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The *Methocha* (Hymenoptera: Thynnidae: Methochinae) of Hong Kong (China), a preliminary faunal list with descriptions of five new species and sexual associations rendered through molecular analysis

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Abstract. Five new species of *Methocha* Latreille, 1804 are described from Hong Kong: two species based on females only, *Methocha haaksek* Barthélémy & Terayama sp. nov. and *Methocha leleji* Barthélémy & Terayama sp. nov.; two on males only, *M. wilsoni* Barthélémy & Terayama sp. nov. and *M. zetetes* Barthélémy & Terayama sp. nov.; and one with females and males associated through molecular analysis, *M. hongkongensis* Barthélémy & Terayama sp. nov. A key to species and a phylogenetic tree of *Methocha* occurring in the Hong Kong SAR are provided.

Keywords. Thynnoidea, morphometrics, Cicindelinae, DNA barcoding, phylogenetic.

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Introduction

The Methochinae Latreille, 1804 is a small subfamily comprising 89 species worldwide (Agnoli 2020; Hanima *et al*. 2021; Narita & Mita 2021; Liao *et al.* 2022) up to now and containing only two genera, *Methocha* Latreille, 1804 and *Karlissa* Krombein, 1979. Species of *Methocha* are specialised ectoparasitoids of the ferocious larvae of Cicindelinae Latreille, 1802 (Coleoptera, Carabidae) and their distribution follows that of their hosts through all biogeographic realms, with the exception of the Australian realm and the Pacific islands, where the genus is not represented. The Oriental realm as

defined by Holt *et al.* (2013) included 46 species but only a few locations/countries have been sampled (Fig. 1A). Five species are added here, bringing the total to 94 worldwide and to 51 in the Oriental realm.

Species in this subfamily are rarely seen and are rather cryptic, although males can be at times abundant in Malaise traps. Live observations of females are usually rare. There is considerable dimorphism in the genus, the males are winged and the females apterous with a strongly segmented mesosoma. This peculiar morphology allows the female to be grabbed by the sickle-like mandibles of the host, and the parasitoid then stings the host ventrally close to the head. The host larva is then dragged down to the end of the burrow and an egg is laid on it; the female finally seals the host burrow with debris and seeks another prey. The particular predatory behaviour of this genus has been quite well documented for Palearctic and Japanese species (e.g., Adlerz 1903, 1905; Bouwman 1909; Champion & Champion 1914; Iwata 1936; Burdick & Wasbauer 1959; Grandi 1961) and Krombein (1982) gives a good account of the biology of some *Methocha* spp. of Sri Lanka.

The placement of this subfamily in the family Tiphiidae Leach, 1815 has been questioned through recent molecular analyses which suggest that, along with the Myzininae Ashmead, 1900, the Methochinae should be placed in the superfamily Thynnoidea Shuckard, 1841 and family Thynnidae Shuckard, 1841 (Pilgrim *et al.* 2008), and we follow this phylogeny here. In any case, the close relationship between Tiphioidea and Thynnoidea is strongly supported (Peters *et al.* 2017) and molecular analysis using Ultra Conserved Elements (UCE) by Branstetter *et al.* (2017) indicated that Methochinae was a sister-group of Thyninnae [(*Methocha* + Thyninnae) + Myzininae].

Agnoli (2020) provides the most up to date checklist of the genus. However, Agnoli's suggestion that *M. hamanni* Hamann, 1960 is a replacement name for *M. nigra* Hamann, 1960 is not validly published in the sense of the International Code of Zoological Nomenclature and consequently should be discarded until further evidence is provided.

The Oriental fauna has not been reviewed systematically and only fragmentary reports exist; Krombein (1982) studied the fauna of Sri Lanka while the Japanese species were reviewed by Terayama & Mita (2015) and those of Laos by Narita & Mita (2018); recently, Narita & Mita (2021) published a revision of the Taiwanese species and Hanima *et al.* (2021, 2022a, 2022b) reported on the species of the Indian subcontinent. Very little is known of the continental Chinese fauna; the first description from China is by Smith (1869) from Shanghai of *Methocha mandibularis* (Smith, 1869), followed by *M. tricha* Strand, 1913 (Taiwan) and *M. formosana* (Williams, 1919) (Taiwan). In the 1960s, Lin (1966) described a further nine species from Taiwan: *M. alutacea* Lin, 1966; *M. areolata* Lin, 1966; *M. cavipyga* Lin, 1966; *M. emarginata* Lin, 1966; *M. foveiventris* Lin, 1966; *M. maai* Lin, 1966; *M. plana* Lin, 1966; *M. priorrecta* Lin, 1966; *M. taoi* Lin, 1966 (= *M. areolata* Lin, 1966) for a total of eight valid species. Tsuneki (1986) described a new species from the island, *M. taiwanica* Tsuneki, 1986, and Narita & Mita (2021) also added a new species, *M. cirrhocrus* Narita & Mita, 2021, for a total of 11 valid species known to occur in Taiwan. On the other hand, the fauna of continental China was poorly known, save for *M. mandibularis*, but a recent work by Liao *et al.* (2022) has provided an additional three species. Our work adds five species to the fauna of continental China and Hong Kong and, as far as we are aware, the genus *Karlissa* is not known locally.

The present paper greatly increases our knowledge of the species in the genus *Methocha* as well as their distribution, and also provides some associations of sexes.

Material and methods

Sampling

This study is based on material collected by Christophe Barthélémy in Hong Kong over the course of the years 2004–2024. The single mode of acquisition was by using Malaise traps, which were placed in three

locations marked A, B and C on Figure 1B and left in situ for eleven, five and three years, respectively, the collecting bottles replaced and collected, and their contents sorted, on average every two weeks. This method yielded 179 specimens of which over 40 were examined for this study; most were kept in alcohol and never mounted. Most specimens were males (166) and we collected only 13 females.

DNA barcoding

DNA barcoding and phylogenetic analysis were performed to determine whether individuals of different sexes belonged to the same species. Fourteen specimens (eight males and six females) were subjected to genomic DNA (gDNA) extraction using the E.Z.N.A.® Tissue DNA Kit (Omega bio-tek, Norcross, USA). Each specimen was DNA-barcoded by amplifying fragments from the mitochondrial cytochrome c oxidase subunit I gene (*COI*). Most specimens were amplified using the primer pair LCO1490 (forward primer: 5′GGTCAACAAATCATAAAGATATTGG3′) and HCO2198 (reverse primer: 5′TAAACTTCAGGGTGACCAAAAAATCA3′) to generate ca 659 bp DNA fragments (Vrijenhoek 1994). Three specimens that failed to amplify with LCO1490 and HCO2198 were amplified using alternative primer pairs. One specimen was amplified using the primer pair BF1 (forward: 5′ACWGGWTGRACWGTNTAYCC3′) (Elbrecht & Leese 2017) and III_C_R (reverse: 5′GGIGGRTAIACIGTTCAICC3′) (Shokralla *et al.* 2015). Two specimens were amplified using two different primer pairs: wasp_COI_53_75F (self-designed forward primer: 5′TGATCAGGAATARTTGGAACTTC3′) and III_C_R, and Fwh_F2 (forward: 5′GGDACWGGWTGAACWGTWTAYCCHCC3′) (Vamos *et al*. 2017) and HCO2198.

Each DNA barcoding PCR was carried out in a 30 µl reaction mixture, including 6 µl of 5X GoTaq® Flexi Buffer, 0.6 µl of 10 mM dNTP Mix, 3.6 µl of 25 mM $MgCl_2$, 0.15 µl of 5 U/µl GoTaq® G2 Flexi DNA Polymerase (Promega, Madison, USA), 1 µl of extracted DNA, 0.6 µl of each primer, 6 µl of 10% DMSO (Sigma, Burlington, USA), and ultrapure water. The PCR thermal cycling conditions involved an initial denaturation at 95°C for two minutes; followed by 35 cycles of denaturation at 95°C for 30 seconds, annealing at 56°C for 30 seconds, and extension at 72°C for one minute; and a final extension step at 72°C for five minutes (Vrijenhoek 1994). The sizes of the PCR products were confirmed by gel electrophoresis, and the PCR products were sequenced by Beijing Genomic Institute (Hong Kong). We obtained *COI* sequences of all specimens except four.

Phylogenetic analysis

Sixteen *COI* sequences were used for phylogenetic analysis, comprising 10 sequences from this study and six from GenBank. The *COI* sequence of *Anthobosca* sp. (GenBank no.: HM394904.1) was selected as an outgroup as it is the only species in the family Thynnidae with the same region of *COI* sequence available in GenBank. The sequences were aligned using the ClustalW algorithm within MEGA12 (Stecher *et al*. 2020; Kumar *et al.* 2024). The best DNA model, determined to be the General Time-Reversible (GTR) model with gamma-shaped (G) distribution across sites and invariants sites (I) (Nei & Kumar 2000), was selected using Models in MEGA12. Phylogenetic trees were reconstructed using the Maximum Likelihood (ML) method, with 1000 bootstrap replications run using MEGA12. Pairwise p-distances were calculated using MEGA12.

The phylogenetic tree of Fig. 2 was inferred using the Maximum Likelihood (ML) method and General Time Reversible model (Nei & Kumar 2000) of nucleotide substitutions. The evolutionary rate differences among sites were modelled using a discrete Gamma distribution across five categories (+G, parameter = 2.1862), with 48.86% of sites deemed evolutionarily invariant (+I). The tree with the highest log likelihood (-2.791.21) is shown.

Terminology

The morphological terminology used in this paper basically follow Krombein (1982) (Figs 3A–C, 4A–C). We provide morphometric data and a suite of standard measurements to produce ratios/indices for the

specimens examined. Not all specimens examined were measured as some were not accessible at the time of measurement or were damaged after examination; we measured 38 specimens in total. Measurement values (except for specimen length) are relative values as measured in the stereo microscope's reticule at various magnifications as indicated below in "[ ]". These measurements are referred to in Figures 3A–C, 4A–C and detailed here; the number of specimens measured is represented by the value "*n*" in the text:

C_H = Clypeus height, distance between the apical margin of clypeus and the epistomal sulcus [× 100], see Figs 3B, 4B
C_L = Clypeus length [× 100], see Figs 3B, 4B
H_H = Head height, measured frontally between the apical margin of clypeus and the frons [× 80], see Figs 3B, 4B
H_W = Head width, measured frontally between external margin of the eyes [× 80], see Figs 3B, 4B
L = Length of specimen in millimetres (mm), this is obtained by adding two measurements in lateral view, the first from frons to posterior apex of propodeum and the second from the petiole attachment to the apical part of the metasoma
Me_H = Mesosoma height, measured vertically from mesoscutum to ventral side of mesopleuron [× 40], see Figs 3C, 4C
Me_L = Mesosoma length, measured medially from pronotal carina to point of insertion of metasoma in propodeum [× 40], see Figs 3C, 4C
O_D = Ocular distance, distance between the eyes measured dorsally across posterior ocelli [× 100], see Figs 3A, 4A
OOD = Ocular-ocellar distance, distance between posterior ocellus and eye margin [× 100], see Figs 3A, 4A
O_W = Occipital width, distance between posterior margins of eyes measured dorsally [× 60], see Figs 3A, 4A
P_L = Pronotal length, maximum length of pronotum measured dorsally [× 60], see Figs 3A, 4A
P_W = Pronotal width, maximum width of pronotum measured dorsally [× 60], see Figs 3A, 4A
POD = Postocellar distance, distance between the two posterior ocelli [× 100], see Figs 3A, 4A
T_L = Mesoscutum length [× 60], see Figs 3A, 4A
T_W = Mesoscutum width, maximum distance between mesoscutal carinas measured dorsally [× 60] for males, measured as the maximum width of mesosoma in females, see Figs 3A, 4A
V_D = Vertex distance, distance between posterior side of posterior ocelli to back of head [× 100], see Figs 3A, 4A

These dimensions are used to define the following eight ratios:

CLR = Clypeal ratio: CL : CH
CR = Cephalic ratio: $H_W : H_H$
FRR = Frontal ratio: $O_D : V_D$;
MER = Mesosomal ratio: ML : MH
MSR = Mesoscutal ratio: $T_L : T_W$
OMR = Occipital-mesosomal ratio: OW : TW
OOR = Ocellar-ocular ratio: POD : OOD
PRR = Pronotal ratio: $P_L : P_W$

The following abbreviations are used in the description: FLx-antennal flagellum, x being the flagellar number; Tx-metasomal tergum, x being the tergal number; Sx-metasomal sternum, x being the sternal number.

The photos were obtained using a Leica M205 C stereo microscope and stacking software LAS ver. 4. at increments of 15–50 steps further enhanced with Photoshop CS6®.

The second author has examined type material deposited in the following institutions: Taiwan Agricultural Research Institute, Taichung, Taiwan (TARI); Entomological Laboratory, Kyushu University, Fukuoka, Japan (ELKU) and the National Agriculture and Food Research Organisation, Tsukuba, Japan (NARO) these include the following species: *M. foveiventris*, *M. maai*, *M. alutacea*, *M. plana*, *M. priorrecta*, *M. emarginata*, *M. taoi*, *M. cavipyga* (TARI); *M. okinawensis* Terayama & Mita, 2015, *M. uchinanensis* Terayama & Mita, 2015, *M. yaeyamensis* Terayama & Mita, 2015, *M. japonica* (Yasumatsu, 1931), *M. yasumatsui* (Iwata, 1936) (ELKU); *M. michinoku* Terayama, 2019 (NARO).

The holotypes will be deposited at the California Academy of Science, San Francisco, California, USA (CASC) the other specimens are deposited in the first author's collection, Hong Kong SAR, China (CBC).

Distribution

The world distribution map (Fig. 1A) and the distribution sections in the text were obtained using all available historical distributional records of *Methocha* (Krombein 1982; Tsuneki 1986; Terayama & Mita 2015; Narita & Mita 2018, 2021; Agnoli 2020; Hanima *et al*. 2021, 2022a, 2022b; Liao *et al*. 2022). The Hong Kong distribution map (Fig. 1B) is based on our material. The base map represents four degrees of anthropogenic disturbance of the ecosystems in Hong Kong, these were obtained by using population census data superimposed on 1:100 000 geographic survey of the territory including Country Parks, with the inference that higher population densities equate to higher disturbances.

The map of Fig. 1A illustrates the number of species recorded in each Asian country (total of 60 spp.) as well as the Oriental realm (51 spp.); the shading of the map follows the number of known species for the given country and this is tabulated in Table 1 which was obtained from historical records and the present study. The red outline of Fig. 1A represents the Oriental realm as understood by Holt *et al*. (2013) and we follow here this updated revision of the world bioregions or realms.

Results

Through the examination of our material and DNA analysis composed of three distinct females and series of males and comparison with published descriptions (e.g., Krombein 1982; Terayama & Mita 2015, Narita & Mita 2018, 2021; Hanima *et al*. 2021, 2022a, 2022b; Liao *et al*. 2022) as well as examination of some type specimens, we have concluded that all five species are new to science. However, because of the extreme sexual dimorphism in the genus, it is generally impossible to associate males and females on morphological characters alone; in consequence we have proceeded with molecular analysis to associate sexes in our material.

Key to species of Methocha Latreille, 1804 from Hong Kong

1. Female: apterous, antenna 12-segmented and not arising from beneath frontal tubercle 2
– Male: fully winged, antenna 13-segmented and arising from beneath frontal tubercle 4

2. Mesosoma mostly red ..... ***M. leleji*** Barthélémy & Terayama sp. nov.
– Body entirely black 3

3. Head trapezoidal in dorsal view, posterolateral corner forming blunt angle (Fig. 8A); ocelli forming large, equilateral triangle (Fig. 8A); tarsal claws with subapical tooth shorter than apical tooth .....***M. haaksek*** Barthélémy & Terayama sp. nov.
– Head subtriangular in dorsal view, posterolateral corner almost straight, not forming angle (Fig. 8B); ocelli forming isosceles triangle (Fig. 8B); tarsal claws with subapical tooth equal to apical tooth ..... ***M. hongkongensis*** Barthélémy & Terayama sp. nov.

4. Anterior margin of pronotum carinate (Fig. 11C); depression on dorsal part of mesepisternum with 7–9 deep longitudinal fovea (Fig. 10C); propodeum dorsally areolate (Fig. 12A) ....***M. hongkongensis*** sp. nov.
– Anterior margin of pronotum with no carina (Fig. 11E–F); no depression on dorsal part of mesepisternum (Fig. 10A–B); propodeum dorsally not areolate (Fig. 12B–C) 5
5. Hind tarsal claw with mid-tooth sharp, bifid and shorter than apical tooth; ocelli forming an equilateral triangle (Fig. 8E); apical part of S7 with alternating longitudinal striations (Fig. 13E) ... . ***M. wilsoni*** Barthélémy & Terayama sp. nov.

– Hind tarsal claw with mid-tooth blunt the same length as apical tooth, ocelli forming an isosceles triangle (Fig. 8F); apical part of S7 shiny with very weak and few punctures (Fig. 13F) ....***M. zetetes*** Barthélémy & Terayama sp. nov.

Molecular analysis

Based on the phylogenetic tree derived from *COI* sequences (Fig. 2; GenBank accession numbers PV631175–PV631184), we were able to determine four species, namely: *Methocha wilsoni* Barthélémy & Terayama sp. nov., *M. leleji* Barthélémy & Terayama sp. nov., *M. hongkongensis* Barthélémy & Terayama sp. nov., and *M. zetetes* Barthélémy & Terayama sp. nov. *Methocha wilsoni* was identified as a sister taxon to *M. leleji* with a p-distance exceeding 5% (Table 2). These species are genetically closest to *M. maai* from Taiwan (GenBank no.: LC420050.1). This group forms a monophyletic cluster with *M. okinawensis* (GenBank no.: LC462850.1), *M. uchinanensis* (GenBank no.: LC462851.1) from Japan and *M. articulata* (Latreille, 1792) (GenBank no.: LC420048.1) from Russia. Notably, this monophyletic cluster is positioned as a sister group to *M. hongkongensis*. Conversely, *M. zetetes* exhibits the most distant genetic relationship among the four species and forms a distinct clade with *M. alutacea* from Taiwan (GenBank no.: LC420051.1). We were unable to extract viable DNA for analysis from *M. haaksek* Barthélémy & Terayama sp. nov.

Species descriptions

Class Insecta Linnaeus, 1758
Order Hymenoptera Linnaeus, 1758
Superfamily Thynnoidea Shuckard, 1841
Family Thynnidae Shuckard, 1841
Subfamily Methochinae Latreille, 1804

Genus ***Methocha*** Latreille, 1804

Methocha Latreille, 1804: 179. Type species: *Mutilla articulata* Latreille, 1792 (by monotypy).
Methoca Latreille, 1805: 268 (incorrect subsequent spelling).

Diagnosis

Within the family Thynnidae, the females of *Methocha* are apterous with setose eyes, pronotum, mesonotum and metanotum-propodeum forming three distinct, similar and almost equal regions separated by marked constrictions, and metatibia with one apical S-shaped and dorsally finely comb-like spur. Males are fully winged with setose eyes, developed antennal lobe; short pronotal disc, shorter than its width, fore wing with two submarginal cells enclosed by tubular veins, vein Rs between true, first and second submarginal cells reduced or absent, at least anteroapically, S6 shorter than S5, S7 partly exposed, and metatibia with posterior (inner) apical spur distinctly S-shaped.

Distribution

Worldwide except Australian Region and the Pacific islands.

Methocha haaksek Barthélémy & Terayama sp. nov.
urn:lsid:zoobank.org:act:E85AD8EF-2B19-43C4-8CEA-721B5630BB2C
Figs 5A, 6A, 7A, 8A, 9A, 10A, 11A

Diagnosis

Females of this species can be distinguished from other Asian congeners by the following combination of characters: body entirely black; legs and antennae dark brown; head dorsally trapezoidal, with convex posterolateral margin; mandibles not distally narrowed; clypeus with rounded anterior margin; frontal tubercule reduced; ocelli forming a large equilateral triangle; pronotum, mesoscutellum, and propodeum largely smooth; tarsal claws with subapical tooth shorter than apical tooth. The male is unknown.

Etymology

The specific epithet refers to the transliteration of the Cantonese ideograms for the colour "black" (黑色) in reference to the black body of this species.

Type material

Holotype

CHINA – **Hong Kong** • ♀; Ping Shan Chai; 22°29′14″ N, 114°11′06″ E; 140 m a.s.l.; 7 Dec. 2019–4 Jan. 2020; C. Barthélémy leg.; Malaise trap; CASC, ref.: M459.D.Hy.1.

Paratype

CHINA – **Hong Kong** • 1 ♀; Lung Fu Shan; 22°16′49″ N, 114°08′18″ E; 143 m a.s.l.; 22–29 Apr. 2021; Andre Ibanez leg.; Malaise trap; CBC, ref.: 0732.E.Hy.1.

Description

Female

Standard ratios (n = 2). L: 3.8–4.1 mm (mean = 3.95 mm); CR: 1.17–1.21 (mean = 1.19); OOR: 0.56–0.82 (mean = 0.69); CLR: 0.37–0.60 (mean = 0.48); MER: 0.24–0.29 (mean = 0.26); OMR: 0.54–0.56 (mean = 0.55); FRR: 2.42–2.83 (mean = 2.63); MSR: 1.27–1.40 (mean = 1.33); PRR: 0.77–1.06 (mean = 0.92).

Head (Figs 5A, 7A, 8A, 9A). Head wider than high in frontal view (mean CR = 1.19) width 2.1× narrowest interocular distance; head trapezoidal dorsally (Fig. 8A), 1.4× as long as wide, with convex posterolateral margin; ocelli forming a large equilateral triangle (Fig. 8A), ocelli minute; frons, vertex and gena largely smooth, with sparse and minute punctures (Figs 5A, 7A, 8A); frontal tubercules much reduced (Fig. 8A), space lateral to tubercules coriaceous; frontal line absent; clypeus convex, anterior margin weakly rounded (Fig. 9A), sub-flat, anterior part coriaceous, posterior part minutely rugulose; mandibles not distally narrowed, lower tooth slightly longer than upper one; pedicel long, 0.7× length of FL1; FL1–FL3 in a ratio of 6 : 7 : 6 in length.

Mesosoma (Figs 10A, 11A). Collar of pronotum smooth in dorsal view (Fig. 11A); pronotal disc smooth bearing a few sparse and minute punctures (Fig 11A); mesonotum longer than pronotum (× 1.25); mesoscutum with concave dorsum in profile, mesoscutellum smooth, rounded in lateral view, not separated from mesepisternum; tegula absent; mesepisternum mostly smooth bearing a few minute punctures; metanotum with transverse ridges anteriorly (Fig. 10A), smooth posteriorly; propodeum globular, smooth (Figs 10A, 11A).

Metasoma. Terga polished, bearing largely interspaced minute punctures, petiole rugose. Sterna polished bearing larger and widely spaced punctures.

Legs. Tarsal claws tridentate, apical tooth sharp, subapical tooth blunt nearly as long as apical one, basal tooth minute, triangular.

Colour and vestiture (Figs 5A, 6A). Body entirely black except legs and antennae dark brown (Figs 5A, 6A). Body bearing sparse long and erect white setae.

Remarks

We were unable to extract viable DNA for analysis from our material; however, the clearly trapezoidal head (in dorsal view) distinguishes this species from the similar looking *M. hongkongensis* sp. nov.

Methocha hongkongensis Barthélémy & Terayama sp. nov.
urn:lsid:zoobank.org:act:079CE0F9-1F02-4F81-9AAC-2099124D344E
Figs 4A–C, 5B–C, H, 6B–C, 7B–C, 8B–C, 9B–C, 10B–C, 11B–C, 12A, D, 13A, D

Diagnosis

Females of this species can be distinguished from other Asian congeners by the following combination of characters: body entirely black, scape dark brown; head dorsally sub-triangular, with shallow convex posterolateral margin; mandibles not distally narrowed; clypeus with narrowly convex anterior margin; frontal tubercule reduced; ocelli forming an isosceles triangle; pronotum, mesoscutellum, and propodeum largely smooth; tarsal claws with subapical tooth equal to apical tooth. Males can be differentiated by the following combination of characters: mandibles, antennae, legs, fore and mid coxae and tegula dark orange-brown; frons densely punctured; clypeus concave; pronotal anterior carina present; notauli present; episternal sulcus deep; propodeum areolate; tarsal claws tridentate, apical tooth sharp, subapical tooth blunt/truncate about the same length of the apical one, basal one smaller.

Etymology

The specific epithet refers to the type locality.

Type material

Holotype

CHINA – **Hong Kong** • ♀; Pak Sha O; 22°26′59″ N, 114°19′04″ E; 70 m a.s.l.; 1–15 Sep. 2018; C. Barthélémy leg.; Malaise trap; CASC, ref.: M364.C.Hy.2.

Paratypes

CHINA – **Hong Kong** • 1 ♀; Mang Kung Wo; 22°22′06″ N, 114°15′12″ E; 60 m a.s.l.; 28 Apr.–12 May 2018; C. Barthélémy leg.; Malaise trap; GenBank no.: PV631180; CBC, ref.: M345.C.Hy.9 • 1 ♀; same collection data as for preceding; 25–29 Sep. 2018; C. Barthélémy leg.; Malaise trap; CBC, ref.: M369.C.Hy.1 • 1 ♀; same collection data as for preceding; 19 Oct.–3 Nov. 2019; C. Barthélémy leg.; Malaise trap; CBC, ref.: M447.C.Hy.2 • 1 ♀; same collection data as for preceding; 25 Apr.–3 May 2020; C. Barthélémy leg.; Malaise trap; CBC, ref.: M485.C.Hy.7 • 1 ♀; Pak Sha O; 22°26′59″ N, 114°19′04″ E; 70 m a.s.l.; 15–29 Jun. 2019; C. Barthélémy leg.; Malaise trap; CBC ref.: M420.C.Hy.3 • 1 ♀; same collection data as for preceding; 15–29 Jun 2020; C. Barthélémy leg.; Malaise trap; CBC, ref.: M470.C.Hy.1 • 2 ♀♀; same collection data as for preceding; 29 Feb.–14 Mar. 2020; C. Barthélémy leg.; Malaise trap; CBC, refs: M474.C.Hy.1, M474.C.Hy.3 • 1 ♀; same collection data as for preceding; 16–30 Jan. 2021; C. Barthélémy leg.; Malaise trap; GenBank no.: PV631177; CBC ref.: M541.C.Hy.1 • 1 ♀; same collection data as for holotype; 5–18 Jul. 2020; C. Barthélémy leg.; Malaise trap; GenBank no.: PV631178; CBC, ref.: M500.C.Hy.3 • 1 ♂; same collection data as for holotype; 10 Apr.–24 May

2021; C. Barthélémy leg.; Malaise trap; GenBank no.: PV631176; CBC, ref.: M556.C.Hy.1 • 1 ♂; same collection data as for holotype; 8–23 May 2021; C. Barthélémy leg.; Malaise trap; GenBank no.: PV631175; CBC, ref.: M561.C.Hy.3.

Description

Female

Standard ratios (n = 10). L: 4.4–7.1 mm (mean = 5.71 mm); CR: 1.02–1.27 (mean = 1.18); OOR: 0.62–0.73 (mean = 0.67); CLR: 0.28–0.40 (mean = 0.35); MER: 0.22–0.25 (mean = 0.24); OMR: 0.45–0.56 (mean = 0.52); FRR: 1.77–2.19 (mean = 1.94); MSR: 1.42–1.71 (mean = 1.52); PRR: 0.70–0.76 (mean = 0.72).

Head (Figs 5B, 7B, 8B, 9B). Head slightly wider than high in frontal view (mean CR = 1.18) width 2.4 × narrowest interocular distance; head subtriangular dorsally (Fig. 8B), 1.4 × as long as wide, with almost straight posterolateral margin; ocelli large, forming an isosceles triangle (Fig. 8B); frons, vertex and gena largely smooth, with sparse and minute punctures (Figs 5B, 7B, 8B); frontal tubercule well defined and bi-lobed (Fig. 8B), space lateral to tubercule minutely rugose; frontal line absent; clypeus convex, anterior margin weakly rounded (Fig. 9B), sub-flat, anterior part with minute punctures, posterior part minutely rugulose; mandibles not distally narrowed, lower tooth longer than upper one (Fig. 9B); pedicel long, 0.6 × length of FL1; FL1–FL3 in a ratio of 10 : 9 : 7 in length.

Mesosoma (Figs 10B, 11B). Collar of pronotum rugulose anteriorly, costate posteriorly in dorsal view (Fig. 11B); pronotal disc smooth bearing a few sparse and minute punctures; mesonotum longer than pronotum (× 1.28), mesoscutum with concave dorsal margin in lateral view, mesoscutellum smooth, gently convex in lateral view, not obviously separated from mesepisternum (evanescent suture) (Fig. 10B); tegula absent; mesepisternum mostly smooth bearing a few minute punctures; metanotum smooth; propodeum globular, smooth (Figs 10B, 11B).

Metasoma (Fig. 5B). Terga polished, bearing largely interspaced minute punctures, petiole rugose. Sterna polished bearing minute punctures.

Legs. All tarsal claws tridentate, apical and subapical tooth sharp both of about the same length, basal tooth minute.

Colour and vestiture (Figs 5B, 6B). Body entirely black except coxae and tarsi dark brown. Body bearing sparse long and erect white setae.

Male

Standard ratios (n = 4). L = 8.4–12.1 mm (mean = 10.35 mm); CR: 1.17–1.31 (mean = 1.25); OOR: 0.47–0.65 (mean = 0.58); CLR: 0.42–0.51 (mean = 0.45); MER: 0.50–0.55 (mean = 0.53); OMR: 0.54–0.58 (mean = 0.57); FRR: 2.8–3.53 (mean = 3.14); MSR: 1.03–1.16 (mean = 1.09); PRR: 1.96–2.45 (mean = 2.25).

Head (Figs 5C, 7C, 8C, 9C). Head wider than high in frontal view (mean CR = 1.25), width 2 × narrowest interocular distance; head 2 × as long as wide dorsally, with convex posterior margin; ocelli forming an equilateral triangle (Fig. 8C); vertex weakly punctured, punctures separated by distance 1–8 × their own diameters (Fig. 8C); frons densely punctured, punctures separated by distance equal or less than their own diameters (Figs 7C, 8C); gena weakly punctate, punctures separated by distance 3–5 × their own diameters; clypeus concave, disc bearing a high convex tubercule, surface uniformly punctured with large punctures, clypeal apex emarginate, apical fifth bearing translucent lamina (Fig. 9C); mandibles not distally narrowed, apical tooth longer than subapical one; FL1–FL3 in a ratio of 3 : 5 : 5 in length.

Mesosoma (Figs 10C, 11C, 12A). Pronotum weakly punctate with smooth interspace (Fig. 10C), puncture separated by distance 3–4 × their own diameters, lateral and ventral surfaces punctate as dorsal

side; pronotal anterior carina present (Fig. 11C); mesoscutum densely punctate, punctures separated by distance equal or less than their own diameter with smooth interspace; notauli present (Fig. 11C); parapsidal furrow with deep fovea, reaching posterior edge of mesoscutum (Fig. 11C); posterior margin of mesoscutum clearly marked; scutellum bulging with large punctures, punctures separated by distance equal or less that their own diameter with smooth interspaces (Fig. 11C), lateral slope with large punctures; mesepisternum convex and punctate, punctures separated by distance equal or less than their own diameter with smooth interspaces (Fig. 10C), dorsal depression with six to seven longitudinal large fovea (Fig. 10C); episternal sulcus deep; metanotum elevated, punctured, laterally smooth; metapleuron with a few weak and shallow transverse striations; propodeum areolate (Fig. 12A).

Metasoma (Figs 12D, 13A–D). T1 weakly punctate, puncture separated by distance 2–8 × their own diameter; T2–T4 uniformly punctate, punctures small and separated by distance 2–3 × their own diameter with smooth interspaces; T1 with weak median depression not reaching apical margin, depression shiny; anterior transverse depression of T2 costate; T3–T5 without anterior carina, T5–T7 punctate as T1; S1 with uniform and dense punctures, punctures separated by distance less than their own diameter; S2–S7 punctate as terga, anterior third bearing sparse small punctures (Fig. 13A); hypopygium punctate (Fig. 13D).

Legs. Tarsal claws tridentate, apical tooth sharp, subapical tooth blunt/truncate about same length of apical one, basal one smaller, length about ½ subapical tooth; hind coxa without a rounded and elevated carina dorsally.

Colour and vestiture (Figs 5C, 6C). Body entirely black except mandibles, antennae, legs, fore and mid coxae and tegula dark brown; wing veins brown. Body with sparse appressed silvery setae; antenna covered with short suberect brownish setae; S2–S4 with row of long brownish setae on apical margin.

Remarks

This species, especially females, resembles *M. maai* from Taiwan in the black body and the tarsal claws with the subapical tooth equal to the apical tooth. However, it is separated from the latter by the convex anterior margin of the clypeus (truncate in *M. maai*), the ocelli forming an isosceles triangle (equilateral triangle in *M. maai*), the weakly convex posterior margin of the head in frontal view (strongly convex in *M. maai)*, and the gently convex dorsal margins of the pronotum, mesonotum and propodeum in profile (strongly convex in *M. maai*).

Females are usually rare in this genus, but this species is commonly seen in Hong Kong with numerous postings on the i-Naturalist website at https://www.inaturalist.org/projects/hong-kong-bees-and-wasps (20 observations) and is the most common female caught in Malaise traps (11 specimens). The male was associated through DNA analysis.

Methocha leleji Barthélémy & Terayama sp. nov.
urn:lsid:zoobank.org:act:AFDE6899-F985-48A3-8F4D-164EB9B4CAEF
Figs 5D, 6D, 7D, 8D, 9D, 10D, 11D

Diagnosis

The female of this species can be distinguished from other Asian congeners by the following combination of characters: head and metasoma black and mesosoma red; dorsal surface of mesoscutum laterally flat; posterolateral margin of head convex, forming blunt angle in dorsal view, clypeus with a large median lobe which is rounded and translucent; pronotal disc largely smooth and shining. The male is unknown.

Etymology

The specific name is in honour of Arkady S. Lelej (Laboratory of Entomology of the Federal Scientific Center of the East Asia Terrestrial Biodiversity in Vladivostok), a charming person and eminent hymenopterist.

Type material

Holotype

CHINA – **Hong Kong** • ♀; Pak Sha O; 22°26′59″ N, 114°19′04″ E; 70 m a.s.l.; 24 Sep.–22 Oct. 2011; C. Barthélémy leg.; Malaise trap; GenBank no.: PV631183; CASC, ref.: M099.C.Hy.2.

Paratypes

CHINA – **Hong Kong** • 1 ♀; same collection data as for holotype; 20 Jun.–4 Jul. 2015; C. Barthélémy leg.; Malaise trap; GenBank no.: PV631182; CBC, ref.: M209.C.Hy.1 • 1 ♀; San Tau Village; 22°17′22″ N, 113°55′07″ E; 5 m a.s.l.; 10 Oct. 2023; M.T. Hamer leg.; hand net, CBC, ref.: 0741.F.Hy.1 • 1 ♀; Yee Ting Campsite; 22°24′30″ N, 114°19′24″ E; 35 m a.s.l.; 19 May 2022; M.T. Hamer leg.; hand net; CBC, ref.: 0742.F.Hy.1.

Description

Female

Standard ratios (n = 4). L: 5.7–8.6 mm (mean = 6.8 mm); CR: 0.88–1.14 (mean = 1.06); OOR: 0.38–0.44 (mean = 0.40); CLR: 0.35–0.44 (mean = 0.39); MER: 0.21–0.28 (mean = 0.24); OMR: 0.29–0.53 (mean = 0.45); FRR: 2.40–2.95 (mean = 2.57); MSR: 1.45–1.62 (mean = 1.54); PRR: 0.69–0.82 (mean = 0.76).

Head (Figs 5D, 7D, 8D, 9D). Head as high as wide in frontal view (mean CR = 1.06), width 2.0 × narrowest interocular distance; head 1.7 × as long as wide dorsally, with convex posterolateral margin; ocelli forming an equilateral triangle (Fig. 8D); frons shagreened; vertex and gena largely smooth, with sparse and shallow punctures (Figs 5D, 8D), punctures separated by distance 2–8 × their own diameter; pair of small frontal tubercules present, surface above tubercules mostly smooth; frontal line weakly present; clypeus with weakly rounded apical margin, disc bearing conspicuous tubercule, apical part with numerous minute punctures, dorsal part finely rugulose (Fig. 9D); mandibles not distally narrowed, lower tooth longer than upper one; pedicel long, 0.7 × length of FL1; FL1–FL3 in a ratio of 7 : 7 : 6 in length.

Mesosoma (Figs 10D, 11D). Pronotum dorsally narrow (mean PRR = 0.76), collar costate dorsally (Fig. 11D), disc with only a few sparse and small puncture (Fig. 11D); mesonotum with trapezoidal disc, mostly impunctate, length a little shorter (× 0.88) than pronotum, mesoscutum with three longitudinal grooves, flat in lateral view; mesoscutellum separated from mesepisternum by distinct groove; tegula vestigial but present (Fig. 11D); mesepisternum mostly smooth bearing a few minute punctures and a sub-horizontal carina in its ventral half (Fig. 10D); metanotum smooth; propodeum globular, smooth (Figs 10D, 11D).

Metasoma (Fig. 5D). Terga mostly polished, bearing a few minute punctures; sterna polished, S3 bearing minute hexagonal mesh pattern on basal half; petiole transversely rugose.

Legs. Tarsal claws tridentate; apical tooth sharp; subapical tooth blunt, about ½ length of apical tooth; basal tooth minute, about ½ length of subapical tooth.

Colour and vestiture (Figs 5D, 6D). Head black, except mandibles and first five antennomeres reddish yellow; 6th to terminal antennomeres blackish; terga mostly black, apical ones dark brown, sterna dark brown; legs with dorsal sides of femora dark brown; mesosoma reddish. Vestiture sparse and white.

Remarks

This female resembles *M. yasumatsui* from Japan, *M. emarginata* and *M. plana*, both from Taiwan. However, it is separated from *M. yasumatsui* by the convex posterolateral margins of the head (almost straight in *M. yasumatsui*) and the absence of median longitudinal striae on the pronotal disc, and from *M. emarginata* and *M. plana* by the shape of the clypeus with a large median lobe which is rounded and translucent.

Methocha wilsoni Barthélémy & Terayama sp. nov.
urn:lsid:zoobank.org:act:9FE8FEF0-2BE5-4090-A61D-4B9BFA48D409
Figs 3A–C, 5E, 6E, 7E, 9E, 10E, 11E, 12B, E, 13B, E

Diagnosis

The male of this species is characterized by the following combination of characters: head from above subtriangular, with convex posterior margin; ocelli forming small, acute triangle; clypeus distally translucent, viewed laterally, with low convex tubercle at base; vertex coarsely punctate; anterior margin of pronotum not carinate; notauli absent; mesepisternum moderately punctate, without distinct median fovea; propodeum dorsally areolate; tarsal claws with subapical tooth shorter than apical tooth. The female is unknown.

Etymology

The specific epithet is in honour of the late famous American ant specialist and revolutionary socio-biologist E.O. Wilson.

Type material

Holotype

CHINA – **Hong Kong** • ♂; Pak Sha O; 22°26′59″ N, 114°19′04″ E; 70 m a.s.l.; 15–27 Apr. 2009; C. Barthélémy leg.; Malaise trap; CASC, ref.: M060.C.Hy.4A.

Paratypes

CHINA – **Hong Kong** • 1 ♂; same collection data as for holotype; CBC, ref.: M060.C.Hy.4B • 1 ♂; same collection data as for holotype; 27 Apr.–14 May 2009; C. Barthélémy leg.; Malaise trap; CBC, ref.: M061.C.Hy.11 • 1 ♂; same collection data as for holotype; 14–31 May 2009; C. Barthélémy leg.; Malaise trap; CBC, ref.: M062.C.Hy.1 • 1 ♂; same collection data as for holotype; 30 Apr.–15 May 2010; C. Barthélémy leg.; Malaise trap; CBC, ref.: M075.C.Hy.4 • 1 ♂; same collection data as for holotype; 3–10 Jul. 2010; C. Barthélémy leg.; Malaise trap; CBC, ref.: M079.C.Hy.4 • 1 ♂; same collection data as for holotype; 1–15 Sep. 2018; C. Barthélémy leg.; Malaise trap; CBC, ref.: M364.C.Hy.11 • 2 ♂♂; same collection data as for holotype; 25 Apr.–9 May 2020; C. Barthélémy leg.; Malaise trap; CBC, refs: M486.C.Hy.2, M486.C.Hy.4 • 1 ♂; same collection data as for holotype; 9–23 May 2020; C. Barthélémy leg.; Malaise trap; GenBank no.: PV631179; CBC, ref.: M488.C.Hy.3 • 2 ♂♂; same collection data as for holotype; 9–23 May 2020; C. Barthélémy leg.; Malaise trap; CBC, refs: M488.C.Hy.5A, M488.C.Hy.5B • 1 ♂; same collection data as for holotype; 10–25 Oct. 2020; C. Barthélémy leg.; Malaise trap; CBC, ref.: M522.C.Hy.2 • 2 ♂♂; Mang Kung Wo; 22°22′06″ N, 114°15′12″ E; 60 m a.s.l.; 10 Apr.–24 May 2021; C. Barthélémy leg.; Malaise trap; GenBank no.: PV631184; CBC, refs: M557.C.Hy.2A, M557.C.Hy.2B.

Description

Male

Standard ratios (n = 14). L: 9.4–13.2 mm (mean = 11.4 mm); CR: 1.29–1.66 (mean = 1.39); OOR: 0.31–0.43 (mean 0.35); CLR: 0.27–0.42 (mean = 0.37); MER: 0.52–0.60 (mean = 0.55); OMR: 0.43–0.51 (mean = 0.46); FRR: 2.33–3.18 (mean = 2.83); MSR: 0.89–1.17 (mean = 1); PRR: 2.30–3.85 (mean = 2.67).

Head (Figs 5E, 7E, 8E, 9E). Head wider than high in frontal view (mean CR = 1.39), width 2.0× narrowest interocular distance; head 1.7× as long as wide dorsally, with convex posterior margin (Fig. 8E); ocelli forming a small isosceles triangle (Fig. 8E); vertex weakly punctured, punctures separated by distance 2–6× their own diameters; frons densely punctured (Figs 7E, 8E), punctures separated by distance less than their own diameters; gena punctate, punctures separated by distance more

or less equal to their own diameter; gena narrowed ventrally; clypeus narrowly convex, disc bearing a low convex tubercule, surface uniformly punctured with large punctures, clypeal apex truncate, apical fifth bearing translucent lamina (Fig. 9E); mandibles not distally narrowed, apical tooth longer than subapical one; FL1–FL3 in a ratio of 5 : 6 : 6 in length.

Mesosoma (Figs 10E, 11E, 12B). Pronotum punctate, anterior two-third with large and numerous punctures separated by their own diameter or less, posterior third with smaller punctures, distance between punctures 2–3 × their own diameter with smooth interspace (Figs 10E, 11E), lateral and ventral surfaces punctate as dorsal side; pronotal anterior carina absent; mesoscutum punctate (Fig. 11E), punctures separated by distance 2–3 × their own diameter with smooth interspace; notauli absent; parapsidal furrow simple, reaching posterior edge of mesoscutum; posterior margin of mesoscutum clearly marked (Fig. 11E); scutellum bulging and punctate, punctures separated by distance less that their own diameter with smooth interspaces, lateral slope with minute punctures; mesepisternum convex and punctate (Fig. 10E), punctures separated by distance less than their own diameter with smooth interspaces; episternal sulcus deep and foveate (Fig. 10E); metanotum elevated, punctured, laterally striate; metapleuron transversely striate; propodeum areolate becoming more or less rugulose posteriorly (Fig. 12B).

Metasoma (Figs 12E, 13B, 13E). T1–T4 uniformly punctate, punctures small and separated by distance 2–6 × their own diameter with smooth interspaces (Fig. 12E); T1 with marked and deep median furrow nearly reaching posterior margin; anterior transverse depression of T2 costate; T3–T5 with anterior carina, T5–T7 punctate as T1 but with anterior quarter bearing dense small punctures; S1 with uniform and dense punctures; S2–S7 punctate as terga, anterior third bearing dense small punctures; hypopygium with longitudinal striae, wide at base (Fig. 13E).

Legs. Tarsal claws tridentate, apical tooth sharp, subapical tooth blunt/truncate about ½ the length of apical one, basal one minute length about ½ of subapical tooth; hind coxa with a rounded and elevated carina dorsally.

Colour and vestiture (Figs 5E, 6E, 11B). Body entirely black except mandibles, legs, coxae and tegula dark brown; wing veins brown. Body with appressed silvery setae; antenna covered with short suberect brownish setae; S2–S7 with erect row of long white setae on apical margins (13B).

Remarks

It most resembles *Methocha mandibularis* from Shanghai; however, it is separated from the latter by the black mandibles with reddish apices (yellow with black apices in *M. mandibularis*), the clypeus narrowly convex (rounded with a notch in the middle in *M. mandibularis*), fore wings uniformly subhyaline (fore wings subhyaline, darkest towards the apex in *M. mandibularis*) and the marginal cell plain (with dark spot in *M. mandibularis*).

Methocha zetetes Barthélémy & Terayama sp. nov.
urn:lsid:zoobank.org:act:980CBBCC-50A4-481E-99FC-F42E12C3219B
Figs 5F, 6F, 7F, 8F, 9F, 10F, 11F, 12C, F, 13C, F

Diagnosis

This male of this species is characterized by the following combination of characters: head from above rectangular, with convex posterior margin; ocelli forming small, equilateral triangle; clypeus emarginate; vertex weakly punctate; anterior margin of pronotum with weak carina; notauli absent; mesepisternum weakly punctate, without distinct median fovea; propodeum dorsally striate, laterally areolate, slope smooth; tarsal claws with subapical tooth equal in length to the apical one. The female is unknown

Etymology

The specific name is derived from the ancient Greek word ζητητῐκός (‘zētētĭkós’), meaning ‘seeker’, in reference to the prey-searching habits of this genus.

Type material

Holotype

CHINA – **Hong Kong** • ♂; Tai Tam Tuk; 22°14′59″ N, 114°13′34″ E; 2 m a.s.l.; 4 Nov.–2 Dec. 2017; C. Barthélémy leg.; Malaise trap; GenBank no.: PV631181; CASC, ref.: M321.E.Hy.4A.

Paratype

CHINA – **Hong Kong** • 1 ♂; same collection data as for holotype; CBC, ref.: M321.E.Hy.4B.

Description

Male

Standard ratios (n = 2). L: 6.6–7.4 mm (mean = 7 mm); CR: 1.24–1.40 (mean = 1.32); OOR: 0.48–0.50 (mean = 0.49); CLR: 0.36–0.38 (mean = 0.37); MER: 0.57–0.62 (mean = 0.59); OMR: 0.52–0.53 (mean = 0.53); FRR: 3.29–3.39 (mean = 3.34); MSR: 1–1.08 (mean = 1.04); PRR: 3.08–3.18 (mean = 3.13).

Head (Figs 5F, 7F, 8F, 9F). Head wider than high in frontal view (mean CR = 1.32), width 2 × narrowest interocular distance; head 2 × as long as wide dorsally, with convex posterior margin (Fig. 8F); ocelli forming a small equilateral triangle (Fig. 8F); vertex weakly punctured, punctures separated by distance 2–3× their own diameters (Fig. 8F); frons densely punctured (Fig. 7F), punctures separated by distance equal to their diameters or less; gena weakly punctate, punctures separated by distance 2–3× their own diameter; clypeus convex, disc bearing a low convex tubercule, surface uniformly punctured with large punctures, clypeal margin emarginate (Fig. 9F); mandibles not distally narrowed, apical tooth longer than subapical one; FL1–FL3 in a ratio of 4 : 5 : 5 in length.

Mesosoma (Figs 10F, 11F, 12C). Pronotum weakly punctate, anterior third with large punctures separated by their own diameter or less, posterior two-thirds with weak and minute punctures, distance between punctures 3–5 × their own diameter with smooth interspace (Fig. 11F), lateral and ventral surfaces punctate as dorsal side; pronotal anterior carina present but weakly expressed; mesoscutum punctate (Fig. 10B), punctures separated by distance 1–2 × their own diameter with smooth interspace; notauli present; parapsidal furrow simple, reaching posterior edge of mesoscutum; posterior margin of mesoscutum clearly marked (Fig.11F); scutellum bulging and weakly punctate, punctures separated by distance 2–4 × their own diameter with smooth interspaces, lateral slope with minute punctures; mesepisternum convex and weakly punctate (Fig. 10F), punctures separated by distance 4–8 × their own diameter with smooth interspaces; episternal sulcus simple (Fig. 10F); metanotum elevated, laterally with fovea; metapleuron transversely striate; sides of propodeum areolate (Fig. 11F), dorsal side striate, slope smooth and shiny centrally (Fig. 12C).

Metasoma (Figs 12F, 13C, F). T1–T7 weakly punctate (Fig. 12F), punctures minute and separated by distance 4–8 × their own diameter with smooth interspaces; T1 without median furrow; anterior transverse depression of T2 smooth; S1–S7 punctate (Fig 13C), punctures separated by distance 2–3 × their own diameter with smooth interspaces, anterior third bearing dense small punctures; hypopygium smooth, wide at base (Fig. 13F).

Legs. Tarsal claws tridentate, apical tooth sharp, subapical tooth blunt/truncate the same length as apical one, basal one minute, length about ½ of subapical tooth; hind coxa with a weak carina dorsally.

Colour and vestiture (Figs 5F, 6F). Body entirely black except apical part of mandibles and tegula dark brown; wing veins brown. Body with appressed silvery setae; antenna covered with short suberect brownish setae; S2–S7 with erect row of long brown setae on apical margins.

Remarks

This species resembles *M. transcarinata* Liao, Chen & Li, 2022 in having the propodeum posteriorly with a transverse carina between the dorsal and posterior surfaces; the mesepisternum anteriorly with a strong carina followed by a deep smooth groove; the clypeus emarginate (circularly) with an obtuse prominence medially; the absence of a pronotal carina and T1 antero-laterally with a pair of strong longitudinal carinae. However, important morphological features differ: FL1 without ventral carina (FL1 with ventral carina in *M. transcarinata*); claws of hind tarsus with subapical tarsal tooth equal in length to apical tooth (shorter than ½ of apical tooth in *M. transcarinata*); species much smaller with a length of 6.6–7.4 mm (9.2–9.6 mm in *M. transcarinata*). In consequence, we consider that the Hong Kong material is a different species, but we hypothesise that it may be closely related to *M. transcarinata*.

DNA analysis revealed that this species was distinct from all other Hong Kong material.

Discussion

Biogeography

The map (Fig. 1A) illustrates our present knowledge of the distribution of this genus in Asia and the Oriental realm; it is not a real distribution map, inasmuch that it shows our paucity of collection records of *Methocha*, a genus rarely observed or collected and somehow cryptic and, in consequence, it is conceivable that the taxon will be discovered in the blank spots of the Oriental realm of Fig.1A (i.e., Pakistan, Bangladesh, Myanmar, Thailand, Cambodia, Vietnam, Indonesian Archipelago and the Philippines Archipelago) when targeted trapping and/or sampled Malaise trap records become available for these countries and islands. Although males are strong flyers, females are apterous which is often considered an impediment to dispersal, and it is likely that the bio-diverse Indonesian and Philippines Archipelagos will harbour a fauna with large components of endemism, when such data becomes available. This is indirectly supported by the lack of overlap of species regionally in Asia, indeed taxa in a country where records exist are generally unique to that country, except for *M. articulata* found in Mongolia and South Korea as well as being widespread in the Palearctic region, *M. cariniventris* Narita & Mita, 2018 found in Laos and China, *M. kandyensis* Krombein, 1982 found in Sri Lanka and China, *M. taprobane* Krombein, 1982 found in Sri Lanka and India, *M. ubiquita* Krombein, 1982 found in Sri Lanka and India, and *M. violaceipennis* (Cameron, 1899) found in India and Peninsular Malaysia, although this could be an artifact of historical recording methods. More work is needed to understand the biogeography of this genus, at least for the Oriental taxa; and future studies could answer the suspected high endemism of species in the genus *Methocha*.

Biology

With the material collected for this study, we have also retrieved a number of possible hosts, Cicindelinae being sometimes numerous in Malaise traps. These include *Cosmodela aurulenta juxtata* Acciavatti & Pearson, 1989 (ca 90% of all specimens caught); *Tricondyla pulchripes* White, 1844; *Myriochila speculifera* (Chevrolat, 1845); *Neocollyris moesta* (Schmidt-Goebel, 1846) and *Cylindera* (*Ifasina*) *decolorata* (Horn, 1907) (Paul Aston HK det.).

Methocha males can be relatively abundant in the catch of Malaise traps, with 13 specimens in a three-week session (3–24 Sep. 2011). Of the 16 females, 10 are of the same species, *Methocha hongkongensis* sp. nov. The male bias observed could be a direct consequence of our collecting method, most females likely evading the trap by remaining on the ground; those that were collected were possibly introduced into the trap during copulation, the male 'transporting' the female in copula as is known in other Thynnidae (e.g., Burrell 1935; Given 1954; Alcock 1981) and the capture of those for which the male is unknown remains unexplained. But, in fact, nothing is known of the reproductive behaviour of the genus *Methocha*. Further research is needed to understand the biology of the genus, particularly mating.

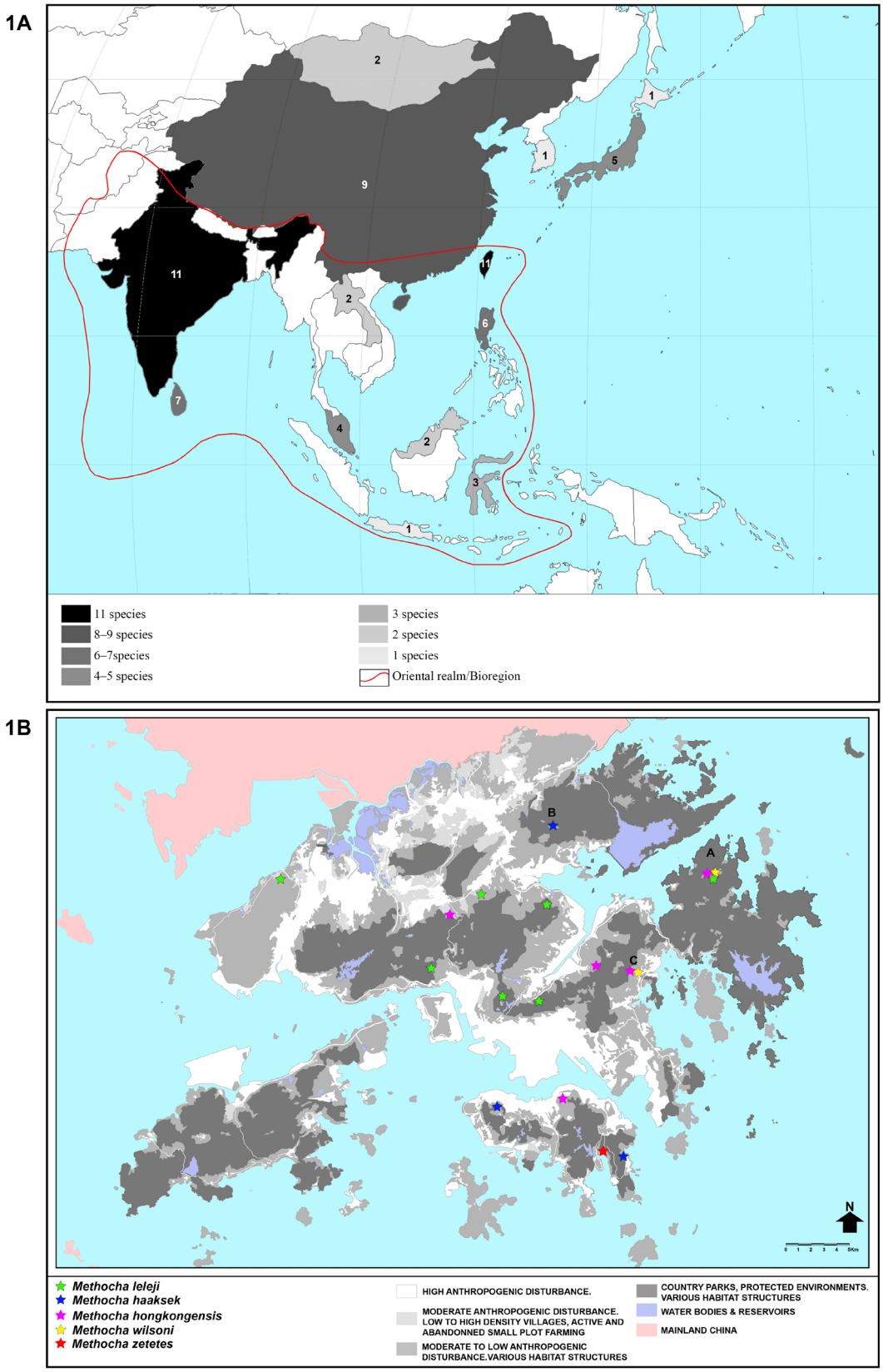

Fig. 1. *Methocha* spp. distribution. **A**. Asian distribution of *Methocha* spp. **B**. Hong Kong distribution of five species of *Methocha* spp.

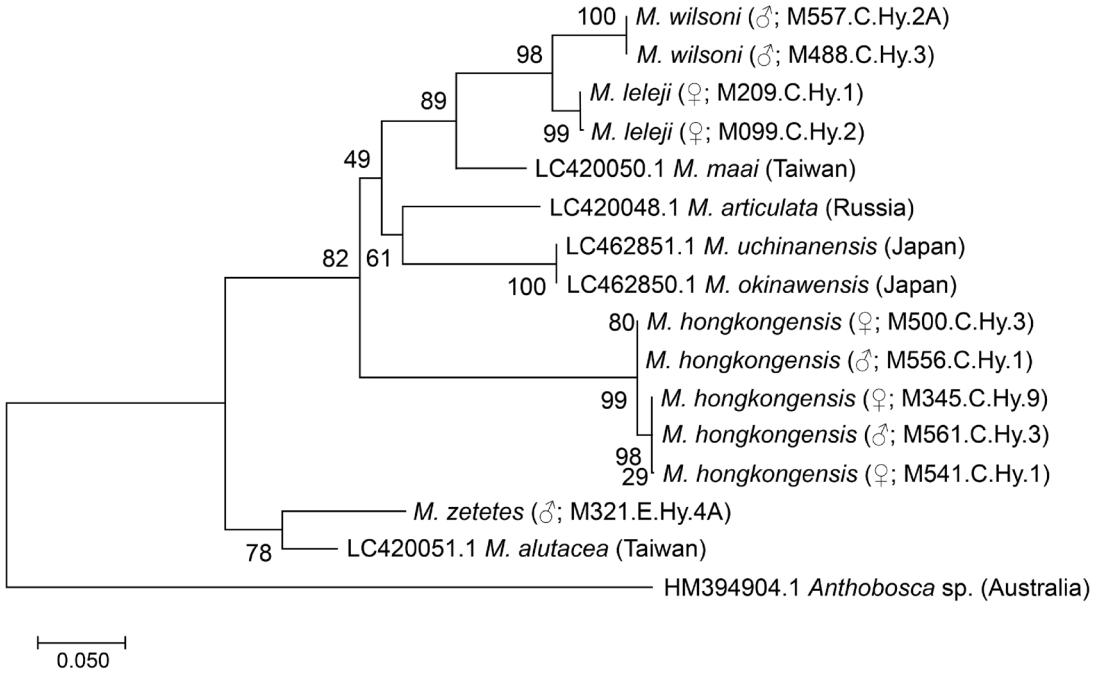

Fig. 2. Phylogenetic relationships of DNA-barcoded individuals of four species from this study. The bootstrap values are shown next to the branches. Individual specimen codes are denoted in brackets. Scale bar shows branch length in substitutions per site.

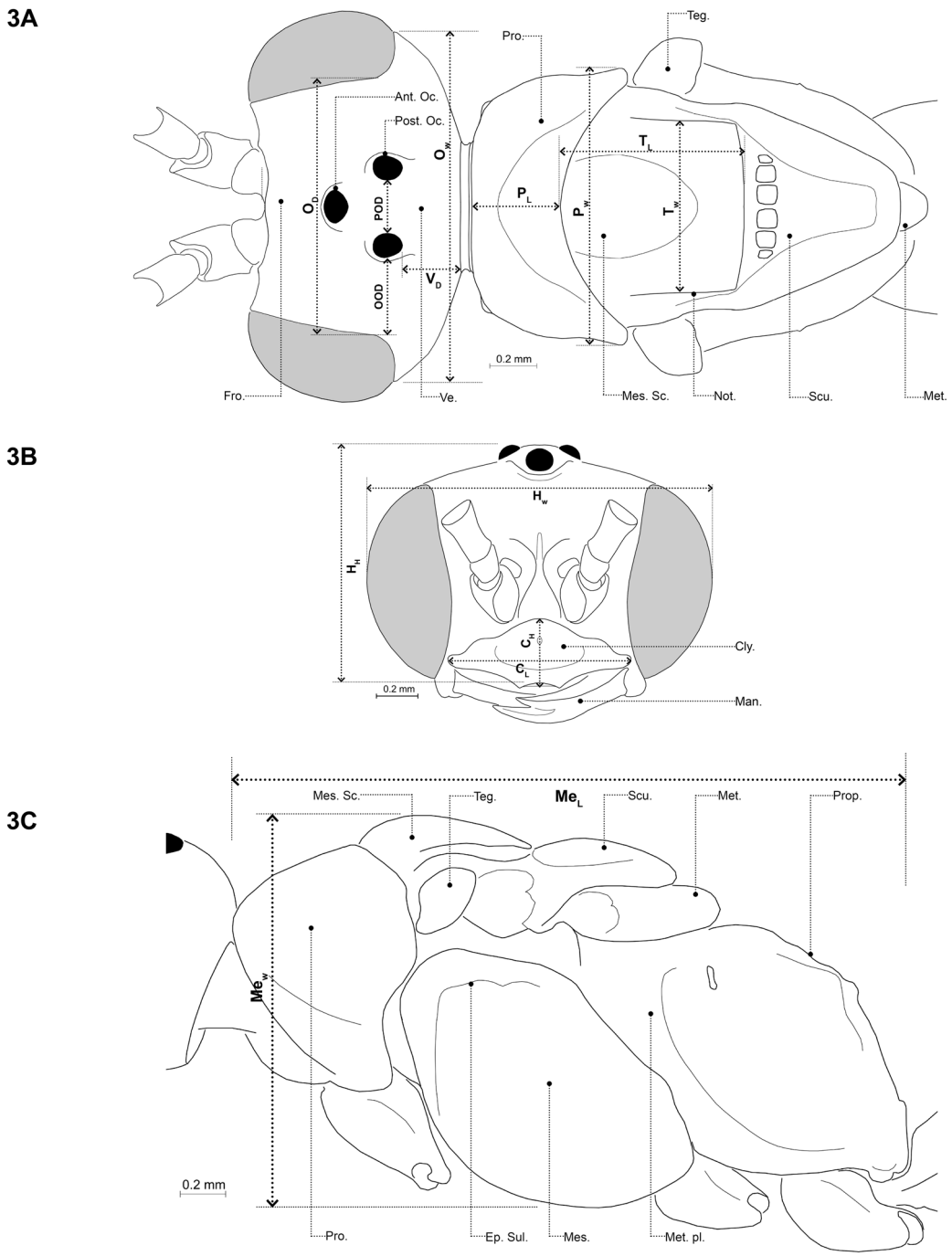

Fig. 3. *Methocha wilsoni* Barthélémy & Terayama sp. nov., ♂, measurements and morphological terms. **A**. Dorsal habitus. **B**. Head frontal view. **C**. Lateral habitus. Abbreviations: Ant. Oc. = Anterior ocellus; Cly. = Clypeus; Ep. Sul. = Episternal sulcus; Fro. = Frons; Man. = Mandible; Mes. = Mesepisternum; Mes. Scu. = Mesoscutellum; Met. = Metanotum; Met.pl. = Metapleuron; Not. = Notauli; Pos. Oc. = Posterior ocellus; Pro. = Pronotum; Prop. = Propodeum; Scu. = Scutellum; Teg. = Tegula; Ve. = Vertex.

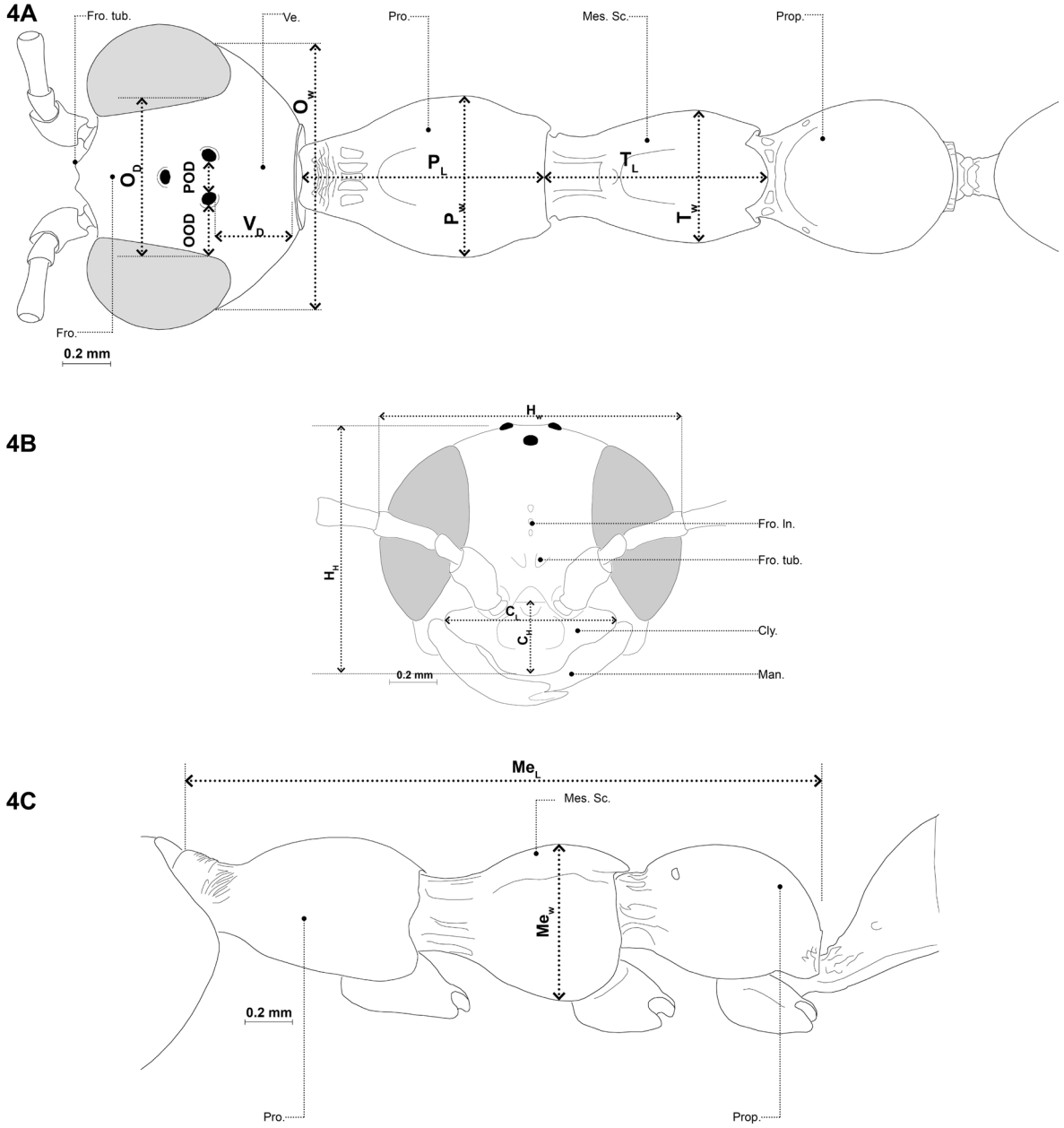

Fig. 4. *Methocha hongkongensis* Barthélémy & Terayama sp. nov., ♀; measurements and morphological terms. **A**. Dorsal habitus. **B**. Head frontal view. **C**. Lateral habitus. Abbreviations: Cly. = Clypeus; Fro. = Frons; Fro. ln. = Frontal line; Fro. tub. = Frontal tubercule; Man. = Mandible; Mes. Scu. = Mesoscutellum; Pro. = Pronotum; Prop. = Propodeum; Ve. = Vertex.

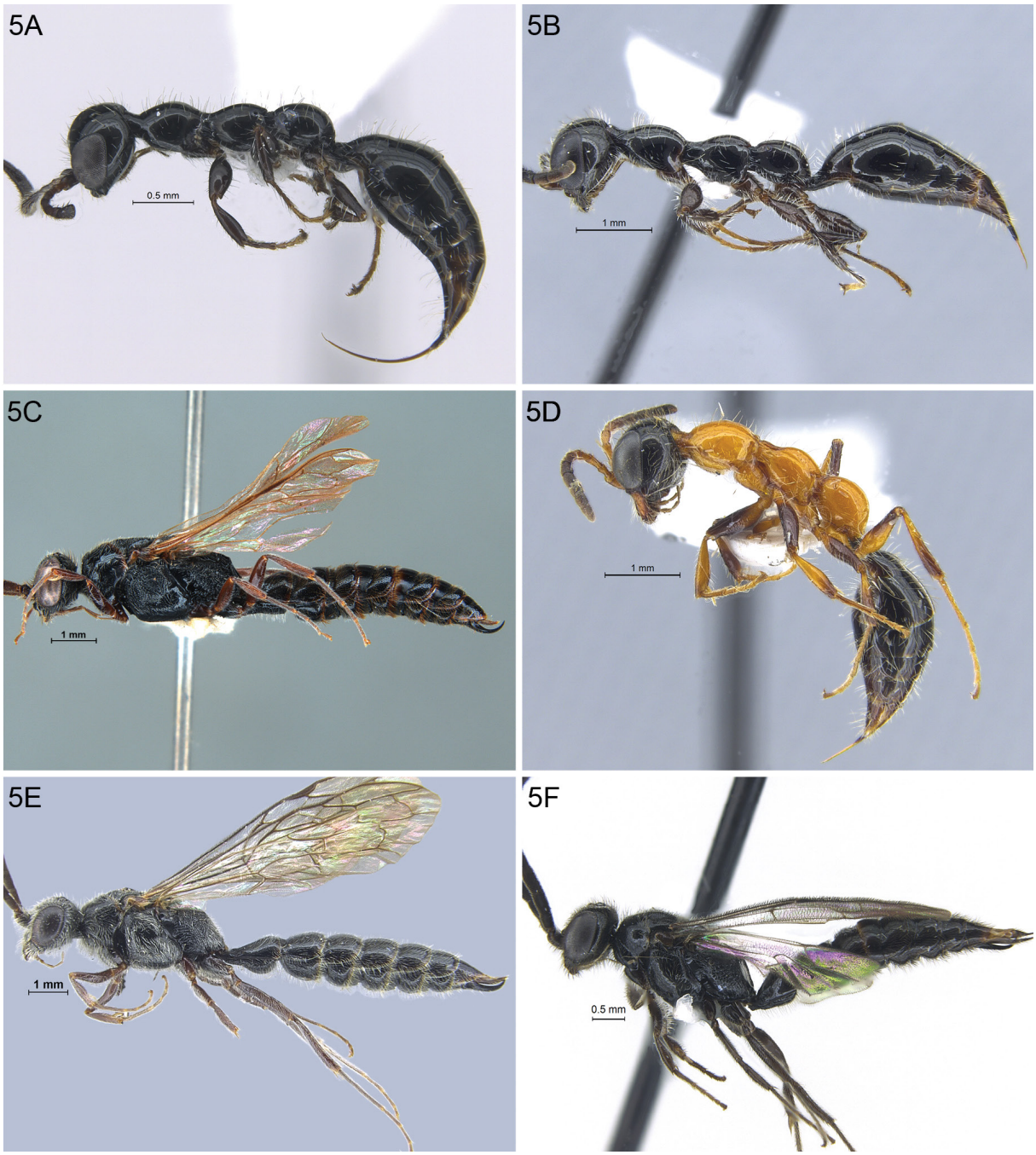

Fig. 5. Holotypes and paratypes, lateral habitus. **A**. *Methocha haaksek* Barthélémy & Terayama sp. nov., holotype, ♀, M459.D.Hy.1, CASC. **B**. *M. hongkongensis* Barthélémy & Terayama sp. nov., holotype, ♀, M364.C.Hy.2, CASC. **C**. *M. hongkongensis*, paratype, ♂, M561CHY3, CBC. **D**. ♀, *M. leleji* Barthélémy & Terayama sp. nov., holotype, ♂, M099.C.Hy.2, CASC. **E**. *M. wilsoni* Barthélémy & Terayama sp. nov., holotype, ♂, M060.C.Hy.4, CASC. **F**. *M. zetetes* Barthélémy & Terayama sp. nov., paratype, ♂, M321.E.Hy.4B, CBC.

Fig. 6. Holotypes and paratypes, dorsal habitus. **A**. *Methocha haaksek* Barthélémy & Terayama sp. nov., holotype, ♀, M459.D.Hy.1, CASC. **B**. *M. hongkongensis* Barthélémy & Terayama sp. nov., paratype, ♀, M561CHY3, CBC. **C**. *M. hongkongensis*, paratype, ♂, M561CHY3, CBC. **D**. *M. leleji* Barthélémy & Terayama sp. nov., holotype, ♀, M099.C.Hy.2, CASC. **E**. *M. wilsoni* Barthélémy & Terayama sp. nov., holotype, ♂, M060.C.Hy.4, CASC. **F**. *M. zetetes* Barthélémy & Terayama sp. nov., paratype, ♂, M321.E.Hy.4B, CBC.

Fig. 7. Holotypes and paratypes, face in frontal view. **A**. *Methocha haaksek* Barthélémy & Terayama sp. nov., holotype, ♀, M459.D.Hy.1, CASC. **B**. *M. hongkongensis* Barthélémy & Terayama sp. nov., holotype, ♀, M364.C.Hy.2, CASC. **C**. *M. hongkongensis*, paratype, ♂, M561CHY3, CBC. **D**. *M. leleji* Barthélémy & Terayama sp. nov., holotype, ♂, M099.C.Hy.2, CASC. **E**. *M. wilsoni* Barthélémy & Terayama sp. nov., holotype, ♂, M060.C.Hy.4, CASC. **F**. *M. zetetes* Barthélémy & Terayama sp. nov., paratype, ♂, M321.E.Hy.4B, CBC.

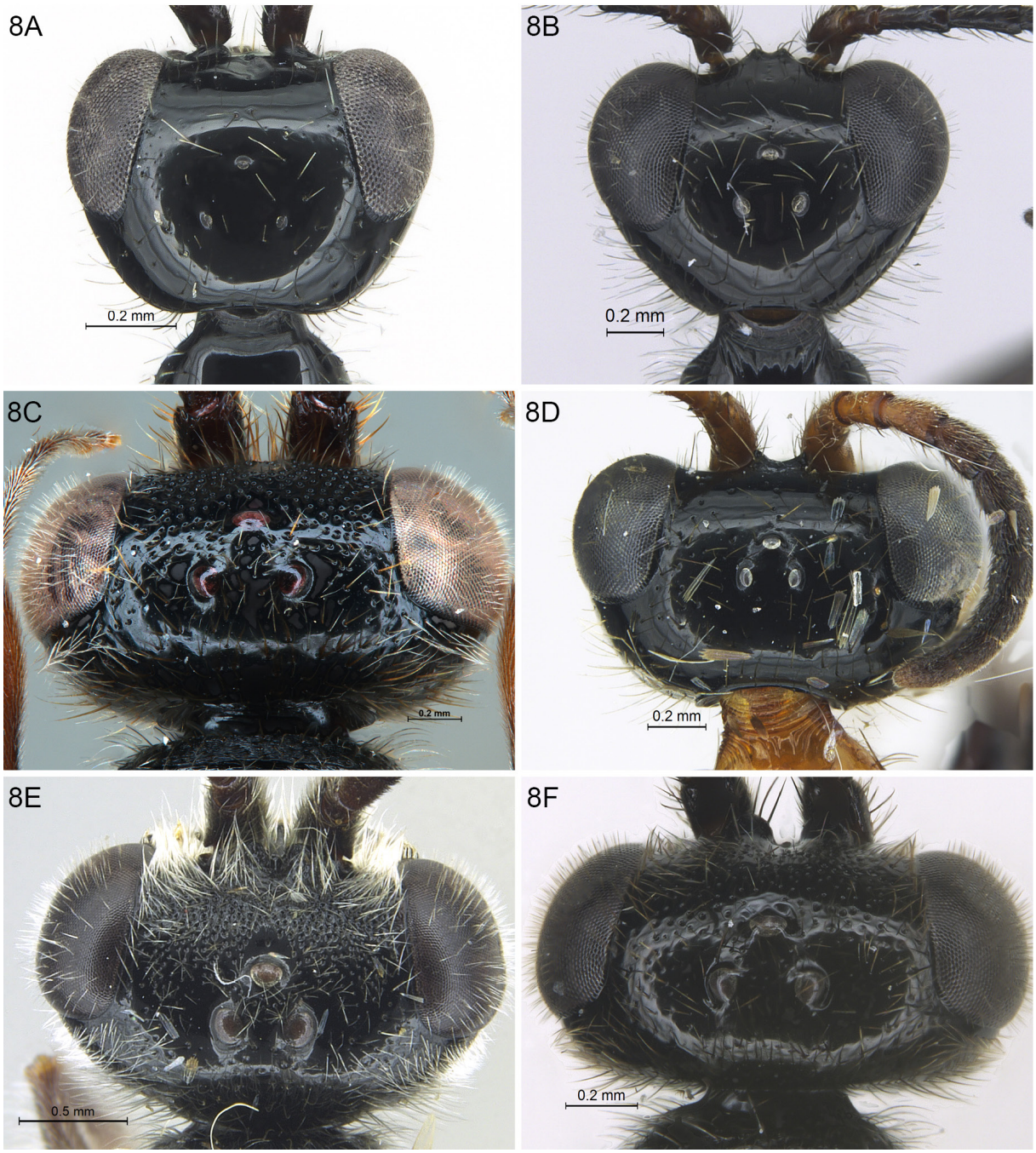

Fig. 8. Holotypes and paratypes, head in dorsal view. **A**. *Methocha haaksek* Barthélémy & Terayama sp. nov., holotype, ♀, M459.D.Hy.1, CASC. **B**. *M. hongkongensis* Barthélémy & Terayama sp. nov., holotype, ♀, M364.C.Hy.2, CASC. **C**. *M. hongkongensis*, paratype, ♂, M561.C.Hy.3, CBC. **D**. *M. leleji* Barthélémy & Terayama sp. nov., holotype, ♀, M099.C.Hy.2, CASC. **E**. *M. wilsoni* Barthélémy & Terayama sp. nov., holotype, ♂, M060.C.Hy.4, CASC. **F**. *M. zetetes* Barthélémy & Terayama sp. nov., paratype, ♂, M321.E.Hy.4B, CBC.

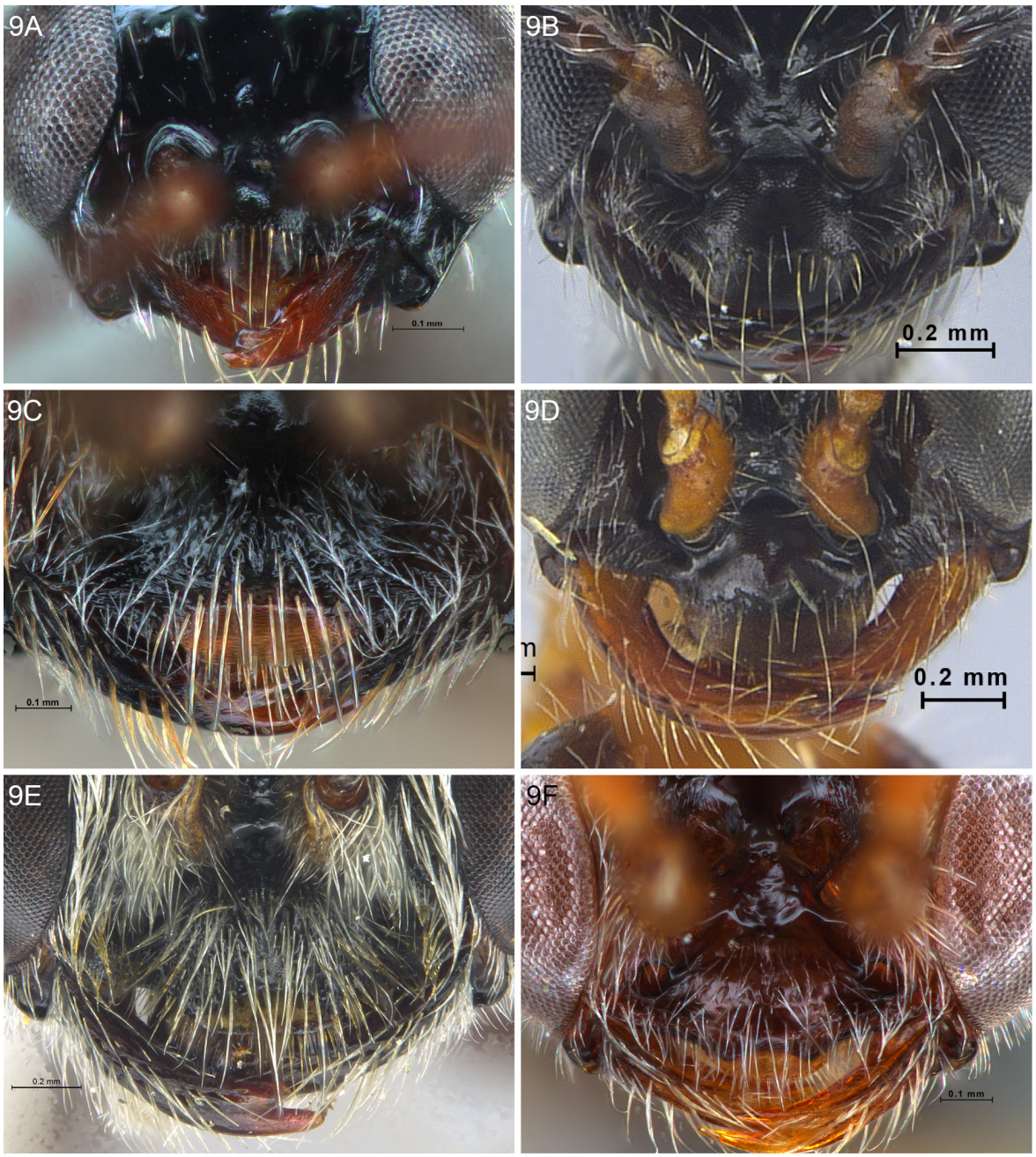

Fig. 9. Holotypes and paratypes, clypeus in frontal view. **A**. *Methocha haaksek* Barthélémy & Terayama sp. nov., holotype, ♀, M459.D.Hy.1, CASC. **B**. *M. hongkongensis* Barthélémy & Terayama sp. nov., holotype, ♀, M364.C.Hy.2, CASC. **C**. *M. hongkongensis*, paratype, ♂, M561CHY3, CBC. **D**. *M. leleji* Barthélémy & Terayama sp. nov., holotype, ♀, M099.C.Hy.2, CASC. **E**. *M. wilsoni* Barthélémy & Terayama sp. nov., holotype, ♂, M060.C.Hy.4, CASC. **F**. *M. zetetes* Barthélémy & Terayama sp. nov., paratype, ♂, M321.E.Hy.4B, CBC.

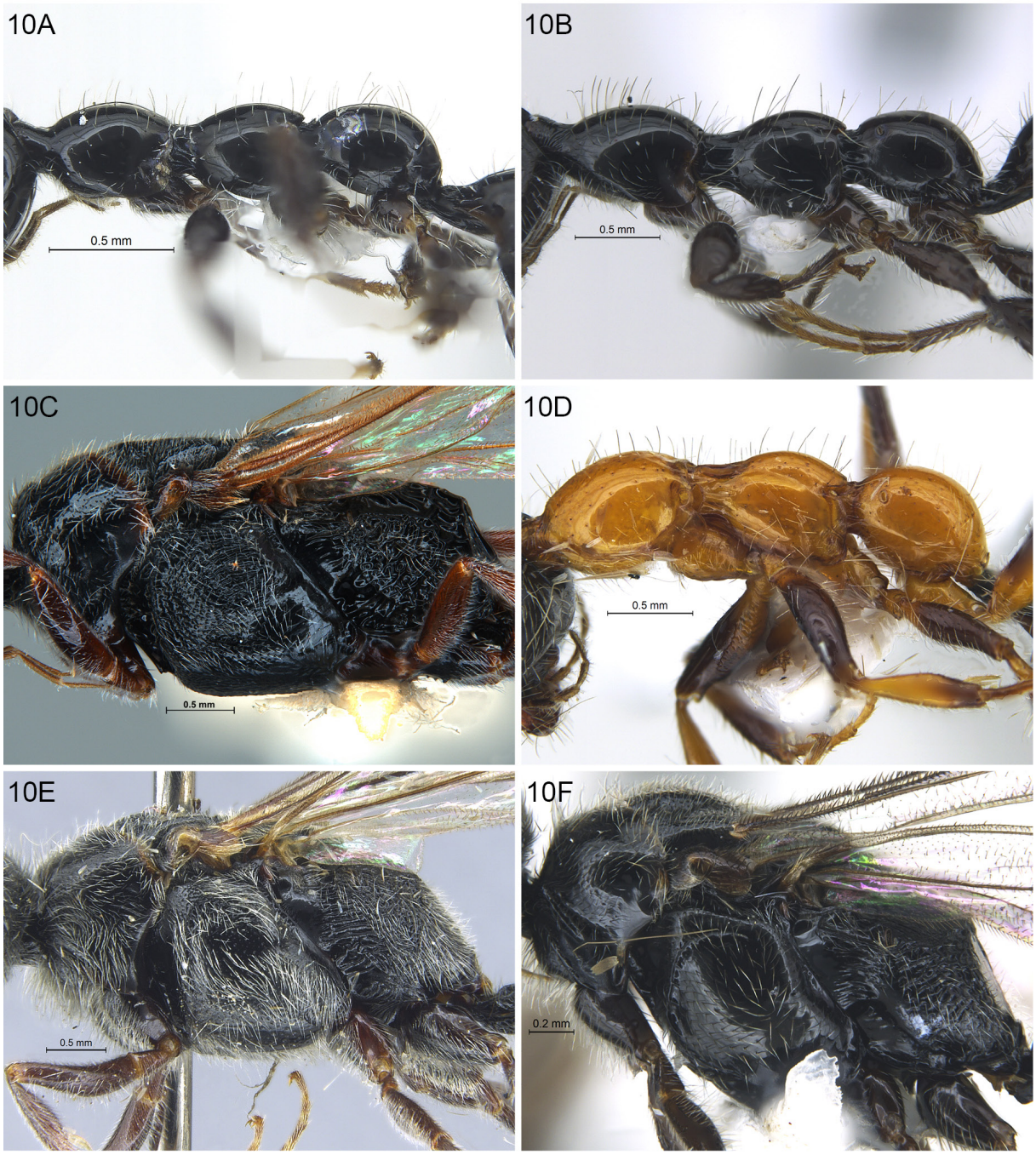

Fig. 10. Holotypes and paratype, mesosoma in lateral view. **A**. *Methocha haaksek* Barthélémy & Terayama sp. nov., holotype, ♀, M459.D.Hy.1, CASC. **B**. *M. hongkongensis* Barthélémy & Terayama sp. nov., holotype, ♀, M364.C.Hy.2, CASC. **C**. *M. hongkongensis*, holotype, ♂, M364.C.Hy.2, CASC. **D**. *M. leleji* Barthélémy & Terayama sp. nov., holotype, ♀, M099.C.Hy.2, CASC. **E**. *M. wilsoni* Barthélémy & Terayama sp. nov., holotype, ♂, M060.C.Hy.4, CASC. **F**. *M. zetetes* Barthélémy & Terayama sp. nov., paratype, ♂, M321.E.Hy.4B, CBC.

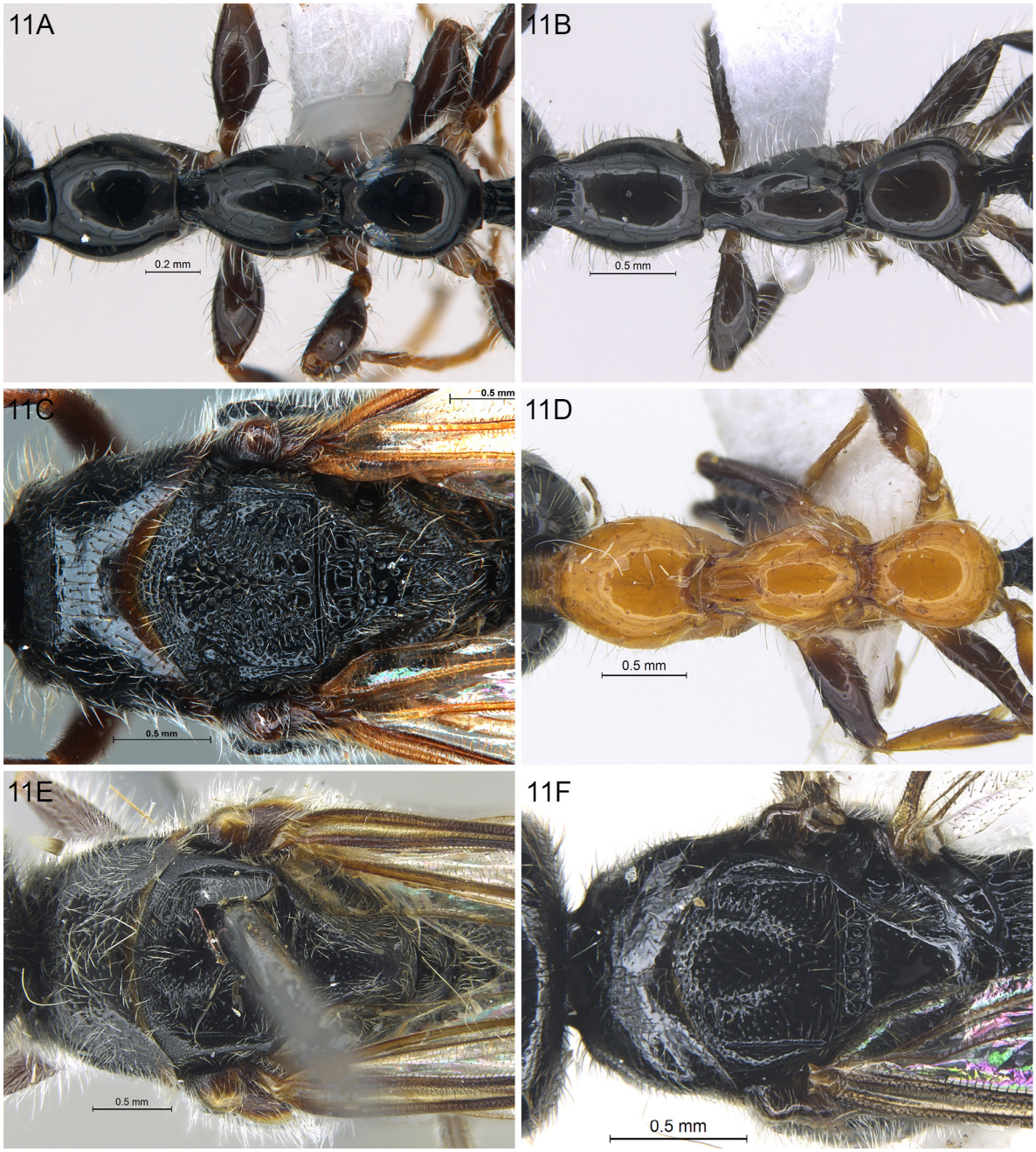

Fig. 11. Holotypes and paratypes, mesosoma in dorsal view. **A**. *Methocha haaksek* Barthélémy & Terayama sp. nov., holotype, ♀, M459.D.Hy.1, CASC. **B**. *M. hongkongensis* Barthélémy & Terayama sp. nov., holotype, ♀, M364.C.Hy.2, CASC. **C**. *M. hongkongensis*, paratype, ♂, M561.C.Hy.3, CBC. **D**. *M. leleji* Barthélémy & Terayama sp. nov., holotype, ♀, M099.C.Hy.2, CASC. **E**. *M. wilsoni* Barthélémy & Terayama sp. nov., holotype, ♂, M060.C.Hy.4, CASC. **F**. *M. zetetes* Barthélémy & Terayama sp. nov., paratype, ♂, M321.E.Hy.4B, CBC.

Fig. 12. Holotype and paratypes, propodeum in dorsal view and mesosoma in lateral view. **A–C**. Propodeum. **D–F**. Metasoma. **A, D**. *Methocha hongkongensis* Barthélémy & Terayama sp. nov., paratype, ♂, M561.C.Hy.3, CBC. **B, E**. *M. wilsoni* Barthélémy & Terayama sp. nov., holotype, ♂, M060.C.Hy.4, CASC. **C, F**. *M. zetetes* Barthélémy & Terayama sp. nov., paratype, ♂, M321.E.Hy.4B, CBC.

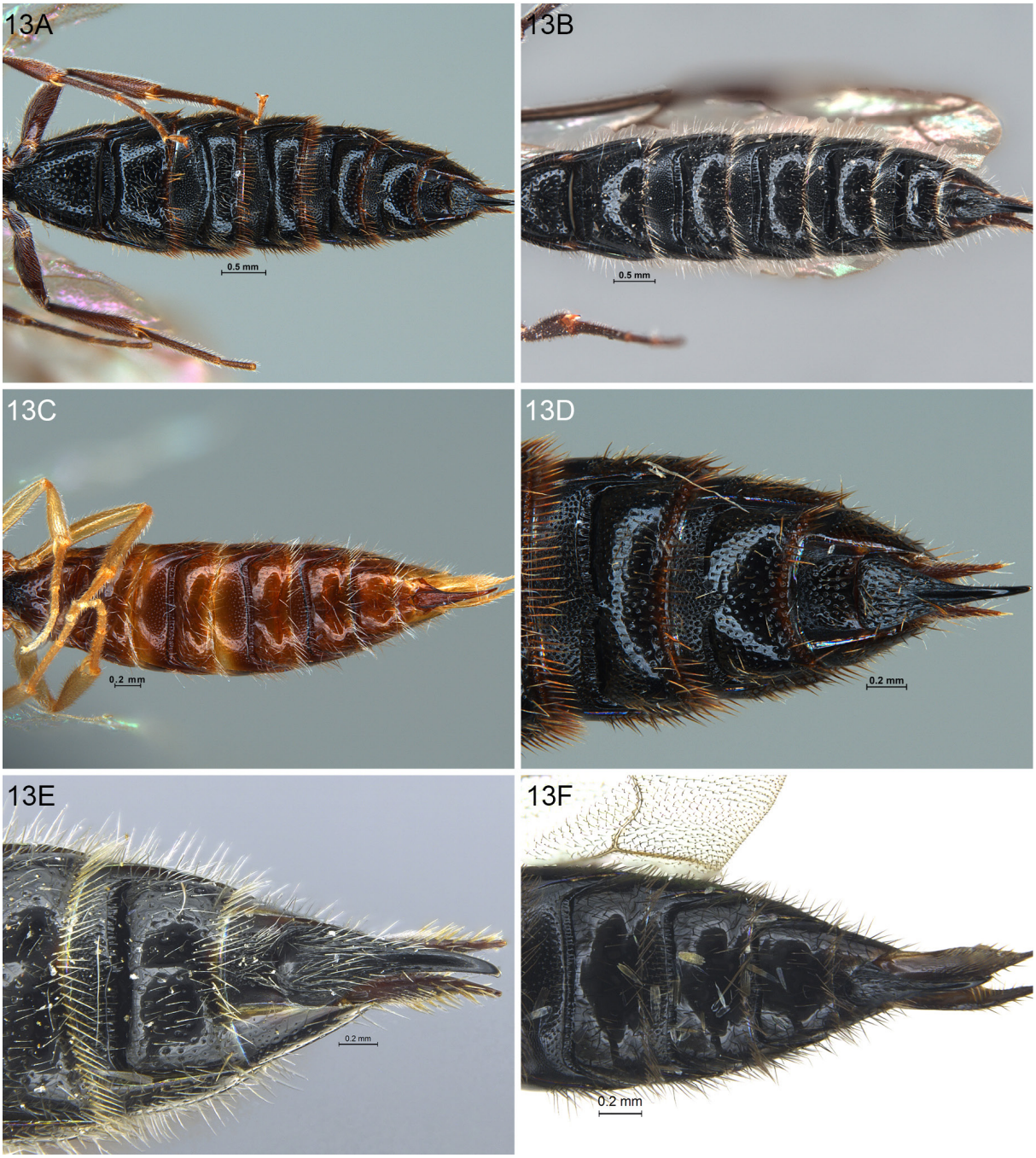

Fig. 13. Holotypes and paratypes, metasoma and apical sterna in ventral views. **A–C**. Metasoma. **D–F**. Apical sterna. **A**. *Methocha hongkongensis* Barthélémy & Terayama sp. nov., paratype, ♂, M561.C.Hy.3, CBC. **B**. *M. wilsoni* Barthélémy & Terayama sp. nov., holotype, ♂, M060.C.Hy.4, CASC. **C**. *M. zetetes* Barthélémy & Terayama sp. nov., paratype, ♂, M321.E.Hy.4B, CBC. **D**. *M. hongkongensis*, paratype, ♂, M561.C.Hy.3, CBC. **E**. *M. wilsoni*, holotype, ♂, M060.C.Hy.4, CASC. **F**. *M. zetetes*, paratype, ♂, M321.E.Hy.4B, CBC.

Table 1 (continued on next page). Asian species of *Methocha* Latreille, 1804 numbers per country and biogeographic realms.

Country/Locality (Realm)	Species	Number of Species
Japan (Sino-Japanese & Palearctic)	*M. japonica* Yasumatsu, 1931 *M. michinoku* Terayama, 2019 *M. okinawensis* Terayama & Mita, 2015 *M. uchinanensis* Terayama & Mita, 2015 *M. yasumatsui* Iwata, 1936	5
Japan (Oriental)	*M. yaeyamensis* Terayama & Mita, 2015	1
Mongolia (Palearctic)	*M. articulata* (Latreille, 1792) *M. picipes* Morawitz, 1890	2
South Korea (Palearctic)	*M. articulata* (Latreille, 1792)	1
China (Palearctic)	*M. mandibularis* (Smith, 1869)	1
China (Oriental; Guangdong, Hainan, Hong Kong)	*M. haaksek* Barthélémy & Terayama sp. nov. *M. hongkongensis* Barthélémy & Terayama sp. nov *M. leleji* Barthélémy & Terayama sp. nov. *M. transcarinata* Liao, Chen & Li, 2022 *M. wilsoni* Barthélémy & Terayama sp. nov. *M. zetetes* Barthélémy & Terayama sp. nov.	6
Taiwan (Oriental)	*M. alutacea* Lin, 1966 *M. areolata* Lin, 1966 *M. cavipyga* Lin, 1966 *M. cirrhocrus* Narita & Mita, 2021 *M. emarginata* Lin, 1966 *M. formosana* (Williams, 1919) *M. foveiventris* Lin, 1966 *M. maai* Lin, 1966 *M. plana* Lin, 1966 *M. priorrecta* Lin, 1966 *M. taiwanica* Tsuneki, 1986 *M. taoi* Lin, 1966	11
Philippines (Oriental)	*M. debilis* (Williams, 1919) *M. fimbricornis* (Williams, 1919) *M. fuscipennis* (Williams, 1919) *M. monticola* (Williams, 1919) *M. punctata* (Williams, 1919) *M. striatella* (Williams, 1919)	6
Laos (Oriental)	*M. cariniventris* Narita & Mita, 2018 (also China: Yunnan) *M. granulosa* Narita & Mita, 2018	2
Peninsular Malaysia (Oriental)	*M. clypeata* (Pagden, 1934) *M. malayana* (Pagden, 1949) *M. penthesilea* (Pagden, 1949) *M. violaceipennis* (Cameron, 1899) (also India)	4
Malaysia: Sabah & Sarawak (Oriental)	*M. nigra* Hamann, 1960 *M. simplicipes* Brues, 1910	2
Indonesia: Sulawesi (Oriental)	*M. gracilis* (Smith, 1860) *M. insularis* (Smith, 1860) *M. thoracica* (Smith, 1861)	3
Indonesia: Java (Oriental)	*M. javanica* (Hamann, 1959)	1

Table 1 (continued). Asian species of *Methocha* Latreille, 1804 numbers per country and biogeographic realms.

Country/Locality (Realm)	Species	Number of Species
India (Oriental)	*M. bicolor* (Cameron, 1897) *M. keralaensis* Hanima & Girish Kumar, 2019 *M. krombeini* Hanima, Girish Kumar & Binoy, 2021 *M. litoralis* Krombein, 1982 *M. orientalis* (Smith, 1855) *M. paraceylonica* Hanima, Girish Kumar & Binoy, 2021 *M. smithii* (Magretti, 1892) *M. shyamagatra* Hanima, Girish Kumar & Sureshan, 2021	8
Sri Lanka (Oriental)	*M. heveli* Krombein, 1982 *M. litoralis* Krombein, 1982 *M. anomala* Krombein, 1982 *M. ceylonica* Krombein, 1982 *M. kandyensis* Krombein, 1982 (also China: Fujian) *M. taprobane* Krombein, 1982 (also India: Kerala) *M. ubiquita* Krombein, 1982 (also India: Kerala)	7
	TOTAL No. OF ASIAN SPECIES	**60**

Table 2. Pairwise p-distances between specimens of *Methocha* Latreille, 1804. A p-distance greater than 2% (0.02) typically indicates a relatively notable genetic difference between the compared COI sequences.

	M. hongkongensis (M345.C.Hy.9)	*M. hongkongensis* (M541.C.Hy.1)	*M. hongkongensis* (M561.C.Hy.3)	*M. hongkongensis* (M556.C.Hy.1)	*M. hongkongensis* (M500.C.Hy.3)	*M. leleji* (M209.C.Hy.1)	*M. leleji* (M099.C.Hy.2)	*M. wilsoni* (M557.C.Hy.2A)	*M. wilsoni* (M488.C.Hy.3)
M. hongkongensis (M541.C.Hy.1)	0.0000								
M. hongkongensis (M561.C.Hy.3)	0.0000	0.0000							
M. hongkongensis (M556.C.Hy.1)	0.0084	0.0077	0.0079						
M. hongkongensis (M500.C.Hy.3)	0.0085	0.0083	0.0083	0.0000					
M. leleji (M209.C.Hy.1)	0.1886	0.1813	0.1801	0.1748	0.1791				
M. leleji (M099.C.Hy.2)	0.1895	0.1808	0.1808	0.1741	0.1785	0.0017			
M. wilsoni (M557.C.Hy.2A)	0.1845	0.1850	0.1850	0.1791	0.1791	0.0512	0.0537		
M. wilsoni (M488.C.Hy.3)	0.1925	0.1925	0.1925	0.1874	0.1874	0.0528	0.0533	0.0000	
M. zetetes (M321.E.Hy.4A)	0.1982	0.1944	0.1944	0.1891	0.1891	0.1751	0.1755	0.1754	0.1885

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