ASIAN MYRMECOLOGY — Volume 16, e016005, 2023
ISSN 1985-1944 | eISSN: 2462-2362 DOI: 10.20362/am.016005

The Amblyoponinae (Formicidae) of Hong Kong

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ABSTRACT. Cryptobiotic ants of the subfamily Amblyoponinae are notoriously difficult to collect and rarely addressed in faunal reviews. Database records are comparatively sparse with little literature regarding regional biogeography, and with most records associated with pristine natural habitats. We review the Amblyoponinae species of Hong Kong, a heavily urbanised region, providing natural history and biogeographic information for each species. Based on recent and historical faunal surveys, our results reveal a comparatively rich diversity including both native and potential exotic taxa. A total of eight species and two genera are found in Hong Kong. One genus, *Prionopelta* Mayr, 1866, and three species, *P. kraepelini* Forel, 1905*, Stigmatomma luyiae* Hsu *et al.,* 2017 and *S. zwaluwenburgi* Williams, 1946 are newly recorded in the region and continental China, while additional records of *S. amblyops* Karavaiev, 1935 and *S. crypticum* (Eguchi *et al*., 2015) are also provided. Two new *Stigmatomma* species are also described, *Stigmatomma draconis* **sp. nov.** and *Stigmatomma pagei* **sp. nov.** Taxonomic assessments are provided for *S. zwaluwenburgi* and specimens previously thought to be *S. rothneyi* (Forel, 1900). With the use of multivariate analysis and examination of morphological characters, we conclude *S. rothneyi* specimens are closely related to *S. quadratum* Karavaiev, 1935 and consequently designated as *S.* nr. *quadratum* until further revisionary work is carried out. Our results also show that some Amblyoponinae species can be relatively common within urban environments, a habitat not previously understood to be associated with this subfamily.

Keywords cryptic, urban, exotic, tramp, *Stigmatomma*, *Prionopelta*, China
Citation Matthew T. Hamer, Mac P. Pierce & Benoit Guénard (2023). The Amblyoponinae (Formicidae) of Hong Kong. Asian Myrmecology 16: e016005

Communicating Editor Adam Cronin

INTRODUCTION

The Amblyoponinae (Formicidae) are a relict, cryptobiotic group of ants likely emerging during the Mid-Cretaceous (93-121 Ma) in the Afrotropical realm (Ward & Fisher, 2016). Amblyoponinae species are characterised by a suite of morphological characters distinctive among ants, most notably the attachment of the posterior portion of the petiole to segment III of the abdomen, the petiole therefore lacks a posterodorsal face (Bolton 2003; Boudinot 2015). The absence of eyes and denticles on the anterior clypeal margin are also observed across Amblyoponinae genera (Ward, 1994; Bolton 2003; Ward & Fisher 2013; Boudinot 2015).

Species are typically crytobiotic, being subterranean or leaf litter foraging, making collection of individuals infrequent, and hindering our understanding of the species biology and natural history. Some natural historical observations have found a degree of prey specificity, such as on chilopods (Gotwald & Levieux 1972; Masuko 1993) and coleopteran larvae (Wilson 1958); alongside one of the fastest mandibular movements in the animal kingdom, within the *Mystrium* Roger, 1862 genus (Larabee *et al.,* 2018). Most notably, species extract haemolymph from their larvae via biting, hence the common name '*Dracula ants*' (Ito & Billen, 1998; Ito 2010). This unusual feeding behaviour is apparently a non-destructive process, with larvae able to reach adulthood (Fisher, 2003; Saux *et al.,* 2004; Masuko 1986). Ward and Fisher (2016) posit that amblyoponines throughout their long evolutionary history never transitioned away from their cryptobiotic habits. Remaining within the leaf litter and subterranean habitats, as well as specialising on particular prey, potentially allowing species to persist by avoiding increased competition with above ground ant clades.

While limited knowledge on Amblyoponinae habitat use is available, species are typically not expected within highly disturbed urban environments, either due to lack of specialised prey or unsuitable microclimatic conditions. Indeed, most species descriptions have been based from specimens collected in natural habitats e.g. protected areas (Gotwald & Levieux, 1972; Xu, 2006; Xu & Chu, 2012; Hsu *et al.,* 2017); and the work of Williams (1946) represents, to the best of our knowledge, the only study to describe an Amblyoponinae species from a disturbed environment (i.e. an agricultural sugar cane field) in Hawaii.

Compared to other ant subfamilies, and based on current taxonomic knowledge, the Amblyoponinae presents a relatively low species diversity, with 143 valid species in 9 genera (Bolton 2021). Species within the subfamily are globally distributed and encountered in both temperate and tropical regions, reaching their diversity peak in the latter, and with numerous species remaining undescribed (Ward & Fisher 2016).

Hong Kong SAR (Special Administrative Region), located in southern China, has a wet and humid sub-tropical climate during the summer months (April-September) and a dry climate in winter (October-March). The region is composed of a rugged topography with low mountains (<900 m), islands, and numerous habitat types as a result of extensive and long deforestation periods, halting in the late 1940's (Dudgeon & Corlett 1994). The large majority of the lowland areas of Hong Kong are now heavily urbanized, with reclamation projects creating artificial land on the ocean. Concrete surfaces are therefore common, however, a substantial proportion is comprised of a matrix of green spaces, such as urban parks, public gardens and roadside planters. Although heavily disturbed and dominated by tramp and exotic ant species (personal observations), pockets of suitable microhabitat, such as leaf litter, can persist.

In China, the Amblyoponinae subfamily is currently represented by four genera including, *Myopopone*, *Mystrium, Stigmatomma*, and *Xymmer* (unpublished record from Yunnan) totaling 17 described species. Within Hong Kong, three species of Amblyoponinae have been previously recorded, *Stigmatomma amblyops* Karavaiev, 1935*, S. crypticum* (Eguchi *et al.,* 2015) and *S. rothneyi* (Forel, 1900).

Here, based on historical and recent sampling within both urban and natural areas, we provide a new genus (*Prionopelta*) and significant new species records for both *Stigmatomma* and *Prionopelta* within Hong Kong. We also describe two new species, *Stigmatomma draconis* sp. nov. and *Stigmatomma pagei* sp. nov. Distribution and morphometric data on alate reproductives of *Prionopelta kraepelini* and *Stigmatomma reclinatum* group are incorporated into our review. In addition, we provide ecological and biogeographic notes, and speculate on the exotic status of several species. Finally, taxonomic evaluations for *S. zwaluwenburgi* and specimens previously thought to be *S. rothneyi* (*S. reclinatum* group) are provided.

MATERIALS AND METHODS

Sampling

Sampling was carried out by members of the Insect Biodiversity and Biogeography Laboratory (IBBL, HKU) between 2014-2022, as well as by Dr. John Fellowes between 1993-2002. Sampling methods included leaf litter extraction, pitfalls and malaise traps alongside hand collection, conducted throughout Hong Kong SAR in urban and natural habitats.

Morphological measurements and terms
Measurements were taken using a Leica M205 C dissecting microscope and Leica Application Suite v. 4.5 software. Measurements based on images of type specimens (antweb.org) were collected using ImageJ (Schneider *et al.,* 2012). Specimen imaging and editing was done with a Leica M205 C Stereomicroscope with a DMC5400 Camera stacked in LASX (v.3.7.4.23463) and Adobe Photoshop (23.0.2 20211119.r.101). All measurements are reported in millimetres to the nearest 0.01 mm. Specimens without a complete set of measurements were excluded from species measurement ranges. Morphological and sculpture terminology follows Keller (2011) and Harris (1979), respectively.

Measurements:
Head Length (HL): maximum length of head from the anterior median clypeal margin to the median posterior margin of the cephalic capsule measured along the midline as a straight line.

Head Width 1 (HW_1): maximum width of head in full-face view, including the eyes in males only (following Yoshimura & Fisher 2014; Boudinot 2015).

Head Width 2 (HW_2): maximum width of the lower portion of the head between posterolateral clypeal corners (following Taylor 1978; Esteves & Fisher 2016).

Scape Length (SL): maximum measurable length of scape, from the proximal point of scape shaft, not including the condyle, to the distal end of scape.

Mandible Length (ML): maximum length of mandible from the anterolateral margin of clypeus at outer side of mandibular insertion to mandibular apex.

Eye Length (EL): maximum diameter of eye measured in lateral view.

Weber's Length of Mesosoma (WL): maximum diagonal distance in lateral view, from base of anterior slope of pronotum to metapleural lobe.

Propodeal Posterior Width (PPW): maximum width of propodeum measured in dorsal view (following Esteves & Fisher 2016).

Dorsal Petiole Width (DPW): maximum width of the petiole measured in dorsal view.

Dorsal Petiole Length (DPL): maximum length of the petiole measured in dorsal view.

Tergite One Width (T1W): width of the first gastral (third abdominal) tergite in dorsal view (following Shattuck 2008).

Gaster Length (GL): length of the gaster in lateral view from the anterior most point of gasteral tergite, to the posteriormost point of the final gastral sternite.

Total Length (TL): The sum of ML, HL, WL, DPL, GL.

Indices:
Cephalic index (CI): HW_1 / HL × 100
Scape index (SI): SL / HW_1 × 100
Mandibular index (MI): ML / HL × 100
Petiolar index (PI): DPW / DPL × 100

Mapping
A tree cover raster map of Hong Kong was obtained from Morgan & Guénard (2018) to visualise habitat differences between urban and natural areas. Records of each species were plotted using QGIS (3.22.5-Białowieża) and categorised by both specimen caste and record source (i.e. iNaturalist based records).

Principal Component Analysis
A principal component analysis (PCA) was conducted in order to understand the morphological groupings, the underlying morphometric variation within the *Stigmatomma reclinatum* group and the identity of *reclinatum* group specimens collected in Hong Kong. We used linear morphometrics collected from members of the group from Hong Kong, with additional specimens collected from Macau (Leong *et al*., 2017; Brassard *et al*., 2021), Thailand (Guénard unpublished data) and Singapore (Lee Kong Chian Natural History Museum). Holotype specimens of the *S. reclinatum* (Mayr,

1879), *S. rothneyi*, *S. bellii* (Forel, 1900) and *S. quadratum* were also measured using imageJ. These species were selected due to their close morphological resemblance to unidentified specimens from Hong Kong and near determinations when using the taxonomic key in Xu and Chu (2012). During morphometric sampling, it was noted that image scale bars of the *S. quadratum* holotype specimen did not correspond to measurements of the holotype specimen given by Karavaiev (1935). As the original descriptor, we therefore used the measurements by Karavaiev as a reference across all *S. quadratum*; including head width for full face view, mesosoma length for lateral view and dorsal view. Other members of the *S. reclinatum* group apparent on AntWeb distributed across Indochina were not chosen due to their current unknown identity.

As PCA is based on correlations between variables, with greater correlation values increasing the success of encapsulating the underlying variation within a dataset, the original measurements were initially checked for correlations using the function *cor* (stats package R core team, 2022). We used the function *prcomp* (stats package R core team, 2022) with scale set to "TRUE" to run the PCA. Setting the scale to true standardised the data avoiding over dominance of variables. Both scree plot and species scores were plotted with the package ggbiplot (Vu 2011) using the functions *ggscreeplot* and *ggbiplot* respectively.

Repositories:

CAS: California Academy of Sciences, San Francisco, California, USA

HKBM: Hong Kong Biodiversity Museum. University of Hong Kong, Hong Kong SAR, China

IBBL: Insect Biodiversity & Biogeography Laboratory, The University of Hong Kong, Hong Kong SAR, China

ZRC: Zoological Reference Collection, Lee Kong Chian Natural History Museum, Singapore.

RESULTS

Two new species are described *Stigmatomma draconis* sp. nov. and *Stigmatomma pagei* sp. nov. *Prionopelta kraepelini* is newly recorded to the Hong Kong SAR fauna, and also represents the first record of this genus and species within mainland China. We also add two *Stigmatomma* species to mainland China, including *S. zwaluwenburgi* Williams, 1946 and *S. luyiae* Hsu *et al.,* 2017. Below a taxonomic synopsis, measurements, a key to known species of the region and species distribution maps for Hong Kong are given, alongside PCA results.

Taxonomic Accounts

Prionopelta Mayr, 1866 **– First record for mainland China and Hong Kong SAR**

Prionopelta Mayr, 1866a: 503 Type-species: *Prionopelta punctulata*, by monotypy.

Concoctio Brown, 1974d: 29 Type-species: *Concoctio concenta* (obsolete combination of *Prionopelta concenta*), by original designation. Junior synonym of *Prionopelta*: Ward & Fisher, 2016: 691.

Examblyopone Donisthorpe, 1949h: 401 Type-species: *Examblyopone churchilli* (now: junior synonym of *Prionopelta nominata*), by original designation. Junior synonym of *Prionopelta*: Brown, 1951: 102.

Renea Donisthorpe, 1947e: 183 Type-species: *Renea testacea* (now: junior synonym of *Prionopelta nominata*), by original designation. Junior synonym of *Prionopelta*: Brown, 1953c: 11.

Prionopelta kraepelini Forel, 1905 - **First record for mainland China and Hong Kong SAR** (Fig. 1A-I; Fig. 2A)

Prionopelta kraepelini Forel, 1905f: 3 (w.q.) INDONESIA (Java). Indomalaya.

Material examined

Workers (n=19); CHINA, HONG KONG SAR, Jordan Valley, Jordan Valley Park, 22.32949, 114.22197, 117m +/-5m, 27 July 2021, A. Ibáñez, Winkler, [JV1T2W2-5#1ANTWEB1010868], JV1T2W2-5#2[ANTWEB1010869]], IBBL • CHINA, HONG KONG SAR, Jordan Valley, Jordan Valley Park, 22.32954, 114.22203,

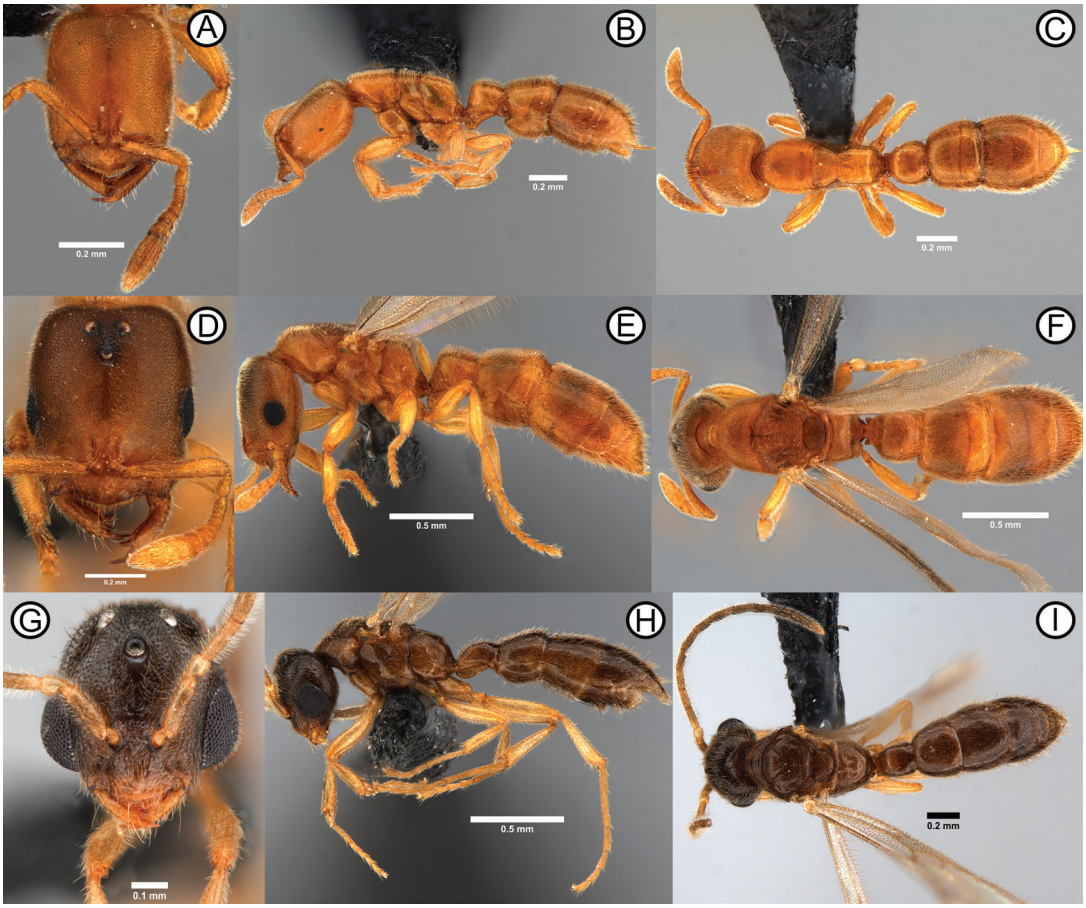

Fig. 1. *Prionopelta kraepelini*, worker (ANTWEB1010881): A) head view B) lateral view C) dorsal view; alate queen (ANTWEB1010878): D) head view E) lateral view F) dorsal view; male (ANTWEB1010879): G) head view H) lateral view I) dorsal view.

118m +/-5m, 27 July 2021, A. Ibáñez, Winkler, [JV1T2W1-8[ANTWEB1010873]], IBBL • CHINA, HONG KONG SAR, Wang Tau Hom, Morse Park, 22.33883, 114.1915, 16m +/- 5m, 26 July 2021, M. T. Hamer, Winkler, [MP1T1W5-4#1-#2[ANTWEB1010870-1]], IBBL • CHINA, HONG KONG SAR, Sha Ta, Nam Chung Yeung Uk, 22.51564, 114.20771, 5m +/-5m, 03 June 2021, A. Ibáñez, Winkler, [NC1T2W1-1[ANTWEB1010872]], IBBL • CHINA, HONG KONG SAR, Sha Ta, Nam Chung Yeung Uk, 22.51572, 114.20786, 3m, 03 June 2021, A. Ibáñez, Winkler, [NC1T2W5-1[ANTWEB1010881]], IBBL • CHINA, HONG KONG SAR, Tin Shui Wai, Tin Shui Wai Park, 22.45539, 114.0022, 14m, 11 August 2021, A. Ibáñez, Winkler, [TSW1T2W3-1[ANTWEB1010877]], ZRC • CHINA, HONG KONG SAR, Tin Shui Wai, Tin Shui Wai Park, 22.45542, 114.0022, 17m, 11 August 2021, A. Ibáñez, Winkler, [TSW1T2W1-5#1-#3[ANTWEB1010874-6]], IBBL • CHINA, HONG KONG SAR, Chek Lap Kok, 22.3153, 113.9407, 3m +/-5m, 08 September 2015, B.M. Worthington, Winkler, [AW3C144[BMW01587]], IBBL • CHINA, HONG KONG SAR, Chek Lap Kok, 22.3153, 113.9407, 4m +/- 5m, 08 September 2015, B.M. Worthington, Winkler, [AW3R72 [BMW00270, BMW00138]], IBBL • CHINA, HONG KONG SAR, Yuen Long, Lok Ma Chau, 22.510858, 114.065022, 8m, 11 August 2017, M. Pierce, Pitfall, [Pi-MPP-16-13 [ANTWEB1009731]], IBBL • CHINA, HONG KONG SAR, Lok Ma Chau, 22.51106, 114.0656, 1m +/- 5m, 01-03 September 2021, T. Bogar, Pitfall, [LMC-01 [ANTWEB1010882]], IBBL • CHINA, HONG KONG SAR, Cheung Chau, Saiyuen

Camping Adventure Park, 22.198927, 114.019639, 3m, 25 November, M. T. Hamer, Hand collection [MTHGC13-1 [ANTWEB1010880]], IBBL • CHINA, HONG KONG SAR, Pok Fu Lam Country Park, 22.26253, 114.1397, 230m, 07 April 2022, M. T. Hamer & A. Ibáñez, Winkler [PFL1T2W1-1], IBBL.

Queen (n=1); CHINA, HONG KONG SAR, Tsim Sha Tsui, Kowloon Park, 22.299639, 114.170782, 30m, 26 October – 02 November 2021, M. T. Hamer, Malaise, [KPC1M1-1[ANTWEB1010878]], IBBL.

Males (n=24); CHINA, HONG KONG, Choi Chee Ming Luen Kwong, 22.41841, 114.0252, 16.6m, 17-24 September 2021, Malaise, A. Ibáñez, [CC1M1-5 [ANTWEB1010950]], IBBL • CHINA, HONG KONG, Girl Guides Pok Hong Campsite, 22.37221, 114.19572, 56m, 09-16 July 2021, Malaise, A. Ibáñez & M. T. Hamer , [GGPH1M1-9 [ANTWEB1010947]], IBBL • CHINA, HONG KONG, Hong Kong Park, 22.27733, 114.1605, 32m, 15-22 September 2021, Malaise, A. Ibáñez, [HKP2M1-7[ANTWEB1010944]], IBBL • CHINA, HONG KONG, Jordan Valley Park, 22.33058, 114.22079, 123m, 27-03 July-August 2021, Malaise, A. Ibáñez, [JV1M1-24#1-#4[ANTWEB1010930-3]], IBBL • CHINA, HONG KONG, Kowloon Tsai Park, 22.33175, 114.18489, 31m, 27-03 July-August 2021, Malaise, A. Ibáñez, [KTP1M1-10[ANTWEB1010951]], IBBL • CHINA, HONG KONG, Lok Fu Recreation Ground, 22.33632, 114.18745, 39m, 05-12 July 2021, Malaise, A. Ibáñez & M. T. Hamer, [LFR1M1-10[ANTWEB1010941]], IBBL • CHINA, HONG KONG, Morse Park, 22.339194, 114.190661, 37m, 26-02 July-August 2021, Malaise, M. T. Hamer [MP1M1-4[ANTWEB1010946]], IBBL • CHINA, HONG KONG, Nam Cheong Park, 22.32501, 114.1569, 9m, 24-01 September-October 2021, Malaise, A. Ibáñez, [NPC2M1-1[ANTWEB1010879]], IBBL • CHINA, HONG KONG, Nam Cheong Park, 22.32501, 114.1569, 9m, 24-01 September-October 2021, Malaise, A. Ibáñez, [NPC2M1-1[ANTWEB1010929]], IBBL • CHINA, HONG KONG, Ocean Park, 22.244611, 114.175859, 58m, 28-05 September-October 2021, Malaise, M. T. Hamer, [OP1M1-5[ANTWEB1010942]], IBBL • CHINA, HONG KONG, Ocean Park, 22.244611, 114.175859, 58m, 05-11 October 2021, Malaise, M. T. Hamer , [OP2M1-5[ANTWEB1010943]], IBBL • CHINA, HONG KONG, Pillar Point, 22.36561, 113.94457, 2m, 21-25 June 2021, Malaise, A. Ibáñez, [PP1M1-1, PP1M1-2[ANTWEB1010939-40]], IBBL • CHINA, HONG KONG, Tung Chung North Park, 22.290691, 113.949224, 25m, 20-27 August 2021, Malaise, M. T. Hamer , [TCN1M1-4 [ANTWEB1010937]], IBBL • CHINA, HONG KONG, Tuen Mun Park, 22.38965, 113.97359, 9m, 13-22 July 2021, Malaise, A. Ibáñez & M. T. Hamer , [TM1M2-1 [ANTWEB1010938]], IBBL • CHINA, HONG KONG, Tai Po Waterfront, 22.45129, 114.1925, 9m, 17-24 August 2021, Malaise, A. Ibáñez, [TPW1M1-2[ANTWEB1010935]], IBBL • CHINA, HONG KONG, Tai Po Waterfront, 22.45129, 114.1925, 2m, 17-24 August 2021, Malaise, A. Ibáñez, [TPW1M2-12, TPW1M2-13[ANTWEB1010934, ANTWEB1010936]], IBBL • CHINA, HONG KONG, Tin Shui Wai Park, 22.45558, 114.0039, 21m, 11-18 August 2021, Malaise, A. Ibáñez, [TSW1M1-2 [ANTWEB1010945]], IBBL • CHINA, HONG KONG, Tsung Tzu Scout Camp, 22.47366, 114.1967, 47m, 13-20 September 2021, Malaise, A. Ibáñez & M. T. Hamer , [TT1M1-10[ANTWEB1010953]], IBBL • CHINA, HONG KONG, Tsing Yi Northeast Park, 22.361474, 114.098201, 12m, 25-01 August-September 2021, Malaise, M. T. Hamer , [TYN1M1-3[ANTWEB1010952]], IBBL.

Measurements

Workers (n=9); HL 0.47-0.51; HW_1 0.35-0.39; SL 0.24-0.27; ML 0.21-0.25; WL 0.55-0.61; DPW 0.18-0.21; DPL 0.14-0.17; T1W 0.3-0.35; GL 0.67-0.79; TL 2.29-2.58; CI 75.55-81.68; MI 41.91-49.21; SI 65.82-71.97; PI 125.15-145

Queen (alate) (n=1); HL 0.65-0.65; HW_1 0.52-0.52; SL 0.35-0.35; ML 0.25-0.25; WL 0.87-0.87; DPW 0.27-0.27; DPL 0.16-0.16; T1W 0.4-0.4; GL 1-1; TL 3.2-3.2; CI 80.15-80.15; MI 39.08-39.08; SI 67.61-67.61; PI 170.37-170.37

Male (n=10); HL 0.41-0.49; HW_1 0.44-0.5; SL 0.14-0.16; ML 0.17-0.21; WL 0.66-0.78; DPW 0.15-0.2; DPL 0.11-0.18; T1W 0.26-0.33; GL 0.59-0.84 ; TL 2.16-2.66 ; CI 93.21-109.39; MI 37.42-48.09; SI 30-33.1; PI 82.44-140

An additional male record was found via iNaturalist (iNat unique code = 967302, table S2). Unfortunately, the picture was not adequate to determine the individual to species level. However, the genus was determined by the authors to be correct. Given that *P. kraepelini* is the only *Prionopelta* species found in Hong Kong so far (and more broadly in China), this iNaturalist record is therefore only tentatively provided, but marked as separate from specimen derived records.

Remarks

Leaf litter sampling within urban green spaces have resulted in numerous collections of *P. kraepelini* throughout Hong Kong (Fig. 2A). Urban sampling sites had little leaf litter hummus layer, and were largely composed of loose soil, stones and general anthropogenic debris. Sampling from more natural environments such as secondary forests, Feng Shui Woods and shrub lands, while commonly performed, has resulted in no specimens (Lee *et al.,* 2021, Nooten *et al.,* 2021). The collection of specimens from urban environments in Hong Kong reinforces the hypothesis that this species is indeed an exotic tramp species, being easily relocated via anthropogenic means (Ward 2006). In contrast, in Macau where recent surveys were performed and included leaf litter extractions, no *P. kraepelini* individuals have been detected to this date (Leong *et al.,* 2017; Brassard *et al.,* 2021).

The relative commonness of *P. kraepelini* in Hong Kong is interesting to note as this species is known only from a single collection in both Taiwan (Liuguei, Kaohsiung province, Terayama 2009) and Vietnam (Hanoi periphery, Anh *et al.,* 2010), which represents the closest geographic records, but still located at 650 km and 850 km respectively from Hong Kong. While ecological information in Taiwan is missing, the record from Hanoi was collected from an organic Pomelo orchard, thus supporting the affinity of this species for disturbed habitats and exotic status in East Asia. Similarly, records from northern India were collected along roadsides and within fragmented habitats, but not in forested habitats (Bharti & Wachkoo 2012), while those from Sri Lanka appears to originate from a small forest fragment surrounded by urban development, based on Google Earth observations, with no ecological information provided directly in the original article (Dias *et al.,* 2018). In contrast, other material collected from SE Asia appears to originate principally from forested habitats (Shattuck 2008) suggesting a native range that includes the Sundaland and Wallacean regions. Recent records from southern Thailand and collected in 2019 are from both secondary forests and oil palm plantation (Khachonpisitsak *et al.,* 2020, Jaitrong pers. comm.), and the records from the Philippines did not include ecological information (General & Alpert 2012). Using Google Earth; specimens from the Philippines within Shattuck (2008) seemed to be recorded in both urban and agricultural habitats (MCZCT-215615), including a parkland (ANIC32-026204). It should be noted, however, that most of these specimens were collected within the last one hundred years, and the likelihood of environmental change since collection remains a possibility. While available information about the ecology of *P. kraepelini* is still fragmentary, habitat use observed for this species in several regions (Hong Kong, NW India, North Vietnam, Sri Lanka) suggest that it may have been introduced there, and that its native range may be limited to regions south of Peninsular Malaysia, the Philippines and the Wallacean region.

Stigmatomma Roger, 1859

Stigmatomma Roger, 1859: 250 Type-species: *Stigmatomma denticulatum*, by subsequent designation of Bingham, 1903: 36.

Arotropus Provancher, 1881a: 205 Type-species: *Arotropus binodosus* (now: junior synonym of *Stigmatomma pallipes*), by monotypy. Junior synonym of *Stigmatomma*: Dalla Torre, 1893: 14.

Bannapone Xu, 2000b: 299 Type-species: *Bannapone mulanae* (obsolete combination of *Stigmatomma mulanae*), by original designation. Junior synonym of *Stigmatomma*: Ward & Fisher, 2016: 691.

Stigmatomma amblyops Karavaiev, 1935 (Fig. 2B; Fig. 3A-C)

Stigmatomma amblyops Karavaiev, 1935a: 57, fig. 1 (w.) VIETNAM. Indomalaya.

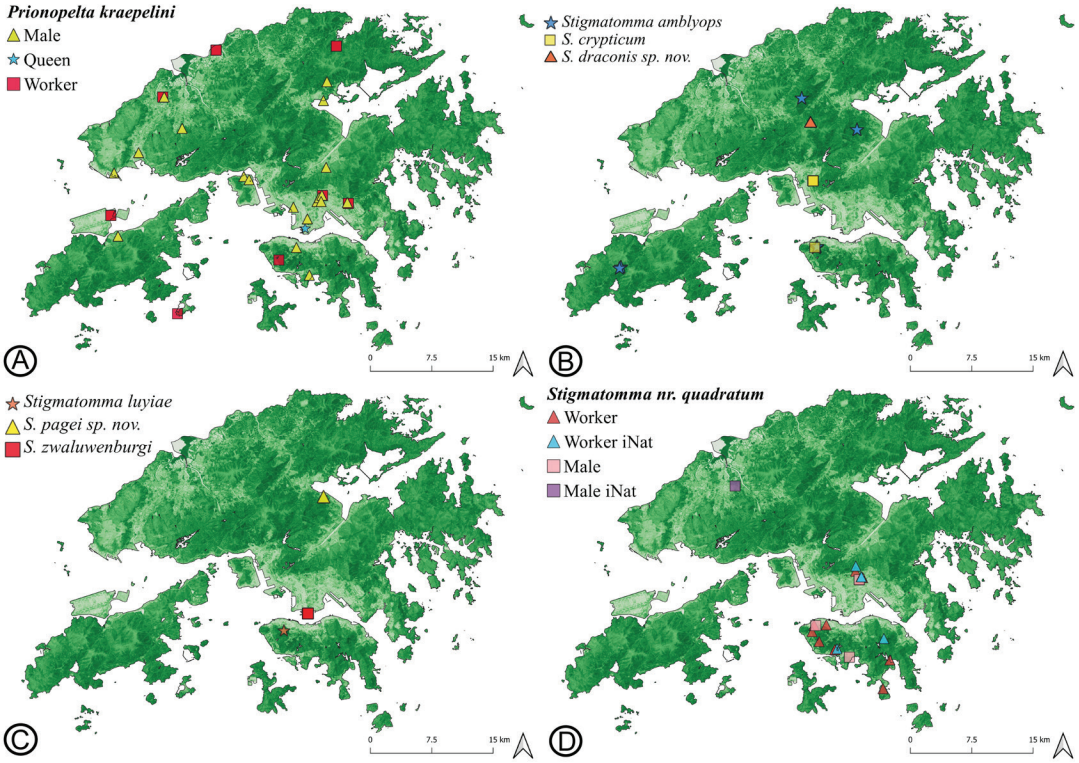

Fig. 2. Distribution map of Amblyoponinae species in Hong Kong (SAR), iNat = iNaturalist. A) *Prionopelta kraepelini*; B) *Stigmatomma amblyops*, *S. crypticum*, *S. draconis*; C) *Stigmatomma luyiae*, *S. pagei, S. zwaluwenburgi*; D) *Stigmatomma* nr. *quadratum*. Dark green zones indicate greater tree cover.

Material examined

Workers (n=6); CHINA, Hong Kong SAR, Tai To Yan, 22.4538, 114.1194, 467m +/- 50m, 7 August 2015, R. H. Lee, Winkler [RHL01457[ANTWEB1017021]], ZRC • CHINA, Hong Kong SAR, Hong Kong Island, Lung Fu Shan Country Park, 22.27673, 114.13669, 294m, 24 November 2014, Mark Wong, Winkler [ANTC37079[CASENT0914939]], CAS • CHINA, Hong Kong SAR, Hong Kong Island, Lung Fu Shan Country Park, 22.278038, 114.137508, 253m +/- 50m, 26 October 2015, T. P. N. Tsang , Winkler in *Lophostemon confertus* plantations [TT00489], IBBL • CHINA, Hong Kong SAR, New Territories, Tai Po Kau, 22.416504, 114.184865, 323m +/-50m, 30 June 2015, T. P. N. Tsang, Winkler in *Lophostemon confertus* plantations [TT01383], IBBL • CHINA, Hong Kong SAR, Lantau Island, Ngong Ping, 22.253949, 113.904726 +/- 250m, 477m +/- 50m, 01 November 2017, M. Pierce, Winkler [IAS-0177[ANTWEB1017075]], IBBL • CHINA, Hong Kong SAR, Lantau Island, Ngong Ping, 22.25252, 113.90362, 446m, 04 May 2022, M. T. Hamer & T. S. R. Silva, Winkler [NP1T1W4-1], IBBL.

Measurements

Workers (n=2); HL 0.81-0.82; HW_1 0.72-0.72; HW_2 0.7-0.71; SL 0.41-0.43; ML 0.59-0.62; WL 1.08-1.1; PPW 0.37-0.38; DPW 0.43-0.43; DPL 0.4-0.4; GL 0.56-1.18; TL 3.5-4.1; CI 87.81-89.13; MI 74.01-75.7; SI 57.96-60.4; PI 106.41-106.87

Remarks

First recorded in Hong Kong in 2014, *Stigmatomma amblyops* is recorded from *Lophostemon confertus* Peter G. Wilson & J. T. Waterhouse (Myrtaceae) plantations alongside natural areas such as country parks within Hong Kong. This species has yet to be recorded from Macau, potentially suggesting low tolerance for urbanization (Brassard *et al*., 2021). Elsewhere in Asia the species

is recorded from Vietnam (type locality), Yunnan and Hainan (unpublished records). In addition, *S. amblyops* seems to be associated with higher elevations, with records in Hong Kong all above approximately 200 m. In other parts of its range, it is also associated with mid elevation mountainous regions (Fontanilla *et al.,* 2019), including those dominated in evergreen forests (Zryanin 2013). This species is likely present in nearby Chinese provinces of Guangdong and Guangxi as well as other Asian countries.

Stigmatomma crypticum (Eguchi *et al*., 2015) (Fig. 2B; Fig. 4A-F)

Bannapone cryptica Eguchi *et al*., 2015: 79, figs. 1-11 (w.q.) VIETNAM. Indomalaya.

Stigmatomma crypticum (Eguchi *et al*., 2015): Ward & Fisher, 2016: 691.

Material examined

Workers (n=8); CHINA, Hong Kong SAR, Lung Fu Shan Country Park: 22.277383, 114.134898, 28 December 2015, 269m +/- 50m, Gordon Yong, Winkler [GYLL004B], IBBL • CHINA, Hong Kong SAR, Kwai Chung, Central Kwai Chung Park, 22.356245, 114.132814 +/-10m, 54m +/-10m, 15 August 2020, Hand collection, iNaturalist user abc-123, [ANTWEB1010855-7], IBBL • CHINA, Hong Kong SAR, Kwai Chung, Central Kwai Chung Park, 22.356245, 114.132814 +/-10m, 54m +/-10m, 15 August 2020, Hand collection, iNaturalist user abc-123, [ANTWEB1010858], ZRC.

Queens (n=2): CHINA, Hong Kong SAR, Kwai Chung, Central Kwai Chung Park, 22.356245 114.132814 +/-10m, 54m +/-10m, 15 August 2020, Hand collection, iNaturalist user abc-123, [ANTWEB1010853], ZRC • CHINA, Hong Kong SAR, Kwai Chung, Central Kwai Chung Park, 22.356245, 114.132814 +/-10m, 54m +/-10m, 15 August 2020, Hand collection, iNaturalist user abc-123, [ANTWEB1010854], IBBL

Measurements

Workers (n=5); HL 0.69-0.73; HW_1 0.59-0.62; HW_2 0.56-0.58; SL 0.34-0.35; ML 0.5-0.53; WL 0.82-0.84; PPW 0.28-0.29; DPW 0.28-0.31; DPL 0.14-0.15; GL 0.85-0.91; TL 3.08-3.11; CI 85.39-87.12; MI 72.17-77.75; SI 56.48-57.97; PI 195.51-207.33

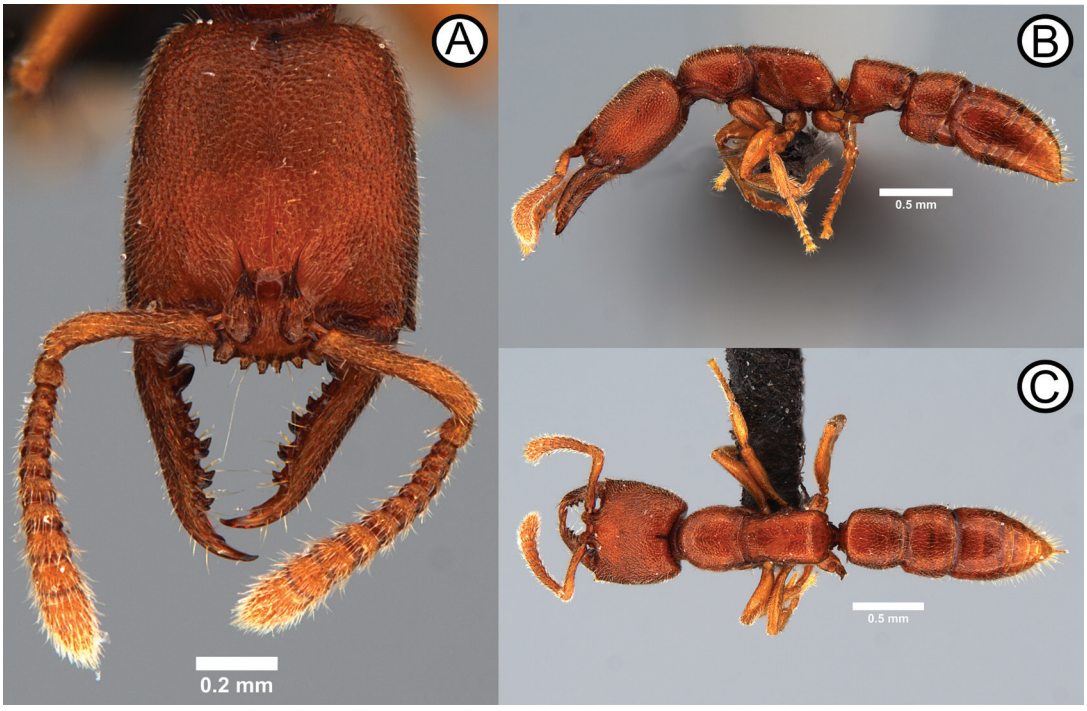

Fig. 3. *Stigmatomma amblyops* worker (ANTWEB1017021) A) head view B) lateral view C) dorsal view.

Queen (dealate) (n=2); HL 0.68-0.71; HW_1 0.6-0.6; HW_2 0.57-0.59; SL 0.34-0.35; ML 0.52-0.54; EL 0.09-0.1; WL 1.01-1.01; PPW 0.39-0.41; DPW 0.33-0.33; DPL 0.11-0.11; GL 1.11-1.23; TL 3.46-3.62; CI 84.52-87.62; MI 76.23-77.07; SI 57.39-58.48; PI 283.19-292.24

Remarks

Known only from Vietnam and Hong Kong (Eguchi *et al.,* 2015), we provide additional records from Hong Kong. In Vietnam, Eguchi and collaborators (2015) indicate specimens derived from 'Sang Le Forest', a forest system abundant with *Lagerstroemia tomentosa* C. Presl, 1844 (Lythraceae). Within Hong Kong, specimens have been collected from country parks (Lung Fu Shan and Tai Po Kau Country Park (Eguchi *et al.,* 2015)) and urban parks (Central Kwai Chung Park) where specimens have been collected in loose soil. These novel records may suggest that this species may be somewhat resilient to anthropogenic disturbances and urban habitats.

***Stigmatomma draconis* sp. nov.**

(Fig. 2B; Fig. 5A-C; Fig. 6A-F; Fig. 7B)

Diagnosis

Head quadrate, slightly wider than long (CI 106.71). Mandibles distinctly shorter than head (MI 52.75). Mandibular dentition asymmetrical; in full face view, left hand mandible with eight teeth, right hand mandible with nine teeth visible; pairs of teeth present; third tooth from apex short and recurved; preapical tooth blunt. Anterior clypeus margin with ten denticles; six median rectangular denticles; four-minute semi- rectangular denticles laterally. Supraclypeal area with confused sculpture. Total of eleven antennal segments. Lateral face of propodeum and declivitous face marginated. Mesepisternum divided into katepisternum and anepisternum. Hypopygium posteriorly with short stout setae.

Type locality; CHINA; Hong Kong SAR, New Territories, Tai Mo Shan Country Park, 22.42392803 114.129858, 525 m, 04 September 2022, Winkler of random leaf litter and soil, extracted over 6 days. Coll. M. T. Hamer & J. H. Park, det. M. T. Hamer & Benoit Guénard, Collection code; TMS1GC1-1, specimen code ANTWEB1010999, ZRC

Measurements:

Worker (n=1); HL 0.477; HW_1 0.509; HW_2 0.490; SL 0.269; ML 0.385; WL 0.633; PPW 0.249; DPL 0.158; DPW 0.266; GL 0.735; TL 2.39; CI 106.71; MI 52.75; SI 80.71; PtI 168.35

Head

In full face view, head quadrate, slightly wider than long (CI 106.71). Lower and maximum head width approximately equal (HW_1 0.509; HW_2 0.490). Posterior head margin subtlety concave. In full face view, anterior half of lateral margins of head subparallel slightly increasing until mid-point, with posterior half narrowing progressively until posterior head corners. Posterior head corners margins broadly rounded. Mandibles long and linear; distinctly shorter than head (MI 52.75). Mandible tooth composition from base to apex as follows; two broadly based triangular teeth; two pairs of narrowly based teeth (see comments); short and recurved; preapical blunt tooth; acute apical tooth. Ventral most tooth in pair always larger than dorsal tooth. Genal tooth absent (see comments). Anterior clypeus margin evenly convex, with ten denticles; six median rectangular denticles and four-minute semi-rectangular denticles laterally. Clypeus narrowly inserted between frontal lobes. Frontal clypeal sulcus broadly rounded. Supraclypeal area concave. Frontal lobes concealing antennal foramen. Frontal carina short. Antennal scrobes absent. Scapes short, half the length of head (SI 80.71); eleven antennal segments; ten antennomeres; pedicle constricted distally. Eye absent. Palp formulae unknown, obscured by labrum. Genal tooth absent (see comments).

Mesosoma

In dorsal view, anterior part of pronotum acutely rounded. Mesosoma constricted medially behind pronotum. Pronotum just wider than propodeum. Promesonotal suture clearly distinct, metanotal groove absent. Angle between propodeal dorsum and declivitous surface blunt. Dorsolateral margins of pronotum and propodeal dorsum gradually curved. Lateral face of propodeum and declivitous face marginated. Mesepisternum divided into katepisternum and anepisternum. Metathoracic spiracle indistinct. Propodeal spiracle circular; cuticle swollen dorso-posteriorly. Declivitous face of propodeum subtlety concave.

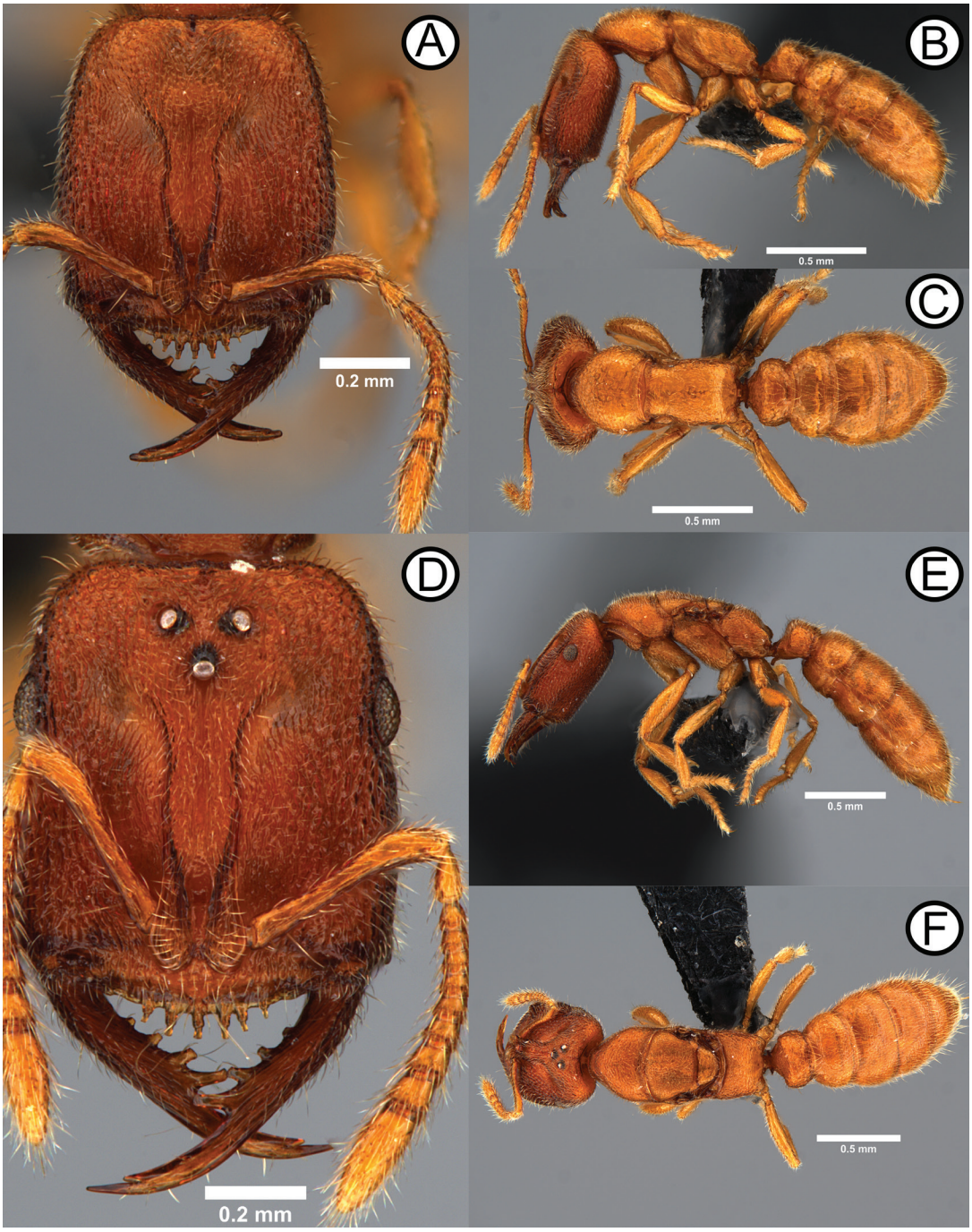

Fig. 4. *Stigmatomma crypticum* worker (ANTWEB1010855): A) head view B) dorsal view C) lateral view, and dealate queen (ANTWEB1010854) D) head view E) dorsal view F) lateral view.

Metasoma
In lateral view, petiole higher than long. Anterior face of petiole straight; anterodorsal angle blunt, only just obtuse. Petiole wider than long in dorsal view. Subpetiolar process present and thick; in lateral view, ventral margin convex, posterior margin straight. Subpetiolar process fenestration absent. Prora present. Gastral tergite one, wider than petiole in dorsal view; gastral segment two longer than all other tergites.

Sculpture
Mandibular dorsum costate, apical most surface smooth. Head dorsum costate-foveolate; foveolate only in posterior corners. Clypeus smooth medially, punctuate laterally. Supraclypeal area with confused sculpture. Dorsum of pronotum, mesonotum, propodeum costate-foveolate. Lateral surface of pronotum punctuate, weakly strigulate, with distinct smooth patches between sculpture. Katepisternum strigulate. Anepisternum punctuate. Lateral propodeal surface anteriorly strigulate-punctulate, posteriorly strigulate. Declivitous face of propodeum smooth. Subpetiolar process densely punctuate. Petiole dorsum punctuate, medially smooth with scarce punctuation. Lateral petiole tergite strigulate, scarcely punctuate. All gastral tergites punctuate; tergite one smooth medially; tergite two imbricate anteriorly. All gastral sternites punctuate.

Setae
Dorsum of mandible with fully erect and suberect setae on outer margin; inner masticatory margin with thick, inwardly projecting setae. Clypeus with two long setae projecting outwards over the mandibles set among numerous short setae. Scapes and funicular segments with sub-decumbent setae. Head, mesosoma, petiole and gastral tergites covered with sub-erect setae. Erect setae scattered across the mesosoma dorsum, petiole and gastral tergite among sub-erect setae; erect hairs more abundant on final three gastral tergites. Erect setae projecting posterolaterally on gastral tergites in dorsal view. Setae on gastral sternites less dense with a greater abundance of erect setae. Hypopygium with numerous erect setae anteriorly; posteriorly with short stout setae (too small to count).

Colour
Core body segments light orange, legs and antennae lighter yellow

Etymology
Stigmatomma draconis (*draconis* meaning of the dragon) is named for the superheated steam vents on Kwun Yam Shan mountain, near the collection locality, which is part of an inactive Jurassic volcano system. Local people call these superheated steam vents and resulting smoke like steam '*dragon breath*' (龍息). The phenomenon is particularly apparent when the surface temperatures are cold.

Taxonomic evaluation
Stigmatomma draconis is superficially similar to *Stigmatomma pertinax* (Baroni Urbani, 1978), a species described from Northern India. The holotype specimen of *S. draconis* will key to *S. pertinax* within the key in Xu et al. (2012). Comparing both species, however, reveals clear morphological differences that we think provide adequate evidence to consider it as a separate species. Firstly, the third tooth from the apex is entirely differently shape in *S. draconis*: it is less apically protruding, recurved towards mandible base with a small acute apex (Fig. 7A-B). The preapical tooth is also differently shaped, being shorter, apically blunt and firmly attached to the mandible on its ventral margin (Fig 5C; Fig. 6D; Fig. 7A-B). Moreover, the *S. draconis* holotype has paired teeth, which the holotype of *S. pertinax* lacks (Fig 5C; Fig. 6D; Fig. 7B). It should be noted however that in *S. draconis* the left hand smaller, dorsal tooth in the first tooth pair, is absent, reducing the number of paired teeth on the left-hand mandible to eight. Baroni Urbani (1978) gave the number of mandibular teeth to be seven in the *S. pertinax* holotype. Interestingly, variation is seen in the mandibular teeth characters of other specimens determined to be *S. pertinax* (CASENT0172385 from India (CASENT0172395, CASENT0172385) and Nepal (CASENT0280668). Most variable is the third tooth from the apex, all which recurve towards the mandible base (unlike the holotype) but differ in length and overall size.

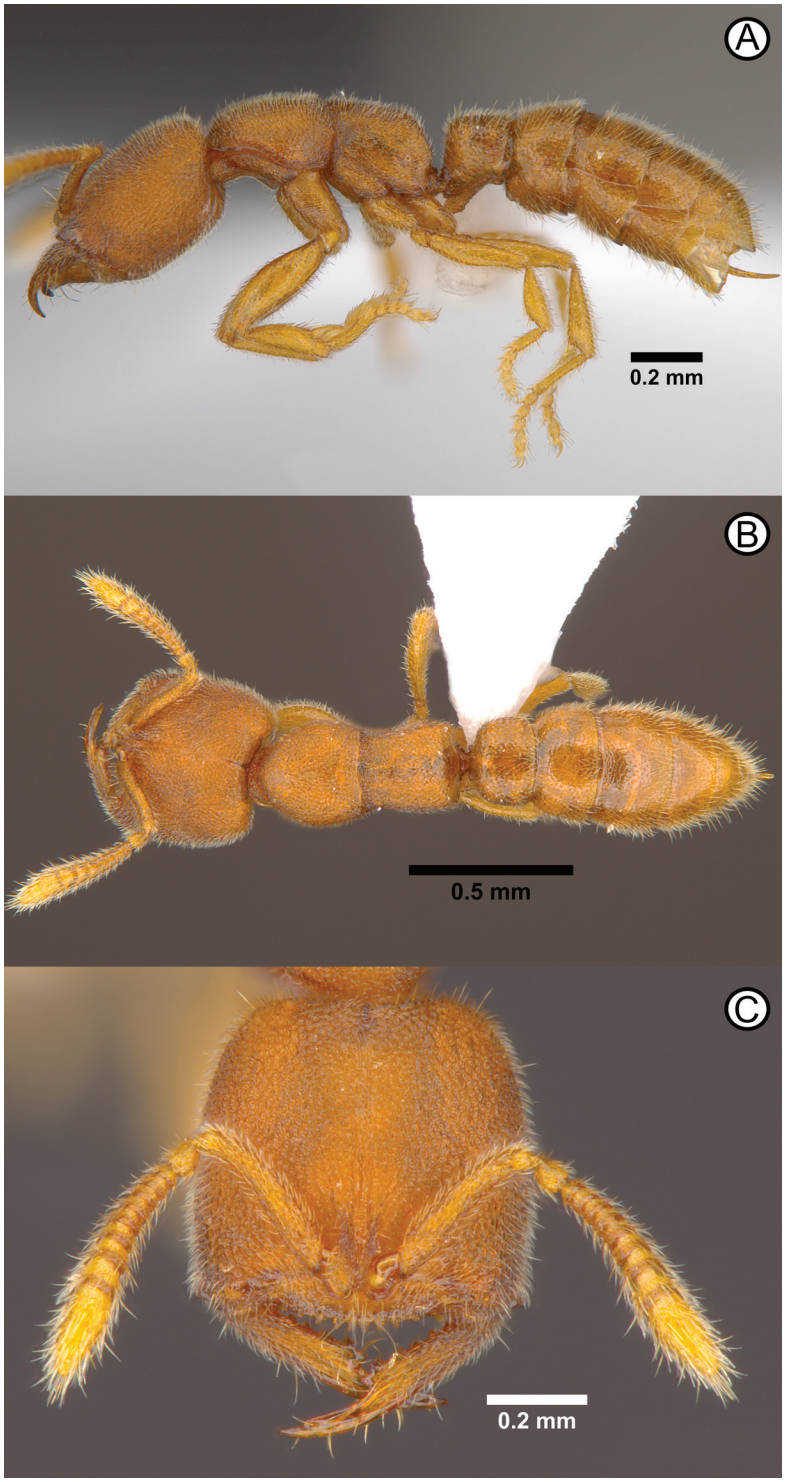

Fig. 5. The holotype specimen of *Stigmatomma draconis* (ANTWEB1010999) A) Lateral view; B) dorsal view; C) full face view.

Additional differing morphological characters between *S. pertinax* and *S. draconis* include a less concave posterior head margin, more sculptured supraclypeal area and a less convex anterior clypeal margin. The anterior clypeal margin is also distinctly less convex than *S. pertinax*, and although, a less reliable character, the number of clypeal denticles is larger in *S. draconis* with a total of ten compared to eight in *S. pertinax*. In full face view it seems like a genal tooth is present in *S. draconis*. However, when seen in posterolateral and ventral view the extension originates from the posterolateral head capsule and is not an anterolateral extension of the gena (Brown 1960). In direct ventral view, minute teeth can also be seen (Fig. 6D). Baroni Urbani (1978) stated that the genal angles in the *S. pertinax* holotype were '*well rounded*' and did not mention posterolateral cuticular extensions or minute ventral teeth. Unfortunately, these characters are not visible in the holotype image (CASENT0906831) but in full face view, such an extension seems absent unlike in *S. draconis*. Finally, both species are originating from two distant regions; the mid-eastern Himalayan foothills for *S. pertinax* and the lowland coastal region of Hong Kong for *S. draconis*.

Biological notes
Stigmatomma draconis was collected via litter and soil sifting within the lowland-montane floristic transition zone (500-550 m) in a secondary forest on the slopes of Tai Mo Shan at 525 m a.s.l. Though not pristine, owing to clear historic anthropogenic disturbance (e.g. tea terraces), the habitat has had a long history of reforestation and lack of human disturbance post-WWII. Here the leaf litter layer is deep, and samples rich in ant diversity (unpublished data). Further sampling at the site, and surrounding site did not reveal additional specimens.

Stigmatomma luyiae Hsu *et al.,* 2017 – **New to continental China and Hong Kong SAR**
(Fig. 2C; Fig. 8A-C)

Stigmatomma luyiae Hsu *et al*., 2017: 83, figs. 1-4, 8B (w.) CHINA (Taiwan). Indomalaya.

Material examined
Worker (n=1); CHINA, HONG KONG SAR, Hong Kong Island, The Peak, 23 February 1994, J.R. Fellowes, HKBM

Measurements
Worker (n=1); HL 0.45; HW_1 0.45; HW_2 0.44 (this value was measured from Fig. 5C); SL 0.25; ML 0.42; WL 0.52 (this value was measured from Fig. 5A); CI 100; SI 55.6; MI 93.3 (GL, and therefore TL, was not collected due to broken gaster).

Remarks
Previously only known from Taiwan, this is the first record for mainland China, and the endemic status to Taiwan is therefore considered obsolete. This species in Hong Kong is known from a single individual which was unfortunately damaged during the imaging process and has been partially destroyed. The head and part of the mesosoma are now preserved in 99% ethanol and is deposited in the Hong Kong Biodiversity Museum. Unfortunately, no dorsal view was obtained. A new set of images of the head were taken with the specimen preserved in ethanol.

Although not continuous, the nearly 30 years of ant research in Hong Kong has included thousands of Winkler extractors and pitfall traps across hundreds of sites and yet this species was has only been collected once and with a single worker. This suggests that this species is potentially very rare and may possess very small colony size. Alternatively, we cannot exclude the possibility of a completely subterranean lifestyle to explain its scarcity in sampling records. Such a hypothesis is supported by the very pale colouration of the specimen, the absence of eyes characteristic of subterranean habits (Wong & Guénard 2017) and last but not least the collection of type specimens in Taiwan from sifted soil (Hsu *et al.* 2017). Further research focusing on soil samples may thus provide useful insights about the ecology and distribution of this species.

Stigmatomma pagei **sp. nov.**
(Fig. 2C; Fig. 9A-C; Fig. 10A-F)

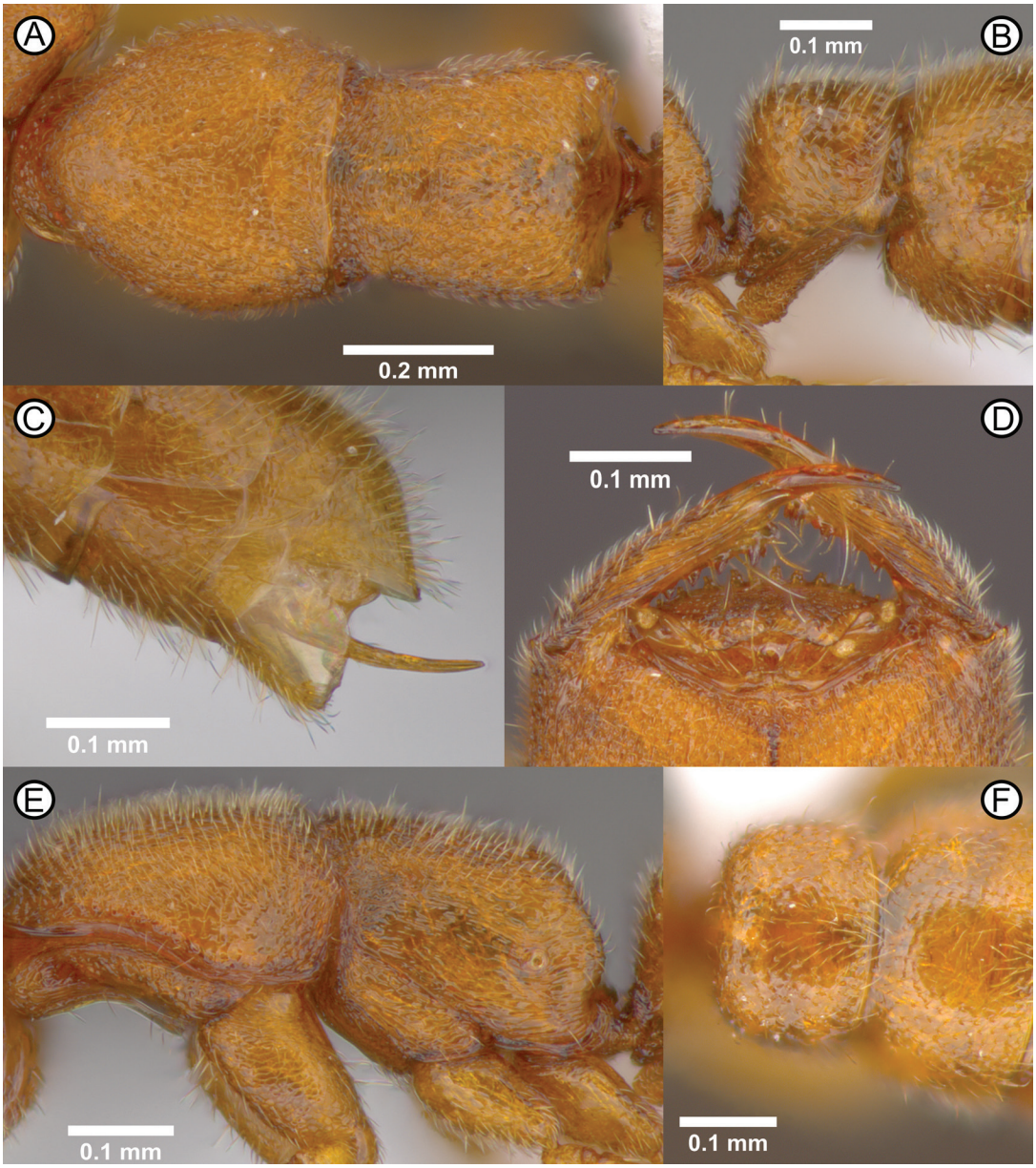

Fig. 6. *Stigmatomma draconis* (ANTWEB1010999) holotype morphological characters. A) mesosoma dorsum; B) petiole in lateral view; C) terminal gastral segments in lateral view; D) head in ventral view, showing minute posterolateral teeth, anterior clypeal denticles and mandibular teeth; E) mesosoma in lateral view; F) petiole dorsum.

Diagnosis

Head longer than broad (CI 87.00). Mandibles shorter than head length (MI 67.19). Clypeus with a total of six clypeal denticles; four-minute rectangular denticles; two conical bilobed denticles. Metanotal groove weakly impressed. Mesepisternum divided into katepisternum and anepisternum. Dorsolateral margin of propodeum marginated; margin begins posterior to mesonotum and extends along the whole propodeum dorsolateral margin including its declivitous face. Metapleuron and anterior area of the lateral surface of the propodeum with long longitudinal striae. In dorsal view, pronotum and propodeum bisected longitudinally by smooth cuticle with scarce punctuation. Metanotal groove weakly impressed.

Type locality; CHINA; Hong Kong SAR, New Territories (Tai Po), Tai Po Kau Headland, 22.43471 114.19264, 74 m, pitfall trap (70% ethanol), 7-day sample time, 18-24 August 2022. Coll. M. T. Hamer & T. S. R. Silva, Determined by M. T. Hamer and Benoit Guénard. Collection code; TPK4SQ4PF3-8; specimen code; ANTWEB1010972, ZRC

Measurements:

Worker (n=1): HL 0.823; HW_1 0.716; HW_2 0.687; SL 0.430; ML 0.553; WL 1.061; PPW 0.374; DPL 0.353; DPW 0.444; GL 1.526; TL 4.32; CI 87.00; SI 60.06; MI 67.19; PtI 125.78.

Head

In full face view, head longer than wide (CI 87). Head margins subparallel, weakly converging posterior to maximum head width. Posterior head margin subtly concave; posterior head corners rounded. Mandibles linear, shorter than head length (MI 67.19). Mandible dentition arrangement from base to apex as follow; one large triangular unpaired tooth; four sets of paired triangular small teeth; blunt preapical tooth; blunt apical tooth. Ventral tooth within pair always larger than dorsal counterpart. Mandible inside margin convex, reaching maximum convexity between second and third pair of teeth. Scapes short (SI 60.05) and thick, as large as the apical part of mandible. On specimen examined, antennomeres damaged and absent; total antennal segment and antennomere count unknown (see comments). Antennal scrobes absent. Anterior clypeal margin broadly convex; margin lined with a total of six reduced clypeal denticles; four-minute rectangular denticles positioned medially, two conical bilobed denticles positioned on each clypeal corners. Clypeus narrowly inserted between frontal lobes. Supraclypeal area concave; expanding laterally behind frontal lobes. Frontoclypeal sulcus acute and weakly impressed. Frontal carina short. Eye absent. Palp formulae unknown (see comments).

Mesosoma

In dorsal view, pronotum broadly rounded anteriorly; median part of mesonotum constricted; widest point of pronotum and propodeum equal in width. Promesonotal suture deeply impressed both dorsally and laterally. Metanotal groove weakly impressed in dorsal view. In lateral view, angle between the dorsoposterior and the declivitous faces of propodeum obtuse; angle not marginated. In lateral view, dorsolateral margin of pronotum gradually curve. Dorsolateral margin of propodeum marginated; margin begins immediately behind mesonotum and extends down propodeal declivitous face. In dorsal view, propodeum trapezoid in shape. Mesepisternum divided into katepisternum and anepisternum. Metathoracic spiracle circular, swollen with cuticle; positioned just ventral of the anterior most point of dorsolateral propodeal margin Propodeal spiracle circular, lacking cuticular swelling. Declivitous face of propodeum flat.

Metasoma

In lateral view, petiole longer than high. Anterior face straight. Anterodorsal angle bluntly curved. Subpetiolar process present; broadly rectangular; anteroventral margin convex; ventral margin straight, posteroventral margin concave; posteroventral angle a blunt right angle. Subpetiolar fenestration absent. In dorsal view, petiolar dorsum as long as wide. Prora present. First three gastral tergites of similar length.

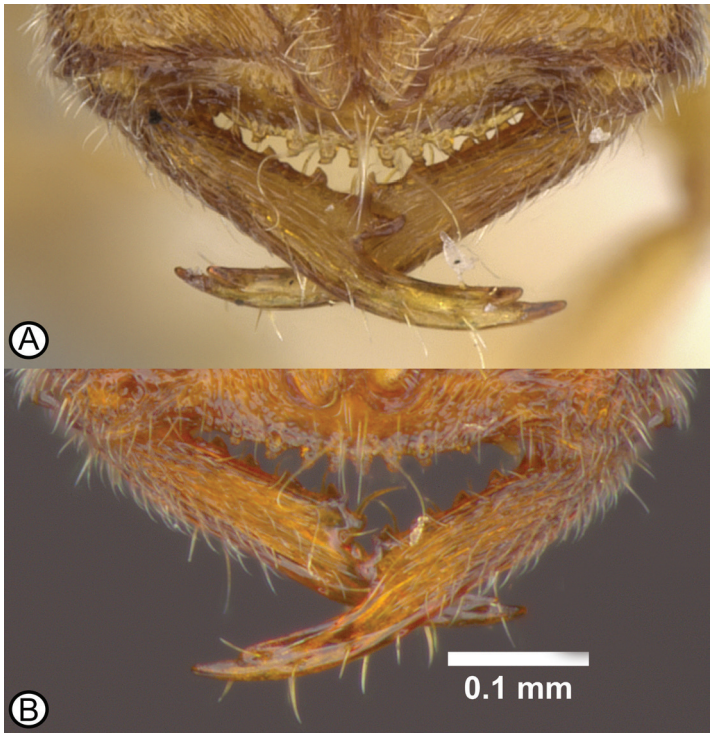

Fig. 7. Mandibular and anterior head caparison between *Stigmatomma pertinax* holotype and S. draconis. A) *Stigmatomma pertinax* (CASENT0906831); B) *Stigmatomma draconis* (ANTWEB1010999).

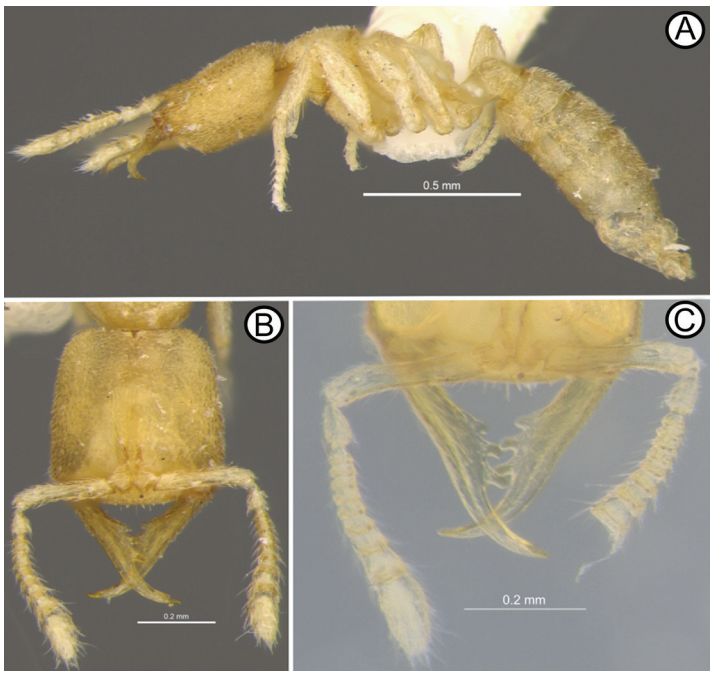

Fig. 8. *Stigmatomma luyiae* A) profile view B) head view C) closeup of mandibles.

Sculpture
Mandibular dorsum longitudinally costate. Clypeus anteriorly smooth; posteriorly and between frontal lobes longitudinally striate. Supraclypeal area smooth. Head dorsum areolate-rugose, posterior corners smoother with scarce areolae. Pronotum, mesonotum and propodeum dorsum densely punctuate on lateral margins; pronotum and propodeum bisected longitudinally by smooth cuticle with scarce punctuation. Mesonotum medially punctuate. Pronotal lateral area punctuate; posteriorly with short, dense longitudinal striae. Katepisternum striate; anepisternum mostly smooth (see comments). Propodeal dorsum smooth; scarcely punctuate laterally. Declivitous surface of propodeum smooth. Metapleuron and anterior area of the lateral surface of the propodeum with long longitudinal striae; beginning at katepisternum, extending to propodeal postero-lateral margin, not extending onto declivitous surface; striae absent immediately below dorsolateral margin, surface smooth and shiny instead. Dorsum of petiole punctuate, punctuation dense on dorsolateral margin. Lateral surface of petiole smooth with scarce punctuation on margins. Gastral tergites one and two with confused punctuation; subsequent tergites smoother. Sternites with similar sculptural patterning. Hypopygium anteriorly imbricate; posteriorly smooth other than setal punctuation.

Setae
Dorsal surface of mandible with decumbent simple setae; inner margin with long inward directed, stout, decumbent setae; immediate ventral margin of masticatory margin with inward directing long, stout, spatulate setae. Anterior clypeal margin with a pair of long, thin setae extending in front of mandibles. Scape with appressed short setae; occasional erect setae of same length also present. Cephalic dorsal and ventral surfaces with short sub-decumbent and suberect setae; setae dense on posterior head margin. Mesosoma dorsum with short sub-decumbent and suberect setae across all segments; setae dense laterally. Petiole dorsum with short sub-decumbent and suberect setae; laterally with fewer setae. Subpetiolar process mostly glabrous; few setae on posterior margin. Dorsum of tergites with short sub-decumbent to erect setae across all segments; third to fifth tergite segments with longer setae and larger glabrous areas. Sternites with short sub-decumbent to erect setae across all segments; erect setae longer than those on tergites. Hypopygium with long, erect and sub-erect setae; presence of stout, spiniform setae posteriorly uncertain (see comments).

Colour
Head dark brown, mesosoma lighter brown. Metasoma and legs amber, contrasting with the later darker metasomal segments.

Etymology
Stigmatomma pagei is named after the guitarist of the rock band *Led Zeppelin* and acclaimed guitar hero, James Patrick Page, known as Jimmy Page. While Jimmy Page wanted to become a biologist as a child but turned into music instead, there is no doubt that he has inspired generations of biologists, including the authors of this work.

Taxonomic evaluation
Within Hong Kong, *S. pagei* is most morphologically similar to *S. amblyops* and, assuming the presence 12 segments to the antennae, would key to this species in Xu & Chu (2012). However, numerous morphological characters differentiate both species. Firstly, the different mandible tooth composition with each tooth pair being closer together in *S. pagei* but more evenly spaced along the masticatory margin in *S. amblyops* (Fig 3A; Fig. 9C; Fig. 10C). The mandible is also distinctly convex medially (between first and final tooth pair) within *S. pagei* but conspicuously more linear in *S. amblyops* (Fig 3A; Fig. 9C; Fig. 10C). The lack of a marginated dorsolateral propodeal margin and metanotal groove in *S. amblyops* differs with *S. pagei* (Fig. 10A; Fig. 10E). *Stigmatomma amblyops* has a conspicuous genal tooth which is inconspicuous in *S. pagei* (Fig. 3A; Fig. 9C; Fig. 10D). Moreover, the median clypeal denticles are longer and distinctly extending beyond the anterior clypeal margin in *S. amblyops*, while the median clypeal denticles hardly projecting forward at all in *S. pagei* (Fig. 3A; Fig. 9C; Fig. 10C). No other species resembles *S. pagei* in continental Asia and eastern Asian islands. A single specimen from Borneo (CASENT0280663; bmnh-f) on AntWeb does show close morphological similarities with *S. pagei*, including marginated dorsolateral propodeal margin and a distinctly striate propodeal lateral

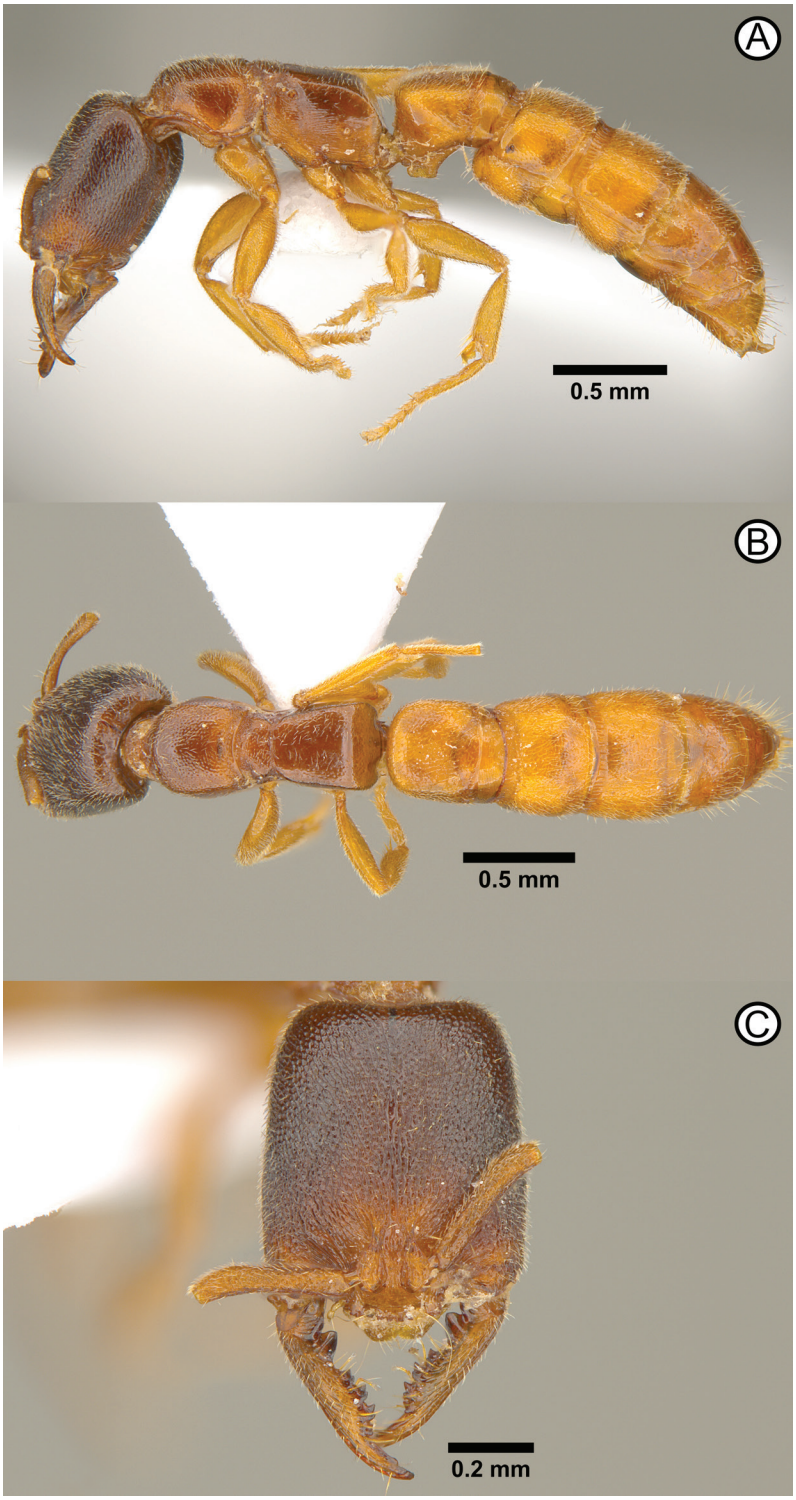

Fig. 9. The holotype specimen of *Stigmatomma pagei* (ANTWEB1010972) A). Lateral view; B) dorsal view; C) full face view.

surface. Both differ in terms of sculpturing and setae density, however, this is particularly obvious on the mesosomal dorsum, as well as the degree to which the posterior head margin in full face is concave. Other characters such as the anterior clypeal denticle characters and mandibular dentition are difficult to differentiate in bmnh-f due to mandible and head positioning.

Unfortunately, the holotype specimen of *S. pagei* was damaged upon collection. The specimen has lost all funicular segments on both antennae and the majority of palp segments (Fig. 9C). The left-hand mandible has also become dissociated at the point of articulation with the head (Fig. 9C). It is likely the specimen acquired this damage during its time in the collection liquid (70% ethanol). Due the long sampling period (7 days), water evidently entered the pitfall and diluted the ethanol, contributing to specimen decomposition. Here and within the key, we assume the funicular segment count is twelve due to the close resemblance to *S. amblyops* and bmnh-f, as well as it's dissimilarity to eleven antennal segmented species within the former *Bannapone* genus (Guénard et al., 2013; Liu et al., 2017). The palps are also highly damaged, rending segment counting impossible. Moreover, the accumulation of organic matter within and between segments as well as between striae obscured the true sculpture of the anepisternum, the posterior sculpture of the pronotal lateral area and the posterior setae on the hypopygium.

Biological notes

The type locality of *S. pagei*, Tai Po Kau Headland, is unique as it is a typical lowland coastal woodland of exceeding quality which is now absent in Hong Kong. The headland, now a Site of Special Conservation Interest, owes its quality to a remnant pre-war Feng Shui relict woodland, post-World War II reforestation, and 60 years with little human disturbance (Kendrick & Barretto 2006). *Stigmatomma pagei* was collected within what is thought to be this remnant woodland site. Whether *S. pagei* is relic of lowland forests in Hong Kong pre-deforestation is unknown, however sampling from higher elevation secondary and other forests habitats in Hong Kong has thus far failed to reveal additional specimens. Moreover, Tai Po Kau Headland has produced numerous new species as well as rare genera and species in Hong Kong.

***Stigmatomma* nr. *quadratum* (*S. reclinatum* group)** – (Fig. 2D; Fig. 11A-F; Fig. 12A; Fig. 14A; Fig. 15A-I)

Material examined

Workers (n=19); CHINA, Hong Kong SAR, Tai Tam, Tai Tam Tuk, 22.241291, 114.223785, 5m, 01 March 2017, M. Pierce, Winkler [ANTWEB1009567], IBBL • CHINA, Hong Kong SAR, Wang Tau Hom, Morse Park, 22.33883, 114.1916, 56m, 26 July 2021, M. T. Hamer, Winkler, [MP1T1W4-3[ANTWEB1010863]], IBBL • CHINA, Hong Kong SAR, Wang Tau Hom, Morse Park, 22.33883, 114.1915, 52m, 26 July 2021, M. T. Hamer, Winkler, [MP1T1W5-5[ANTWEB1010864]], IBBL • CHINA, Hong Kong SAR, Lok Fu, Lok Fu Recreation Ground, 22.33612, 114.18763, 48m, 05 July 2021, A. Ibáñez & M. T. Hamer, Winkler, [LFR1T2W1-6[ANTWEB1010865]], IBBL • CHINA, Hong Kong SAR, Lok Fu, Lion Rock Park, 22.34624, 114.1832, 123m, 25 August 2021, A. Ibáñez, Winkler, [LR1T1W1-6[ANTWEB1010866]], IBBL • CHINA, Hong Kong SAR, Hong Kong Island, Lung Fu Shan Country Park, 22.28258, 114.13401, 115m, 29 October 2014, B. Guénard, Hand collection, [ANTC37080[CASENT0914940, CASENT0195916, CASENT0195917]], CAS • CHINA, Hong Kong SAR, Mid-Levels, Caine Road Garden, 22.282811, 114.148435, 79m, 30 October 2021, M. Taylor, Hand collection [ANTWEB1010861], IBBL • CHINA, Hong Kong SAR, Aberdeen Lower Reservoir, 22.2545, 114.1612, 101m +/-10m, 14 October 2020, F. Brassard, Hand collection [ANTWEB1010862], IBBL • CHINA, Hong Kong SAR, Aberdeen Country Park, 22.2534663, 114.1585721 91m +/10m 19 January 2022, M. T. Hamer, Hand collection [MTHGC18-1# [ANTWEB1010954]], IBBL • CHINA, Hong Kong SAR, Aberdeen Country Park, 22.2534663, 114.1585721 91m +/10m 19 January 2022, M. T. Hamer, Hand collection [MTHGC18-#2[ANTWEB1010955]], ZRC • CHINA, Hong Kong SAR, Pok Fu Lam Country Park, 22.26316, 114.14000, 240m, 07 April 2022, M. T. Hamer & A. Ibáñez, Winkler [PFL1T1W5-1], IBBL • CHINA, Hong Kong SAR Pok Fu Lam Country Park, 22.26316, 114.14000, 240m, 07 April 2022, M. T. Hamer , hand collection of colony [MTHGC30[ANTWEB1010959-65]],

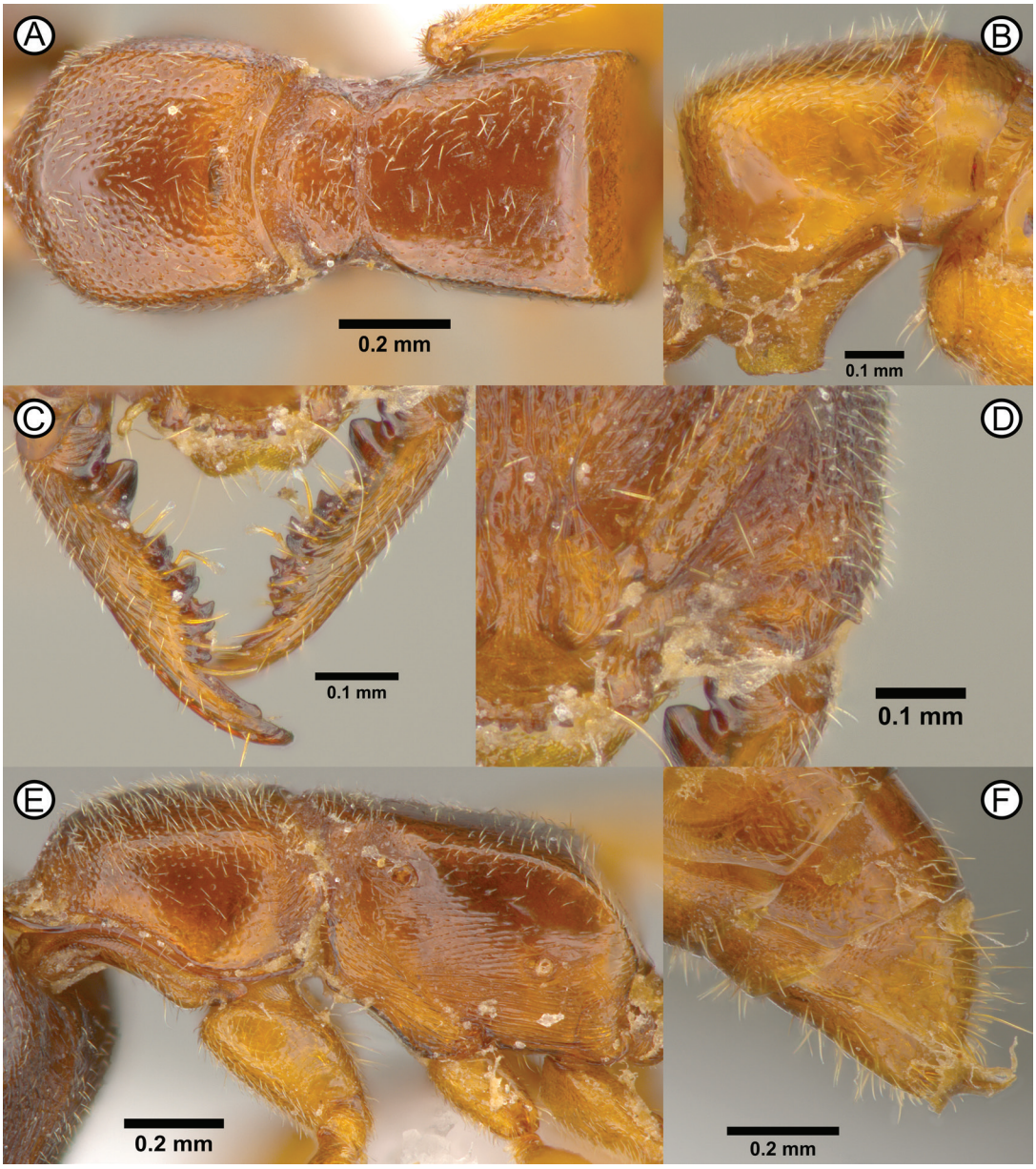

Fig. 10. *Stigmatomma pagei* (ANTWEB1010972) holotype morphological characters. A) mesosoma dorsum; B) petiole in lateral view; C) anterior clypeal margin and mandibles; D) minute genal teeth and anterior head region; E) mesosoma in lateral view; F) terminal gastral segments in lateral view.

IBBL • CHINA, Hong Kong SAR, South Stanley, 22.20727, 114.21561, 187m, 12 April 2022, M. T. Hamer & T. S. R. Silva [SS1T1W3-1], IBBL • CHINA, Hong Kong SAR, Lung Fu Shan 22.27483, 114.13167, 222m, 31.x.2015 T. Tsang, Winkler, [TT01331[ANTWEB1010956], IBBL

Males (n=3): CHINA, Hong Kong SAR, Ocean Park, 22.244611, 114.175859, 58m, 28-05 August-September 2021, Malaise, M. T. Hamer [OPM1-2[ANTWEB1010866]], IBBL • CHINA, Hong Kong SAR, Ocean Park, 22.23792, 114.1723, 114m, 28 October 2021, Light trap, M. T. Hamer [OP3LT1-1], IBBL • CHINA, Hong Kong SAR, Lok Fu Recreation Ground, 22.33632, 114.18745, 39m, 05-12 July 2021, Malaise, A. Ibáñez & M. T. Hamer [LFR1M1-2[ANTWEB1010867]], IBBL.

An additional six records of the *Stigmatomma* nr. *quadratum* group were found on iNaturalist (Table S2.). Reliable identification was possible due to the large and unique morphology of this species relative to other Amblyoponinae species known in Hong Kong. Higher quality photographs also enabled accurate identification.

Measurements

Workers (n=12): HL 1.63-1.87; HW_1 1.56-1.8; HW_2 1.46-1.72; SL 0.96-1.17; ML 1.36-1.56; EL 0.2-0.25; WL 2.3-2.65; PPW 0.78-0.98; DPW 0.82-1.09; DPL 0.72-0.93; GL 2.46-3.69; TL 8.66-10.37; CI 94.46-99.65; MI 80.61-84.77; SI 60.59-65.74; PI 76.63-103.51

Males (n=3); HL 1.57-1.64; HW_1 1.64-1.75; HW_2 1.05-1.17; SL 0.43-0.45; ML 0.81-0.85; EL 0.78-0.85; WL 2.67-2.98; PPW 1.00-1.17; DPW 0.62-0.69; DPL 0.59-0.71; GL 2.57-2.99; TL 8.58-8.77; CI 104.49-106.48; MI 51.33-52.07; SI 25.96-26.44; PI 97.48-106.17

Remarks

Taxonomic evaluation

The *Stigmatomma reclinatum* species group is characterized by a rectangular to subquadrate head, a straight to convex clypeal margin lined with small, rectangular or trapezoid shaped cuticular denticles, long linear mandibles lined with a double row of teeth, and an overall comparatively large size relative to other members of the genus (Brown 1960). Previous determination efforts of specimens from the *reclinatum* group from the Pearl River Delta by our lab using the key of Xu and Chu (2012), as well as historically by Wheeler (based on material from Macau) resulted in identification as *S. rothneyi* (Brown 1960). However, the use of morphological characters with poor reliability, (see below), within previous literature has led to numerous character misinterpretations and subsequently unsatisfactory determinations.

Interpretation of Principal Component Analysis

Here, using morphometric analysis of linear measurements, morphometric indices and the examination of morphological characters, we suggest that the *reclinatum* group specimens from Hong Kong and likely Macau, Vietnam and Singapore are closely related to *Stigmatomma quadratum*, a species described from Southwestern Vietnam (Gulf of Siam) (Karavaiev, 1935). The majority of measurements contribute predominantly to the first principal component (PC1) (Table S5). Eye length however contributes more to PC2. Principal component 1 likely represents specimen size, with PC2 representing eye length. *Stigmatomma reclinatum* specimens are distinctly larger than other specimens, particularly compared to *S. crenatum* and *S. feae* Emery, 1895 (Fig. 13A-B). Both of which are comparatively small, with smaller eyes and likely represent a group to themselves, being substantially different morphologically and morphometrically to the core *reclinatum* group species examined. Type specimens of *S. rothneyi*, *S. belli* and *S. quadratum* cluster within the same vicinity in ordination space, suggesting all species are similarly sized but differ in eye length (Fig. 13A-B). Interestingly, the type specimen of *S. reclinatum* (Java) is smaller than specimens collected in Singapore (Fig. 13A-B). Misidentification is doubtful here, with specimens from Singapore sharing all morphological characters with the *S. reclinatum* type description and specimen. This discrepancy could be attributed to size variation within the species or the use of software to measure specimens which are dependent on picture angle and correct scale bars.

Eye size and eye ommatidia count, in combination with other characters, have previously been used to separate *Stigmatomma* species (Xu 2001; Xu 2006; Xu & Chu 2012). Ommatidia counts are not included here due to the use of image-based inspection of type specimens, where image resolution is not adequate to count individual ommatidia. However, eye length, when plotted against the first principal component, separates many species well (Fig. 13B). *Stigmatomma quadratum* and *reclinatum* group specimens collected in Hong Kong, Macau, Singapore and Vietnam fall into the same morphological space, as do *S. crenatum* and *S. feae* to the left of the graph. However, eye size could be allometrically variable, as is potentially seen within the *reclinatum* group specimens due to the relatively large variation in the eye length axis (Fig. 13B) (Brown 1960). More sampling within each species is certainly required to fully elucidate this variation.

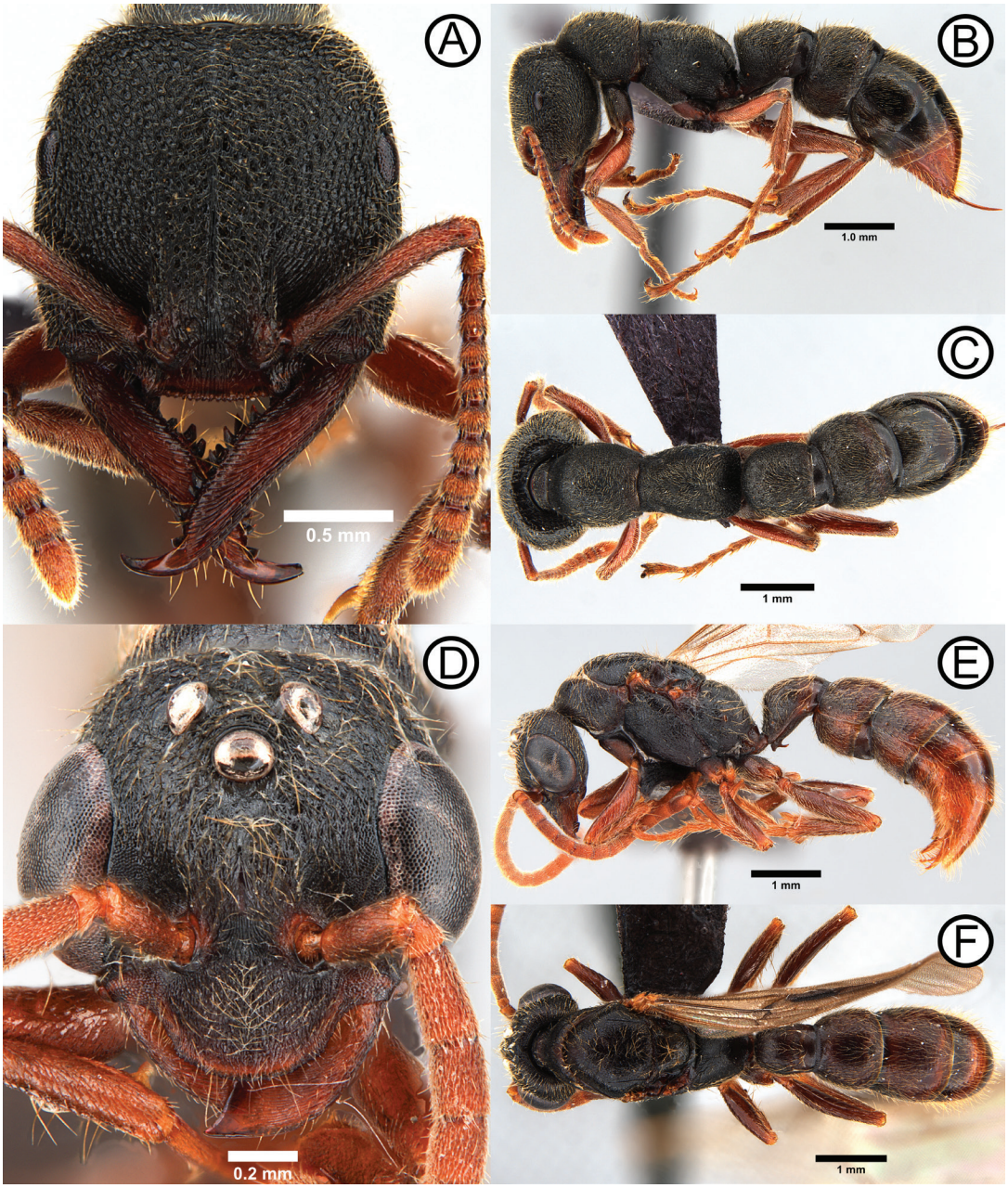

Fig. 11. *Stigmatomma* nr. *quadratum* group worker (ANTWEB1010866): A) head view B) dorsal view C) lateral view, and male (ANTWEB1009609): D) head view E) dorsal view F) lateral view.

Morphological characters

In addition to shared ordination placement and eye length, *Stigmatomma quadratum* and *S.* nr. *quadratum* specimens from Hong Kong share a rectangular, apically truncated genal tooth and a subquadrate head (CI; 95.62 in *S. quadratum*, CI; 94.46-99.65 in Hong Kong specimens). Comparison of *S. quadratum* type specimen images with specimens collected in Hong Kong reveals several characters that differ. The head is clearly bisected in Hong Kong specimens by a long longitudinal carina between and immediately posterior to the frontal lobes, terminating at or slightly before the occiput (Fig. 11A; Fig. 12A; Fig. 14G-I). Accord-

ing to Karaviev (1935) *Stigmatomma quadratum* also shows this character, '*from the posterior edge of the clypeus (the frontal area is not distinguishable) there is a median line, which becomes progressively finer, but nevertheless extends almost to the occipital edge'*. Examining the holotype image shows that the strip is significantly diffused, poorly defined, and overlain medially by costulate-reticulate integument (Fig. 12B). Within Hong Kong specimens, the strip is less diffused and considerably more prominent, and only overlain by integument anterior to the occiput, often 'reappearing' at the occiput itself (Fig. 11A; Fig. 12A; Fig. 15G-I). Variation in the prominence and degree of overlain integument is observed however within Hong Kong specimens (Fig. 15G-I). Whether this variation would encompass the degree of diffusion seen in the *S. quadratum* holotype is unknown due to the lack of *S. quadratum* material available.

Another head character is the integument sculpturing either side of the longitudinal strip. In Hong Kong specimens, this region of the head is scattered with deep foveate pits, each varying in size and surrounded by embossed costae, extending directly posterior from the frontal lobes to just anterior of the occiput (Fig. 11A; Fig. 12A; Fig. 15G-I). This region differs in *S. quadratum*, apparently lacking deep foveate pits, replaced instead with impressed areolate regions bordered by feeble costae. Karaviev (1935) does not mention all the above characters but specified the '*Head with dense hair-bearing points and between them extremely fine longitudinal stripes'*, distinctly different to those observed in Hong Kong specimens. Brown (1960) stated specimens from Macau (that are highly likely to be the same species as the specimens examined in this study) represent a different species. However, additional characters are required to help differentiate the morphological relatedness between *S. quadratum* (a species Brown did not state he examined) and specimens collected in Hong Kong. Such characters are presently out of reach, either due to photo resolution or they are completely obscured. For example, Brown (1960) examined palp counts of specimens collected in Macau, finding five segments on the maxillary palps and three on the labial, different to those in the *S. bellii* type (4, 3). One dissected worker specimen collected in Hong Kong also had a palp arrangement of 5, 3. Unfortunately, Karavaiev (1935) never stated palp number for *S. quadratum*. This character is certainly worth investigating, if visible in the holotype, and may provide useful information for further species delimitation across the *reclinatum* group. Another character worth investigation is the presence or absence, as well as its shape (when present) of the genal tooth. There are clear differences between holotype specimens (Figure 14A-F), and we found next to no variation for this character within *reclinatum* group specimens from Hong Kong and *S. reclinatum* specimens from Singapore. Furthermore, the dorsum of the mesosoma and petiole are scattered with deep foveate pits, similar to those found in the frontal region of the head in Hong Kong specimens but are significantly more widely spaced and more readily found on the dorsum of the propodeum and petiole. Karavaiev, in the description of *S. quadratum*, stated *'Mesothorax and the sides of the epinotum finely dotted lengthwise, above and on the sloping surface of the latter, with coarser hair-bearing dots, the sides of the epinotum beyond the spiraal also with sparse large dots'*. The description of '*coarser hair bearing dots*' and '*sparse large dots*' are similar to those observed in specimens collected in Hong Kong. Whether these dots (i.e. foveae) are of an equivalent depth is impossible to discern due to obscuring hairs and poor image resolution.

Several characters used by previous authors (Xu 2001; Xu 2006; Xu & Chu 2012) are found to be considerably more variable than initially anticipated while examining multiple nest series of the *reclinatum* group specimens from Hong Kong. Firstly, we find a high degree of variability of clypeal denticle number, a frequently used character to dichotomous keys. Specimens collected in Hong Kong had 9-20 denticles, while those collected in Macau (16-19 denticles). One specimen (ANTWEB1009567, Fig. 15A) from Hong Kong lacks denticles on half of the clypeal margin, suggesting either a growth defect or clypeal denticles can easily become worn down or broken (Fig. 15A-C). We also found a remarkable variation in subpetiolar process shape across multiple specimens (Fig. 15D-F). In one colony sample (ANTWEB1010959-65) of 12 workers, the subpetiolar processes varied in anterior dorsoventral width, emargination depth, and angle of the posterior projecting denticle. Subpetiolar process

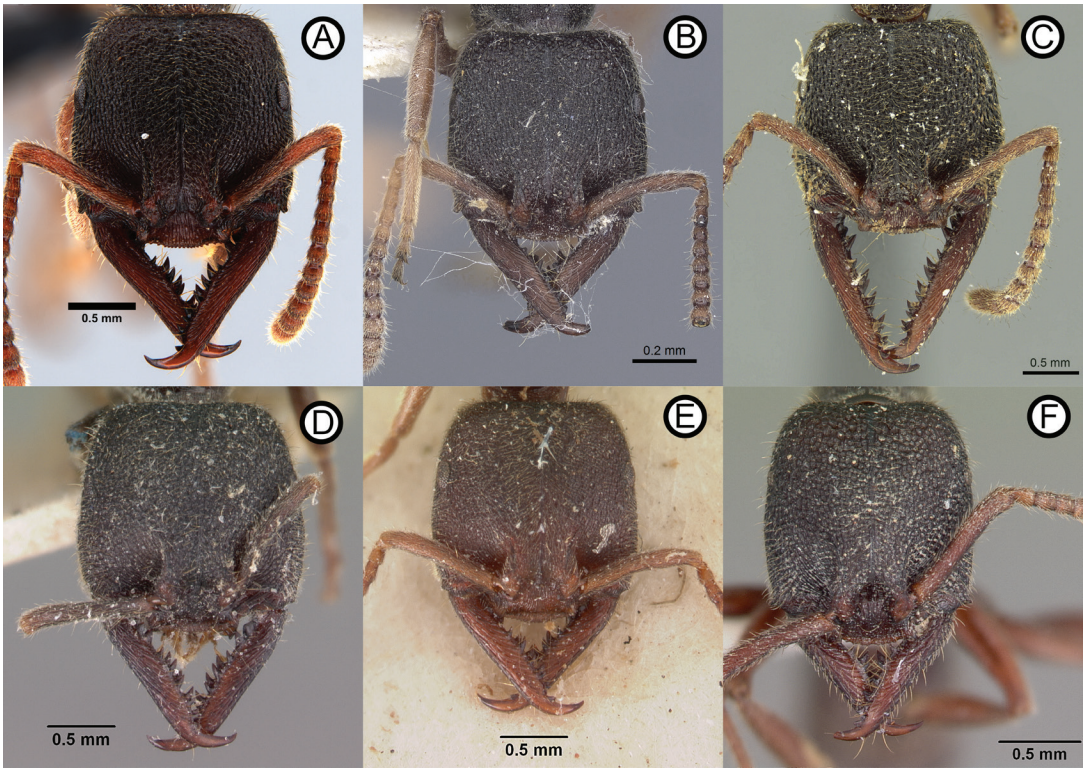

Fig. 12. Head comparison of *Stigmatomma* nr. *quadratum* group specimen collected in Hong Kong (A; ANTWEB1010961) to the holotypes of *Stigmatomma quadratum* (B; CASENT0916797, Flavia Esteves*), S. reclinatum* (C; CASENT0915649, Harald Bruckner), *S. belli* (D; CASENT0102510, April Nobile), *S. rothneyi* (E; CASENT0102517, April Nobile) and *S. crenatum* (D; CASENT0104983, April Nobile). *Stigmatomma feae* holotype (CASENT0102126) not included here. Pictures available from www.antweb.org.

denticles were also broken in several specimens (e.g. Fig. 15D). The high intraspecific variability within two commonly used characters for delimitation and identification of *Stigmatomma* species throws into question the utility of both characters, at least within this member of the *reclinatum* group. Whether such variability is also observed in other members is yet to be fully examined due to lack of material. Once all mentioned characters are fully evaluated, and unreliable characters discarded, the combination of stable characters will likely prove reliable in differentiating species within the *reclinatum* group.

Biogeography of the *reclinatum* group in Southeast Asia and identity of *S. rothneyi* specimens from the Pearl River Delta

Numerous unidentified and undescribed members of the *S. reclinatum* group can be found on AntWeb. Specimens include but are not be limited to; *Stigmatomma* sp. bmnh-a (Borneo [CASENT0280657]), bmnh-b (Sulawesi [CASENT0280659]), in02 (Myanmar [CASENT0172384]), mhng08 (Malaysia [CASENT0102488]), my01 (Borneo [CASENT0102477]) and th03 (Thailand [CASENT0156065]). Misidentified specimens can also be found, such as the specimens CASENT0102186 and CASENT0102478 that were previously determined to be *S. rothneyi*, which are erroneous when compared to type description and images of *S. rothneyi*. Differing characters include alternative eye lengths (and likely ommatidia counts), presence of genal teeth and a head that is evidently longer than wide. The *S. reclinatum* group is widely distributed across the whole Indochinese biogeographic realm (Fig. S1) and a full revision of this group across its range would represent a welcome addition.

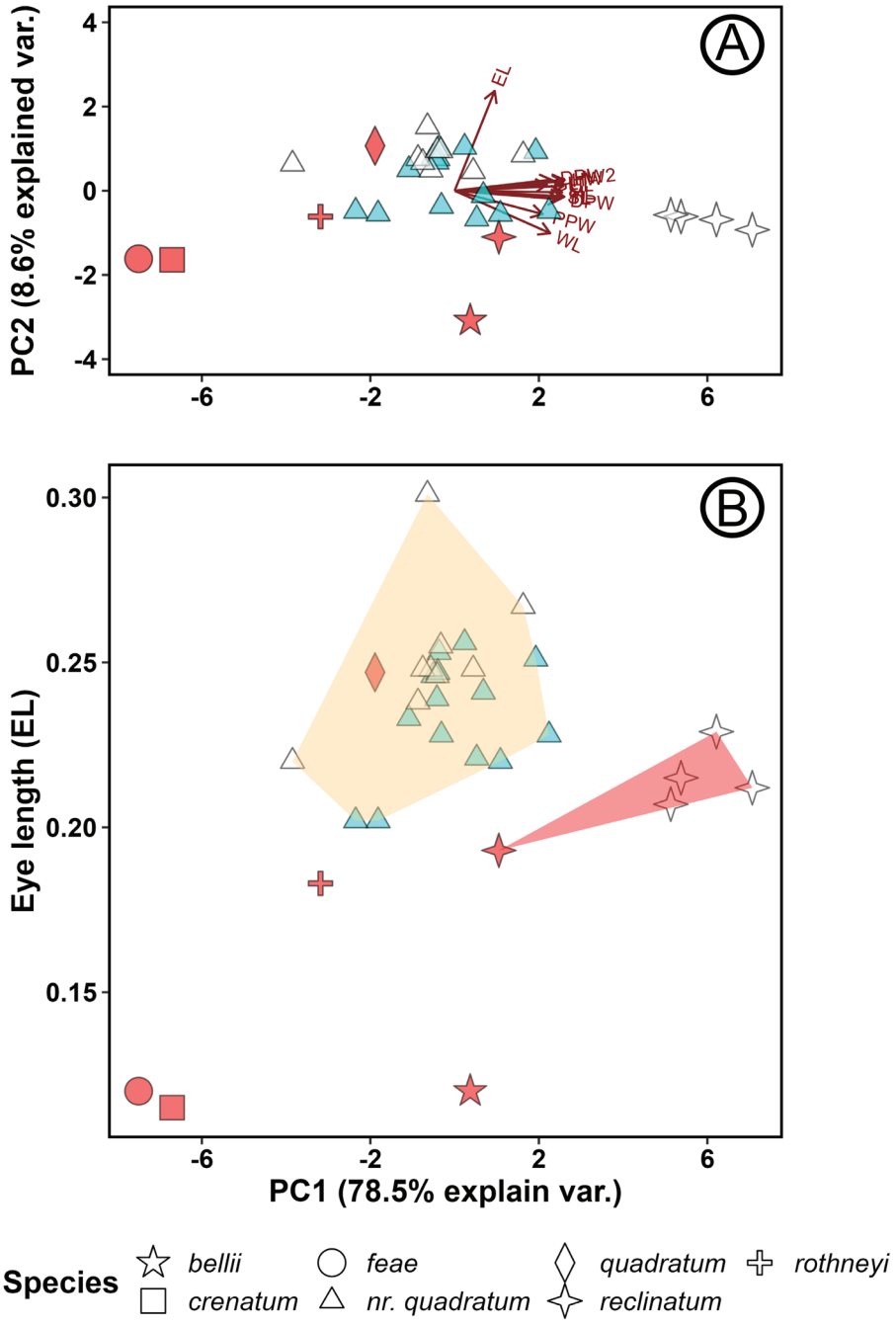

Fig. 13. Principal component analysis (A) and the first Principal Component (PC1) in function of Eye Length (EL) (B). Light blue points represent *nr. quadratum* specimens collected in Hong Kong, unshaded stars represent morphologically similar specimens to those collected in Hong Kong from Macau, Vietnam, and Singapore. Red shaded points represent type specimens measured using imageJ via Antweb images.

The inability to accurately and confidently determine the Hong Kong specimens using the most up-to-date key to Asian *Stigmatomma*, alongside the potential unique morphological characters we observe suggests that the Hong Kong and Macau specimens might represent a new species. However, considering the complexity of the group, lack of material (including holotypes and paratypes) of other members of the group from other surrounding regions, the amount of undescribed material present in Southeast Asia and the previous use of an apparently morphological variable character in the literature, we refrain from describing it here. Instead, we apply the name *Stigmatomma* nr. *quadratum* until further work is carried out. We apply this name to specimens from Hong Kong and Macau only. Due to the clear geographic distances between localities, and the potential for an incomplete sampling. We suggest the status of specimens from Singapore and Vietnam should remain as unidentified. Such specimens should be reexamined in the context of their own *Stigmatomma* fauna whilst incorporating the findings of this study. Whether those specimens are deemed to be closer to *S.* nr *quadratum*, rather than *S. quadratum* itself, is up to future investigators. We do suggest that CASENT0914940 is not *S. rothneyi* and previous mentions of this species from Hong Kong and Macau should be considered as erroneous. Mentions of *S. rothneyi* from Guangdong province, a species originally described from West Bengal, India, may also be erroneous. Future revision work, ideally with thorough morphological, molecular phylogenetic analysis and potentially the use of males (not fully examined in detail here due to lack of comparative material), as suggested by Brown (1960), is required to resolve the species limits of the *S. reclinatum* group within the Indochinese realm.

Biological notes

Unlike most members of the *Stigmatomma* genus in Hong Kong, workers of *S.* nr. *quadratum* group are large and relatively common. Individuals have been collected from under stones, in soil (M. T. Hamer pers. obs.), under wood (B. Guénard pers. obs.) and can be aggressive (M. T. Hamer pers. obs.). Multiple specimens have also been obtained through leaf litter extraction. Workers were also observed moving along trails in the open carrying larvae during the daytime (see Electronic Supplementary Material). Whether this was to position larvae on prey or to move nesting location remains uncertain. Tentative records have also been made by the public via iNaturalist (Table S2), suggesting to a greater degree that this species is common and readily encountered unlike other members of this genus. Individuals are also collected in urban environments (e.g. urban parks), on the edges of natural areas (country parks) as well as from within country parks themselves. It remains undetermined whether this group as a whole is truly epigaeic (Brown 1960), but observations in Hong Kong suggest it is certainly encountered away from hypogaeic and leaf litter habitats.

Stigmatomma zwaluwenburgi Williams, 1946 – **new to Eurasia, China and Hong Kong SAR**
(Fig. 2C; Fig. 16A-C; Fig. 17C)

Stigmatomma (Fulakora) zwaluwenburgi Williams, 1946: 639 (w.) HAWAII. Oceania.

Material examined

Workers (n=2); CHINA, Hong Kong SAR, Tsim Sha Tsui, Signal Hill Gardens, 22.2962 114.1741, 35m, 17 August 2021, M. T. Hamer, Winkler, [SHG1T1W3-1#1 [ANTWEB1010859]], ZRC • CHINA, Hong Kong SAR, Tsim Sha Tsui, Signal Hill Gardens, 22.2962 114.1741, 35m, 17 August 2021, M. T. Hamer, Winkler, [SHG1T1W3-1#2 [ANTWEB1010860]], IBBL.

Measurements

Workers (n=2); HL 0.38-0.39; HW_1 0.39-0.39; HW_2 0.37-0.38; SL 0.19-0.2; ML 0.29-0.29; WL 0.51-0.53; PPW 0.19-0.21; DPW 0.21-0.21; DPL 0.14-0.14; GL 0.54-0.56; TL 1.88-1.94; CI 101.56-102.3; MI 75-77.99; SI 51-51.15; PI 149.31-150.34

Remarks

Taxonomic evaluation

Stigmatomma zwaluwenburgi presents a taxonomic and biogeographic challenge. On examination of available literature records, published images and new material, we found irregularities in the morphology of the species. In the original description, Williams (1946) describes the holotype and paratype as having '*5 rather blunt denticles*' on the clypeus. In the figure of the type specimen from his manuscript, he represents the antennae

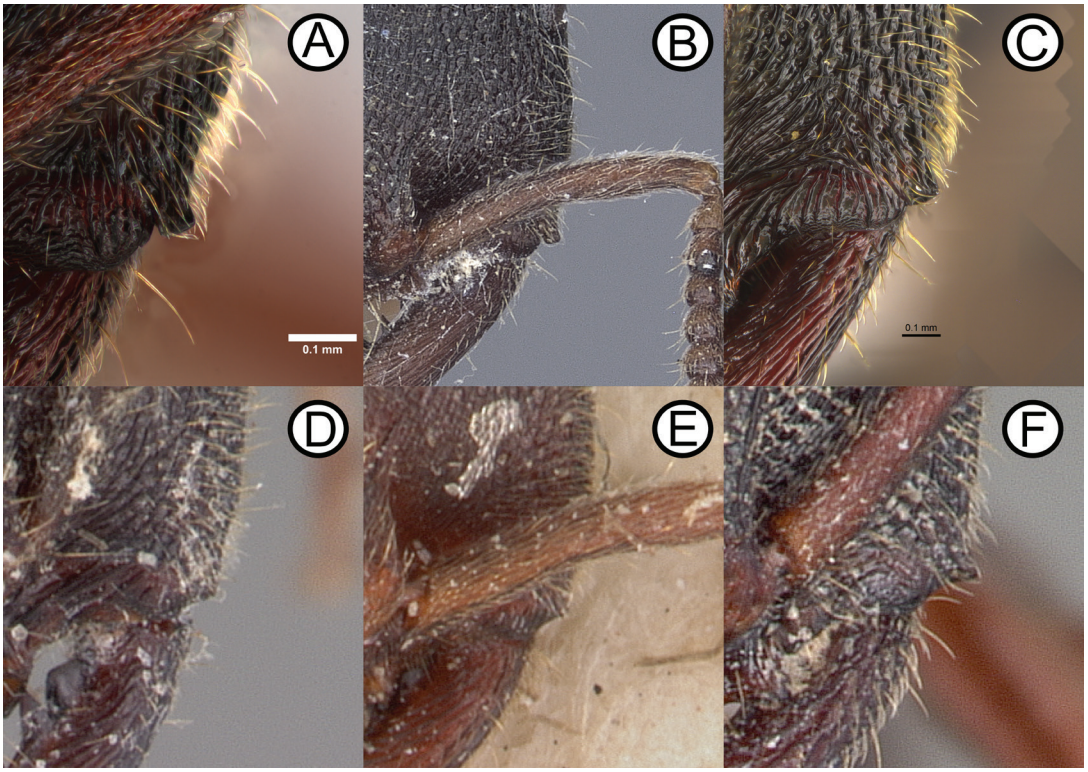

Fig. 14. Genal tooth shapes, in full face view, across species within the *Stigmatomma reclinatum* group. *Stigmatomma* nr. *quadratum* (A; ANTWEB1010866), *Stigmatomma quadratum* (B; CASENT0916797, Flavia Esteves), *S. reclinatum* (C; ZRC_HYM_571.1), *S. bellii* (D; CASENT0102510, April Nobile), *S. rothneyi* (E; CASENT0102517, April Nobile) and *S. crenatum* (D; CASENT0104983, April Nobile). *Stigmatomma feae* holotype (CASENT0102126) not included here. Pictures available from www.antweb.org.

as having 12 segments (Fig. 16B), though he does not explicitly state the number of segments in the text. He describes the mandibles as "bearing five simple teeth" on the thickened basal portion, in addition to the apical and pre-apical teeth. Conversely, in the redescription of *S. zwaluwenburgi* by Onoyama (1999), the paratype specimen is reported as having 11 antennal segments (the holotype had lost its head by this point) but confirmed the presence of five clypeal denticles and seven mandibular teeth, including the five basal teeth and apical plus pre-apical teeth. Of the available images on AntWeb, a specimen from the type locality (CASENT0173925, though not collected at the same time as the type specimens) appears to have 11 antennal segments but presents only four clypeal denticles (Fig. 16A). The mandibles appear to bear only four basal teeth. The only other specimen with an available image of the head is from a specimen identified from Fiji (CASENT0187702) and described by Sarnat & Economo (2012). They describe the specimen as possessing 11 antennal segments and five clypeal denticles. The number of mandibular teeth is reported as seven (apical, pre-apical, and five basal teeth) in one section of text (page 22) and six in another (page 23). In the available image the mandibles appear to bear only six in teeth total. Compared to the newly collected specimens from Hong Kong, we find that individuals possess five distinct clypeal denticles and 11 antennal segments (including the scape) (Fig. 16C). In addition, both specimens possess six mandibular teeth (one apical, one preapical and four basal teeth) closely aligning with the second quoted number by Sarnat & Economo (2012) on page 23 and the imaged specimen but differing to Williams original description and Onoyama (1999) redescription.

Another difference between the Fiji specimen (CASENT0187702) and the description of the type and newly collected specimens includes the significantly more concave occipital margin in the Fiji specimen, a trait it shares with a specimen from Hawaii (CASENT0173925). In a taxonomic key to the species of the former genus *Bannapone* (Eguchi *et al.,* 2015), CASENT0173925 (from the type locality) is described as having a distinctly wider and shorter mesosoma than the other two specimens imaged (CASENT0187702 from Fiji, and the holotype specimen CASENT0249113). Due to the unique morphology of CASENT0173925 the authors posit the idea that CASENT0173925 is either an independent species or an ergatoid queen of *S. zwaluwenburgi*.

Clearly there are inconsistencies regarding the morphology of *S. zwaluwenburgi*. Even if the number of antennal segments can be explained by an author error, the numbers of clypeal denticles (a likely no longer a reliable character) and mandibular teeth are inconsistent. These inconsistencies could be due to either polyphenism or the existence of multiple species and can only be determined through the examination of all available material in addition to further collections. In the key to Hong Kong species of *Stigmatomma* below, we assume *S. zwaluwenburgi* to have 11 antennal segments instead of 12. We make this assumption based on the redescription by Onoyama (1999), the non-type specimens from Fiji and Hawaii and the additional specimens detailed here. Because Williams did not explicitly state the number of antennal segments, with the holotype head lost, it seems likely that the 12th segment was added in the figure by mistake.

Biological notes

Two specimens were collected from southern Kowloon (Tsim Sha Tsui) from Signal Hill Gardens, one of the most urbanised areas of Hong Kong (Fig. 2A). Individuals were collected within the same Winkler sample from a single transect. The sample comprised loose vegetation and soil, with some leaf litter hummus. No other specimens have been collected from the nine additional Winkler samples taken at the same site. Type material of *Stigmatomma zwaluwenburgi* was collected via hypogaeic sampling within '*a field of sugar cane*' in Honolulu, Hawaii (Williams, 1946). Several additional specimens are known from Christmas Island) collected mostly near human made roads (Wilson & Taylor 1967; Taylor 1990; Framenau & Thomas 2008). Further specimens have been collected on Fiji via leaf litter sampling within an area with large populations of introduced ant species (Sarnat & Economo, 2012). The cryptobiotic nature of this species makes it one of the most rarely collected ants in the world, but probably even more surprisingly, one for which at this point, the native range remains completely unknown, with only records from remote islands (Hawaii, Christmas Island, Fiji). The record for Hong Kong thus represents the first inland record of this species. Whether or not this species is native to China is difficult to discern. Considering the flow of goods to and from Hong Kong it could easily have been introduced to the region or exported from it. Nevertheless, the small size (TL 1.88-1.94), clearly soil dwelling habits, cryptobiotic nature and tolerance of anthropogenic disturbance in this species would undoubtedly aid its ability to spread via human commerce.

Stigmatomma zwaluwenburgi thus represents a biogeographic conundrum. Assuming all specimens are correctly identified as *S. zwaluwenburgi*, it is known exclusively from volcanic islands in the Pacific and Indian oceans and now Hong Kong, China. The type locality is Hawaii, but it was probably introduced from elsewhere, possibly Melanesia or the East Indies (Brown, 1960; Wilson & Taylor, 1967; Sarnat & Economo, 2012). The recent phylogenetic analysis of the Amblyoponini by Ward & Fisher (2016) places *S. zwaluwenburgi* closest to *Stigmatomma scrobiceps* (Guénard *et al.,* 2013) and several undescribed morphospecies of *Stigmatomma* (th01, th04, & my04). Interestingly, these specimens are all from Southeast Asia, and to the best of our knowledge known only from the type/collection localities (*S. scrobiceps* from Yunnan, China, *Stigmatomma* my04 from Sabah, Malaysia, *Stigmatomma* th01 from Khon Kaen, Thailand, and *Stigmatomma* th04 from Sakon Nakhon, Thailand). It should be noted that the specimen included in the Ward & Fisher (2016) analysis is CASENT0187702 from Serua, Fiji. If the Fijian specimen is in fact *Stigmatomma zwaluwenburgi*, then an east Asian origin of the species seems most likely.

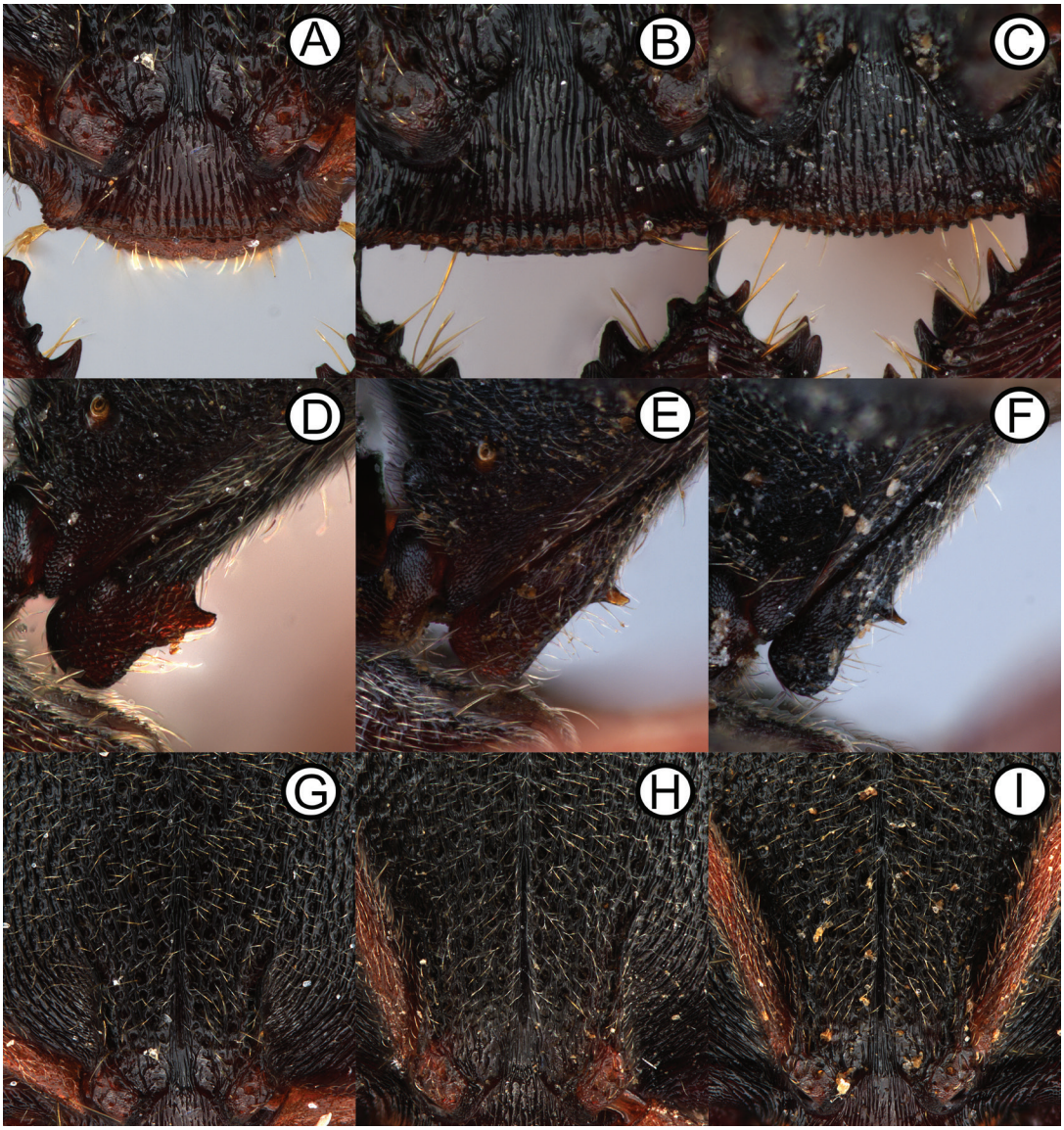

Fig. 15. Variation in morphological characters within *Stigmatomma* nr. *quadratum* specimens from Hong Kong. A - C shows variation in cuticular clypeal denticles, A) ANTWEB1009567; B) ANTWEB1010954; C) ANTWEB1010863; D - F displays variation within the subpetiolar process; D) ANTWEB1010955; E) ANTWEB1010884; F) ANTWEB1010864. G - I shows the subtle variation in cephalic sculpture G) ANTWEB1009567; H) ANTWEB1010924; I) ANTWEB1010960.

Multivariate analysis results of the *Stigmatomma reclinatum* group

A total of 33 specimens, comprising 7 known species of the *S. reclinatum* group (including specimens of unknown identity) were measured for 12 linear morphological measurements. The first PC axis (PC1) explained 78.5% of the variance, with the second PC (PC2) axis explaining 8.6% (total variance = 87.1%) (Fig. 11A; Table S4). All variables had good correlations with other variables, other than EL which consistently had correlation statistics below 0.5 (Table S3). Principal component 1 likely represents a spectrum of overall individual specimen size, whilst PC2 likely represents the specimen eye length (EL), which is seen to correlate with PC2 (Fig. 13A; Table S5)

Stigmatomma feae and *S. crenatum* on the left of Fig. 13A were smaller than specimens found further right in ordination space, with *S. reclinatum* specimens from Singapore being substantially larger than other sampled specimens. Specimens were also distributed along the second PC axis in accordance with specimen eye length, with specimens located lower in ordination space with smaller eyes, as is seen in *S. bellii* (Fig. 12D; Fig 13A) and vice versa. Holotype specimens of *S. rothneyi*, *S. reclinatum*, *S. belli* and *S. quadratum* and *S.* nr. *quadratum* specimens clustered within the same space, with greater variation seen in *S.* nr. *quadratum* specimen size (PC1) than EL (PC2) (Fig. 13A). Considering the correlative difference between EL and many of the other variables (Table S3 & S5), it was deduced that EL might separate species when correlated against PC1 (Fig. 13B). All species, other than *S. quadratum* and *reclinatum* group of unknown identity (see above) as well as *S. crenatum* and *S. feae*, separate relatively well when considering EL.

Taxonomic synopsis of Amblyoponinae of Hong Kong SAR

Prionopelta kraepelini Forel, 1905. *Native:* Malaysia and Singapore. Borneo. Philippines. Sulawesi *Exotic* China: Hong Kong SAR, Taiwan. India: Jammu & Kashmir, Himachal Pradesh. Sri Lanka. Vietnam. Thailand.. Palau. Caroline Islands. Fiji. New Zealand (indoor introduced).

Stigmatomma amblyops Karavaiev, 1935. *Native*: Vietnam; China: Yunnan, Hainan (unpublished), Hong Kong SAR

Stigmatomma crypticum (Eguchi *et al*., 2015). *Native*: Vietnam; China: Hong Kong SAR.

Stigmatomma draconis sp. nov. *Native*: China: Hong Kong SAR.

Stigmatomma pagei sp. nov. *Native* : China: Hong Kong SAR.

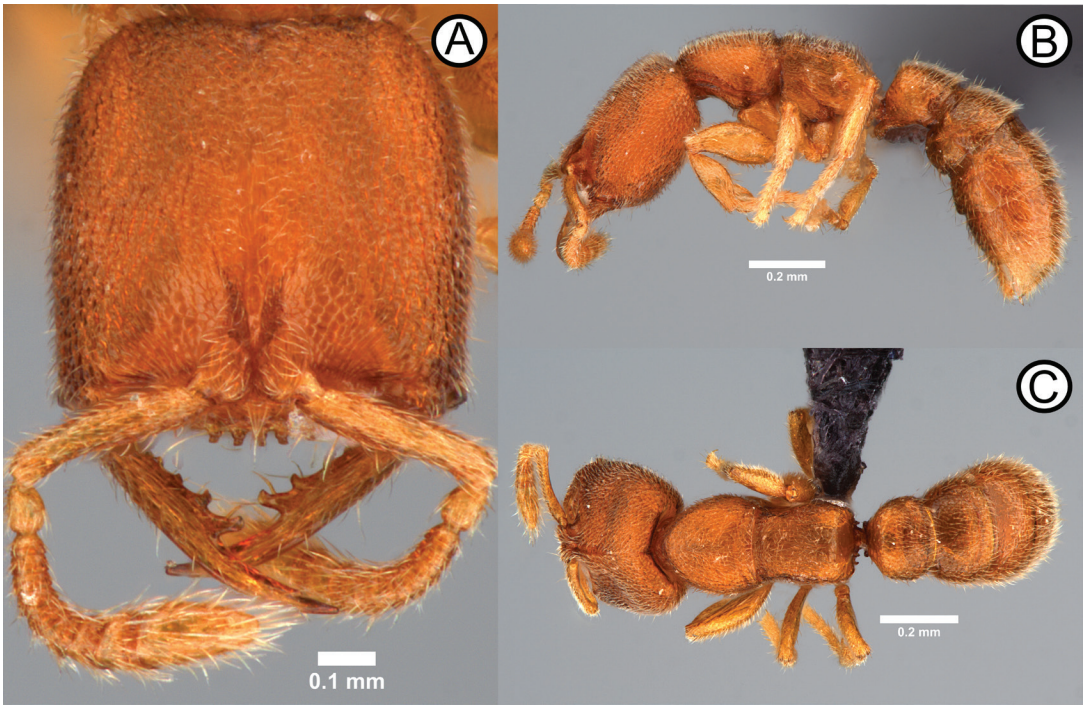

Fig. 16. *Stigmatomma zwaluwenburgi* worker (ANTWEB1010860); A) head view B) lateral view C) dorsal view.

Stigmatomma nr. *quadratum* (*S. reclinatum* group). *Native*: China: Macau, Hong Kong SAR. Singapore (potential), Vietnam (potential).

Stigmatomma luyiae Hsu *et al.,* 2017. *Native*: China: Hong Kong SAR, Taiwan.

Stigmatomma zwaluwenburgi Williams, 1946. *Native range unknown*, suspected here to be in Southeast Asia China: Hong Kong SAR. *Likely introduced in*: Hawaii, Fiji, Christmas Island.

Key to Amblyoponinae genera in Hong Kong SAR based on workers

1 Mandibles triangular (Fig 1A); gap between mandibles and clypeus when mandibles closed small to absent (Fig 1A) .... ***Prionopelta (Prionopelta kraepelini)***

-Mandibles linear (Fig 3A); gap present between mandibles and clypeus when mandibles closed (Fig 3A) ..... ***Stigmatomma***

Key to the *Stigmatomma* species of Hong Kong SAR based on workers

1 Antenna segment count 12 (Fig. 3A; Fig. 11A) **2**

- Antenna segment count 11 (Fig. 5C; Fig. 8B; Fig. 16A; Fig. 17C) **4**

2 Large (TL 8.7-10.4); head almost as wide and long (CI 94.46-99.65); eye conspicuous; genal teeth truncated apically (Fig 11A; Fig 14A); cephalic integument immediately adjacent to longitudinal strip with deep foveate pits (Fig 15G-I) .. .. ***Stigmatomma* nr. *quadratum***

- Small (TL 3.5-4.1); head distinctly longer than wide (87-89.13); eye minute to absent; genal teeth tapering to a point apically (Fig. 3A; Fig. 10D); cephalic integument without deep foveate pits (Fig 3A; Fig. 9C) **3**

3. Genal teeth conspicuous (Fig. 3A); dorsolateral propodeal margin lacking margination (Fig. 3B); metanotal groove absent (Fig 3C); median clypeal denticles conical, distinctly extending from the anterior clypeal margin (Fig. 3A) .... ***Stigmatomma amblyops***

- Genal teeth present but inconspicuous (Fig. 10D); dorsolateral propodeal margin marginated (Fig. 10E); metanotal groove present, weakly impressed (Fig. 10A); median clypeal denticles small, not distinctly extending beyond anterior clypeal margin (Fig. 10C-D) ..... ***Stigmatomma pagei* sp. nov**

4 Antennal scrobes present, nearly reaching the occipital margin (Fig 4A); head longer than wide (CI; 85.4-87.1)). ..... ***Stigmatomma crypticum***

- Antennal scrobes absent, not reaching occipital margin (Fig. 5B; Fig. 11A); head as wide and long (CI; 100-106) **5**

5 Denticles on anterior clypeal margin absent (Fig. 8B-C); mandibles as long as head length (MI 93.3-100) ..... ***Stigmatomma luyiae***

-Denticles on anterior clypeal margin present (Fig. 5A; Fig. 6D; Fig 7B; Fig. 16A; Fig. 17C); mandibles shorter than head length (MI 52.8-78) 6

6. Smaller (TL 1.88-1.94); third apical mandibular tooth long and jigsaw tab-like (Fig. 16A; Fig. 17C); absence of paired teeth on mandible (Fig. 16A; Fig. 17C); 5 denticles on anterior clypeal margin (Fig. 16A; Fig. 17C) .... ***Stigmatomma zwaluwenburgi***

- Larger (TL 2.39); third apical mandibular tooth not jigsaw tab-like, short and recurved upwards instead (Fig. 5C; Fig. 6D; Fig. 7B); presence of paired teeth on mandible (Fig. 5C; Fig. 6D; Fig. 7B); 10 denticles on anterior clypeal anterior margin (Fig. 6D) ... ***Stigmatomma draconis* sp. nov.**

Discussion

Although pan-tropically distributed (Guénard *et al*., 2013, 2017; Janicki *et al*., 2016), the cryptic nature of the Amblyoponinae subfamily means that it is taxonomically challenging (Ward & Fisher 2016). Though Hong Kong is relatively small (1,100 km²) the large sampling effort within this region has revealed eight species, two of which are new to science. This species richness is greater than the number of species recorded in Taiwan (five) and significantly more than in the larger neighbouring Guangdong province (one species) (Guénard *et al*., 2017; Janicki *et al*., 2016). Low richness in Guangdong is undoubtedly due to lower sampling effort and publications compared to Hong Kong. In China, only the Yunnan province presents more species of Amblyoponinae, with 12 species recorded so far (Guénard & Dunn 2012; Guénard *et al*., 2017; Janicki *et al*., 2016; Liu *et al.,* 2020).

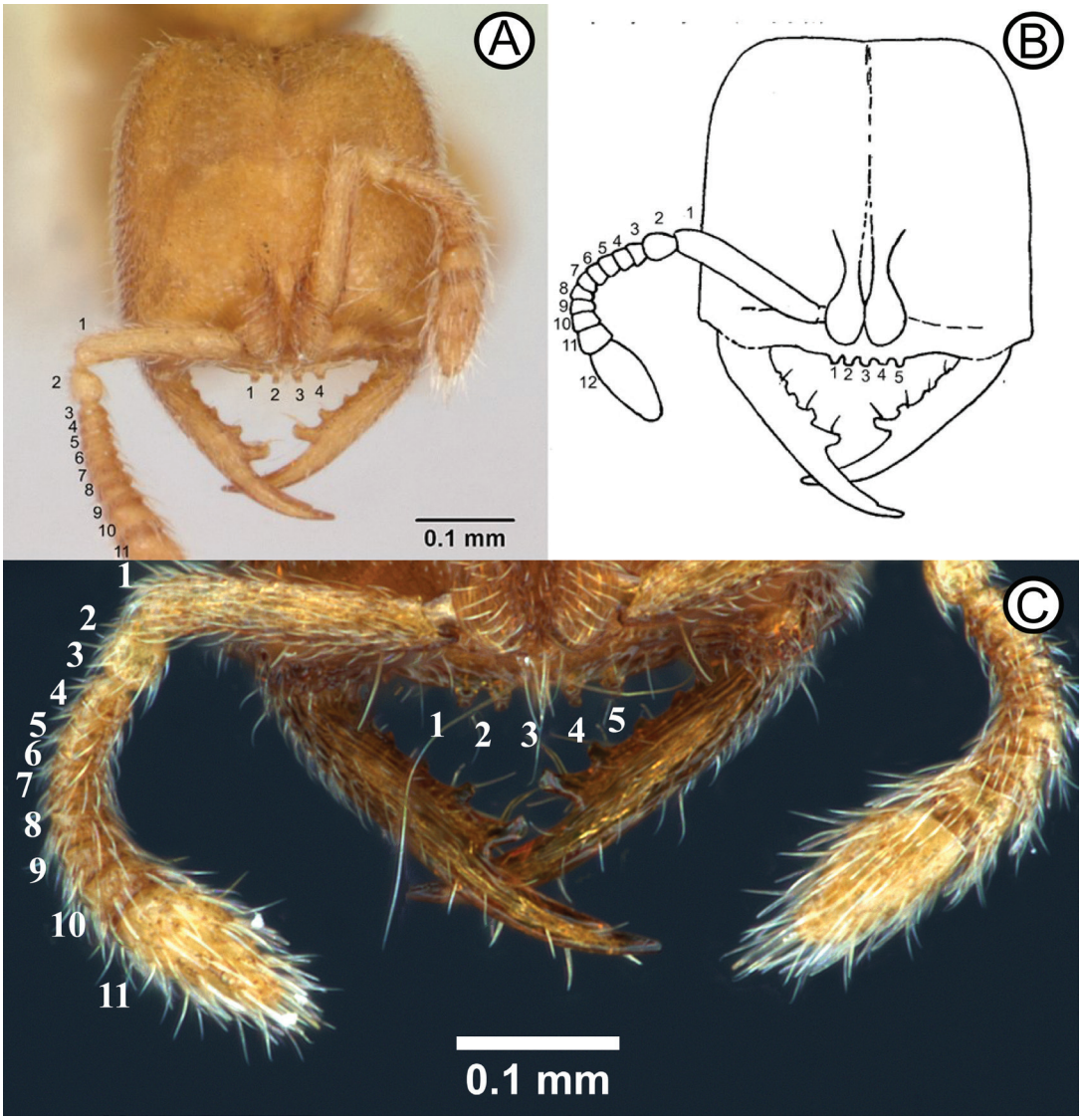

Fig. 17. *Stigmatomma zwaluwenburgi*, comparing A) CASENT0173925 (April Nobile); B) a specimen from the type locality to the original representation by Williams (1946); C) the newly collected specimens from Hong Kong (ANTWEB1010859). Pictures available from www.antweb.org.

Many species in the past have been described on the basis of single individuals likely due in part to the low catch rate as a result of their crytobiotic nature. In Hong Kong we show a similar pattern, with some species recorded only once (*S. draconis*, *S. pagei*, *S. luyiae*, *S. zwaluwenburgi*) or only with a handful of records such as *S. amblyops* and *S. crypticum.* However, we also find some species that are considerably more frequently encountered. For example, *S.* nr. *quadratum* has a total of 15 unique specimen records from both male and workers, which is likely due to its larger size and more epigaeic nature. This is shown in the number of records on iNaturalist, which suggests that the species is readily encountered by the general public. *Prionopelta kraepelini* is the opposite however, being relatively small but with a large number of records from both males and workers, suggesting the relative commonness of this species compared to the roughly equally sized *Stigmatomma*.

Four of the eight species reviewed here were collected within urban environments, specifically *Prionopelta kraepelini*, *Stigmatomma* nr. *quadratum*, *S. crypticum* and *S. zwaluwenburgi*. Urban habitats are typically regarded as areas of low diversity, a high degree of anthropogenic disturbance and dominated by exotic species. However recent studies including multiple sampling methods, habitats and strata (Guénard *et al.,* 2014; Brassard *et al.,* 2021; Wong *et al*., 2022), revealed a substantial number of both native and exotic species occupying green spaces within densely urbanised areas. The presences of species of the Amblyoponinae subfamily, often regarded as rare, within such habitats suggests the some Amblyoponinae species are resistant to anthropogenic disturbance.

Urban environments are, however, undoubtedly gateways for exotic species. Here we argue that *Prionopelta kraepelini* is not native to China, with records from urban environments and other highly disturbed lowland habitats. This species is yet to be collected outside of these habitats even with past sampling effort predominately targeted towards natural areas (Lee *et al.,* 2021, Nooten *et al.,* 2021). The apparent lack of records from natural areas indicates the habitat type *P. kraepelini* associates with in its newly found distribution, which strongly differs from recorded localities in its native range (see *Prionopelta kraepelini* remarks). Additionally, a specimen from a vegetable garden in Cheng Chau (ANTWEB1010880], an outer island of Hong Kong, may indicate how long the species has been in the region due to its distance from other islands, but because of the species cryptobiotic nature it had not been previously observed. Unless the species was brought through building or plant material, this may also suggest some potential dispersal abilities for this species to reach an island located at 1.1 km from the nearest coast. However, the apparent absence in Macau (Brassard *et al*., 2021), suggest that long-distance dispersal could be less likely. Further sampling effort in the Pearl River Delta metropolitan area, as well as urban areas of neighbouring mainland Chinese provinces may also reveal further records of *P. kraepelini*.

Novel records of both alate queen and male specimens are here provided alongside worker caste specimens. We found a considerable number of male individuals, particularly of *P. kraepelini*, from urban sampling (Table S1). Associating winged reproductive individuals from malaise samples with a habitat type is challenging as it is unclear whether individuals originated from the trapping locality or have flown in. However, worker specimens were also found at several sites alongside males (Table S1), suggesting workers, males and habitat type could potentially be associated. We were only able to associate *P. kraepelini* and *Stigmatomma* nr. *quadratum* with males. The former species male, *P. kaepelini* are described by Bharti & Wachkoo (2012), enabling more accurate identification. The later species being the only large (> 3 mm) *Stigmatomma* species in Hong Kong, making corresponding worker and males easier. In addition, considerably smaller male specimens (< 4mm) of at least two morphospecies, identified to Amblyoponinae using Boudinot (2015) and subsequently to *Stigmatomma* using Yoshimura and Fisher (2012), were also collected but not incorporated into this study due to lack of corresponding workers.

Identifying robust morphological and morphometric characters for species delimitation is a core aspect of taxonomy (Csősz *et al.,* 2020). When specimens within a group are either rare or difficult to obtain, such as many Amblyoponinae species, outlining robust morphological and morphometric characters is challenging. Here we show by examining numerous *S.* nr. *quadratum* specimens from a relatively small region, that the clypeal denticles along the anterior clypeal margin, a character used frequently in previous literature (Xu 2001; Xu 2006; Xu & Chu 2012), is more variable than previously thought. This is also potentially seen in *S. zwaluwenburgi* as well. Additionally, the shape and structure of the subpetiolar process also shows high variability in shape, decreasing the characters utility in species demarcation. Such characters need to be considered carefully in future descriptions of *reclinatum* group species and likely species of the former *Bannapone* genus. We do not wholly rely on clypeal denticle counts and subpetiolar shape in species delimitation (e.g. in *S. draconis*), but provide alternative characters instead.

ACKNOWLEDGEMENTS

MTH is grateful to André Ibáñez and all volunteers who helped to collect specimens between 2021 and 2022, as well as all other specimen collectors including Chi-Man Leong, Mark Wong, Roger Ho Lee, Toby Tsang, Mac P. Pierce, Benoit Guénard. We are also indebted to iNaturalist user abc-123 who collected the *Stigmatomma crypticum* specimens. We would also like to thank Dr. Wendy Wang for lending us *Stigmatomma* specimens from Singapore. MTH would also like to thank Thiago S. R. Silva for thoughtful commentary on manuscript. We are grateful to the Hong Kong Government Leisure and Cultural Services Department (LCSD) for allowing the survey of their managed urban parks. We would also like to thank the Hong Kong government departments of the Agriculture, Fisheries and Conservation Department for providing permits and the Environment and Conservation Fund for funding (ECF 89/2019 & ECF 137/2020).

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ASIAN MYRMECOLOGY
A Journal of the International Network for the Study of Asian Ants
Communicating Editor: Adam Cronin