cotton and water (Jones pers. comm.).

Polyrhachis dives

Polyrhachis dives Smith, 1857: 64. Holotype worker. Type locality: SINGAPORE (A.R. Wallace), NHMUK (images examined via AntWeb). Descriptions of queen and male: Mayr, 1867: 49. Combination in *P. (Myrmhopla)*: Wheeler, 1919: 132. Description of larvae: Wheeler & Wheeler, 1953: 208. Description of karyotype: Hung *et al.*, 1972: 1025. See Bingham, 1903: 396; Kohout, 2010: 180.

Polyrhachis vicina Roger, 1863a: 7. Replacement name for *P. affinis* Smith, 1858: 63. Combination in *P. (Myrmhopla)*: Emery, 1925: 197. Synonymy by Wang & Wu, 1991: 599.

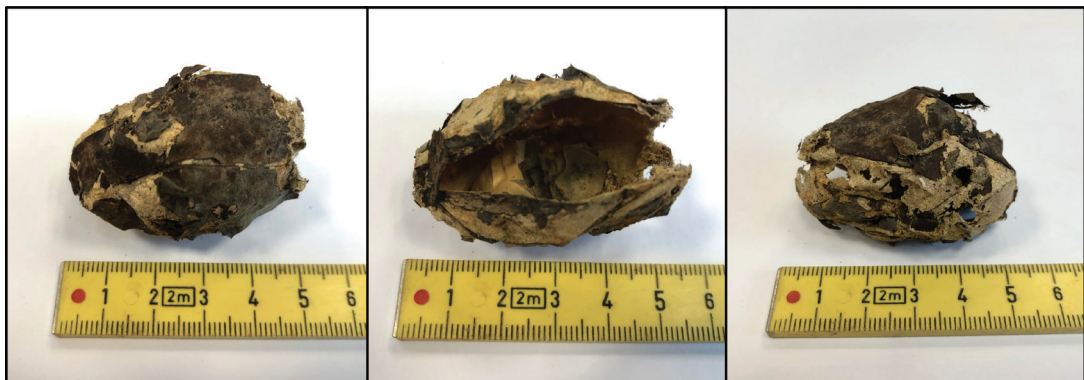


Fig. 11. The Saturniidae pupal case that was occupied by a colony of *Polyrhachis demangei*. Images kindly provided by E. Jones.

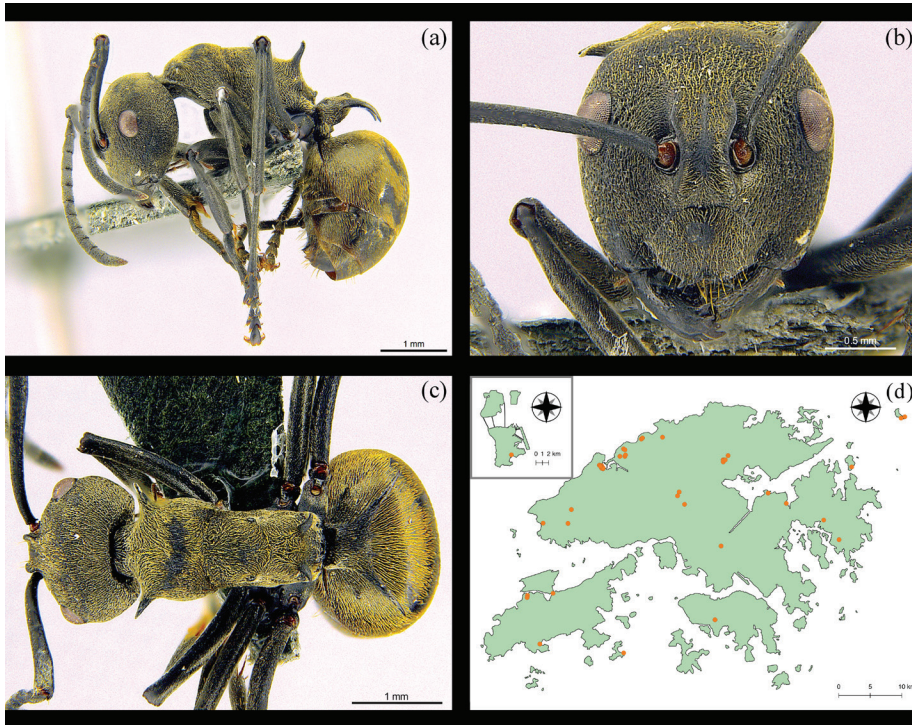


Fig. 12. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis dives* worker (ANTWEB1009175), and (d) the species' distribution in Hong Kong and Macau.

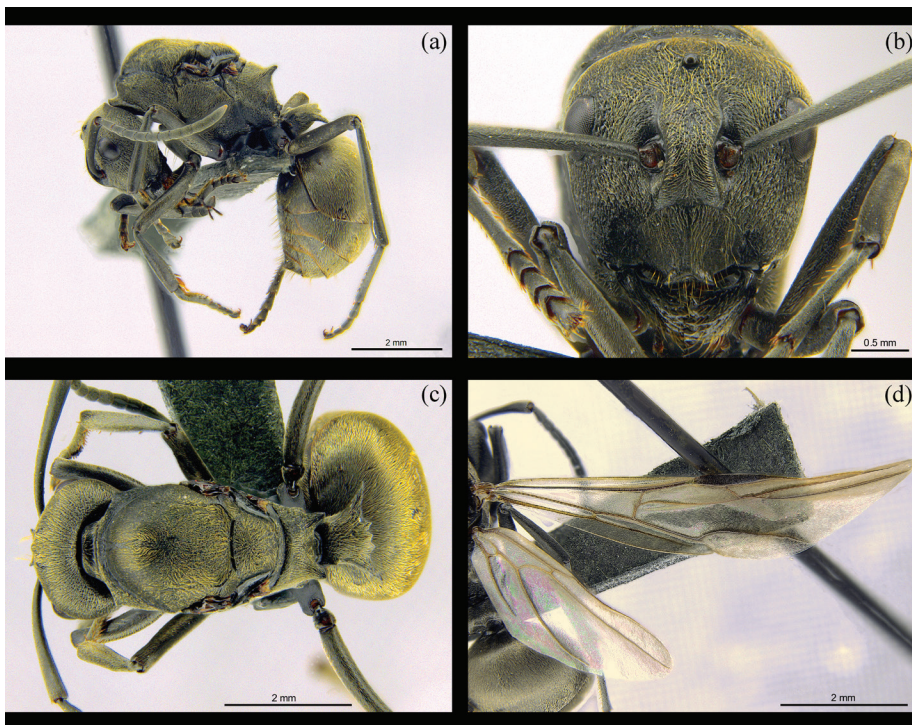


Fig. 13. The (a) profile, (b) full-face and (c) dorsal views and (d) wing of a *Polyrhachis dives* queen (WTL0019(1); wings belonging to WTL0017(2)).

Polyrhachis dives var. *euclides* Forel, 1913: 202.
Syntype workers, queens and males. Type locality: TAIWAN, Akau, Anping (H. Sauter), MHNG, MSNG, NHMUK, NMOK, SDEI. Synonymy by Bolton, 1974: 173.
(For full synonymic citations see AntCat (Bolton 2020))

Earliest known record: HONG KONG: see Forel 1893. **MACAU:** see Tang *et al.* 1995.

Other material examined : HONG KONG: Hong Kong Wetland Park, 22.4719266°N 114.0067966°E, 7 m, 18.x.2019 (*T.L. Wong*) (1w: WTL0009); Yuen Long, Tien Shui Wai, 22.46902°N 114.00877°E ± 500 m, 4 ± 10 m, 31.v.2016, urban park at bait (*Y. Luo*) (1w: #ISP0096, ANTWEB1009180) (*P. dives*_cf); North, Ma Tso Lung, 22.51199°N 114.09359°E ± 10 m, 52 ± 10 m, 18.xi.2016, closed landfill ground forager, hand collection (*M. Pierce*) (1w: #IAS-0170, ANTWEB1009175); Lok Ma Chau, 22.50936°N 114.0634°E ± 45 m, 4 ± 10 m, wetland park bund edge, Pitfall (*M. Pierce*) (1w : ANTWEB1016856); Mai Po, 22.48497°N 114.0328°E ± 45 m, 3 ± 10 m, wetland park bund edge, Pitfall (*M. Pierce*) (1w : ANTWEB1017053); (*M. Pierce*) (1w: ANTWEB1016977); Western New Territories, Nam Long, 22.3907°N 113.9232°E, 20 m, F[eng] S[hui] Wood, 7.xi.1996, Winkler (*J.R. Fellowes*) (1w: ANTWEB1015808); Sha Lo Tung, 22.48°N 114.18°E, 175 m, lowland grassland, mixed/bamboo forest, marsh, 24.iii.1992, Pitfall or bait (*G.T. Reels & J.R. Fellowes*) (4w: ANTWEB1015809, ANTWEB1016082, ANTWEB1016083, ANTWEB1016084); Park (NT), 9.i.2016 (*GYOT*) (1w: GYOT042); Sha Lo Wan, 22.2881°N 113.9013°E, 1 m, subtropical forest, 19.x.2015, LW2R72, Winkler, 12 Random, 72 hr extraction (*B.M. Worthington*) (1w: BMW00044) (identified as *P. dives*_cf); Chek Lap Kok, 22.2911°N 113.9377°E, 3 m, subtropical forest, 28.vi.2016, LT1B35, baiting (*B.M. Worthington*) (1w: BMW00930); Chek Lap Kok, 22.2851°N 113.9008°E, 18 m, subtropical forest, stream edge nearby LT4, 26.x.2016, LT4B30 (*B.M. Worthington*) (1w: BMW01798); Chek Lap Kok, 22.2851°N 113.9008°E, 18 m, 26.x.2016, LT4B30, hand collection (*B.M.*

Worthington) (1w: BMW01800); Tung Ping Chau, 22.5409°N, 114.4387°E, 13 m, 2.x.2017, Winkler, 12 Random, 72 hr extraction (*R. Cheung & B. Morgan*) (1w: BAM10016, TPC S1-R, ANTWEB1016644); Tung Ping Chau, 22.539°N, 114.4333°E, 18 m, semi-open forest footpath, 2.x.2017, hand (*R. Cheung & B. Morgan*) (1w: BAM10019, ANTWEB1016649); Starfish Bay, 22.4329°N, 114.244°E, 0 m, beach, 17.x.2017, hand (*B. Morgan*) (2w: BAM10023, ANTWEB1016657); Hong Kong Wetland Park, 22.4681549°N 114.0068090°E, 10 m, 22.4672371°N 114.0087878°E, 3 m, 22.4679804°N 114.0092009°E, 1 m, 22.4718705°N 114.0048752°E, 0 m, 22.4724217°N 114.0037956°E, 4 m, 22.4709433°N 114.0051065°E, 5 m, 30.x.2019, in nest (*T.L. Wong*) (12q, 12m: WTL0010–WTL0021); Sha Lo Tung, 22.47902°N 114.1801°E, 162 m, grassland, 28.v.2015, P-T2S0, P-T2S3, P-T2S5, P-T2S15, pitfall (*R.H. Lee*) (5w: RHL01783, RHL01784, RHL01791, RHL01801); Tap Mun, 22.47°N 114.363°E, 23 m, grassland, 28.vii.2015, P-T4S5, pitfall (*R.H. Lee*) (1w: RHL02303); (*K.H. Chan*) (5w: CKH-0100, CKH-0115, CKH-0142, CKH-0265, CKH-0269); Sai Kung, 22.41831°N 114.26985°E, 0 m, 26.vi.2018, 40M2 Malaise trap (*C. Taylor & R. Cheung*) (1 w: ANTWEB1017979); Shui Hau, 15.v.2017, 19M2 Malaise trap (*C. Taylor & U. Cheung*) (1w: ANTWEB1018098); (*R.H. Lee*) (2w: RHL00469, RHL00471); Mai Po Nature Reservoir, 22.485°N 114.04°E, 1 m, 20.ix.2014–18.x.2014, 29.xi.2014–27.xii.2014, Malaise trap (3w: MLT0035, MLT0040, MLT0045, MLT0052); Ping Shan Chai, 22.486°N 114.187°E, 134 m, 27.ix.2014–11.x.2014, 25.x.2014–8.xi.2014, 8.xi.2014–22.xi.2014, 15.viii.2015–29.viii.2015, 7.xi.2015–22.xi.2015, malaise trap (8w: MLT0037, MLT0038, MLT0042, MLT0043, MLT0044 MLT0273, MLT0274, MLT0352); CB00008 (1w: MLT0046); CB00001 (3w: MLT0047, MLT0048, MLT0049); Mai Po, 22.4868°N 114.0409°E, 0 m, grassland, 26–29.x.2015, P-T1S5, pitfall (*R.H. Lee*) (1w: RHL002925). **MACAU:** Coloane, Hac Sa Reservoir East, 22.12659°N 113.57272°E, 69 m, 19.iii.2019, HandCol. (*F. Brassard*) (1w: MAC_S03 HC_01_Sp.2).

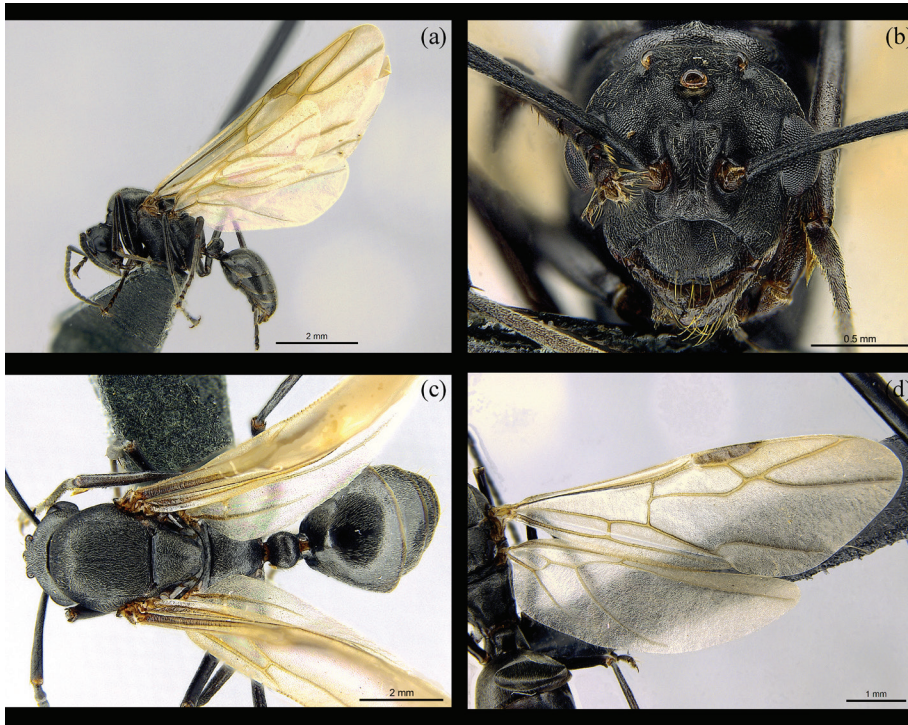


Fig. 14. The (a) profile, (b) full-face and (c) dorsal views and (d) wing of a *Polyrhachis dives* male (WTL0016(2)).

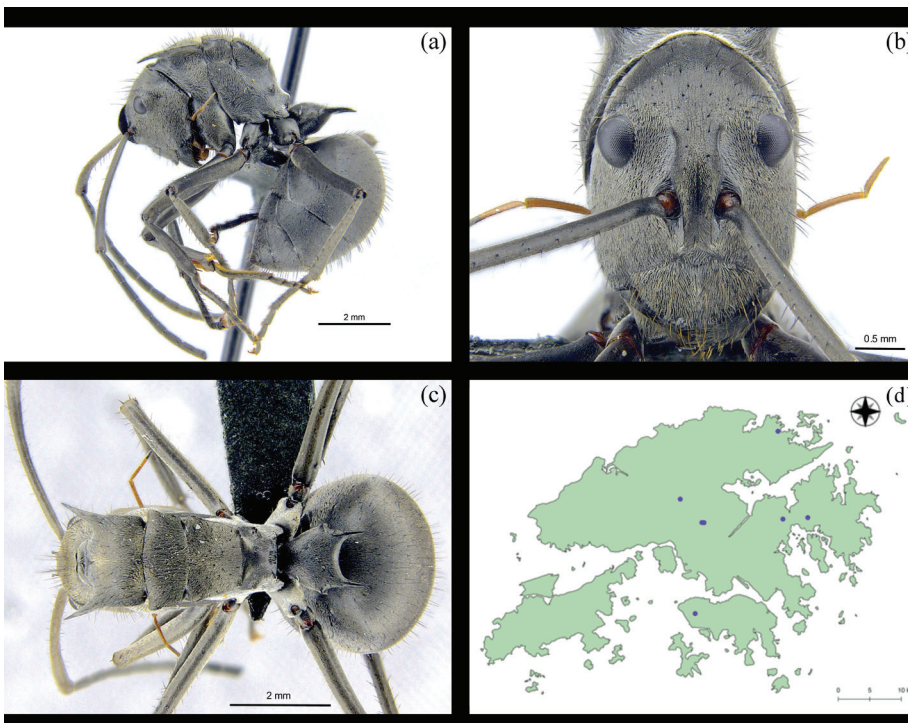


Fig. 15. The (a) profile, (b) full-face and (c) dorsal views of the *Polyrhachis fellowesi* holotype worker (WTL0007), and (d) the species' distribution in Hong Kong.

Worker (Figs. 12a–c, 21 non-type workers measured): TL c. 5.61–7.20; HL 1.34–1.77; HW 1.28–1.77; EL 0.35–0.46; ML 0.52–0.70; SL 1.65–2.15; WL 1.86–2.36; PW 0.89–1.18; PTL 0.35–0.55; PTW 1.16–1.72; PTH 0.51–0.81; MTL 1.57–2.24; CI 93–100; EI 24–27; MI 34–41; SI 115–129; PTI 245–388; PTHI 120–165 See Kohout (2010: 180) for detailed description.

Queen (Fig. 13, 12 non-type queens measured): TL c. 8.82–10.43; HL 1.97–2.22; HW 1.86–2.18; EL 0.51–0.58; ML 0.73–0.88; SL 1.95–2.29; WL 3.20–3.67; PW 1.80–2.02; PTL 0.62–0.706; PTW 1.46–1.76; PTH 0.55–0.77; MTL 2.30–2.81; CI 92–102; EI 27–28; MI 34–40; SI 99–113; PTI 222–264; PTHI 81–115.

Description (non-type queens described): **Forewing.** Costa and subcosta almost parallel, meeting over mid-length of wing before pterostigma. Vertical radial sector about semi-perpendicular to subcosta; radial sector-media convex near radius-radial sector, almost straight near radial sector. Semi-parallel radius and horizontal radial sector semi-perpendicular to radius-radial sector, tips reaching wing margin; almost reaching wing margin for tip of outer media branching from radial sector-media and to a lesser extent for cubitus and anal tips. Outer cubitus more inwards than middle cubitus. Inner media parallel to cubitus-anal; media-cubitus and anal subparallel, perpendicular to cubitus-anal.

Hindwing. Costa, subcosta and media-cubitus almost parallel, with the former two meeting before mid-length of wing and series of very short (about the length of two to three ocelli) distal hamuli. Subparallel horizontal radius and horizontal radial sector perpendicular to short vertex radial sector, tips almost reaching wing margin; to a lesser degree for cubitus tip and even less for anal tip. Radial sector-media concave towards basal cell, portion near radial sector semi-parallel to subcosta. Anal semi-parallel to cubitus, perpendicular to convex cubitus-anal. See Kohout (2010: 180–181) for further detailed description.

Male (Fig. 14, 12 measured): TL c. 6.43–7.97; HL 1.13–1.30; HW 1.06–1.21; EL 0.40–0.47; ML 0.42–0.49; SL 1.27–1.47; WL 2.27–2.94; PW 1.24–1.50; PTL 0.44–0.56; PTW 0.38–0.46;

PTH 0.29–0.37; MTL 1.71–2.24; CI 93–100; EI 34–42; MI 34–41; SI 112–130; PTI 77–91; PTHI 63–71.

Description: In sculpture and colouration similar to worker, but with the following differences: bearing sexual traits, such as three ocelli, well-developed thorax and wings. Anterior clypeal margin lacking acute teeth. Head smaller than worker, but with relatively more convex and larger eyes (EI 34–42). Antennae with 13 segments; scape slender and longer than head width (SI 112–130), antennal segments II to XIII a bit longer than broad, with segments II and XIII slightly longer. Pronotum much reduced compared with that of worker, seen from above almost hidden by massive mesoscutum. Mesoscutum roundly convex dorsally in profile view, with rather flat posterior slope; anterior margin rounded onto flat dorsum in dorsal view; median line short, visible up to 2/5 length of mesoscutum, often represented by two shiny lines that diverge anteriorly and posteriorly; parapsides flat. Mesoscutellar disc flat, not elevated above mesoscutum, but its anterior margin slightly higher than posterior margin of mesoscutum. Metanotum short, sloping posteriad, lower than mesoscutellum and propodeum. Petiole low and thick. Pronotal, propodeal and petiolar spines absent. Gaster much slender than that of worker, often with tip of genitalia exposed at end. Pubescence on all body parts much sparser than in worker. Wings same as those of queens.

Diagnostic notes. In the worker caste *Polyrhachis dives* is characterized by its pair of outward-pointing acute teeth at the anterior clypeal margin; weakly convex pronotum; slender pronotal, propodeal and petiolar spines; and black body often covered by very dense, golden pubescence. It is morphologically stable across its distribution range with a few minor distinctions. For examples, compared to their Oceanian counterparts, the anterior clypeal margin of Southeast Asian individuals is more distinctly emarginated; their eyes are less likely to exceed the lateral margins of the head; and the tips of their propodeal spines and petiolar spines curve more outwards and downwards correspondingly (Kohout 2010). Variations also exist among members of the same colony, as individuals can bear two or three teeth

between their petiolar spines (Wang & Wu 1991). This species resembles members of the *Polyrhachis dives* species-group (e.g. *Polyrhachis griseescens* Emery, *Polyrhachis lacteipennis* Smith, *Polyrhachis menelas* Forel and *Polyrhachis rupicapra* Roger), but has pale to golden pilosity densely covering most of its body, a condition that is not observed in the other species.

Distribution and natural history. *Polyrhachis dives* is widely distributed in Hong Kong's Aberdeen, Lion Rock, Lantau Island, the New Territories, and remote islands such as Cheung Chau, Tap Mun and Tung Ping Chau (Fig. 12d). It can also be found on southern Coloane, Macau (Fig. 12d). It is widely distributed in east and south-east China, Taiwan (Guénard & Dunn 2012; Ran & Zhou 2013), southern islands of Japan (Terayama *et al.* 2014), India (Bharti *et al.* 2016), Nepal (CAS 2020), Southeast Asia, New Guinea and northern Australia with few differences in terms of morphology and nesting habits across its geographical ranges (Kohout 2010), and has been introduced, but is not established outdoor, in Netherlands (Boer 2019) and Hawaii (Nishida 2002). The species is the best studied species of the *Polyrhachis* genus that can be found in Hong Kong and Macau, probably due to its wide range distribution (Hannan & Yamane 2005). Our records indicate that this species mainly occupies lowland forest, shrubland, grassland and mangrove habitat edges (0–175 m alt.) where it can be particularly abundant.

Polyrhachis dives can be infected by the fungus *Ophiocordyceps unilateralis sensu lato* (Lin *et al.* 2020) and is a host of the parasitic eucharitid wasp *Stilbula polyrhachicida* Wheeler & Wheeler (Noyes 2019), but the ants may get rid of the parasites and infection primarily by frequent self-cleaning (Zhukovskaya *et al.* 2013) and secondarily by producing antimicrobial chemical venom (Graystock & Hughes 2011; Tranter & Hughes 2015). It is preyed by the Chinese pangolin (*Manis pentadactyla*) (Wu *et al.* 2005) and even consumed by humans (Tang *et al.* 2015), and has been used as a natural enemy to control leaf-eating pests in China (Hannan & Yamane 2005; Yan *et al.* 2011). The species mainly feeds on plant sap (Staab *et al.* 2017), secretions of trophobionts and honeywater, but can also pre-

date other insects, and communicate via tactile stimulations (Liefke *et al.* 1998). It lives in open forests, grasslands and coastal swamps (e.g. Mai Po area in Hong Kong), and constructs arboreal nests containing fine plant materials and larval silk with leaves and twigs (Robson & Kohout 2007) on lower trees and shrub branches (Kohout 1988), also in herbs and on ground (Liefke *et al.* 1998). The ant has a critical thermal maximum limit of 39.46°C (Chung & Lin 2017).

Based on the nests collected in the Hong Kong Wetland Park for this study, the nests of *P. dives* are irregular in shape and size. They can take the forms of a box, pear or realistic heart and ranged from 15.7 cm to 34.0 cm in length, with an average size of 22.57 ± 7.37 cm, although larger ones were observed at the sampling sites and have been reported in other regions (e.g. 51 cm length on Iriomote Island, Hannan & Yamane 2005). However, all are carton nests made up of the same materials, including dead and alive plant materials, soil particles and larval silk, reinforced by branches and with larvae and pupae attached on inner surfaces, matching the descriptions reported from other countries (Liefke *et al.* 1998; Hannan & Yamane 2005; Kohout 2010). The species is polydomous and polygynous, where all nests containing two to over 200 dealate queens, although this can be variable due to their flexible social organization (Liefke *et al.* 1998, Table 2). Its mating season may be in between October and November, as all nests collected included relatively high proportions of males and alate queens (Table 2). Although all castes and life stages of *P. dives* were discovered in the collected nests, most nests did not have the full set of them whose numbers varied greatly, ranging from 595 to over 20,000 individuals (Table 2). Two out of six of the nests collected were clearly parts of larger polydomous colonies, which may explain the different ratios of various castes in the nests. Only two nests contained alate queens and the smallest nest had a larger number of males and queens than workers and immature stages, which may be due to the nests being at different phases. This is suggested by that some *P. dives* nests examined only in the field were a bit dilapidated and empty, where the ants might have abandoned the old nests to reconstruct a new one.

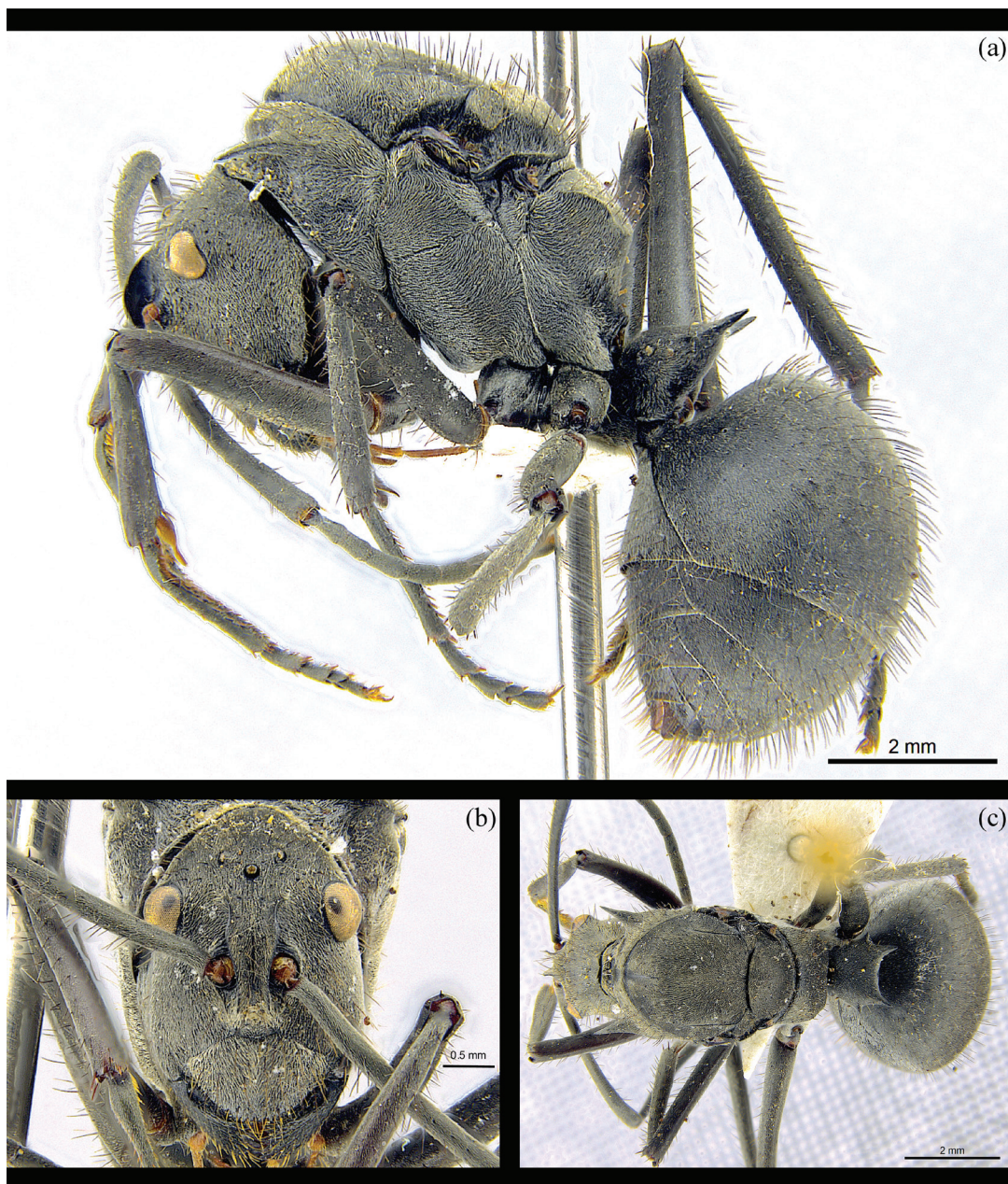


Fig. 16. The (a) profile, (b) full-face and (c) dorsal views of the *Polyrhachis fellowesi* paratype queen (ANT-WEB1015770).

Polyrhachis dives symbiont diversity

A wide variety of arthropods were found in the collected nests of *P. dives*. This includes four species of spiders, including three species of jumping spiders (Salticidae), *Phintelloides versicolor* (Koch), a species from the genus *Siler* Simon and another unidentified species, and a spider in the family Gnaphosidae (or Corinnidae – identification uncertain). *Siler cupreus* Simon, a jumping spider that preys on ants of all live stages (Touyama *et al.* 2008), can be found in all *P. dives* nests, where the spider may mimic the gait of ants to prey on or protect themselves from ants, similar to the closely related *Siler semiglaucus* (Simon) (Grob 2015). The spiders may also provide silk for nest constructions, as in the cases of some other *Polyrhachis* species (Liefke *et al.* 1998; Dias 2015).

Several Hymenoptera species have also been found within nests, including a parasitoid wasp (Hymenoptera) probably in the family Proctotrupidae; as well as a colony of the ant *Tapinoma melanocephalum* (Fabricius) which appeared to represent a case of xenobiosis, with further interactions (e.g. cleptobiosis) unknown. *Tapinoma melanocephalum*, a highly successful tramp species (Wetterer 2009; Klimes & Okrouhlik 2015), has likely taken advantage of the space between foliage of a *P. dives* nest to establish its own colony.

Two species of true bugs (Hemiptera) have also been retrieved from *P. dives* nests, including *Appoloniuss* sp. (Rhyparochromidae: Lygaeoidea) and *Thabena* sp. (Issidae: Fulgoroidea), while scale insects in the family Monophlebidae in the colony of *T. melanocephalum* were also found. The bugs and scale insects are likely to be trophobionts of *P. dives*, as the ant has a symbiotic relationship with hemipteran insects (Dorow & Maschwitz 1990), including Aphidae, Coccidae, Membracidae and Pseudococcidae (Liefke *et al.* 1998), such as the pink mealybug (*Maconellicoccus hirsutus* (Green)) (Shen *et al.* 2007). They even live in pavilions built by *P. dives* and are guarded by the latter (Liefke *et al.* 1998). Finally, unidentified cockroaches were also found within two nests. The cockroaches may also be myrmecophiles of *P. dives*, similar to the relationships between members in the genus

Attaphila Wheeler and leaf-cutting ants (Waller & Moser 1990; Nehring *et al.* 2016).

Remains of termite worker and soldier as well as larva of probably a moth species were also found in some nests. The termites may be consumed by *P. dives*, since there were observations of *P. dives* consuming dead insect prey (Liefke *et al.* 1998), while the beetle and fly larvae might be myrmecophilous to the ants, similar to the relationship between larvae of the hoverfly *Microdon katsurai* Maruyama & Hironaga and *P. lamellidens* (Iwai *et al.* 2016).

***Polyrhachis fellowesi* sp. nov.**

<http://zoobank.org/A72820B0-28C0-4E7B-B163-2DE6DF95BA12>

Holotype: HONG KONG: Pok Fu Lam Country Park, 22.267818°N 114.140483°E, 221m, 24.vii.2019, beating (*S.P. Yau & C.M. Leong*) (w: WTL0007).

Paratypes: HONG KONG: Shing Mun, 22.397°N 114.15°E, 220 m, lowland dense/open-canopy mixed forest, 22.vi.1992, pitfall or bait (*J.R. Fellowes*) (1w: ANTWEB1016093) (mistaken as *Polyrhachis striata*); Eastern New Territories, Tai Mong Tsai, 22.404°N 114.301°E, 60–90 m, F[eng] S[hui] Wood, 1.viii.1996, Winkler or pitfall (*J.R. Fellowes*) (2w: ANTWEB1016098, ANTWEB1016099) (mistaken as *Polyrhachis striata*); Shing Mun Park, 22°23.807'N 114°9.186'E, 244 m, 14.v.2015 (1w) (identified as “*Polyrhachis Mayr*” species); Kadoorie Farm and Botanical Garden, 22.4302°N 114.1192°E, 264 m, secondary forest, 14.ix.2015, P-T1S0, pitfall (*R.H. Lee*) (1w: RHL02450) (identified as *Polyrhachis pruinosa* nr.); Ma On Shan, 22.4019°N 114.2656°E, secondary forest, 26.12.2015, hand collection (*R.H. Lee*) (1w: RHL003412) (mistaken as *P. striata*). **GUANGDONG:** Ding Hu Shan, 23.10°N 112.33°E, 280 m, 6.v.1998 (*J.R. Fellowes*) (1w, 1q: ANTWEB1015770) (mistaken as *Polyrhachis striata*). **GUANGXI:** Noon Gang, 5.v.1998 (*J.R. Fellowes*) (1w, ANTWEB1015769) (mistaken as *Polyrhachis striata*). **ZHEJIANG:** Gutianshan, CSP 16, 29.2425°N 118.0997 °E, 309 m, sec(ondary) subtrop(ical) mixed forest, NW 10 (2009), pitfall (*Andreas Schuldt*) (mistaken as *P. striata*) (1W).

Worker (Figs. 15a–c, 7 measured, holotype cited first): TL c. 12.59, 10.90–12.90; HL 2.93, 2.52–2.94; HW 2.08, 1.76–2.08; EL 0.51, 0.46–0.51; ML 1.05, 0.87–1.19; SL 3.80, 3.70–4.24; WL 3.97, 3.58–4.15; PW 1.80, 1.64–1.87; PTL 0.93, 0.84–1.05; PTW 1.40, 1.15–1.59; PTH 1.55, 1.38–1.84; MTL 3.96, 3.38–4.43; CI 71, 70–75; EI 24, 24–28; MI 36, 34–40; SI 183, 189–204; PTI 151, 137–153; PTHI 167, 150–211.

Description: Head. Head oval-shaped and clearly longer than broad in full-face view (CI 70–75), ventrally angular in profile. Lateral margins of head in front of eyes slightly convex, converging towards bases of mandibles, behind eyes rounding into convex, medially slightly emarginate occipital margin. Eyes located at posterior part of head, facing anteriorly and mildly truncate posteriorly; strongly convex, slightly exceeding lateral cephalic outline in full-face view. Frontal carinae sinuate, raised and slightly laminate at mid-length. Frontal triangle apparent. Clypeus with slightly evident median carina; anteriorly straight, posteriorly rounding into mildly impressed basal margin in lateral view. Anterior clypeal margin arcuate; posterior margin laterally slightly concave, medially emarginate. Mandibular masticatory border with five teeth, apical tooth longest, subsequent teeth gradually reducing in length. Antennal scape slender and much longer than head width (SI 183–204); antennal segments II to XII longer than broad and gradually reduced in length, except the slightly shorter segment III and slightly longer segment XII.

Mesosoma. Mesosomal dorsum highly laterally marginate. Pronotal dorsum subrectangular and weakly convex; humeri armed with long spines directing anterolaterally and slightly dorsally, mildly curving downwards. Promesonotal suture distinct; mesonotum mildly convex dorsally, curving towards both promesonotal suture and metanotal groove, anterior dorsal part significantly protruded. Metanotal groove laterally moderately impressed, medially indistinct; propodeal dorsum armed with short upturned denticles, with laminate lateral margins converging towards metanotal groove.

Metasoma. Petiole scale-like; armed with two tiny broad-based lateral denticles, and two posteriorly projecting acute dorsal spines that slightly curve backwards to form a U-shape

in dorsal view. Anterior face of first gastral tergite flat, extensively rounding onto dorsum of segment.

Pilosity. Pale yellow appressed pilosity densely distributed over most body surfaces, with shorter pubescence on antennae, legs and ventral gaster. Head, scapes, clypeus, dorsal mesosoma, upper dorsal petiole, legs and gaster with dozens of very dark brown erected setae, with those on head and mesosoma directing anteriorly and petiolar and gastral ones posteriorly. Clypeus and mandibles at apical and outer borders with some curved, golden suberected hairs. Dark brown erected hairs on side of mesosoma in lower portion, tarsi and petiole, and around joints of legs. Tuft of short erect brownish golden hairs at tibial spurs and tarsi of forelegs.

Sculpture. Mandibles longitudinally striate with piliferous pits. Head, mesosoma and petiole costulate, legs imbricate. Forehead, mesosomal, petiolar and gastral dorsa, scapes and tibiae punctulate. Gaster finely shagreened.

Colouration. Body black; eyes light to dark brown, purplish brown or black; condylar bulbs, palps, tips of apical funicular segments, claws and gastral tip dark yellowish brown.

Queen (Fig. 16, paratype queen measured): TL c. 14.02; HL 3.10; HW 2.24; EL 0.61; ML 1.05; SL 4.22; WL 5.05; PW 2.73; PTL 1.04; PTW 1.72; PTH 1.39; MTL 4.23; CI 72; EI 27; MI 34; SI 189; PTI 165; PTHI 133.

Description: Similar to but larger than worker, with the following distinctions: sexual characters, including three ocelli on cephalic dorsum, fully developed mesosoma and wings (or scars left by the detached wings), present. Mesoscutum highly convex in lateral view, anterior margin rounded onto dorsum in dorsal view; median line short, reaching 1/4 of mesoscutum; parapsides flat. Mesoscutellar disc slightly convex. Metanotum deeply impressed. Pronotal and petiolar spines smaller in size; propodeal spines reduced to protrusions.

Diagnostic notes. *Polyrhachis fellowesi* is marked by its posteriorly mildly truncated eyes that barely exceed the outline of the head in full-face view; angular ventral head when viewed in profile; a black body with dense pale yellow pi-

losity over its body; and blackish brown setae on dorsal parts of the body and appendages. It also has a strongly laterally marginated mesosomal dorsum armed with long pronotal spines and short upturned propodeal spines, with significant protrusions at the anterior mesonotal dorsum; a scale-like petiole with two short lateral teeth, and two acute long dorsal spines that are almost parallel and form a U-shape in dorsal view.

This species is similar to *Polyrhachis noesaensis* Forel and *Polyrhachis pruinosa* Mayr, but *P. noesaensis* has more protruding eyes, less angular ventral face of the head in profile and reddish black legs, and *P. pruinosa* lacks any erected setae and mesonotal protrusions. Both *P. noesaensis* and *P. pruinosa* have their dorsal petiolar spines more diverging outwards than *P. fellowesi*. Many of the *P. fellowesi* specimens were also originally misrecognized as *Polyrhachis striata* Mayr, but *P. striata* has a costate head instead of a costulate one; more strongly bulged eyes breaking the lateral cephalic margin in full-face view; flatter mesosomal dorsal outline in profile; more diverging dorsal petiolar spines; and a body covered with much less dense pilosity.

Etymology. The specific name is dedicated to Dr. John R. Fellowes, who first discovered the ant in Hong Kong as well as in Guangdong and Guangxi provinces, and has provided samples and information on the specimens that were collected before 2000 in China and Hong Kong used in this study. We also recognize here his great contributions to myrmecology in the region.

Distribution and natural history. *Polyrhachis fellowesi* can be found in lowland forests (60–280 m alt.) on western Hong Kong Island and in the eastern, central and northeastern New Territories (Fig. 15d). It is also more widely distributed in Guangdong and Guangxi provinces according to BSM specimens, as well as further north in Zhejiang province (specimen donated by Michael Staab) and potentially other provinces in China where it seems to have been mistaken with other species such as *P. striata*. As *P. striata* was originally described from Indonesia, it seems that northern records of this species, including those from Fujian (Wheeler 1927), should be revised as they most likely belong to *P. fellowesi*.

Its natural history is unknown.

Polyrhachis halidayi

Polyrhachis halidayi Emery, 1889: 517. Syntype worker. Type locality: MYANMAR, Tenasserim, Kawkareet (L. Fea), MSNG (examined via AntWeb). Description of queen: Bingham, 1903: 413, fig. 144. Combination in *P. (Campomyrma)*: Emery, 1925: 180.

Earliest known record: HONG KONG: Tai Mo Shan, 22.416°N 114.126°E, 770–840 m, Montane dwarf mixed forest/dense grassland, 17.vii.1993, pitfall or bait (*J.R. Fellowes*) (3w: ANTWEB1015790, ANTWEB1015794, ANTWEB1015796).

Other material examined: HONG KONG: East Central New Territories, Wong Chuk Yeung, 22.40°N 114.26°E, 215 m, 29.x.1996 (*J.R. Fellowes*) (1w: ANTWEB1016085); **GUANGDONG:** Qi Mu Zhang, 5.v.1997, 6.v.1997 (*J.R. Fellowes*) (2w: ANTWEB1015792, ANTWEB1015793). **HAINAN:** Jiang Feng Ling, 18.67°N 108.83°E, 920 m, 11.iv.1998 (*J.R. Fellowes*) (1w: ANTWEB1015791); (*R.H. Lee*) (1w, 1q, *Polyrhachis* HNA-sp2: HNA-01512, HNA-00939).

Worker (Figs. 17a–c, 9 non-type workers measured): TL c. 7.13–8.70; HL 1.75–2.11; HW 1.54–1.91; EL 0.46–0.53; ML 0.59–0.76; SL 1.65–2.22; WL 2.23–2.67; PW 1.16–1.40; PTL 0.48–0.71; PTW 1.18–1.53; PTH 0.55–0.84; MTL 1.91–2.24; CI 84–94; EI 26–30; MI 31–40; SI 106–117; PTI 213–308; PTHI 110–145.

Description (Non-type workers described): **Head.** Head longer than broad in full-face view (CI 84–94), broader posteriorly. Lateral margins of head in front of eyes slightly convex, converging towards bases of mandibles, behind eyes rounding into curved occipital margin. Eyes located at posterior part of head, facing anterolaterally; moderately convex, slightly exceeding lateral cephalic outline in full-face view. Frontal carinae sinuate, moderately raised. Frontal triangle apparent. Clypeus shield-shaped, with evident median carina; anteriorly straight, posteriorly rounding into relatively impressed basal margin in profile. Anterior clypeal margin slightly emar-

ginate at middle; shield shaped, covering closed mandibles in full-face view; posterior margin convex but medially moderately emarginate. Mandibular masticatory border with five teeth, apical tooth longest, subsequent teeth gradually reducing in length. Antennal scape slender and slightly longer than head width (SI 106–117); antennal segments II to XII longer than broad, with segments II and XII slightly longer.

Mesosoma. Mesosomal dorsum significantly laterally marginate. Pronotum weakly convex in profile, subtrapezoidal, wider anteriorly, with anterior margin arcuate in dorsal view; humeri bluntly angular. Promesonotal suture distinct; mesonotum with flat dorsal outline in profile view, anterior margin arcuate in dorsal view, narrower than pronotum but wider than propodeum. Metanotal groove laterally impressed, medially indistinct; propodeal dorsum posteriorly armed with short, upturned teeth.

Metasoma. Petiole scale-like with two acute spines projecting posterolaterally and conforming to shape of gaster in dorsal view, and two denticles in between in dorsal view. Anterior face of first gastral tergite flat, rounding in evenly curve line onto dorsum of segment.

Pilosity. Very short (about the length of two to three ocelli) pale yellow pubescence distributed mostly closely appressed to body surface, and rather dense on gastral tergites, funiculi and tarsi. Anterior and basal clypeal margins and sometimes space between frontal carinae with some anteriorly projecting golden setae, and several shorter ones fringing margin laterally. Mandibles at apical and outer borders with a few curved, golden suberected hairs and short appressed basal ones. Dozens of short golden hairs at apical portion of scape. Yellowish brown erected hairs at lower portion of side of mesosoma, femora, tarsi and around joints of legs. Tuft of brownish golden hairs at tibial spurs and tarsi of forelegs. Dorsal and ventral gaster with numerous suberected, posteriorly directed golden hairs.

Sculpture. Mandibles punctulate and costulate at base. Frontal face of head costate. Lateral body strigate-reticulate, dorsum costulate. Legs imbricate. Gaster finely shagreened.

Colouration. Body black; scapes, coxae, tarsi and gaster reddish-brown to black; eyes brown, dark reddish brown or grey; condylar

bulbs, apical funicular segments and gastral tip yellowish to dark reddish brown; palps and claws yellow to brown; most of legs, except coxae and tarsi, brown, light to dark reddish-brown.

Queen (Fig. 18, 1 measured): TL c. 11.33; HL 2.36; HW 2.12; EL 0.65; ML 0.84; SL 2.13; WL 3.47; PW 1.94; PTL 0.81; PTW 1.46; PTH 0.84; MTL 2.20; CI 89; EI 31; MI 35; SI 101; PTI 181; PTHI 104.

Description: Similar to but larger than worker, with the following distinctions: sexual characters like three ocelli on cephalic dorsum, fully developed mesosoma and wings exist. Eyes slightly larger. Anterior clypeal margin with distinct notch and blunter median carina. Pronotal denticles reduced to protrusions. Mesoscutum in lateral view convex, with anterior one-third sloping and the rest almost flat; median line very short, only reaching 1/5 length of mesoscutum; parapsides flat. Mesoscutellar disc flat. Metanotum medially very short but longer laterally, much lower than mesoscutellum and propodeum. Propodeal and petiolar spines smaller than those of workers.

Forewing. Costa and subcosta almost parallel, meeting slightly over mid-length of wing before pterostigma. Vertical radial sector about semi-perpendicular to subcosta; radial sector-media convex. Semi-parallel radius and horizontal radial sector semi-perpendicular to radius-radial sector, tips reaching wing margin; almost reaching wing margin for tip of outer media branching from radial sector-media and to a lesser extent for cubitus and anal tips. Outer cubitus more inwards than middle cubitus. Inner media subparallel to cubitus-anal; media-cubitus and anal subparallel, perpendicular to cubitus-anal.

Hindwing. Costa, subcosta and media-cubitus semi-parallel, with the former two meeting before mid-length of wing and series of distal hamuli. Subparallel horizontal radius and horizontal radial sector perpendicular to short verticle radial sector, tips almost reaching wing margin; to a lesser degree for cubitus and even less for anal. Radial sector-media concave towards basal. Anal semi-parallel to cubitus, perpendicular to convex cubitus-anal.

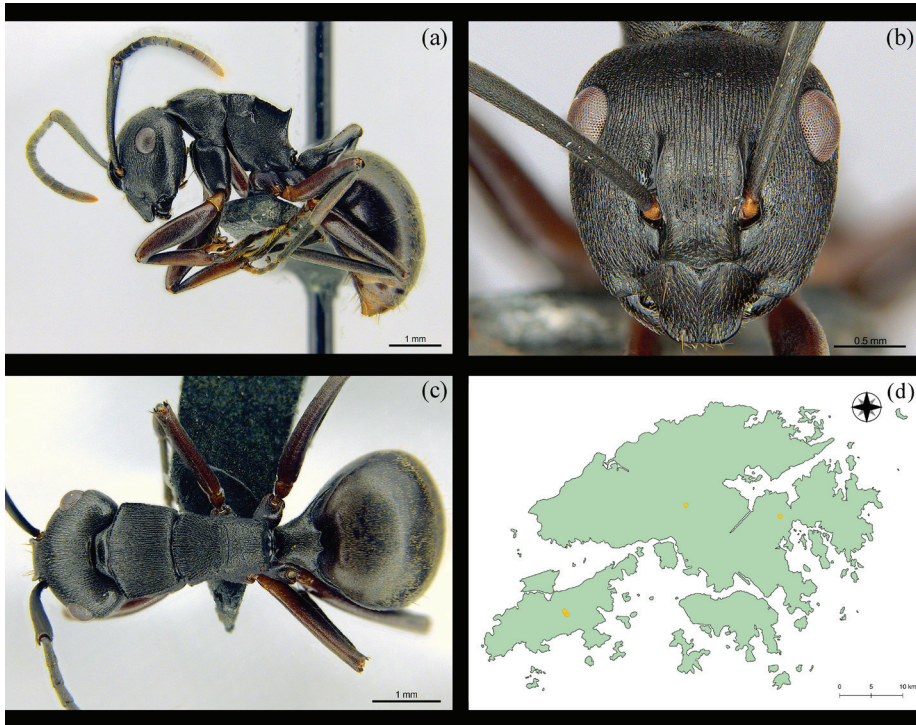


Fig. 17. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis halidayi* worker (HNA-01512), and (d) the species' distribution in Hong Kong.



Fig. 18. The (a) profile, (b) full-face and (c) dorsal views and (d) wing of a *Polyrhachis halidayi* queen (HNA-00939).

Diagnostic notes. In the worker caste *Polyrhachis halidayi* can be identified by its peculiar shield-shaped clypeus; costate frontal head; unarmed but bluntly angular pronotum; strongly laterally margined mesosomal dorsum; and petiolar spines that weakly conform to the shape of the gaster in dorsal view. The set of traits helps separate this species from its *Campomyrma* relatives, for examples, *Polyrhachis creusa* Emery, *Polyrhachis exercita* Walker, *Polyrhachis hashimotoi* Kohout and *Polyrhachis shixingensis* Wu & Wang, where their petiolar spines generally do not conform the shape of the gaster, and some such as *P. hashimotoi* and *P. shixingensis* have propodeal spines pointing posteriorly instead of bearing short, upturning teeth.

Distribution and natural history. *Polyrhachis halidayi* is reported from Guangdong, Guangxi, Hainan, Yunnan, Fujian and Zhejiang Provinces in China (Guénard & Dunn 2012), Vietnam, Laos, Myanmar (Ran & Zhou 2013), Thailand (Jaitrong & Nabhitabhata 2005) and northeastern India (Bharti *et al.* 2016). In Hong Kong, its known distribution is restricted to small areas in Wong Chuk Yeung, Tai Mo Shan and on Lantau Island in the New Territories (Fig. 17d), at a median height of 580 m (Morgan & Guénard 2018) with maximum elevation over 800 m in Hong Kong, but found at higher elevation in southeast China. It is estimated that the ant has a narrow distribution in Hong Kong mountains and hills and may be considered as locally endangered due to the limited numbers of recent records (Morgan & Guénard 2018).

Little is known about the species' natural history, apart from having arboreal nests built in-between leaves (Bingham 1903; Robson & Kohout 2007), however, the exact nesting ecology of this species may require further studies.

***Polyrhachis hunggeuk* sp. nov.**

<http://zoobank.org/D215C2C3-C890-4760-8AF1-39E7DFA515C3>

Holotype: HONG KONG: Tai Po Kau, secondary forest, 22.42786°N 114.180962°E, 162 m, footpath, 12.vi.2016, hand collection (*R.H. Lee*) (w: RHL03201) (identified as *Polyrhachis* sp. *mucronata* group; mistaken as *P. phalerata*)

Worker (Figs. 19a–c, holotype measured): TL c. 5.95; HL 1.39; HW 1.16; EL 0.41; ML 0.50; SL 1.67; WL 1.88; PW 0.90; PTL 0.45; PTW 1.41; PTH 0.60; MTL 1.72; CI 84; EI 35; MI 36; SI 143; PTI 311; PTHI 133.

Description: Head. Head longer than broad in full-face view (CI 84), slightly broader posteriorly. Lateral margins of head in front of eyes slightly convex, converging towards mandibular bases, behind eyes rounding into curved occipital margin. Eyes located at posterior part of head, facing anterolaterally; large (EI 35) and moderately convex, exceeding lateral cephalic outline in full-face view. Frontal carinae sinuate, moderately raised. Frontal triangle indistinct. Clypeus with poorly defined median carina; anteriorly straight, posteriorly rounding into relatively impressed basal margin in profile. Anterior clypeal margin slightly emarginate at middle, laterally flanked by acute teeth; posterior margin mildly convex, medially slightly emarginate. Mandibular masticatory border with five teeth, apical tooth longest, subsequent teeth gradually reducing in length. Antennal scape slender and longer than head width (SI 143); antennal segments II to XII longer than broad, with segments II and XII slightly longer.

Mesosoma. Mesosoma immarginate. Pronotum highly convex in profile, dorsally rounded; humeri with small, bluntly angular denticles. Promesonotal suture distinct; mesonotum flat in profile view, narrower than pronotum but wider than propodeum. Metanotal groove laterally impressed, medially indistinct; propodeal dorsum armed with slender spines elevated at right angle, directing posterolaterally.

Metasoma. Petiole columnar with two horizontal acute spines conforming to shape of gaster in dorsal view, and two intercalary teeth in between in dorsal view. Anterior face of first gastral tergite extensively rounding onto dorsum of segment.

Pilosity. Very short (about the length of a single ocellus) pale yellow pubescence distributed sparsely over scapes, legs and gaster, denser on apical funicular segments and tarsi. Anterior and basal clypeal margins plus space between frontal carinae with a few anteriorly projecting golden setae. Mandibles at apical borders with a few curved, golden suberected hairs. Dozens of

short golden hairs at apical portion of scape. Yellowish brown erected hairs on side of mesosoma in lower portion, tarsi and around joints of legs. Tuft of golden hairs at tibial spurs and tarsi. Ventral gaster with a number of suberected, posteriorly directed golden hairs.

Sculpture. Mandibles longitudinally striate with piliferous pits. Forehead areolate; lateral mesosoma areolate-rugulose; rest of head, mesosoma and petiole reticulate-costulate. Legs imbricate. Gaster reticulate to finely shagreened.

Colouration. Body black and reflective; eyes greyish purple; condylar bulbs, apical funicular segments, palps, claws and gastral tip yellow to brown; coxae and femora reddish-brown; tibiae dark brown, gaster blackish brown.

Diagnostic notes. Originally included in the *Polyrhachis mucronata* species-group, this specimen could not be assigned confidently to any one of the following species: *P. bismarckensis* Forel, *P. hippomanes ceylonensis* Emery, *P. hortensis* Forel, *P. lucidula*, *P. mucronata janthinogaster* Emery, *P. ridleyi* Forel or *P. rubigastrica* Wang & Wu after comparison with images of types available on AntWeb or pre-existing descriptions (e.g. Wang & Wu 1991), as either the shape of the propodeal or petiolar spines or the body sculpture of the suspected ants do not match with those of the Hong Kong specimen. *Polyrhachis bismarckensis* has a more angular pronotum and less robust propodeal spines; *P. hippomanes ceylonensis* and *P. mucronata janthinogaster* have a duller body, a less rounded pronotum and slenderer propodeal and petiolar spines; similar for *P. hortensis* except that it has a sculpture more resembling the specimen; *P. lucidula* and *P. ridleyi* lack intercalary teeth between its more robust petiolar spines; and *P. rubigastrica* has shorter petiolar spines and a brighter gaster. This species was once identified as *Polyrhachis* sp. nr *mucronata* after being compared with the *P. mucronata* specimen presented in Kohout (2010) because of their similar overall appearances, although the ant still possesses some subtle differences with *P. mucronata*, such as having blunter humeri; brighter reddish-brown coxae and femora; slightly different sculpture as well as straighter, more robust propodeal and petiolar spines. It was also mistaken as *P. phalerata* that has a slightly more

elongated head; straighter posterior eye margin; duller, more laterally marginated body of coarser sculpture; more angular pronotum and more robust and curver propodeal spines. As a result, this specimen is here described as a new species and given the name *Polyrhachis hunggeuk*.

In Hong Kong, the species can be confused with *P. confusa*, *P. moesta* or *P. peetersi* but can be easily distinguished by the size and orientation of its propodeal and pronotal spines, head and body sculptures (more granulose in *P. moesta* and *P. peetersi*) and head shape (more elongated in *P. peetersi*).

Etymology. The specific name, literally meaning “red legs” in Cantonese, refers to the prominent reddish-brown legs of the species.

Distribution and natural history. *Polyrhachis hunggeuk* is only known from the type locality, Tai Po Kau, the New Territories, Hong Kong (Fig. 19d) (Lee pers. comm.). Its natural history is unknown.

Polyrhachis illaudata

Polyrhachis illaudatus Walker, 1859: 373. Holotype worker (initially mistaken as male). Type locality: SRI LANKA, NHMUK (examined via AntWeb). Description of karyotype: Imai *et al.*, 1984: 68. Combination in *P. (Myrma)*: Donisthorpe, 1932: 576. (For full synonymic citations see AntCat (Bolton 2020))

Earliest known record: HONG KONG: See Wheeler 1928. **MACAU:** Ka Ho Reservoir, 22.1244°N 113.5672°E, 102 m, 11.vii.2015, 20.viii.2015 (*C.M. Leong*) (2w: Macau Ant Checklist-222, -224).

Other material examined: HONG KONG: Lung Fu Shan(?) (*C.M. Leong*) (1w: WTL0003); Lung Fu Shan, 22.280466°N 114.1380918°E, 151 m, 5.vii.2019 (*T.L. Wong*) (1w: WTL0004); Tai Tam Country Park (Quarry Bay Extension), 22.2721944°N 114.211°E, 245 m, 16.x.2019 (*T.L. Wong*) (1w: WTL0008); Tai Po: Tai Po Kau, 22.43232°N 114.17513°E ± 500 m, 222 ± 50 m, mature 2° forest at bait, 28.ix.2016 (*T.K. Wong*) (1w: #Ba-IAS-13-01-20, ANTWEB1009177);

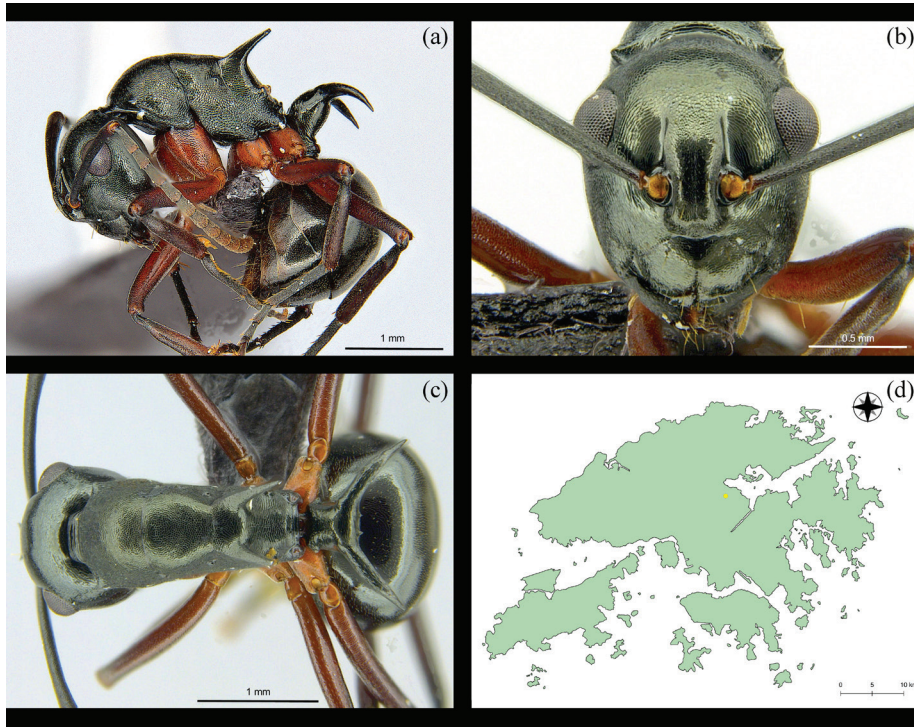


Fig. 19. The (a) profile, (b) full-face and (c) dorsal views of the *Polyrhachis hunggeuk* holotype worker (RHL03201), and (d) the species' distribution in Hong Kong.

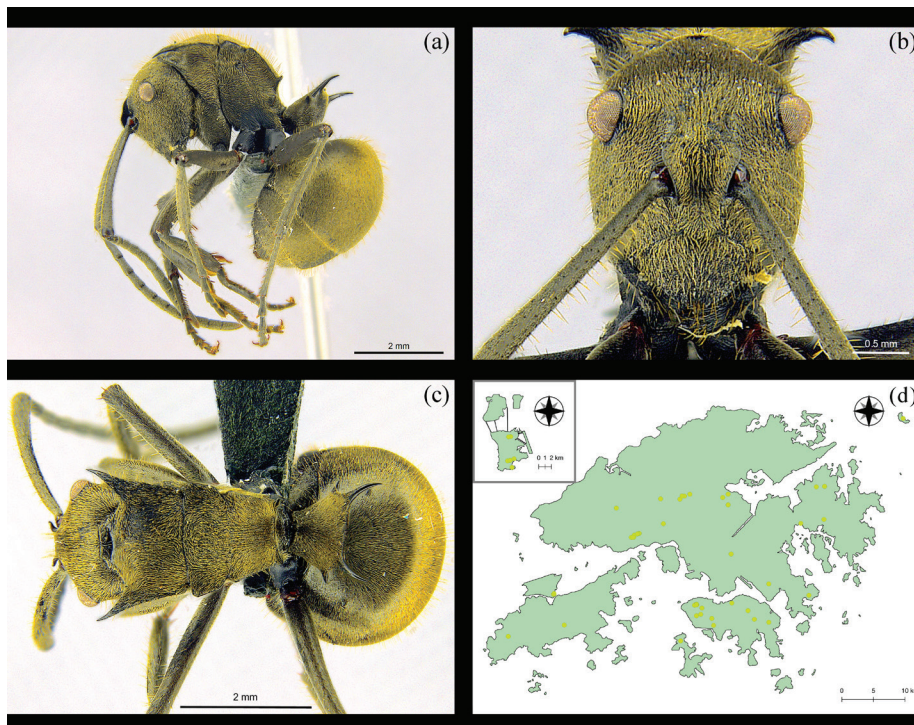


Fig. 20. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis illaudata* worker (ANTWEB1009192), and (d) the species' distribution in Hong Kong and Macau.

Tsuen Wan: Tai Lam, 22.37622°N 114.0487°E ± 500 m, 191 ± 30 m, subtropical dry forest at bait, 26.viii.2016 (*M. Pierce*) (1w: #Ba-IAS-12-03-19, ANTWEB1009192); Southern: Shek O, 22.25578°N 114.24059°E ± 500 m, 189 ± 10 m, subtropical 2° forest at bait, 15.vii.2016 (*M. Pierce*) (2w: #Ba-IAS-10-01-05, ANTWEB1009193, #Ba-IAS-10-01-07, ANTWEB1009196); Sai Kung: Clear Water Bay, 22.29393°N 114.29765°E ± 500 m, 120 ± 10 m, disturbed forest at bait, 20.vii.2016 (*M. Pierce*) (1w: #Ba-IAS-07-03-06, ANTWEB1009186); Hong Kong Island, Victoria Park, 22.283°N 114.188°E ± 0.2 km, 0–20 m, 27.vi.1999 (*Sk. Yamane*) (1 w, SKYC: ANTWEB1015772) (identified as *Polyrhachis illaudata intermedia*); Chek Lap Kok, 22.2952°N 113.9345°E, 125 m, subtropical forest, 31.x.2016, AT10B15, baiting (*B.M. Worthington*) (1w: BMW01657); Chek Lap Kok, 22.2953°N 113.9354°E, 20 m, subtropical forest, 12.x.2015, AW8R72, Winkler, 12 Random, 72 hr extraction (*B.M. Worthington*) (1w: BMW00275); Chek Lap Kok, 22.2964°N 113.9352°E, 20 m, subtropical forest, 10.ix.2015, AW6R144, Winkler, 12 Random, 144 hr extraction (*B.M. Worthington*) (1q: BMW01058); Chek Lap Kok, 22.2952°N 113.9345°E, 125 m, subtropical forest, 3.v.2016, AT10B5, baiting (*B.M. Worthington*) (1w: BMW00578); Chek Lap Kok, 22.2952°N 113.9345°E, 125 m, subtropical forest, 27.viii.2016, AT10B10, baiting (*B.M. Worthington*) (1w: BMW00391); Pak Tam Chung Family Walk, 22.4013°N 114.319°E, barbecue area, 18.x.2017, on ground, low vegetation, hand (*B. Morgan*) (1w: BAM10024); Sunset Peak, 22.2518°N 114.9497°E, 7.iv.2017, hand (*B. Morgan*) (1w: BAM10066); Lion Rock Nature Trail, 22.36°N 114.18°E, 140 m, Lowland mixed forest, 24.viii.1992, pitfall or bait (*J.R. Fellowes*) (2w: ANTWEB1016091, ANTWEB1016092) (identified as *Polyrhachis* #3); Lung Fu Shan, 25.xii.2015 (*GYOT*) (1q, GYOT042) (mistaken as *P. wolfi*); Tai Po Kau; Tai Po Kau, roadside, 4.vi.2015 (*R.H. Lee*) (1w); Tai Po Kau, 22.25.19 N, 12.xii.2014 (*R.H. Lee*) (1w); (5w: F4W-R80) (mistaken as *P. wolfi*); 24.xi.2014 (3w: F4W-R) (mistaken as *P. wolfi*); 20.xi.2014 (1w: F.3.W R) (mistaken as *P. wolfi*); Tai Po Kau, T4 0 m (*T. Tsang*) (1w); Wong Chuk Wan, 22.39572°N 114.28617°E, 8.v.2018, 34M2 Malaise Trap (*C. Taylor & R. Cheung*) (1w: AN-TWEB1017968); (1w: TI-20-A Vial 1); (*R.H. Lee*) (1w: RHL000233); Tai Tam, 22.25993°N 114.2201°E, shrubland, 27.vii.2015, B-T1(P), baiting (*R.H. Lee*) (1w: RHL03097) (mistaken as *P. tyrannica*); Tai Lam, 22.3952°N 114.0907°E, shrubland, 26.x.2015, B-T2(P), baiting (*R.H. Lee*) (1w: RHL03140); Aberdeen Reservoir, 22.26113°N 114.1596°E, secondary forest, 26.vi.2015, P-T3S0, pitfall (*R.H. Lee*) (1w: RHL01291); New Territories, Kadoorie Institute Shek Kong Centre, 22.43982°N 114.11417°E ± 10 m, 205 m, secondary rainforest edge, 4.vii.2011, ground forager(s) (*P.S. Ward*) (1w: #16604-14); New Territories, Kadoorie Institute Shek Kong Centre, 22.43433°N 114.1208°E ± 5 m, 215 m, disturbed second-growth rainforest along “Woodland Trail”, 3.vii.2011, ground nest (*P.S. Ward*) (1w: #16600); Pak Sha O, 22.448°N 114.32°E, 27.ix.2014–11.x.2014, 25.x.2014–8.xi.2014, 8.xi.2014–22.xi.2014, malaise trap (3w: MLT0033, MLT0031, MLT0051); CB00006 (1q, MLT0032); Tai Tong Tsuen, 18.iv.2014–23.v.2014, malaise trap (1w: MLT0036); Pok Fu Lam Reservoir, 22°15′54″N 114°08′16″E, 110 m, on ground (*Claudianne*) (1w); The Peak, 8.x.2017 (*Claudianne*) (1w); The Peak, on *Ficus vanegata*, 12.iv.2018 (*Claudianne*) (1w: CL-UHK-T729-003); (*Claudianne*) (2w, 2q); Lung Fu Shan, 22.2812778°N 114.1376667°E, 10.vi.2020 (*T.L. Wong*) (1w: WTL0023); Lung Fu Shan, 22.2814057°N 114.1377015°E, 10.vi.2020 (*T.L. Wong*) (1w: WTL0024); Lung Fu Shan, 22.2812509°N 114.1379017°E, 10.vi.2020 (*T.L. Wong*) (2w: WTL0025); Lung Fu Shan, 22.2803320°N 114.1375530°E, 10.vi.2020 (*T.L. Wong & B. Guénard*) (1w: WTL0027). **MACAU:** Coloane, Morro de Hac Sa Family Trail nr 1-07-08, 22.1144°N 113.56988°E, 53 m, 12.ix.2019, Arboreal Baits (*F. Brassard*) (1w, MAC_S15_T1 4m_Sp.2); Coloane, Hac Sa Reservoir East, 22.12659°N 113.57272°E, 69m, 19.iii.2019, HandCol. (*F. Brassard*) (3w, MAC_S03_HC_01_Sp.1); Coloane, Hamma Temple Estatua de Deusa A-ma, 22.1237°N 113.5656°E, 161 m, 8.viii.2019, Arboreal Baits (*F. Brassard*) (2w, MAC_S7_T1 3m_Sp.1); Coloane, Coastal Trail, 22.1144°N 113.56988°E, 121 m, 17.v.2019, Winkler (*F. Brassard*) (1w, MAC_S15 LLSP_Sp.2); Tai Tam Hill, 22.1578°N 113.5679°E, 99 m,

26.vii.2018, hand (*C.M. Leong*) (1w: CML-FW-26vii2018 [MO]); Hac Sa Reservoir, 22.1575°N 113.565°E, 14.viii.2015 (*C.M. Leong*) (1w: Macau Ant Checklist-223).

Worker (Figs. 20a–c, 18 non-type workers measured): TL c. 8.57–10.61; HL 1.96–2.53; HW 1.52–2.04; EL 0.42–0.50; ML 0.79–1.02; SL 2.53–3.11; WL 2.72–3.36; PW 1.34–1.81; PTL 0.63–0.90; PTW 1.28–1.84; PTH 1.18–1.43; MTL 2.65–3.36; CI 76–85; EI 22–27; MI 33–42; SI 137–173; PTI 165–254; PTHI 152–212.

Description (Non-type workers described): **Head.** Head oval-shaped and clearly longer than broad in full-face view (CI 76–85). In full-face view outer margins of head in front of eyes very slightly convex, converging towards bases of mandibles, behind eyes rounding into convex, medially slightly emarginate posterior margin. Eyes located at posterior part of head, facing anterolaterally; strongly convex, exceeding lateral cephalic outline in full-face view. Frontal carinae sinuate, raised and moderately laminate at mid-length. Frontal triangle apparent. Clypeus with evident median carina; anteriorly straight in profile, posteriorly rounding into barely impressed basal margin. Anterior clypeal margin arcuate and broadly produced anteriorly, with median anterior margin very slightly emarginate; posterior margin convex but medially moderately emarginate. Mandibular masticatory border with five teeth, apical tooth longest, subsequent teeth gradually reducing in length. Antennal scape slender and much longer than head width (SI 137–173); antennal segments II to XII longer than broad and gradually reduced in length, except the slightly shorter segment III and slightly longer segment XII.

Mesosoma. Mesosomal dorsum significantly laterally marginate. Pronotal dorsum weakly convex, subtrapezoidal, slightly wider anteriorly; humeri armed with long horizontal spines directed anterolaterally and slightly curving downwards. Promesonotal suture distinct; mesonotum dorsally flat, with moderately raised, laminate lateral portions weakly diverging anteriorly, narrower than pronotum (including anterolateral spines) but wider than propodeum, anterior margin shallowly convex. Metanotal groove laterally moderately impressed, medially indistinct;

propodeal dorsum flat without lamellate lateral portions, posteriorly armed with short upturned acute teeth.

Metasoma. Petiole scale-like; armed with two lateral teeth, and two acute dorsal spines that slightly curve backwards and inwards and project posterolaterally in dorsal view. Anterior face of first gastral tergite flat, extensively rounding onto dorsum of segment.

Pilosity. Golden yellow appressed pilosity very densely distributed over most body surfaces with shorter pubescence on antennae, legs and ventral gaster. Head, scapes, anterior clypeal margin and dorsal mesosoma with dozens of anteriorly directed erected golden setae. Mandibles at apical and outer borders with some curved, golden suberected hairs. Brown erected hairs present on side of mesosoma in lower portion, tarsi, around joints, and venter of petiole. Tuft of short erect brownish golden hairs at tibial spurs and tarsi of forelegs. Petiolar dorsal tip, dorsal and ventral gaster with numerous suberected, posteriorly directed golden hairs.

Sculpture. Mandibles longitudinally striate with piliferous pits. Head, mesosoma and petiole costulate, legs imbricate. Head, mesosomal, petiolar and gastral dorsa, scapes, tibiae and tarsi with piliferous pits. Gaster finely shagreened.

Colouration. Body black; eyes light brown, purplish brown or black; condylar bulbs dark brown; palps, tips of apical funicular segments, claws and gastral tip yellowish brown.

Queen (Fig. 21, 4 non-type queens measured): TL c. 12.13–12.30; HL 2.51–2.67; HW 2.05–2.13; EL 0.60–0.63; ML 0.96–1.05; SL 2.94–3.32; WL 4.14–4.22; PW 2.49–2.56; PTL 0.80–0.95; PTW 1.75–1.93; PTH 1.10–1.25; MTL 2.80–3.22; CI 79–85; EI 28–31; MI 36–40; SI 143–157; PTI 203–223; PTHI 131–142.

Description (Non-type queens described): Similar to but larger than worker, with the following distinctions: sexual characters such as three ocelli on cephalic dorsum, fully developed mesosoma and wings (or scars left by the detached wings) present. Eyes larger. With mesosoma in profile view mesoscutum with dorsal outline sloping in anterior 1/3 and very shallowly convex in posterior 2/3; median line very

short, only reaching 1/5 length of mesoscutum; parapsides sloping to ventral margin on each side. Mesoscutellar disc slightly convex. Metanotum very short, much lower than mesoscutellum and as high as propodeum. Propodeal dorsum wider anteriorly than posteriorly, with posterior margin emarginate medially. Pronotal, propodeal and petiolar spines smaller in size.

Diagnostic notes. In the worker caste *Polyrhachis illaudata* is characterized by its sinuate frontal carinae that are moderately laminate at mid-length (frontal lobes roundly produced laterad); strongly convex eyes that clearly exceed the lateral cephalic margins; laterally strongly marginated mesosomal dorsum with long, slightly curving pronotal spines and short, acute upturned propodeal teeth; scale-like petiole with two lateral teeth and two acute dorsal spines, and golden yellow appressed pilosity and erected setae distributed over most of its body surface. It can be differentiated from the closely related sympatric *Polyrhachis proxima* Roger and *Polyrhachis relucens* Latreille, as the latter two have their frontal carinae unlaminate (frontal lobes almost vertical); their eyes barely exceed the lateral outline of the head, and *P. relucens* has paler, less dense appressed pilosity. *Polyrhachis illaudata* also highly resembles *P. tyrannica*, but the latter has red legs instead of black ones, and its pilosity of paler colour less densely distributed over most of its body.

Distribution and natural history. *Polyrhachis illaudata* is a common species that is native to Hong Kong and Macau, and found all over Hong Kong, including Hong Kong Island, Kowloon, the New Territories, Lantau Island and Chek Lap Kok, Lamma Island and Tung Ping Chau, and on Coloane Island of Macau (Fig. 20d). It is also widely distributed in southern and central China, Tibet, Taiwan (Guénard & Dunn 2012), northeast and southern India (Bharti *et al.* 2016), Sri Lanka, Nepal (Tiwari 1999), all over southeast Asia to western Papua New Guinea (Emery 1887; Karavaiev 1930; Tiwari 1999; Zryanin 2011; Jaitrong *et al.* 2016; Hosoiishi *et al.* 2017). Our records show that this species mainly inhabits lowland forests (below 20–270 m alt.).

Polyrhachis illaudata is known to live in forests and to have polydomous lignicolous nests of varying sizes in low-elevated dead or living wood holes or abandoned soil nests of other species on ground (Liefke *et al.* 1998). It is predominantly diurnal, feeding on honeydew on leaf surfaces, extrafloral nectar and dead insects, and recruit other members via tactile and chemical signals (Liefke *et al.* 1998). The ant is relatively less competitive than other ant species and would not defend their food sources (Liefke *et al.* 1998). It is kleptoparasitized by the fly *Milichia* sp. (Yusah & Fayle 2014) and parasitized by the several fungi species of the *Ophiocordyceps* genus including *O. irangiensis* Sung *et al.*, *O. granospora* (Khonsanit *et al.* 2019) and *O. unilateralis* s.l. (Lin *et al.* 2020).

Polyrhachis lamellidens

Polyrhachis lamellidens Smith, 1874: 403. Syn-type worker. Type locality: JAPAN, Settsu, Hiogo (G. Lewis), NHMUK (examined via AntWeb). Description of queen: Donisthorpe, 1937: 627. Description of larvae: Kohri-
ba, 1963: 200; Wheeler & Wheeler, 1970: 649. Description of male: Hung, 1970: 29.

Earliest known record: HONG KONG: (5, NHMUK) (Smith 1874; Ryder pers. comm.) (not examined).

Other material examined: GUANGXI: Qing Shi Tan, 25.26°N 110.08°E, 240 m, 26.viii.1998 (*J.R. Fellowes*) (2w: ANTWEB1015767); Mu Lun, 20.vii.1998 (*J.R. Fellowes*) (2w: ANTWEB1015768). **GUANGDONG:** Gu Tian, 3.iv.1997 (*C.H. Hau*) (2w: ANTWEB1016074, ANTWEB1016075).

Worker (Figs. 22, 6 non-type workers measured): TL c. 8.78–9.61; HL 1.92–2.24; HW 1.78–2.00; EL 0.45–0.47; ML 0.82–0.90; SL 2.31–2.69; WL 2.72–2.96; PW 1.08–1.24; PTL 0.76–0.85; PTW 2.02–2.24; PTH 1.67–2.05; MTL 2.57–2.90; CI 88–93; EI 23–26; MI 38–47; SI 123–141; PTI 251–290; PTHI 205–256.

See Hung (1970) for detailed description.

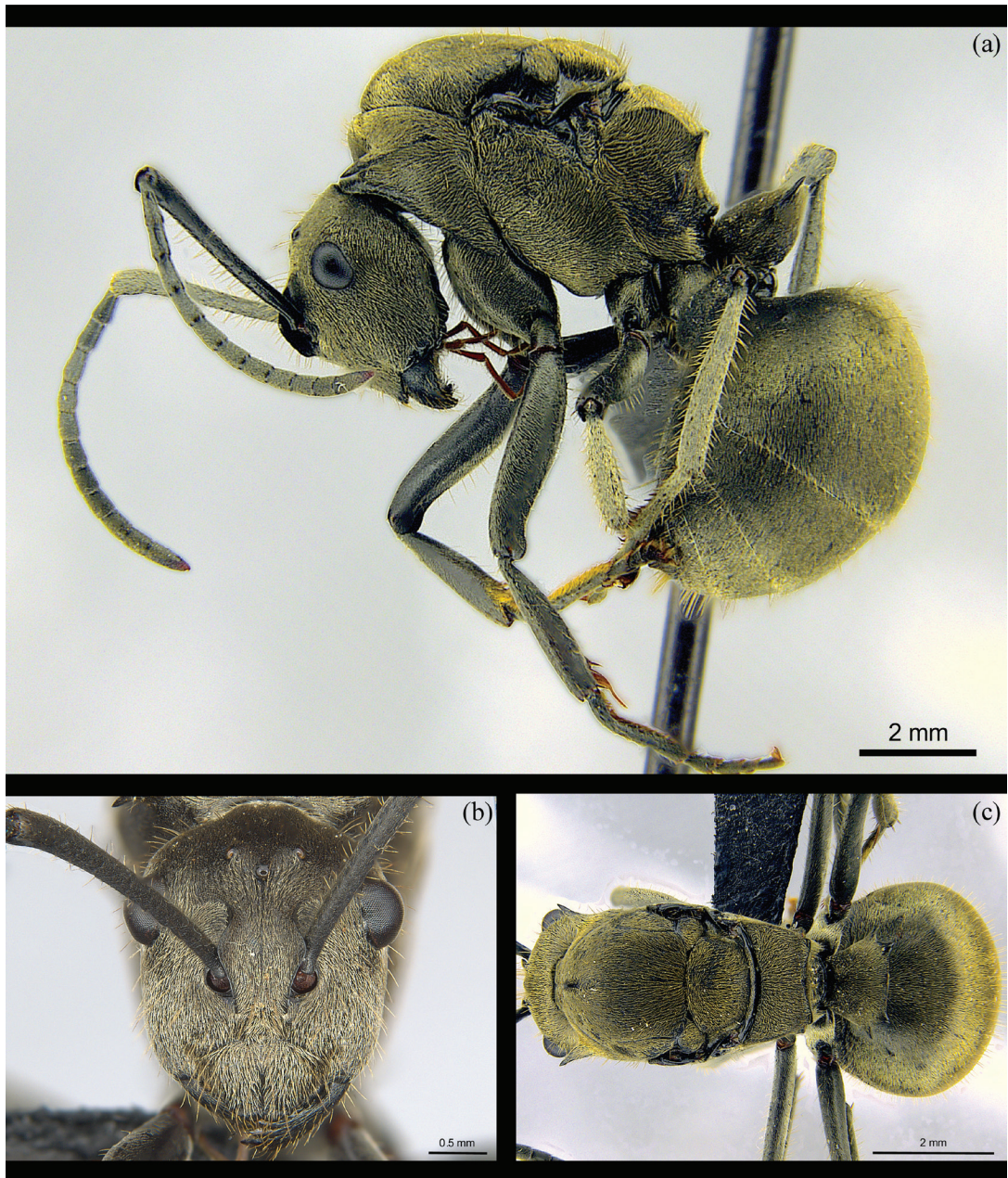


Fig. 21. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis illaudata* queen (TI-20-A Vial 1).

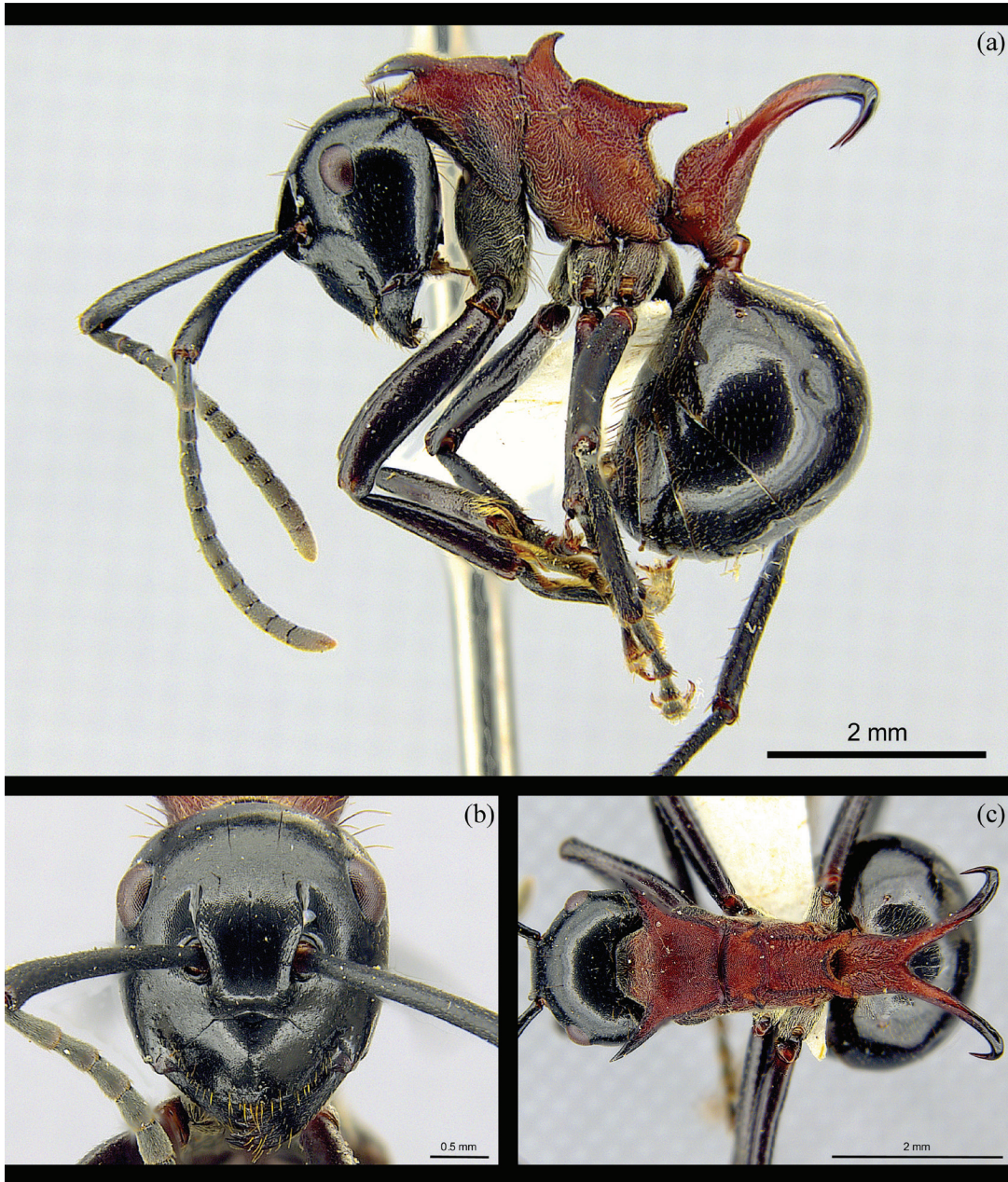


Fig. 22. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis lamellidens* worker (ANT-WEB1015767(2)).

Diagnostic notes. In the worker caste *Polyrhachis lamellidens* can be easily recognized from the other *Polyrhachis* ants in Hong Kong and Macau in having hook-shaped petiolar spines, and from other species in the subgenus *Polyrhachis* by the dorsal mesosoma that is strongly laterally margined throughout and armed with a pair of slender pronotal spines; a pair of short, robust mesonotal spines, and a pair of long, blunt propodeal spines that direct posteriorly (Kohout 2014). It can be distinguished from the closely related *Polyrhachis craddocki* Bingham as follows: *P. lamellidens* has reddish brown mesosoma and petiole, posterolaterally directed mesonotal spines and widely diverged petiolar spines, whereas *P. craddocki* has much darker body with mesosoma and petiole being dark reddish brown, laterally directed mesonotal spines, and more parallelly aligned petiolar spines (Kohout 2014).

Distribution and natural history. *Polyrhachis lamellidens* is likely to be the most studied member within the subgenus *Polyrhachis* (Kohout 2014). Although all the examined specimens were collected from mainland China, the ant is native to Hong Kong according to five specimens preserved in NHMUK (Smith 1874; Ryder pers. comm.). As we did not examine these specimens directly, we are unable to confirm their identification, and the following discussion assumes that these specimens were correctly identified. This species has a northern distribution than other *Polyrhachis* species, inhabiting across eastern, southern and central China (not recorded in Jiangxi and Yunnan), north in Liaoning and Jilin; Taiwan, North and South Korea (Guénard & Dunn 2012), and Japan beneath Hokkaido (Terayama *et al.* 2014). Although this implies that the species may only live in cooler habitats of higher elevations in Hong Kong, no recent specimens of *P. lamellidens* have been collected despite intensive sampling in the early 90's and since 2014. As a result, Hong Kong represents the southern known record of this species (22.3°N), with other records in Guangdong from Lianzhou County (24.8°N) and Ruyuan Yao Autonomous County (24.9°N) (Zhao *et al.* 2009) and from Guangxi Province in Dashapo, nr. Mulun Nature Reserve (25.2°N) and in Jiuwu, Qingshitan Headwater Forest Nature Reserve (25.4°N) (Kohout 2014), marking the southern distribution of this species

in mainland China. However, until new records of *P. lamellidens* in Hong Kong are found, the species should be considered as locally extinct as it has not been collected for at least 150 years.

Living in forests (Yoshimura 2009), this species constructs nests in various locations, including rotten logs, tree stumps, soil cavities and on ground beneath rocks or logs (Hung 1967; Robson & Kohout 2007; Kohout 2014). Winged ants are produced during August, and mating flights are seen from late August to November (Terayama *et al.* 2014). They are temporary parasites of the ants *Camponotus japonicus* Mayr (Kohribe 1963), *Camponotus obscuripes* Mayr and potentially *Camponotus kiusiuensis* Santschi (Sakai 1990), and hosts of the larvae of the hoverfly *M. katsurai* (Iwai *et al.* 2016), *Myrmecophilus* ant crickets (Komatsu *et al.* 2013) and the fungus *Ophiocordyceps satoi* Araújo *et al.* (Shrestha *et al.* 2017; Araújo *et al.* 2018). *Polyrhachis lamellidens* likely feeds on honeydew produced by insects such as aphids (Seki *et al.* 2018) and can cut large preys into smaller pieces for easier retrieval (Yamamoto *et al.* 2009). Workers have characteristically large hook-like petiolar spines for self-protection against predators like the Japanese tree frog (*Hyla japonica* Günther) (Ito *et al.* 2016). This species is used for traditional medicine in China (Kou *et al.* 2005).

Polyrhachis latona

Polyrhachis latona Wheeler, 1909: 337. Syntype workers. Type locality: TAIWAN (examined via AntWeb). Description of male: Forel, 1912b: 79. Combination in *P. (Myrma)*: Emery, 1925: 201.

Polyrhachis latona var. *dorsorugosa* Forel, 1913: 202. Syntype workers and male. Type localities: TAIWAN, Koshun [Hengchun] (H. Sauter), MHNG, SDEI; TAIWAN, Chip-Chip (H. Sauter), SDEI. Combination in *P. (Myrma)*: Emery, 1925: 201. Raised to species: Wang & Wu, 1991: 599. Synonymy by Wu & Wang, 1995: 167.

Earliest known record: HONG KONG: New Territories: Tai Po Kau for., 29.x.1980, tree fern stump, (*R. Winney*) (1 w, see Kohout 2013a) (not examined). **MACAU (new record):** Coloane, Hac Sa, 25.vi.1999 (*Sk. Yamane*) (1w in SKYC) (not examined).

Other material examined: HONG KONG: Sha Tau Kok, 22.528033°N 114.207667°E, 5 m, 25.ix.2019 (*B. Guénard*); Eastern New Territories, Tai Mong Tsai, 22.404°N 114.301°E, 60–90 m, F[eng] S[hui] Wood, 1.viii.1996, Winkler or pitfall (*J.R. Fellowes*) (1w: ANTWEB1016081); Castle Peak, 22.39012°N 113.9558°E, shrubland, 30.vi.2015, P-T3S3, pitfall (*R.H. Lee*) (1 w: RHL01127) (identified as *P. latona* nr.); Tai Lam, 22.3952°N 114.0907°E, shrubland, 26.x.2015, P-T3S3, pitfall (*R.H. Lee*) (1 w: RHL02357) (identified as *P. latona* nr.); Tai Tong Tsuen, 18.iv.2014–23.v.2014, malaise trap (1w: MLT0034); Pak Sha O, 22.448°N 114.32°E, 8.xi.2014–22.xi.2014, malaise trap (1w: MLT0039); Ping Shan Chai, 22.486°N 114.187°E, 27.ix.2014–11.x.2014, malaise trap (2w: MLT0041, MLT0053); Tsuen Wan: Tai Lam, 22.36605°N 114.02487°E ± 1 km, 9 ± 100 m, disturbed forest, 25.viii.2016, ground forager (*M. Pierce*) (1w: #IAS-0024, ANTWEB1009382). **MACAU:** Coloane, Hac Sa Reservoir East, 22.12659°N 113.57272°E, 69 m, 19.iii.2019, Winkler (*F. Brassard*) (1w: MAC_S03 LLSA_Sp.5).

Worker (Figs. 23a–c, 8 non-type workers measured): TL c. 7.14–8.04; HL 1.62–1.91; HW 1.33–1.51; EL 0.40–0.45; ML 0.62–0.73; SL 1.97–2.32; WL 2.32–2.53; PW 1.34–1.47; PTL 0.53–0.66; PTW 1.15–1.39; PTH 0.76–0.94; MTL 1.91–2.40; CI 76–82; EI 28–31; MI 35–41; SI 138–158; PTI 179–235; PTHI 121–153.

Description (Non-type workers described): **Head.** Head suboval and clearly longer than broad in full-face view (CI 76–82), slightly broader posteriorly. Lateral margins of head in front of eyes almost straight before rounding towards mandibular bases, behind eyes rounding into relatively narrow occipital margin. Eyes located at posterior part of head, facing anteriorly and mildly truncate posteriorly; moderately convex, exceeding lateral cephalic outline in full-face view. Frontal carinae close to each other; sinuate and raised. Frontal triangle apparent. Clypeus with mildly evident median carina; anteriorly straight in profile, posteriorly rounding into somehow impressed basal margin; clypeus anteriorly weakly produced, with median portion of anterior margin straight to very shallowly emarginate medially; posterior margin laterally almost

straight, medially slightly emarginate. Mandibular masticatory border with five teeth, apical tooth longest, subsequent teeth gradually reducing in length. Antennal scape slender and longer than head width (SI 138–158); antennal segments II to XII longer than broad and gradually reduced in length, except the slightly shorter segment III and slightly longer segment XII.

Mesosoma. Mesosomal dorsum significantly laterally marginate. Pronotal dorsum weakly convex, subtrapezoidal with anterior margin slightly convex, anteriorly wider; humeri armed with long, broad-based horizontal spines directed anterolaterally and slightly curving downwards. Promesonotal suture distinct; mesonotum narrower than pronotum but wider than propodeum; dorsally flat, with slightly raised, laminate lateral margins. Metanotal groove almost absent except for lateral incisions; propodeal dorsum posteriorly armed with miniature upturned denticles.

Metasoma. Petiole scale-like; armed with two lateral teeth, two acute dorsal spines slightly curving downwards and inwards and projecting posterolaterally in dorsal view, and a prominent intercalary tooth at apical centre. Anterior face of first gastral tergite flat, extensively rounding onto dorsum of segment.

Pilosity. Silvery to pale yellow appressed pilosity densely distributed over most body surfaces, with shorter pubescence on antennae and ventral gaster. Anterior clypeal margin with few anteriorly projecting golden setae. Mandibles at apical and outer borders with several curved, golden suberect hairs. Brownish golden erected hairs at apical portion of scape, on side of mesosoma in lower portion, petiole and tarsi, and around joints of legs. Tuft of short erect golden hairs at tibial spurs and tarsi of forelegs. Gastral tergites 1 and 2 without erect hairs; other tergites and most of sternites with erect hairs.

Sculpture. Mandibles longitudinally striate with several piliferous pits. Forehead costate, remaining head and dorsal mesosoma costulate, lateral mesosoma rugulose, petiole costulate, legs imbricate. Gaster finely shagreened.

Colouration. Body black; eyes light brown, purplish brown or black; condylar bulbs dark brown; palps yellow to brown; tips of apical funicular segments, claws and gastral tip yellowish brown.

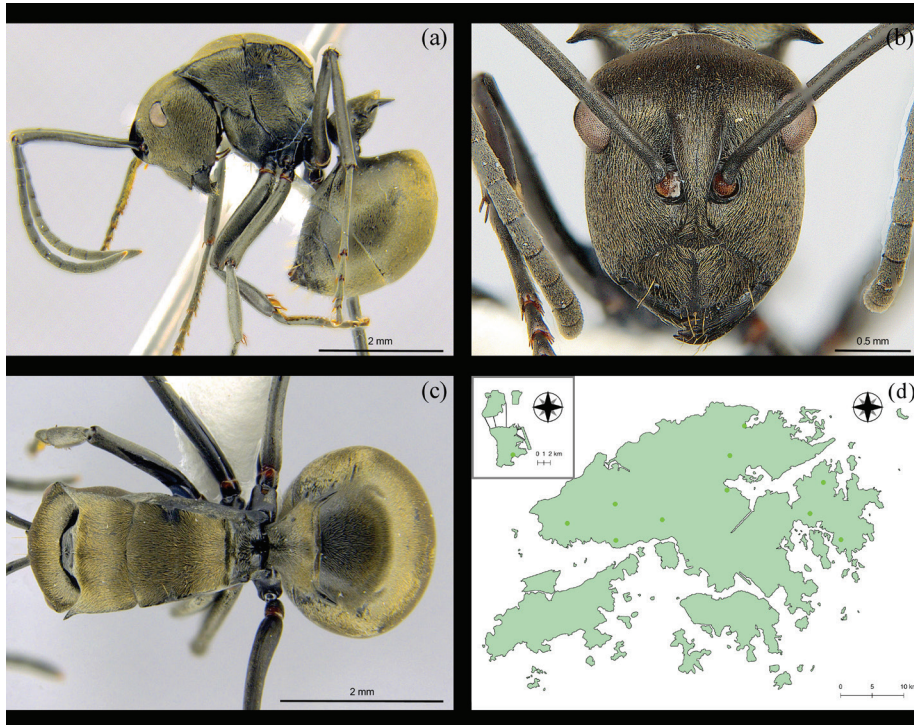


Fig. 23. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis latona* worker (MLT0034), and (d) the species' distribution in Hong Kong and Macau.

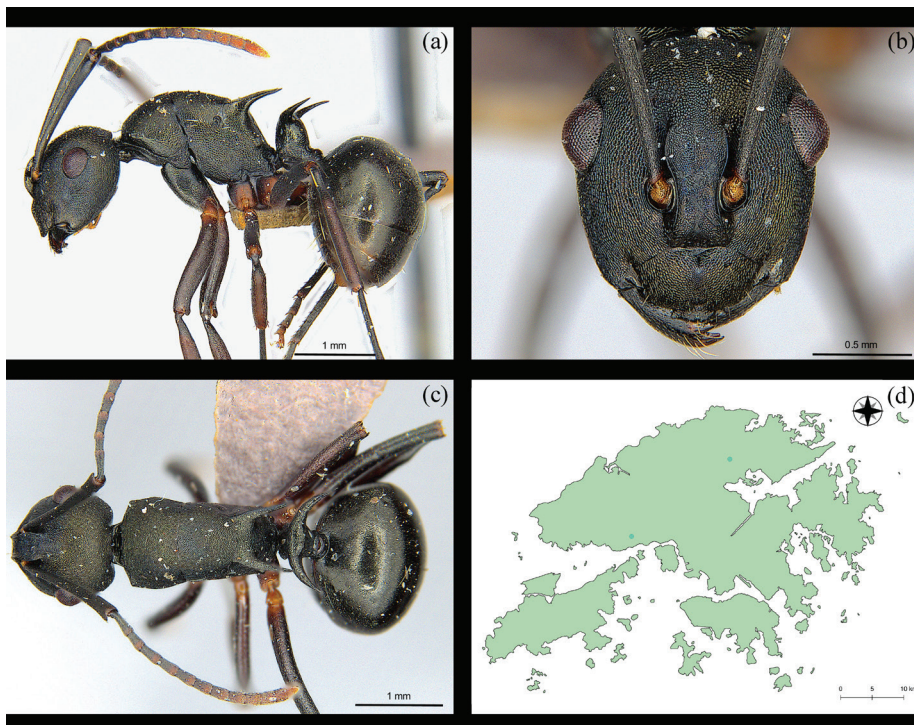


Fig. 24. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis moesta* worker (ANTWEB1016255), and (d) the species' distribution in Hong Kong.

Diagnostic notes. In the worker caste *Polyrhachis latona* is characterized by its eyes that are mildly truncated posteriorly; strongly marginated lateral mesosomal dorsum; median tooth between dorsal petiolar spines, and body very densely covered by silvery to golden yellow pubescence. It looks similar to its sympatric relatives *Polyrhachis diana* Wheeler and *Polyrhachis murina* Emery. However, *P. diana* has more convex eyes; shorter thorax; stronger sculpturation of the head and mesosoma; differently shaped petiole, and petiolar dorsum without intercalary tooth, while *P. murina* has shorter pronotal spines and short lateral petiolar spines instead of teeth (Kohout 2013a). *Polyrhachis latona* can be distinguished from other closely related species such as *P. illaudata*, *P. proxima* and *P. relucens* through its posteriorly weakly protracted eyes and a set of characters as noted by Wheeler (1909) (Kohout 2013a).

Distribution and natural history. *Polyrhachis latona* can be found in lowland forests and shrublands (9– \geq 125 m alt.) in the New Territories, Hong Kong, and is newly recorded on southern Coloane Island, Macau (Fig. 23d). The species has also been recorded from Taiwan, Guangxi (Guénard & Dunn 2012), Guangdong, Guizhou (Ran & Zhou 2013) and Zhejiang Provinces of China, Vietnam (Kohout 2013a), the southern remotes islands of Japan (Terayama *et al.* 2014), the Philippines (Janicki *et al.* 2016; Guénard *et al.* 2017) and Thailand (Jaitrong & Nabhitabhata 2005).

Little of its natural history is studied, but it is parasitized by the fungus *O. unilateralis s.l.* (Lin *et al.* 2020) and seems to live in tree stumps based on known sampling locations (Kohout 2013a).

Polyrhachis moesta

Polyrhachis hippomanes var. *moesta* Emery, 1887: 237. Holotype worker. Type locality: INDONESIA, Sumatra, Sungei-Bulu (O. Beccari), MSNG (examined via AntWeb). Description of queen: Santschi, 1928b: 39. Combination in *P. (Myrmhopla)*: Emery, 1925: 195. Raised to species: Wang & Wu, 1991: 599.

(For full synonymic citations see AntCat (Bolton 2020))

New record: HONG KONG: Ping Shan Chai, 22.486°N 114.187°E, 140 m, 30.vii.2016–3.ix.2016, M258 Malaise (*C. Barthelemy*) (1w: ANTWEB1016255); Tai Lam Country Park, 22.37598°N 114.04713°E, 3.xi.2017, S2-R Winkler leaf litter (*R. Cheung & M. Pierce*) (1w) (identified as *Polyrhachis* sp. *mucronata* group); Ping Shan Chai (*C. Barthelemy*) (1w: M295).

Worker (Figs. 24a–c, 3 non-type workers measured): TL c. 6.06–6.71; HL 1.45–1.55; HW 1.23–1.28; EL 0.39–0.40; ML 0.53–0.64; SL 1.67–1.87; WL 1.92–1.99; PW 1.01–1.04; PTL 0.48–0.54; PTW 0.96–1.22; PTH 0.62–0.67; MTL 1.65–1.90; CI 82–87; EI 31–33; MI 37–42; SI 133–146; PTI 178–251; PTHI 114–138.

Description (Non-type workers described): **Head.** Head longer than broad in full-face view (CI 82–87), broader posteriorly. Lateral margins of head in front of eyes slightly convex, converging towards mandibular bases, behind eyes rounding into curved occipital margin. Eyes located at posterior part of head, large (EI 31–33), facing anterolaterally; moderately convex, exceeding lateral cephalic outline in full-face view. Frontal carinae sinuate, moderately raised. Frontal triangle distinct. Clypeus with slightly apparent median carina; anteriorly straight, posteriorly rounding into relatively impressed basal margin in profile. Anterior clypeal margin arcuate and slightly emarginate at middle, laterally flanked by acute teeth; posterior margin mildly convex, medially very slightly emarginate. Mandibular masticatory border with five teeth, apical tooth longest, subsequent teeth gradually reducing in length. Antennal scape slender and longer than head width (SI 133–146); antennal segments II to XII longer than broad, with segments II and XII slightly longer.

Mesosoma. Mesosoma not marginate laterally. Pronotum highly convex in profile, dorsally roundly prominent and subtrapezoidal, with lateral margins slightly convex and anteriorly a bit wider; humeri slightly bluntly angular. Promesonotal suture almost absent but lateral face of pronotum distinctly demarcated from mesopleuron; mesonotum slightly convex in profile, narrower than pronotum but slightly wider than propodeum in dorsal view. Metanotal groove laterally impressed near propodeal spines; propode-

al dorsum posteriorly armed with slender spines elevated at near right angle, directing posterolaterally.

Metasoma. Petiole columnar with two acute spines projecting posterolaterally and closely conforming to shape of gaster in dorsal view. Anterior face of first gastral tergite straight in lateral view, broadly rounding onto dorsum of segment.

Pilosity. Very short (about the length of a single ocellus) golden pubescence distributed sparsely over scapes, legs and gaster, denser on apical funicular segments and tarsi. Anterior and basal clypeal margins plus space between frontal carinae with several anteriorly directed golden setae. Mandibles at apical borders with a few curved, golden suberected hairs. Dozens of short golden hairs at apical portion of scape. Yellowish brown erected hairs on side of mesosoma in lower portion, tarsi and around joints of legs. Tuft of short erect golden hairs present at tibial spurs and tarsi of forelegs. Apical and ventral gastral segments with several suberected, posteriorly directed golden hairs.

Sculpture. Mandibles sparsely longitudinally striate with piliferous pits. Forehead finely areolate. Lateral face of head between eyes and mandibular bases finely reticulate-costulate. Clypeus, cheeks, coxae of forelegs, mesosomal and petiolar dorsa finely areolate. Other parts of head and lateral mesosoma areolate-rugulose. Lateral petiole strigate, legs imbricate. Gaster finely shagreened.

Colouration. Body black; eyes purplish to brownish grey; condylar bulbs, tips of apical funicular segments, and claws yellowish brown; palps yellowish to dark brown; apical funicular segments and gastral tip yellowish brown or black; coxae of middle and hind legs, femora and tibiae of all legs dark reddish to pure black.

Diagnostic notes. In the worker caste *Polyrhachis moesta* has relatively big bulging eyes; areolate-rugulose black body; bluntly angular pronotal protrusions; long, almost straight propodeal spines and petiolar spines conforming the shape of gaster. It is similar to *Polyrhachis rubigastrica* Wang & Wu, but *P. rubigastrica* has a narrower space between the frontal carinae, as well as antennal scapes and gaster of brighter colours

(Wang & Wu 1991). Although *P. moesta* was said to have teeth between the petiolar spines (Wang & Wu 1991), the specimens examined in this study have higher resemblance to the type specimens of the species, where both have only a pair of slender petiolar spines conforming the shape of the gaster.

Distribution and natural history. *Polyrhachis moesta* is a newly recorded species in Hong Kong, living in forests in Tai Lam and Ping Shan Chai, the New Territories (Fig. 24d). It also newly recorded from Hainan based on an IBBL specimen, while it was previously recorded from Hunan, Yunnan, Guangxi, Guizhou, Hubei, Jiangxi, Zhejiang and Shanghai (Guénard & Dunn 2012; Ran & Zhou 2013), Taiwan, central and southern Japan (Terayama *et al.* 2014), Malaysia (Bolton 1998), the Philippines, Sumatra (Wheeler 1921), Java (Ito *et al.* 2001), Borneo (Widodo *et al.* 2001), Lesser Sunda Islands (CAS 2020) and possibly Jiangsu and Sri Lanka (Hua 2006), with these two latter records to be confirmed.

This species originally described from Sumatra (Indonesia) presents a wide distribution range, being reported from the Kanto region (Japan) to the Lesser Sunda Islands (Indonesia), which is, however, suspicious and would deserve further investigation, including the specimens presented here. Such distribution may indicate a complex of species in needs of further taxonomic revisions with a combination of morphological and molecular approaches through its range, but it is outside the scope of this study. It is thus possible that the specimens assigned to *P. moesta* here, may have to be revised under a different name following future studies.

Polyrhachis moesta constructs polydomous and secondarily monogynous arboreal colonies in dead twigs after its nuptial flight in September to October (Sasaki *et al.* 2005). Nests are cofounded by multiple genetically unrelated queens (Sasaki *et al.* 1996) to cooperatively exchange food, lay eggs earlier and produce more viable offsprings (Sasaki *et al.* 2005), increasing survival chances and accelerating colonial establishment (Koyama *et al.* 2015). However, after the emergence of workers during winter, queens become more aggressive, especially to non-nest-mates, under the effect of octopamine (Koyama

et al. 2015), having fewer social behaviours like trophallaxis and grooming (Hashimoto *et al.* 2013). This may often lead to only a single queen and its offspring surviving (Sasaki *et al.* 1996). The species is a host of the fungus *Ophiocordyceps ootakii* Araújo *et al.* (Araújo *et al.* 2018).

***Polyrhachis peetersi* sp. nov.**

<http://zoobank.org/BF258BF7-25EC-4CAC-9BDF-758401FEE47F>

Holotype: HONG KONG: West Central New Territories, Tai Po Kau, 22.43°N 114.18°E, 160–200 m, lowland dense/open mixed forest/dense shrubland, 14.viii.1993, pitfall or bait (*J.R. Fellowes*) (w: ANTWEB1015814) (identified as *Polyrhachis* species 13).

Worker (Figs. 25a–c, holotype measured): TL c. 8.51; HL 1.98; HW 1.43; EL 0.48; ML 0.70; SL 2.77; WL 2.78; PW 1.20; PTL 0.65; PTW 1.31; PTH 0.81; MTL 2.87; CI 72; EI 34; MI 35; SI 194; PTI 201; PTHI 123.

Description: **Head.** Head elliptical and clearly longer than broad in full-face view (CI 72), broader at eye position. Lateral margins of head in front of eyes almost straight before rounding towards mandibular bases, behind eyes rounding into strongly convex posterior margin. Eyes located at posterior part of head, large (EI 34), facing anterolaterally; greatly convex, exceeding lateral outline of head in full-face view. Frontal carinae close to each other, sinuate, moderately raised. Frontal triangle small but distinct. Clypeus with evident median carina; anteriorly straight, posteriorly rounding into relatively impressed basal margin in profile. Anterior clypeal margin arcuate, laterally flanked by acute teeth; posterior margin laterally concave and almost straight, medially slightly emarginate. Mandibular masticatory border with five teeth, apical tooth longest, subsequent teeth gradually reducing in length. Antennal scape slender and much longer than head width (SI 194); antennal segments II to XII longer than broad and gradually reduced in length, except the slightly shorter segment III and slightly longer segment XII.

Mesosoma. Mesosoma immarginate laterally. Pronotum fairly convex in profile, in dorsal view roundly prominent and subtrapezoi-

dal, wider posteriorly, posterior margin concave; humeri armed with short robust denticles. Prome-sonotal suture only laterally distinct; mesonotum more or less flat in profile, in dorsal view laterally bulged, about as wide as pronotum but wider than propodeum. Metanotal groove laterally impressed near propodeal spines; propodeal dorsum armed with slender spines elevated at near right angle, directing posteriorly and slightly laterally.

Metasoma. Petiole columnar with two slender spines projecting posterolaterally and roughly conforming to shape of gaster in dorsal view. Anterior face of first gastral tergite straight in lateral view, broadly rounding onto dorsum of segment.

Pilosity. Very short (about the length of one to two ocelli) golden pubescence distributed sparsely over scapes, legs and gaster, denser on apical funicular segments and tarsi. Anterior and basal clypeal margins plus space between frontal carinae with several anteriorly directed golden setae. Mandibles at apical borders with a few curved, golden suberected hairs. Dozens of short golden hairs at apical portion of scape. Yellowish brown erected hairs on side of mesosoma in lower portion, tarsi and around joints of legs. Tuft of short erect golden hairs at tibial spurs and tarsi of forelegs. Dorsal apical and ventral gastral segments with several suberected, posteriorly directed golden hairs.

Sculpture. Mandibles with dense piliferous pits. Posterolateral faces of head and areas between eyes and frontal carinae reticulate-rugulose. Remaining parts of head, pronotal and mesonotal dorsa finely areolate. Lateral mesosoma irregularly reticulate-rugulose. Propodeal dorsum, petiole, and legs strigate. Gaster finely shagreened.

Colouration. Head, mesosoma, petiole, scapes, most funicular segments and tarsi black; eyes purplish to brownish grey; condylar bulbs, apical funicular segments, palps, claws and gastral tip yellowish brown; gaster, coxae of middle and hind legs blackish brown; femora and tibiae of all legs dark reddish to blackish brown.

Diagnostic notes. *Polyrhachis peetersi* has big bulging eyes; an elongated head; black hairless body; short pronotal teeth; long propodeal and petiolar spines; and dark brown gaster and legs,

making it distinguishable from other sympatric species and most members of the subgenus *Myrmhopla*, the latter often have a more robust mesosoma. This species has some resemblance to *Polyrhachis tristis* Mayr, but *P. tristis* has a shorter head; a body covered with fine dense punctation; petiolar spines pointing more outwards; a brighter gaster and darker legs.

Etymology. The specific name is a remembrance of Dr. Christian Peeters, who suddenly passed away recently, and a tribute to his major contributions in myrmecology for almost 40 years, in particular within Asia.

Distribution and natural history. *Polyrhachis peetersi* was found in a lowland forest (160–200 m alt.) located in Tai Po Kau, the New Territories (Fig. 25d), with its natural history unknown. The species appears to be rarely collected in Hong Kong and Macau as it has been recorded only once in 30 years.

Polyrhachis punctillata

Polyrhachis punctillata Roger, 1863b: 152. Syntype workers and queen. Type locality: SRI LANKA (J. Roger), ZMHB (examined via AntWeb). Combination in *P. (Myrma)*: Emery, 1925: 204. See Bingham, 1903: 409. (For full synonymic citations see AntCat (Bolton 2020))

New record: HONG KONG: Northeast New Territories, Wang Shan Keuk, 22.49°N 114.23°E, 230–450 m, 2.x.1996, Winkler (*J.R. Fellowes*) (1w: ANTWEB1015782) (identified as *Polyrhachis* species 19); Lam Tsuen, 16–24.vii.2018 (*A. Goldman*) (1w, Non-Burn: #17); Kwan Tei, 3–19.ix.2018 (*A. Goldman*) (4w, Non-Burnt: #12–#15).

Worker (Figs. 26a–c, 6 non-type workers measured): TL c. 6.42–7.51; HL 1.53–1.71; HW 1.32–1.53; EL 0.36–0.40; ML 0.55–0.74; SL 1.88–2.13; WL 2.05–2.35; PW 1.08–1.23; PTL 0.51–0.58; PTW 0.91–1.05; PTH 0.64–0.76; MTL 1.90–2.08; CI 86–93; EI 25–27; MI 36–46; SI 138–143; PTI 170–198; PTHI 125–144.

Description (Non-type workers described): **Head.** Head longer than broad in full-face view (CI 86–93), broader posteriorly. Lateral

margins of head in front of eyes slightly convex, converging towards bases of mandibles, behind eyes rounding into convex occipital margin. Eyes located at posterior part of head, facing anterolaterally; moderately convex, exceeding lateral cephalic outline in full-face view. Frontal carinae sinuate and raised. Frontal triangle distinct. Clypeus with slightly evident median carina; anteriorly straight in profile, posteriorly rounding into slightly impressed basal margin. Anterior clypeal margin arcuate and slightly emarginate medially; posterior margin mildly convex but medially moderately emarginate. Mandibular masticatory border with five teeth, apical tooth longest, subsequent teeth gradually reducing in length. Antennal scape slender and longer than head width (SI 138–143); antennal segments II to XII longer than broad, with segment XII slightly longer and segment II twice the length of each remaining antennal segment.

Mesosoma. Mesosomal dorsum moderately marginate laterally. Pronotum moderately convex in profile, in dorsal view subtrapezoidal with anterior part wider and lateral margins slightly concave; humeri armed with short, broad-based horizontal teeth. Promesonotal suture dorsally distinct; mesonotum barely convex dorsally, rounding towards metanotal groove, narrower than pronotum but wider than propodeum. Metanotal groove dorsolaterally distinct; propodeal dorsum armed with miniature upturned denticles, laterally slightly raised and laminate.

Metasoma. Petiole scale-like; armed with two broad-based lateral teeth and two smaller dorsal ones. Anterior face of first gastral tergite flat, extensively rounding onto dorsum of segment.

Pilosity. Pale to silvery yellow appressed hairs distributed fairly densely over most body surfaces, with shorter pubescence on antennae and darker, more golden ones on posterior head, dorsoposterior mesosoma, petiole, and dorsal gaster. Anterior clypeal margin and head with several anteriorly directed golden setae. Mandibles at apical and outer borders with dozens of curved, golden suberect hairs. Golden to brown erected hairs at apical portion of scape, on side of mesosoma in lower portion, petiole, and tarsi, and around joints of legs. Tuft of short erect golden hairs at tibial spurs and tarsi of forelegs.

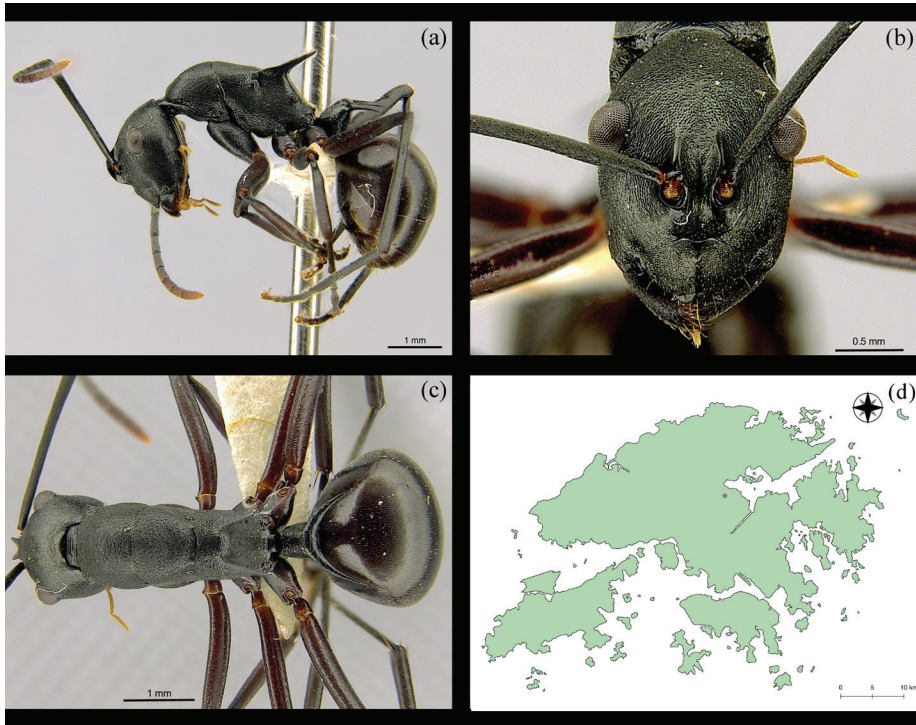


Fig. 25. The (a) profile, (b) full-face and (c) dorsal views of the *Polyrhachis peetersi* holotype worker (ANT-WEB1015814), and (d) the species' distribution in Hong Kong.

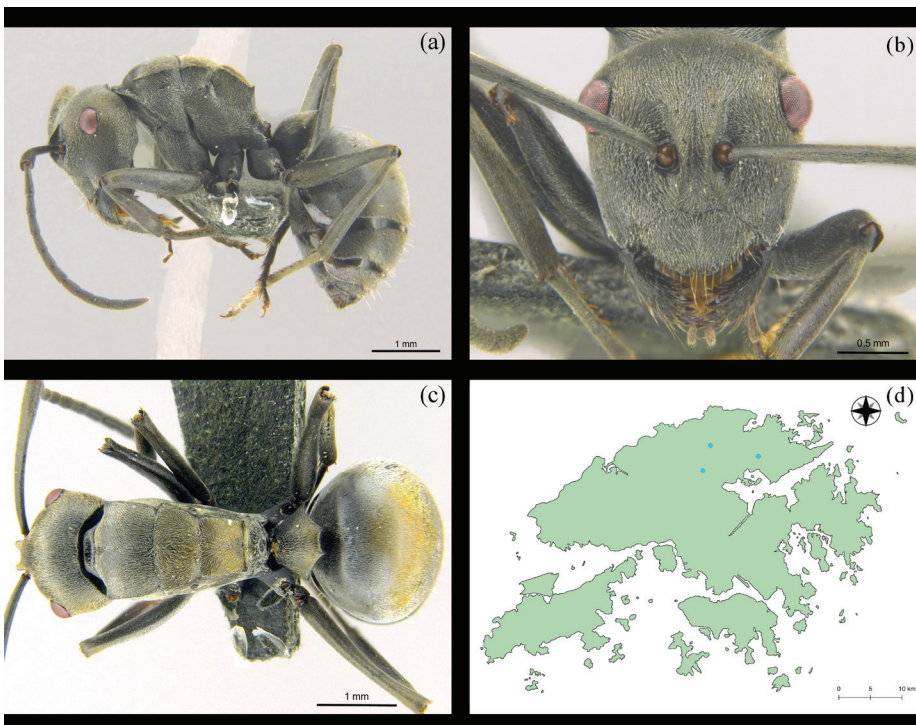


Fig. 26. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis punctillata* worker (#17), and (d) the species' distribution in Hong Kong.

Dorsal and ventral posterior gastral segments with numerous suberected, posteriorly directed pale golden hairs.

Sculpture. Mandibles longitudinally striate with several piliferous pits. Head costulate, mesosoma and petiole strigate or costulate, legs imbricate. Gaster finely shagreened.

Colouration. Body black; eyes light to very dark brown or pinkish purple; condylar bulbs dark brown; palps and gastral tip yellowish to very dark brown; tips of apical funicular segments and claws yellowish brown.

Diagnostic notes. In the worker caste *Polyrhachis punctillata* is characterized by its black body densely covered by mainly pale to silvery yellow pubescence; moderately marginate lateral mesosomal dorsum; and pronotum, propodeum and petiole armed with short teeth, the latter separating it from other sympatric species in the subgenus *Myrma*. It resembles *Polyrhachis edentula* Emery and *Polyrhachis zopyra* Smith, but *P. edentula* has much more erected hairs distributed over its body, and *P. zopyra* has more silvery pubescence and fewer golden appressed hairs.

Distribution and natural history. As another species that has not been recorded in Hong Kong previously, *Polyrhachis punctillata* has its known distribution restricted to the northern New Territories (Fig. 26d). It is also distributed in Uttar Pradesh (CAS 2020) Gujarat, West Bengal, Meghalaya, Manipur and southern India (Bharti *et al.* 2016), Sri Lanka, Java, Myanmar (Tiwari 1999), parts of China, including Guangdong, Guangxi, Hainan, Yunnan, Guizhou and Sichuan, with presence in Taiwan requiring confirmation (Ran & Zhou 2013).

Information about this species' natural history is scant, but it seems to inhabit shrub-grassland (Li *et al.* 2017), here confirmed for the Hong Kong population, and is associated with lac insects (Kerriidae: Coccoidea: Hemiptera) (Chen *et al.* 2011).

Polyrhachis rastellata

Formica rastellata Latreille, 1802: 130. Holotype queen. Type locality: INDONESIA ("Indes orientales"), lost (Kohout 2006). Combination in *Polyrhachis*: Smith, 1858:

59. Description of worker: Mayr, 1862: 688. Description of male: Mayr, 1876: 70. Combination in *P. (Cyratomyrma)*: Forel, 1915: 107. Description of karyotype: Crozier, 1970: 115, fig. 2D. Description of larvae: Wheeler & Wheeler 1990: 756. See Kohout, 2006: 114.

(For full synonymic citations see AntWeb (CAS 2020))

New record: HONG KONG: Chek Lap Kok, 22.2851°N 113.9008°E, 18 m, subtropical forest, 26.x.2016, stream edge nearby LT4, hand collection (*B.M. Worthington*) (1q: BMW01799).

Queen (Figs. 27a–c, 1 non-type queen measured): TL c. 8.77; HL 1.83; HW 1.86; EL 0.58; ML 0.74; SL 2.03; WL 2.94; PW 1.80; PTL 0.65; PTW 0.79; PTH 0.71; MTL 2.26; CI 102; EI 31; MI 40; SI 109; PTI 122; PTHI 108.

Description (Non-type queen described): Highly resembling that of *P. demangei*, but with rounder posterior clypeal margin, complete lack of propodeal protrusion, four reduced subequal petiolar teeth instead of two lateral teeth and two teeth that share a combined elongated base in between, a few more golden setae behind ocelli, and suberected posteriorly directed golden hairs on dorsal apical and ventral gaster.

Diagnostic notes. See also Xu (2002), Kohout (2006) and the diagnostic notes of *P. demangei*.

Distribution and natural history. Although *P. rastellata* is only found in a lowland forest (18 m alt.) in Chek Lap Kok, Hong Kong (Fig. 27d), the species appears to be widely distributed in southern China, Taiwan (Guénard & Dunn 2012), Nepal (Ran & Zhou 2013), Vietnam (Zryanin 2013), northeast, western and southern India (Bharti *et al.* 2016), Sri Lanka, Myanmar, Thailand (Tiwari 1999; Hua 2006), Malaysia (Wheeler & Wheeler 1990), the Phillipines, Sumatra, Java, Borneo (Tiwari 1999), Maluku Islands (Karavaiev 1927), Papua New Guinea, Queensland (Viehmeyer 1912; Tiwari 1999) and Solomon Islands (Mann 1919). However, as many later-established species were once identified as subspecies of *P. rastellata*, the ant may only inhabit areas from India and Indochina to Sumatra and possibly Java (Kohout 2006).

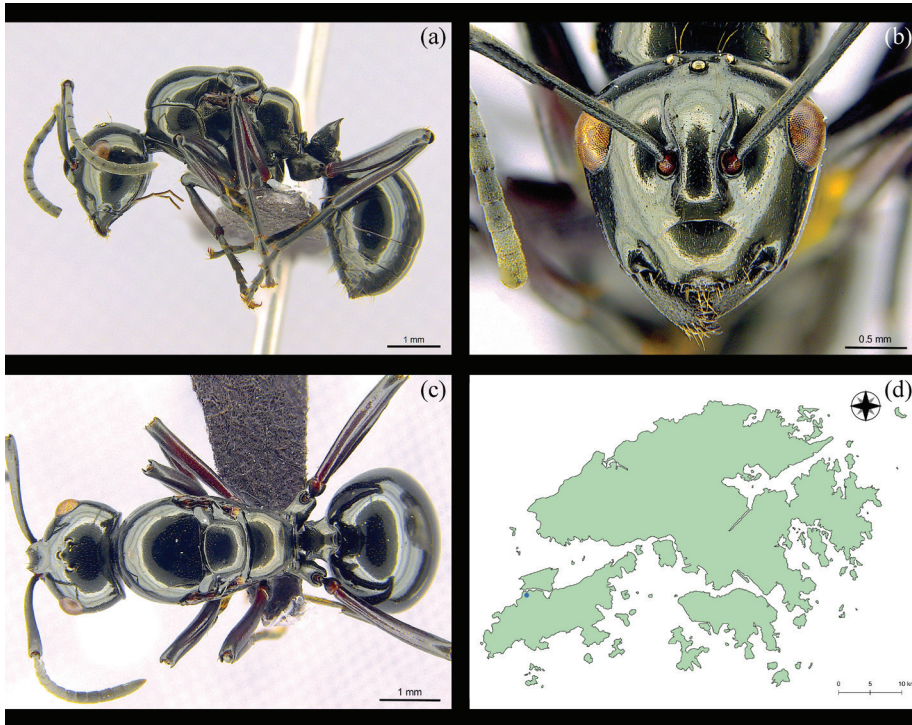


Fig. 27. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis rastellata* queen (BMW01799), and (d) the species' distribution in Hong Kong.

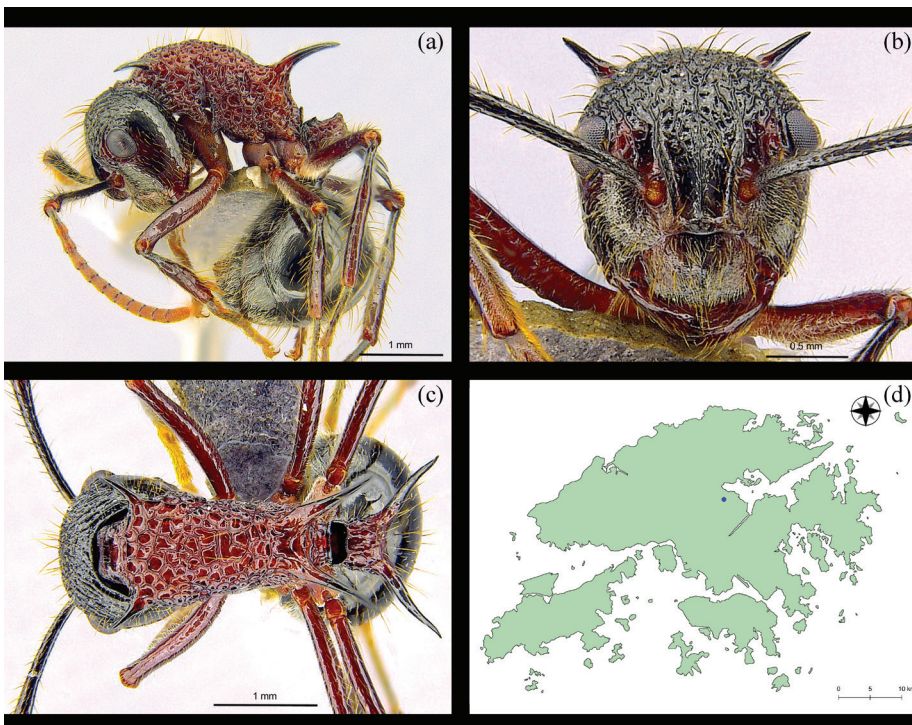


Fig. 28. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis rufipes* worker (BG(2)), and (d) the species' distribution in Hong Kong.

Polyrhachis rastellata is known to construct arboreal polydomous nests made up of larval and spider silk along with plant fragments between or underneath leaves (Forel 1909, Dias 2015).

Polyrhachis rufipes

Polyrhachis rufipes F. Smith, 1858: 66, pl. 4, fig. 28. Holotype worker. Type locality: MALAYSIA, Borneo, Sarawak, NHMUK (examined via AntWeb). Combination in *P. (Myrmhopla)*: Emery, 1925: 196.

(For full synonymic citations see AntCat (Bolton 2020))

New record: HONG KONG: Tai Po Kau, 22.42865°N 114.181312°E, 158 m, 16.ix.2015 (*B. Guénard*) (2w: BG). **HAINAN:** Yinggeling, rubber plantation, 19.09104°N 109.535279°E, 412 m, 1.viii.2016, winkler extractor (*C. Wang*) (1w: HNA-00141).

Worker (Figs. 28a–c, 3 non-type workers measured): TL c. 6.14–6.50; HL 1.48–1.56; HW 1.33–1.46; EL 0.35–0.39; ML 0.58–0.63; SL 1.63–1.78; WL 1.97–2.17; PW 1.01–1.09; PTL 0.56–0.59; PTW 1.38–1.74; PTH 0.76–0.82; MTL 1.84–1.99; CI 90–94; EI 26–27; MI 39–40; SI 121–125; PTI 242–310; PTHI 135–139.

Description (Non-type workers described): **Head.** Head longer than broad in full-face view (CI 90–94), broader posteriorly. Lateral margins of head in front of eyes slightly convex, converging towards mandibular bases, behind eyes rounding into curved occipital margin. Eyes located at posterior part of head, facing anterolaterally; moderately convex, slightly exceeding lateral cephalic outline in full-face view. Frontal carinae sinuate with moderately raised margins. Frontal triangle obvious. Clypeus with slightly apparent median carina; anteriorly straight, posteriorly strongly rounding into impressed basal margin in profile. Anterior clypeal margin arcuate and almost straight at middle; posterior margin laterally straight, medially convex but slightly emarginate medially. Mandibular masticatory border with five teeth, apical tooth longest, subsequent teeth gradually reducing in length. Antennal scape slender and longer than head width (SI 121–125); antennal segments II to XII longer than broad, gradually reduced in length to almost as long as broad in segments III–XI.

Mesosoma. Mesosoma immarginate. Pronotum moderately convex in profile, in dorsal view subtrapezoidal with anterior margin convex, anteriorly wider; humeri armed with anterolaterally projecting slender spines slightly curving outwards and downwards. Promesonotal suture only laterally moderately distinct; mesonotum slightly convex in lateral view, narrower than pronotum but wider than propodeum. Metanotal groove poorly indicated laterally; propodeal dorsum armed with slender spines elevated at right angle, directing posterolaterally and slightly curving outwards and downwards.

Metasoma. Petiole scale-like; in profile anterior slope with elevated basal disc, distinctly separated from dorsal face by more or less developed carina; seen from above dorsal face roundly narrowed anteriorly; with two long dorsolaterally projecting acute spines conforming to shape of gaster in dorsal view. Anterior face of first gastral tergite rounding onto dorsum of segment.

Pilosity. Long golden setae directing anteriorly present on clypeus, anterior face of head, dorsum of head extensively, dorsum of pronotum posteriorly, dorsum of mesonotum and over gaster; shorter ones on lateral face of head, scapes, pronotal and petiolar dorsa including propodeal spines. White to pale yellow appressed hairs on clypeal margins, space between temple and gena, and posterior gaster, denser on ventral femora. Very short (about the length of a single ocellus) but dense golden pubescence on funicular segments and tarsi. Mandibles at apical borders with several curved, golden suberected hairs. Tuft of short erect golden hairs at tibial spurs and tarsi of forelegs.

Sculpture. Mandibles with very sparse piliferous pits. Dorsum of head costate-rugulose. Clypeus rivulose. Mesosoma and lateral petiole strongly areolate-rugose. Legs striate-imbricate. Scapes and legs punctulate. Lateral face of head, petiolar dorsum and gaster finely shagreened.

Colouration. Body reflective; head, scapes, spines, upper tarsi and gaster black; mesosoma, petiole, legs, bases of spines, mandibles, cheeks and spaces between eyes and antennae dark or blackish red; eyes purplish grey; funiculi and lower tarsi red; condylar bulbs and gastral tip dark yellowish brown; palps, tips of apical funicular segments and claws yellowish brown.

Diagnostic notes. *Polyrhachis rufipes* workers have a black, reflective head and gaster, with the dorsum of the head costate-rugulose; areolate-rugose dark or blackish red mesosoma and petiole; long pronotal, propodeal and petiolar spines that have black tips and slightly curve downwards; white to pale yellow appressed pubescence on frontal head and posterior gaster; and long golden setae covering most of its body. The set of characters make it unique to most other *Polyrhachis* ants co-occurring in the same region. The ant looks similar to *Polyrhachis etheli* Chapman and *Polyrhachis gracilior* Forel, but the head colour and sculpture of *P. etheli* is the same as its mesosoma and petiole, and *P. gracilior* has a smooth head and curver petiolar spines in dorsal view.

Distribution and natural history. Newly recorded in a lowland forest (158 m alt.) in Tai Po Kau, Hong Kong (Fig. 28d), *P. rufipes* is also newly recorded here from Hainan according to an IBBL specimen, with both records extending significantly the distribution in the northeastern range of this species. Previously, the species has been recorded from Yunnan (Guénard & Dunn 2012), Myanmar (Ran & Zhou 2013), Vietnam (Zryanin 2011), Laos (Jaitrong *et al.* 2016), Thailand (Watanasit *et al.* 2007), Malaysia (Bolton 1974, 1998), the Philippines (General & Alpert 2012), Sumatra, (Asfiya *et al.* 2008), Mentawai Islands (Emery 1900), Borneo, Sulawesi (Kohout 2008), Maluku Islands (Janicki *et al.* 2016; Guénard *et al.* 2017) and Bali Island (Yamane pers. comm.).

Polyrhachis rufipes builds lignicolous nests and has pupae that metamorphose into adult inside cocoons (Robson & Kohout 2007). The species demonstrates the only known commensal relationships between ectatommine and formicine ants, where workers reach sugar sources by following the trails of *Gnamptogenys menadensis* (Mayr) (Gobin *et al.* 1998). It also acts aggressively towards the submissive *G. menadensis*, where the former grabs the latter's ventral thorax and boxes its antennae on the latter's head, likely to investigate if *G. menadensis* has recently gained access to sugary food (Gobin *et al.* 1998).

Polyrhachis tyrannica

Polyrhachis tyrannicus Smith, 1858: 69, pl. 4, fig. 29. Holotype worker. Type locality: CHINA, NHMUK (examined via AntWeb). Combination in *P. (Myrma)*: Emery, 1925: 204.

Earliest known record: HONG KONG: Botanical Gardens, 25.viii.1992 (*Sk. Yamane*) (2w in SKYC) (not examined). **MACAU (new record):** Hac-Sa, Coloane Is., 25.vi.1999 (*Sk. Yamane*) (2w in SKYC) (not examined).

Other material examined: HONG KONG: (*K. Cheung*) (9w, in pangolin's gut provided by Kadoorie Farm and Botanical Garden: K6558, PGC0003, PGC0015, KC-GCA 032, KC-GCA 034–039) (1 identified as *Polyrhachis* species, 5 mistaken as *P. illaudata*); Tai Po: Tai Po Kau, 22.39566°N 114.14997°E ± 500 m, 245 ± 40 m, 25.v.2016, country park at bait (*Y. Luo*) (1w: #ISP0074, ANTWEB1009182); West Central New Territories, She Shan, 22.4479°N 114.1445°E, 50 m, F[eng] S[hui] Wood, 19.xi.1996, Winkler or pitfall (*J.R. Fellowes*) (2w: ANTWEB1016077, ANTWEB1016087); Northeast New Territories, Sheung Wo Hang, 22.5219°N 114.1945°E, 40 m, F[eng] S[hui] Wood, 20.xi.1996, Winkler or pitfall (*J.R. Fellowes*) (1w: ANTWEB1016086); Kadoorie Farm and Botanical Garden, 25.x.2014 (1w); HKU Campus, 29.x.2014 (1w); Wong Chuk Wan, 22.39575°N 114.28598°E, 9.viii.2018, 34B8 Beating (*C. Taylor & R. Cheung*) (1w: ANTWEB1017854); Aberdeen Reservoir, 22.26°N 114.162°E, secondary forest, 26.vi.2015, P-T4S10, pitfall (*R.H. Lee*) (1w: RHL01315); Sheung Wo Hang, 22.52231°N 114.1972°E, 16.vi.2015, P-T2S0 (*R.H. Lee*) (1w: RHL00461) (mistaken as *P. illaudata*); Tai Lam, 22.3759°N 114.045°E ± 45 m, 225 ± 10 m, disturbed 2° forest trail edge, Pitfall (*M. Pierce*) (1w: Pi-MPP-38-02, ANTWEB1009617) (mistaken as *P. wolffi_cf*).

Worker (Figs. 29a–c, 9 non-type workers measured): TL c. 9.54–10.24; HL 2.11–2.42; HW 1.66–1.95; EL 0.44–0.55; ML 0.75–1.00; SL 2.64–3.34; WL 2.97–3.41; PW 1.53–1.71; PTL 0.69–0.98; PTW 1.35–1.69; PTH 1.20–1.42; MTL 2.56–3.38; CI 71–87; EI 25–32; MI 34–46; SI 149–193; PTI 149–204; PTHI 139–179.

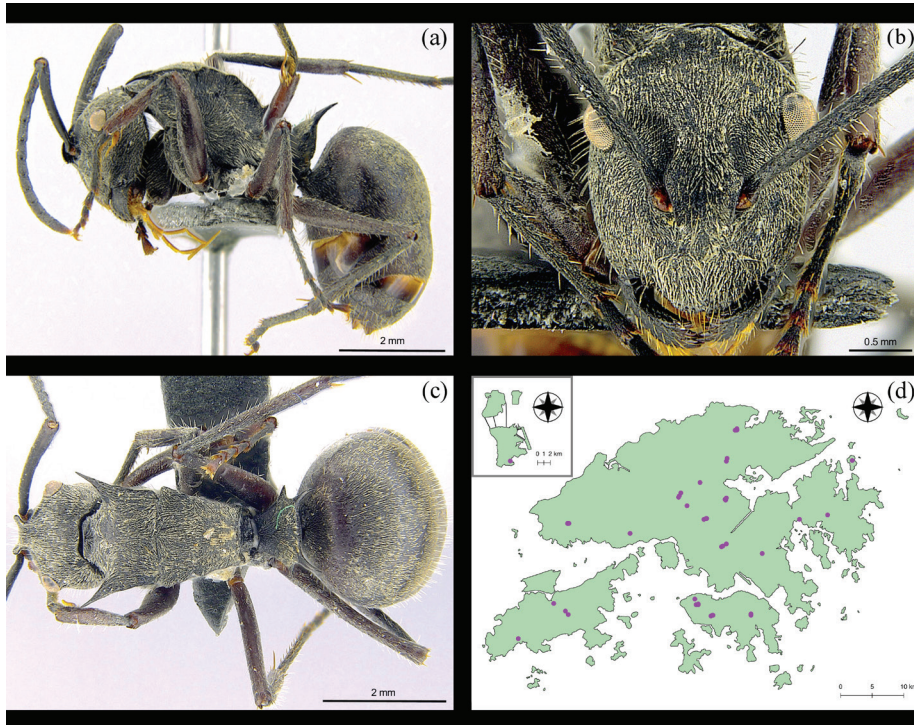


Fig. 29. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis tyrannica* worker (K6558(2)), and (d) the species' distribution in Hong Kong and Macau.

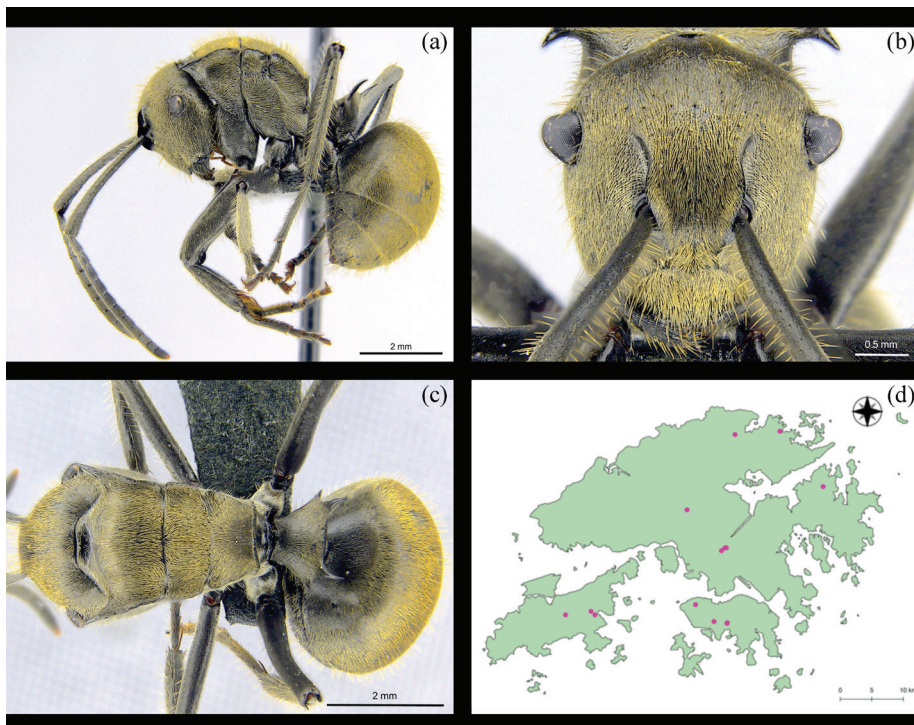


Fig. 30. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis vigilans* worker (WTL0005), and (d) the species' distribution in Hong Kong.

Description (Non-type workers described): **Head.** Head oval-shaped and clearly longer than broad in full-face view (CI 71–87). Lateral margins of head in front of eyes very slightly convex, converging towards bases of mandibles; behind eyes rounding into convex, medially slightly emarginate posterior margin. Eyes located at posterior part of head, facing anterolaterally; strongly convex, exceeding lateral cephalic outline in full-face view. Frontal carinae sinuate, raised and moderately laminate at mid-length. Frontal triangle apparent. Clypeus with distinct median carina; anteriorly straight in profile, posteriorly rounding into barely impressed basal margin. Anterior clypeal margin arcuate and broadly produced anteriorly, with median anterior margin very slightly emarginate; posterior margin convex but medially moderately emarginate. Mandibular masticatory border with five teeth, apical tooth longest, subsequent teeth gradually reducing in length. Antennal scape slender and obviously longer than head width (SI 149–193); antennal segments II to XII longer than broad and gradually reduced in length, except the slightly shorter segment III and slightly longer segment XII.

Mesosoma. Mesosomal dorsum significantly laterally marginate. Pronotal dorsum weakly convex, subtrapezoidal and slightly wider anteriorly; humeri armed with long horizontal spines directed anterolaterally and slightly curving downwards. Promesonotal suture distinct; mesonotum dorsally flat, anteriorly shallowly convex, laterally moderately raised and laminate, narrower than pronotum but wider than propodeum. Metanotal groove laterally moderately impressed, medially indistinct; propodeal dorsum posteriorly armed with short upturned acute teeth.

Metasoma. Petiole scale-like; armed with two lateral teeth, and two acute dorsal spines that slightly curve backwards and inwards and project posterolaterally in dorsal view. Anterior face of first gastral tergite flat, rounding onto dorsum of segment.

Pilosity. Pale yellow appressed pilosity densely distributed over most body surfaces with shorter pubescence on antennae, legs and ventral gaster. Head, scapes, anterior clypeal margin

and dorsal mesosoma with dozens of anterior-directed erected golden setae. Mandibles at apical and outer borders with some curved, golden suberected hairs. Brown erected hairs on side of mesosoma in lower portion, tarsi, around joints, and venter of petiole. Tuft of short erect brownish golden hairs at tibial spurs and tarsi of forelegs. Petiolar dorsal tip, dorsal and ventral gaster with numerous suberected, posteriorly directed golden hairs.

Sculpture. Mandibles longitudinally striate with piliferous pits. Head, mesosoma and petiole costulate, legs imbricate. Head, mesosomal, petiolar and gastral dorsa, scapes, tibiae and tarsi with piliferous pits. Gaster finely shagreened.

Colouration. Body black; eyes light brown, purplish brown or black; condylar bulbs dark brown; palps, tips of apical funicular segments, claws, and gastral tip yellowish brown; femora and tibiae dark to very dark red.

Diagnostic notes. See diagnostic notes of *P. illaudata*.

Distribution and natural history. According to our records, *P. tyrannica* mainly inhabits forests and shrublands across a wide elevation range (40–840 m alt.) on Hong Kong Island, the New Territories, Lantau Island and Tap Mun, and is also found in Hac Sa, Macau (Yamane pers. comm.) (Fig. 29d). It is distributed in Tamil Nadu, India (Bharti *et al.* 2016), Sumatra (Gillison 2000), Borneo (Pfeiffer *et al.* 2011), Guangdong, Guangxi, and Hainan (Guénard & Dunn 2012; Ran & Zhou 2013). It should be noted however that the mentions of this species from southeast Asia (Borneo and Sumatra) and southern India represent disjunct records from its original description in China (without further geographical information, Smith 1858) and would thus deserve confirmation.

Little is known about the species' natural history, except that it is preyed by the Chinese pangolin (*M. pentadactyla*) (Lee *et al.* 2017).

Polyrhachis vigilans

Polyrhachis vigilans Smith, 1858: 69, pl. 4, fig. 39. Holotype queen. Type locality: CHINA: Hong Kong, NHMUK (examined via AntWeb). Combination in *P. (Myrma)*: Emery, 1925: 204. Description of worker: Donisthorpe, 1937: 626.

Polyrhachis pyrgops Viehmeyer, 1912: 9, fig. 10. Holotype worker. Type locality: CHINA, SDEI (examined via AntWeb). Combination in *P. (Myrma)*: Emery, 1925: 202. Synonymy by Kohout, 1998: 525.

Earliest known record: HONG KONG: Hong Kong, before 1858 (Holotype, Smith 1858) (examined online).

Other material examined: HONG KONG: Lung Fu Shan, 22.280466°N 114.1380918°E, 151m, 5.vii.2019, baiting (*T.L. Wong*) (1w: WTL0005); Southern: Aberdeen, 22.25654°N 114.16447°E ± 500 m, 110 ± 10 m, 30.x.2016, subtropical 2° forest at bait (*C. Leung*) (1w: #BA- IAS-25-01-12, ANTWEB1009170); Northeast New Territories, Sheung Wo Hang, 22.5219°N 114.1945°E, 40 m, F[eng] S[hui] Wood, 20.xi.1996, Winkler or pitfall (*J.R. Fellowes*) (2w: ANTWEB1016079, ANTWEB1016089); Sunset Peak, 22.265942°N 113.952788°E, secondary forest, 3.vi.2015, Winkler (R.H. Lee) (2w, 1q: RHL00133, RHL00178, RHL00696); Lion Rock, 22.36121°N 114.182°E, secondary forest, 13.vii.2015, P-T4S0, pitfall (*R.H. Lee*) (1w: RHL01726); Lion Rock, 22.36092°N 114.180°E, secondary forest, 13.vii.2015, P-T3S5, pitfall (*R.H. Lee*) (1w: RHL01703); Lion Rock, 22.357°N 114.175°E, secondary forest, 13.vii.2015, B-T1(H), baiting (*R.H. Lee*) (1w: RHL03047); Lion Rock, 22.36121°N 114.182°E, secondary forest, 13.vii.2015, B-T4H, baiting (*R.H. Lee*) (1w: RHL03054); Mui Wo, 11–14.ix.2018 (*A. Goldman*) (2w: #9, Non-Burn, UNB A.E.G.); Pak Sha O, 22.448°N 114.32°E, 18.iv.2015–9.v.2015, malaise trap (1q: MLT0339); Pak Ngan Heung, 22.27099°N 113.9891°E, F[eng] S[hui] Wood, 25.x.2016, Pitfall-T3S15 (*R.H. Lee*) (1w: RHL003355); Nam Fung Road, 22.2546°N 114.1833°E, F[eng] S[hui] Wood, 20.viii.2016, Pitfall-T2S5 (*R.H. Lee*) (1w: RHL003383).

Worker (Figs. 30a–c, 8 non-type workers measured): TL c. 10.05–11.49; HL 2.36–2.74; HW 2.14–2.43; EL 0.44–0.50; ML 0.92–1.09; SL 2.92–3.55; WL 3.32–3.77; PW 1.79–2.15; PTL 0.79–0.96; PTW 1.59–1.76; PTH 1.33–1.49; MTL 3.00–3.53; CI 84–96; EI 19–21; MI 34–45; SI 130–154; PTI 169–222; PTHI 151–187.

Description (Non-type workers described): **Head.** Head longer than broad in full-face view (CI 84–96), broader posteriorly. Lateral margins of head in front of eyes slightly convex, converging towards mandibular bases, behind eyes rounding into curved, shallowly convex occipital margin. Eyes located at posterior part of head, relatively small (EI 19–21) but very strongly convex laterally, exceeding lateral cephalic outline in full-face view. Frontal carinae sinuate, raised and moderately laminate at mid-length. Frontal triangle apparent. Clypeus with distinct median carina; anteriorly straight in profile, posteriorly rounding into fairly impressed basal margin. Anterior clypeal margin arcuate and medially slightly emarginate; posterior margin convex but medially slightly emarginate. Mandibular masticatory border with five teeth, apical tooth longest, subsequent teeth gradually reducing in length. Antennal scape slender and longer than head width (SI 130–154); antennal segments II to XII longer than broad and gradually reduced in length, except the slightly shorter segment III and slightly longer segment XII.

Mesosoma. Mesosomal dorsum significantly laterally marginate. Pronotal dorsum weakly convex, subtrapezoidal, slightly wider anteriorly; humeri armed with long, horizontal spines directed anterolaterally and slightly curving downwards. Promesonotal suture distinct; mesonotum dorsally flat, laterally laminate, slightly narrower than pronotum but wider than propodeum. Metanotal groove laterally moderately impressed, medially indistinct; propodeal dorsum armed with short upturned acute teeth.

Metasoma. Petiole scale-like; armed with two lateral teeth, two acute dorsal spines that slightly curve backwards and project posterolaterally in dorsal view. Anterior face of first gastral tergite flat, rounding onto dorsum of segment.

Pilosity. Pale to golden yellow appressed pilosity densely distributed over most body surfaces, with shorter pubescence on anten-

nae, legs and ventral gaster. Head, scapes, anterior clypeal margin and mesosomal dorsum with dozens of anteriorly directed erected golden setae. Mandibles at apical and outer borders with some curved, golden suberect hairs. Brown erected hairs in anterior and lower parts of lateral face of mesosoma, tarsi and petiole, and around joints of legs. Tuft of short erect brownish golden hairs at tibial spurs and tarsi of forelegs. Petiolar dorsal tip, dorsal and ventral gaster with numerous suberect, posteriorly directed golden hairs.

Sculpture. Mandibles longitudinally striate with piliferous pits. Head, mesosoma and petiole costulate, legs imbricate. Forehead, scapes, tibiae and tarsi with piliferous pits. Gaster finely shagreened.

Colouration. Body black; eyes dark brown, purplish brown or black; condylar bulbs dark to very dark brown; palps, tips of apical funicular segment, claws and gastral tip yellowish to dark brown.

Queen (Fig. 31, 2 non-type queens measured): TL c. 13.52–13.73; HL 2.92–3.03; HW 2.68–2.75; EL 0.59–0.62; ML 1.11–1.12; SL 3.30–3.63; WL 4.59–4.65; PW 2.68–2.75; PTL 1.04; PTW 1.89–2.01; PTH 1.18–1.29; MTL 3.45–3.69; CI 91–92; EI 22–23; MI 37–38; SI 123–132; PTI 183–194; PTHI 114–125.

Description (Non-type queens described): Similar to but larger than worker, with the following distinctions: containing sexual traits such as three ocelli on cephalic dorsum, fully developed mesosoma and wings (or scars left by the detached wings). Eyes slightly larger (EI 22–23). Mesoscutum rather flat in lateral view, with anterior 2/5 gently sloping; in dorsal view median line very short, reaching up to 1/5 length of mesoscutum; parapsides flat. Mesoscutellar disc slightly convex. Metanotum short, lower than mesoscutellum and propodeum. Pronotal, propodeal and petiolar spines highly reduced.

Diagnostic notes. In the worker caste *Polyrhachis vigilans* has a black body densely covered with pale to golden yellow appressed pubescence and erected setae; laterally strongly marginated mesosomal dorsum armed with long pronotal

spines and short, upturned acute propodeal teeth; and scale-like petiole armed with two short lateral teeth and two longer dorsal spines. It also has laterally strongly protruding eyes that are distally narrowed significantly, although the extent is smaller for specimens in Hong Kong, making them distinct from most sympatric *Myrma* species. This species is similar to *P. wolffi*, but the latter has less protruding eyes with a broadly rounded distal outline, slender body covered with fewer setae, and slightly shorter dorsal petiolar spines. *Polyrhachis vigilans* can also be easily separated from *P. tyrannica*, as the former has a body covered by denser, more goldenish appressed pilosity; a less elongated head; much more laterally strongly convex eyes; and wider space between frontal carinae, with the widest part being the posterior region instead at mid length.

Distribution and natural history. *Polyrhachis vigilans* mainly inhabits lowland forests (40–110 m alt.) on western Hong Kong Island, Lion Rock, the northern and central New Territories and eastern Lantau Island (Fig. 30d). It is also found in Taiwan, Guangdong, Guangxi, Hainan, Fujian, Hunan, Hubei, Zhejiang (Guénard & Dunn 2012), Henan (Guo *et al.* 2015), Anhui (Santschi 1925) and Jiangsu, Vietnam (Eguchi *et al.* 2005) and Borneo (Chapman & Capco 1951), with the last record to be confirmed.

Much of the ant's natural history is unclear, but it can be parasitized by the fungus *O. unilateralis* s.l. (Lin *et al.* 2020).

Polyrhachis wolffi

Polyrhachis wolffi Forel, 1912b: 79. Syntype worker. Type locality: TAIWAN, Kosempo [Jaxianpu] (H. Sauter), NHMUK (examined via AntWeb). Combination in *P.* (*Myrma*): Emery, 1925: 204.

Earliest known record: HONG KONG: East Central New Territories, Tate's Cairn, Kwun Yum Shan, 22.362°N 114.216°E, 260 m, 15.xi.1996 (*J.R. Fellowes*) (2w: ANTWEB1016080, ANTWEB1016090).



Fig. 31. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis vigilans* queen (RHL00133).

Other material examined: HONG KONG: Lung Fu Shan, 6.i.2016, 4.i.2016 (*GYOT*) (2w: GYOT014, GYOT016); The Peak, 22.27604°N 114.142°E, secondary forest, 2.x.2015, W-T2, Winkler (*R.H. Lee*) (1w: RHL02515); Tai Po Kau, 22.42614°N 114.1818°E, secondary forest, 14.vii.2015, P-T1S0, pitfall (*R.H. Lee*) (1w: RHL02072); Lai Chi Wo, 22.527°N 114.258°E, F[eng] S[hui] Wood, 8.v.2015, W-T1M, Winkler (*R.H. Lee*) (1w: RHL00268); Aberdeen Reservoir, 22.25887°N 114.1596°E, secondary forest, 26.vi.2015, P-T2S13, pitfall (*R.H. Lee*) (1w: RHL00856); Aberdeen Reservoir, 22.26113°N 114.1596°E, secondary forest, 26.vi.2015, pitfall (*R.H. Lee*) (1w: RHL01296); Lung Fu Shan, 22.2812940°N 114.1376606°E, 10.vi.2020, on concrete (*T.L. Wong*) (1w: WTL0022); Lung Fu Shan, 22.2803320°N 114.1375530°E, 10.vi.2020 (*T.L. Wong & B. Guénard*) (1w: WTL0028). **HAINAN:** Bawangling, Old-growth secondary forest, 19.088238°N 109.196806°E, 30.vi.2016, winkler extractor (*R.H. Lee*) (1q: HNA-01013, BWLP3).

Worker (Figs. 32a–c, 8 non-type workers measured): TL c. 7.53–9.67; HL 1.76–2.27; HW 1.43–1.79; EL 0.38–0.47; ML 0.69–0.87; SL 2.11–2.76; WL 2.43–3.05; PW 1.30–1.69; PTL 0.67–0.84; PTW 1.12–1.54; PTH 1.02–1.30; MTL 2.21–2.64; CI 74–85; EI 25–27; MI 37–41; SI 144–169; PTI 168–211; PTHI 144–178.

Description (Non-type workers described): **Head.** Head clearly longer than broad in full-face view (CI 74–85), broader posteriorly. Lateral margins of head in front of eyes slightly convex, converging towards bases of mandibles, behind eyes rounding into convex posterior margin. Eyes located at posterior part of head, facing anterolaterally; very strongly convex, exceeding lateral cephalic outline in full-face view. Frontal carinae sinuate, raised and moderately laminate at mid-length. Frontal triangle apparent. Clypeus with clear median carina; straight in profile, posteriorly rounding into barely impressed basal margin. Anterior clypeal margin arcuate and medially slightly emarginate; posterior margin convex but medially slightly emarginate. Mandibular

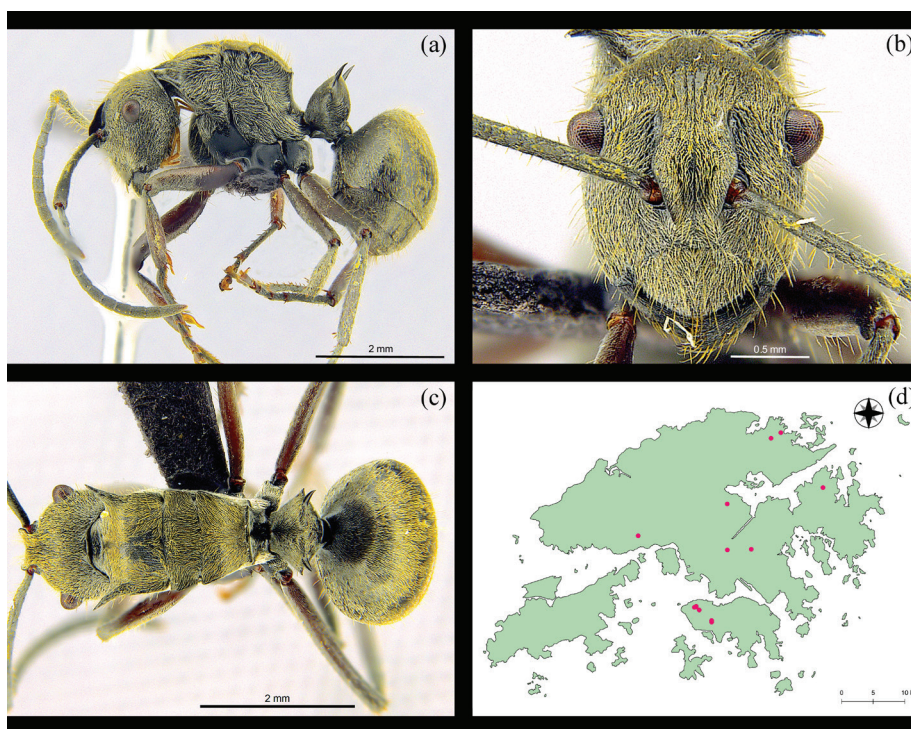


Fig. 32. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis wolffi* worker (GYOT016), and (d) the species' distribution in Hong Kong.

masticatory border with five teeth, apical tooth longest, subsequent teeth gradually reducing in length. Antennal scape slender and longer than head width (SI 144–169); antennal segments II to XII longer than broad and gradually reduced in length, except the slightly shorter segment III and slightly longer segment XII.

Mesosoma. Mesosomal dorsum significantly laterally marginate. Pronotal dorsum weakly convex and subrectangular; humeri armed with long, horizontal spines directed anterolaterally and slightly curving downwards. Promesonotal suture distinct; mesonotum dor-

sally flat. Metanotal groove laterally moderately impressed, medially indistinct; propodeum with slightly raised, laminate lateral margins towards metanotal groove, narrower than rest of mesosoma, dorsum armed with short upturned acute teeth.

Metasoma. Petiole scale-like; armed with two lateral teeth and two acute dorsal spines that curve slightly backwards and inwards and project posterolaterally in dorsal view; median denticle on dorsal margin of petiole distinct. Anterior face of first gastral tergite flat, rounding onto dorsum of segment.



Fig. 33. The (a) profile, (b) full-face and (c) dorsal views of a *Polyrhachis wolfi* queen (HNA-01013, BWLP3).

Pilosity. Pale to golden yellow appressed pilosity densely distributed over most body surfaces, with shorter pubescence on antennae, legs and ventral gaster. Head, scapes, anterior clypeal margin and mesosomal dorsum with dozens of anteriorly projecting golden setae. Mandibles at apical and outer borders with some curved, golden suberected hairs. Pale yellowish erected hairs present in anterior and lower parts of lateral face of mesosoma, tarsi and petiole, around joints of legs, and ventral subpetiolar process. Tuft of short erect brownish golden hairs at tibial spurs and tarsi of forelegs. Petiolar dorsal tip, dorsal and ventral gaster with numerous suberected, posteriorly directed golden hairs.

Sculpture. Mandibles longitudinally striate with piliferous pits. Head, mesosoma and petiole costulate, legs imbricate. Forehead, scapes, tibiae and tarsi with piliferous pits. Gaster finely shagreened.

Colouration. Body black; eyes light to dark brown, purplish brown or black; condylar bulbs and gastral tip brown to very dark brown; legs reddish brown to black; palps, tips of apical funicular segments and claws yellowish brown.

Queen (Fig. 33, 1 measured): TL c. 13.40; HL 2.84; HW 2.18; EL 0.71; ML 1.23; SL 3.72; WL 4.66; PW 2.57; PTL 1.06; PTW 1.82; PTH 1.36; MTL 3.64; CI 77; EI 32; MI 43; SI 171; PTI 172; PTHI 128.

Description: Similar to but larger than worker, with the following distinctions: sexual characters, including three ocelli on cephalic dorsum, fully developed mesosoma and wings (or scars left by the detached wings), present. Eyes larger. Mesoscutum highly convex in lateral view, anterior margin rounded onto dorsum in dorsal view; median line short, reaching around 1/4 of mesoscutum; parapsides flat. Mesoscutellar disc slightly convex. Metanotum deeply impressed dorsally. Pronotal, propodeal and petiolar spines smaller in size.

Diagnostic notes. See diagnostic notes of *P. vigilans*.

Distribution and natural history. *Polyrhachis wolffi* lives on western Hong Kong Island and the eastern and northern New Territories (Fig.

32d). It is also distributed in Taiwan, Guangdong, Guangxi, and Hainan (Guénard & Dunn 2012; Ran & Zhou 2013). Based on our records, the species mainly occupies lowland forests (140–260 m alt.).

The ant's natural history is poorly known, but the species is known to be infected by the fungus *O. unilateralis* s.l. (Lin *et al.* 2020).

DISCUSSION

A total of 17 *Polyrhachis* species have been recognized in Hong Kong and Macau after examining the specimens available in the IBBL and BSM collections, where most, if not all, were collected in forests and wetlands. Four new species, *P. confusa*, *P. fellowesi*, *P. hunggeuk* and *P. peetersi*, are here described from Hong Kong, with *P. confusa* also recorded in Macau and *P. fellowesi* recorded from Guangdong, Guangxi and Zhejiang (Table 3). Four previously known species, *P. moesta*, *P. punctillata*, *P. rastellata* and *P. rufipes* are newly recorded in Hong Kong, whilst *P. latona* and *P. tyrannica* are newly recorded from Macau (Table 3). *Polyrhachis rufipes* is also found to be native in Hainan with these records from southeast China representing the first records from China (Table 3). Finally, *P. demangei* is here recorded for the first time from Zhejiang, while previous records of *P. striata* from Fujian and Zhejiang are here considered as dubious. Overall, and in light of the relatively limited specimens examined here, these results suggest that the extent of the distribution of many *Polyrhachis* species is still poorly understood in southeast China. Hong Kong is also home to 54.8% of the 31 *Polyrhachis* species recorded in southeast China, which represents the third highest diversity in the region after Guangxi and Guangdong (Table 3) and indicates its rich biodiversity. Macau, on the other hand, has fewer than 1/5 of all known *Polyrhachis* species in southeast China (Table 3). This is likely because Macau is smaller than Hong Kong, with the former only about 3% the size of the latter (Statistics and Census Service 2018; SMO 2020). It may also be resulted from Macau's high level of urbanization and relative lack of suitable habitats used by *Polyrhachis* ants, such as forests, shrublands and wetlands, which currently

occupy less than a quarter of Macau's total land area (Mongabay 2006), being much less than Hong Kong's 66.1% (LegCo Secretariat 2016). However, with 47.1% and half of the species being newly recorded respectively (Table 3), it is expected that more *Polyrhachis* species could be found both from Hong Kong and Macau in the future.

Here, we adopted the morphological measurements used in previous studies on *Polyrhachis* taxonomy (e.g. Kohout 2010, 2014), but included several amendments. Some measurements remain, however, somehow problematic, which may cause confusions particularly for variable traits like the petiolar sizes and total length. The pronotal width was measured without taking any spine or protuberance into account, with limits of the measurement sometimes challenging to determine for species with long pronotal spines. The petiolar width was defined as the greatest width of the petiole, which includes the petiolar spines, but also varied a lot in function of the shape of the petiole and length of the spines or teeth present in some species. The petiolar height was measured from the petiolar spiracle to the tangent line of the petiolar spine, which might be more accurate if it was measured from the subpetiolar process to the tangent line of the petiolar spines. The total length of the ant was estimated from the sum of several other measurements, which can, overall, vary in function of various factors including the position of the specimen or the state of the specimen. For instance, the metasoma of *Polyrhachis* species can present important physiogastry in function of the state on the specimen upon collection, or depending of the preservation condition. Nonetheless, total length remains useful to provide an overall estimation of the size of a species, for instance in the field, which can allow to quickly discriminate particular species.

This study also complements and summarizes part of the knowledge on the ecology and natural history of several *Polyrhachis* species. For instance, a better understanding of *P. dives*, a fairly well studied species within the genus, as well as some novel natural history notes for other *Polyrhachis* species (*P. confusa*, *P. demangei*) are here provided. According to the high number of males and queens found in the nests collected in

late October (Table 2), *P. dives* likely mate in late autumn to early winter, similar to *P. lamellidens* (Hung 1970) and *P. moesta* (Sasaki *et al.* 2005). The number of different castes and life stages of *P. dives* were found to be highly variable and uneven between nests (Table 2), which may be because the collected nests were at slightly different phases and are possibly only parts of larger polydomous colonies, where workers can freely move between separate but interrelated nests, similar to the case of supercolonies (Hölldobler & Wilson 1990). Although there can be more than 70,000 individuals of different castes and life stages within a nest constructed by *P. dives* (Hannan & Yamane 2005), some intact nests found in the field were empty, and one collected nest had more reproductive castes than workers with fewer than 1,000 individuals in total. This implies that *P. dives* relocate their nests and abandon their old ones, a behaviour similar to *Polyrhachis ammon* Fabricius that discards smaller, less domed and shaded nests (Gibb & Hochuli 2003). Besides, even though the nests of *P. dives* were known to be associated with many invertebrate species, including adults, cocoons and larvae of arthropods, mollusks and crustaceans (Hannan & Yamane 2005), many of the arthropods found within the collected nests of *P. dives*, apart from the hemipterans (Liefke *et al.* 1998), were not known to be associated with this species previously. With new discoveries of jumping spiders, parasitoid wasp, cockroaches, the ant *T. melanocephalum* and larvae of other insects from their nests, *P. dives* may be more ecologically important than previously thought, where the species might support the survival of some of these arthropods (e.g. Grob 2015; Iwai *et al.* 2016; Nehring *et al.* 2016). Yet the ecological roles of the arthropods in *P. dives* nests are interpreted only based on existing knowledge (e.g. Liefke *et al.* 1998; Nehring *et al.* 2016).

This work provides descriptions of four new species, namely *P. confusa*, *P. fellowesi*, *P. hunggeuk* and *P. peetersi*, and highlights the morphological features that make them distinguishable from their previously known relatives. It also describes the previously unrecorded queen of *P. demangei* for the first time and provides more information regarding the species' ecology, presents a dichotomous key to identify the

Polyrhachis ants in Hong Kong and Macau, and integrates all currently available knowledge about their natural history. Based on the limited information on *Polyrhachis* ants, most species in Hong Kong and Macau seem to live in forests (but see *P. punctillata*), construct polydomous nests above ground (Robson & Kohout 2007), communicate through tactile signals (Liefke *et al.* 1998), are omnivorous or mainly feed on honeydew and other sugary food (Gobin *et al.* 1998; Liefke *et al.* 1998; Yamamoto *et al.* 2009) potentially from symbiotic hemipteran insects (Liefke *et al.* 1998; Seki *et al.* 2018), and are prey or hosts of many other faunal and fungal species (e.g. Iwai *et al.* 2016; Lee *et al.* 2017; Lin *et al.* 2020). On the other hand, certain species possess characters and behaviours that are unique. For example, *P. lamellidens* is temporarily parasitic to *Camponotus* species (Kohriba 1963; Sakai 1990), although potential hosts in Hong Kong are unknown. *Polyrhachis moesta* is secondarily monogynous due to behavioural change in winter (Sasaki *et al.* 2005; Hashimoto *et al.* 2013), and *P. rufipes* makes use of *Gnamptogenys menadensis* to locate food sources (Gobin *et al.* 1998). The similarities and differences of *Polyrhachis* species in terms of habitats, behaviours (e.g. Liefke *et al.* 1998; Graystock & Hughes 2011; Hashimoto *et al.* 2013), nest and colony structures (Liefke *et al.* 1998; Robson & Kohout 2007) and ecological roles (e.g. Kohriba, 1963; Dorow & Maschwitz 1990) may have resulted in multiple species co-existing in the same region (Fig. 3), explaining the genus's high biodiversity. However, the nest and colony structures, behaviours and interspecific relationships of most *Polyrhachis* species remain completely or partially unknown. New information such as the utilization of the Saturniidae pupal case by *P. demangei* (Fig. 9) can be obtained from further sampling and examinations, even for comparatively well studied species like *P. dives*. As a result, future studies and field work are needed to further investigate the ecology of the different species within this genus.

The sampling time and locations of the examined specimens can shed light to the extent of conservation efforts towards *Polyrhachis* species. For example, by incorporating the climate, vegetation covers and topology of its known sampling locations, *P. halidayi* is believed to be

restricted to mountainous areas (Morgan & Guénard 2018). Given that few individuals of the species have been discovered in Hong Kong in recent years, *P. halidayi* is likely to be a regionally endangered species (Morgan & Guénard 2018), while other species appear to be extremely rare (e.g. *P. peetersi*) and should be prioritized for being conserved and protected. On the other hand, the absence of new records of *P. lamellidens* from Hong Kong for several decades now, indicates that this species may have gone locally extinct in its southern distribution range. The causes that may have contributed to its extension are to this point speculative in the absence of precise information on its original distribution within Hong Kong, and due to the important changes that occurred in Hong Kong landscape and climate over the past century. If *P. lamellidens* is still extant in Hong Kong, it may, similar to its Japanese counterpart, be a temporary parasite of *Camponotus fuscivillosus* Xiao & Wang, a species present in Hong Kong (Guénard & Dunn 2012) and belonging to the same subgenus as *C. japonicus* and *C. obscuripes*.

Even though this study has increased the number of *Polyrhachis* species known from Hong Kong, Macau and other Chinese provinces, the results are rather conservative as it only includes specimens with known origin. Since a few specimens in the collections completely lack any information about the collectors, sampling dates and locations, this, though unlikely, might cause some *Polyrhachis* species that are native to the regions being overlooked and not taken into account. At the same time, the *Polyrhachis* ants are identified mainly based on morphological traits, meaning that morphologically cryptic species, particularly those that are not known to exist in certain areas before, may be overlooked (Hsieh *et al.* 2014). The described morphological traits of the ants can also be potentially subjective (Aldhebiani 2018), as *Polyrhachis* species can only be identified with confidence by a few experts in the world, such as the late Rudolf J. Kohout (Antbase.Net 2017). To reach more precise and concrete taxonomic conclusions, different characteristics of the *Polyrhachis* ants, for instances, their morphology, anatomy, genetics, and ecology, can be considered together with multiple species concepts (Hsieh *et al.* 2014; Aldhebiani

2018). Phylogenetic analyses should also be incorporated into taxonomic analyses to detect for any possible cryptic *Polyrhachis* species (Padial *et al.* 2010), as well to comprehend the ants' phylogenetic relationships (Latella *et al.* 2018), given some subgenera such as *Myrmhopla* are polyphyletic (Mezger & Moreau 2016).

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