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ORIGINAL ARTICLE

Review of Neoneurini Bengtsson (Hymenoptera: Braconidae: Euphorinae) from China

Jun Li[1, 2, 3], Cornelis van Achterberg[4 *], Minlin Zheng[1, 2, 3], Jiahua Chen[1, 2, 3 *]

[1]*State Key Laboratory of Ecological Pest Control for Fujian and Taiwan Crops, Fuzhou 35002, China*
[2]*Key lab of Biopesticide and Chemical Biology, Ministry of Eduaction, Fujian Agriculture and Forestry University, Fuzhou 35002, China*
[3]*Institute of Biological Control, Fujian Agriculture and Forestry University, Fuzhou 35002, China*
[4]*State Key Laboratory of Rice Biology, Ministry of Agriculture Key Lab of Agricultural Biology of Crop Pathogens and Insects, and Institute of Insect Sciences, Zhejiang University, Hangzhou 310058, China*
[*]*Corresponding authors, E-mails: kees@vanachterberg.org; jhchen34@163.com*

Abstract The tribe Neoneurini Bengtsson, 1918 (Braconidae, Euphorinae) from China is reviewed. The genus *Sinoneoneurus* He, Chen & van Achterberg, 1997 is synonymized with *Elasmosoma* Ruthe, 1858, and two species, *Elasmosoma* (*Sinoneoneurus*) *obscuripennis* (He, Chen & van Achterberg, 1997) and *E.* (*S.*) *pallidipennis* (He, Chen & van Achterberg, 1997) are new combinations. The genus *Neoneurus* Haliday, 1838 and two species, *Neoneurus clypeatus* (Foerster, 1863) and *Elasmosoma pergandei* Ashmead, 1895, are recorded from China for the first time. A key to the five species of Neoneurini from China is provided.

Key words Synonym, new combinations, fauna, China, key.

1 Introduction

Euphorinae (Hymenoptera, Braconidae) is a large and very diverse subfamily of endoparasitoid wasps, with 1,270+ described species worldwide (Yu *et al.*, 2016). Besides Aphidiinae, they are the only known braconid wasps attacking adults as their hosts. The tribe Neoneurini Bengtsson, 1918 is the most aberrant taxa of the subfamily Euphorinae. It was original treated as a separate subfamily of Braconidae (Bengtsson, 1918). Tobias (1966) proposed it was a tribe of the Euphorinae based on the morphological characters (vein CU1b of fore wing absent and the first metasomal tergite almost petiolate) and the biology (the parasitoid of adult insects—ants), but the treatment was not widely accepted for a long time. Dowton *et al.* (1998), Belshaw & Quicke (2002) and Sharanowski *et al.* (2011) supported the treatment that the group was a tribe of the Euphorinae based on DNA sequence data. Gómez Durán and van Achterberg (2011) reported the oviposition behaviour of four neoneurine wasps, which is in according with other euphorine species, supported the point that neoneurine should be part of the subfamily Euphorinae. Stigenberg *et al.* (2015) also supported the placement of Neoneurini as a tribe of the Euphorinae based on their concatenated molecular data (18S, 28S, CAD, and COI) and morphological characters. Nowadays, the treatment of Neoneurini as a tribe of Euphorinae is widely accepted.

So far, Neoneurini includes seven genera, *Elasmosoma* Ruthe, 1858, *Elasmosomites* Brues, 1933 (fossil), *Euneoneurus* Tobias & Yuldashev, 1979, *Kollasmosoma* van Achterberg & Argaman, 1993, *Neoneurus* Haliday, 1838, *Parelasmosoma* Tobias & Yuldashev, 1979 and *Sinoneoneurus* He, Chen & van Achterberg, 1997 (Yu *et al.*, 2016). Prior to this study, three neoneurine species were reported from China belonging to two genera: *Elasmosoma* (one species from Taiwan) and *Sinoneoneurus* (two species from mainland China). Here, we propose *Sinoneoneurus* as a subgenus of *Elasmosoma*. Furthermore, two species, *Elasmosoma pergandei* and *Neoneurus clypeatus*, are recorded in China for the first time, and a

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key to five species of Neoneurini from China is provided.

2 Materials and methods

All specimens examined in this study are deposited in Biological Control Research Institute, Fujian Agriculture and Forestry University, Fuzhou, China (FAFU) (former Beneficial Insects Institute, China (BIIC)). The specimens were collected using a sweep net. All specimens studied are deposited in FAFU.

The specimens were examined using a Zeiss Stemi 2000 stereomicroscope. Photographs were taken with a Leica DFC450 digital camera mounted on a Leica M205C stereo microscope. All images were further processed using minor adjustment in Adobe Photoshop CC®. Morphological terminology follows van Achterberg (1988, 1993), including the abbreviations for the wing venation. Sclerite surface sculpturing follows Eady (1968). Measurements are taken as indicated by van Achterberg (1988). For identification of the subfamilies, see van Achterberg (1993; as Neoneurinae).

3 Results and discussion

Neoneurini Bengtsson, 1918

Neoneurinae Bengtsson, 1918: 27.
Elasmosomini Viereck, 1918: 69.

General description. Maxillary palp with 2–3 segments, labial palp with 1–2 segments. Eyes bare. First metasomal tergite sessile. Ovipositor short, bent, variable in broadness. Fore legs always modified, tarsal claws slender. Wing venation largely reduced, with widened costa, and truncate marginal cell of fore wing. Fore wing vein r present (Stigenberg *et al.*, 2015)

Distribution. Palaearctic, Nearctic, Oriental Regions.

Key to Chinese species of tribe Neoneurini.

1. Antenna longer than head and mesosoma combined (Fig. 1); marginal cell of fore wing well defined and with a pigmented cross-vein (Fig. 8); hind wing with closed cell (Fig. 8); Heilongjiang; (**genus *Neoneurus* Haliday**) ..... ***N. clypeatus* (Foerster, 1863)**
   Antenna shorter than head and mesosoma combined (Figs 10–11); marginal cell of fore wing only indicated, not closed by a fully pigmented vein (Fig. 18); hind wing without closed cell (Fig. 18); (**genus *Elasmosoma* Ruthe**) 2
2. Malar space short, eyes almost touching base of mandible (Fig. 14); vein cu-a of fore wing approx. equal to vein 1-CU1 of fore wing (Fig. 18); (**subgenus *Elasmosoma***) 3
   Malar space medium-sized (fig. 1 in He *et al.*, 1997); vein cu-a of fore wing distinctly longer than vein 1-CU1 of fore wing (Fig. 3, *loc. cit.*); (**subgenus *Sinoneoneurus***) 4
3. Hypopygium deeply notched posteriorly (fig. 5 in Chou, 1985); hind inner tibial spurs approx 0.8 × as long as basitarsus; Taiwan.... ..... ***E.* (*E.*) *taiwanense* Chou, 1985**
   Hypopygium moderately notched posteriorly (Figs 20–21); hind inner tibial spurs nearly as long as basitarsus (Fig. 19); Heilongjiang ..... ***E.* (*E.*) *pergandei* Ashmead, 1895**
4. Wing membrane brownish and veins distinctly pigmented; clypeus and face similarly transversely aciculate; second and third metasomal tergites granulate-punctate; Qinghai ..... ***E.* (*S.*) *obscuripennis* (He, Chen & van Achterberg, 1997)**
   Wing membrane subhyaline and veins largely unpigmented; clypeus smooth and face transversely aciculate; second and third metasomal tergites finely coriaceous; Ningxia..... ***E.* (*S.*) *pallidipennis* (He, Chen & van Achterberg, 1997)**

Neoneurus Haliday, 1838

Neoneurus Haliday, 1838: 213. No species included. Type species: *Neoneurus halidaii* Marshall, 1897 [= *Neoneurus auctus* (Thomson, 1895)]. First included species by Marshall (1897).

Ecclites Foerster, 1863: 244. Type species: *Ecclites clypeatus* Foerster, 1863 [= *Neoneurus clypeatus* (Foerster, 1863)]. Synonymized with *Neoneurus* by Ashmead (1900).

General description. Antenna with 16 antennomeres, longer than head and mesosoma combined. Head comparatively large and transverse. Maxillary palp with 2 segments, labial palp with 1 segment. Fore wing with a short and complete marginal cell, with a spectral spurious vein (wing fold) extending from apex of radial cell towards wing margin, hind wing with closed cell. Fore legs of ♀ modified, fore tibia robust, often with a basal longitudinal carina along inner margin and a

sub-basal protuberance on anterior margin; tibial spurs large and distinct, outer spur at least 0.5 × as long as hind basitarsus; tarsi slender, tapering towards apex; tarsal claws minute; arolium, especially fore arolium, greatly enlarged. Metasoma narrow, with apex of ♀ strongly compressed. Ovipositor shorter than hind basitarsus, compressed, sickle-like, and strongly curving anterad when exserted.

Biology. Parasitoid of adult ant workers, for details see Shaw (1993) and Gómez Durán and van Achterberg (2011). The known hosts are *Formica cunicularia* Latreille, *F. podzolica* Francoeur, *F. pratensis* Retzius and *F. rufa* L. (Yu *et al.*, 2016).

Distribution. Palaearctic and Nearctic Regions.

Remarks. The genus is recorded in China for the first time.

***Neoneurus clypeatus* (Foerster, 1863)**

Ecclites clypeatus Foerster, 1863: 245. Transferred to *Neoneurus* by Ashmead (1900).
Elasmosoma viennense Giraud, 1871: 301.Transferred to *Neoneurus* by Bengtsson (1918).

Material examined. 2♂, NE China, Heilongjiang, Mudanjiang, Mudanfeng 17.VII.2011, Minlin Zheng; 2♂, NE China, Heilongjiang, Mudanjiang, Mudanfeng 17.VII.2011, Yingying Zhao.

Description. Specimen from NE China, ♂, length of fore wing 1.7 mm, body 2.7 mm.

Head. Antennomeres 16, antenna 1.1 × as long as fore wing, 0.8 × as long as body, and 1.8 × as long as head and mesosoma combined (Fig. 1). First flagellomere 1.2 × as long as second flagellomere; first and second flagellomere 3.0 and 2.6 × as long as wide, respectively; penultimate flagellomere shorter than other flagellomeres (Fig. 2). In dorsal view, eye 2.8 × as long as temple; temples slightly linearly narrowed behind eyes (Fig. 4); ocelli medium-sized, almost in right triangle, OOL : OD : POL = 5 : 3 : 7 (Fig. 4); frons almost flat, largely rugulose; vertex granulate (Fig. 3). Face 1.9 × wider than high, sparsely setose, granulate (Fig. 3); clypeus smooth, 3.7 × wider than high, 0.6 × as wide as face, ventral margin straight (Fig. 3); anterior tentorial pits large (Fig. 3); malar suture shallow, narrow (Fig. 3); mandibles stout, strongly twisted (Fig. 3).

Mesosoma. Length of mesosoma 1.4 × as its height; side of pronotum coriaceous-punctate (Fig. 7); propleuron largely smooth (Fig. 7); mesopleuron largely granulate; prepectal carina completely present (Fig. 7); episternal scrobe short, wide and deep (Fig. 7); precoxal sulcus deep and wide, granulate (Fig. 7); mesonotum densely setose, flat, granulate; notauli absent (Fig. 6); scutellar sulcus smooth and deep with four crenulae (Fig. 6); scutellum flat, granulate (Fig. 6); metapleuron reticulate-rugose (Fig. 5); propodeum reticulate-rugose (Figs 6–7).

Figure 1. *Neoneurus clypeatus* (Foerster, 1863), ♂, habitus, lateral view. Scale bar = 1.0 mm.

Wings. Fore wing (Fig. 8): venation largely unpigmented; 1-R1 nearly 0.4 × as long as pterostigma; vein r issued after middle of pterostigma; 1-M short, 1.2 × as long as 1-SR; cu-a oblique and longer than 1-CU1, cu-a : 1-CU1 = 3 : 2. Hind wing

Figures 2–9. *Neoneurus clypeatus* (Foerster, 1863), ♂. 2. Antenna. 3. Head, anterior view. 4. Head, dorsal view. 5. Mesosoma, lateral view. 6. Mesosoma, dorsal view. 7. First metasomal tergites, dorsal view. 8. Wings. 9. Fore leg. Scale bar = 0.5 mm.

(Fig. 8): venation unpigmented, M+CU : 1-M : 1r-m = 8 : 5 : 6.

Legs. Fore leg typical, tibia 4.0 × as long as wide, rather enlarged apically (Fig. 9); fore tibial spur slightly curved, 0.8 × as long as basitarsus (Fig. 9). Middle leg normal, tibia 6.5 × as long as wide; middle tibial spurs slightly curved. Hind leg modified, tibia 7.1 × as long as wide, larger apically; hind tibial outer spurs 0.4 × as long as basitarsus.

Metasoma. First tergite 1.1 × longer than its maximum width, apically 2.7 × wider than its minimum width, with spiracular tubercles medially, without dorsope, largely rugose (Fig. 7); second and third tergite rugulose-rugose; first tergite with laterope, remaining segments smooth and shiny.

Colour. Mainly brown; apex of antenna, legs yellow; fore wing darkened, veins of wings yellowish brown; antenna, clypeus, mandible, metasoma yellowish brown; apex of mandible and ventral margin of clypeus reddish brown; face and mesosoma brown; vertex and propodeum black.

Biology. Parasitoid of adult worker ants of *Formica rufa* (Tobias, 1976).

Distribution. Eastern Palaearctic Region: China, Mongolia, Kazakhstan; Western Palaearctic Region: Austria, Czech Republic, Denmark, Finland, Germany, Hungary, Iran, ltaly, Korea, Lithuania, Moldova, Netherlands, Norway, Russia, Sweden, Ukraine, former Yugoslavia.

Remarks. The species is recorded in China for the first time.

Elasmosoma Ruthe, 1858

Elasmosoma Ruthe, 1858: 7. Type species: *Elasmosoma berolinense* Ruthe, 1858.

Sinoneoneurus He, Chen & van Achterberg 1997: 70. **Syn. nov.** Type species: *Sinoneoneurus obscuripennis* He, Chen & van Achterberg [= *Elasmosoma obscuripennis* (He, Chen & van Achterberg, 1997) **comb. nov.**].

General description. Antenna of ♀ with 13 antennomeres (of ♂ with 14 antennomeres and somewhat longer), shorter than head and mesosoma combined. Head large and transverse. Maxillary palp with 2–3 segments, labial palp with 1–2 segments. Hind tibial spur acute apically. Hind wing without closed cell.

Biology. Attacks adult ant workers, for details see Gómez Durán and van Achterberg (2011). The known hosts are *Camponotus castaneus*, *C. vagus*, *F. fusca*, *F. integra*, *F. obscuripes*, *F. obscuriventris clivia*, *F. pratensis*, *F. rubicunda*, *F. rufa*, *F. rufa japonica*, *F. rufibarbis*, *F. sanguinea*, *F. schaufuss*, *F. subpolita*, *F. subsericea*, *Lasius niger*, and *Polyergus lucidus* (Yu *et al*., 2016).

Distribution. Palaearctic, Nearctic and Oriental Regions.

Remarks. The type species of *Sinoneoneurus* was recently re-examined by C. van Achterberg. The differences between *Sinoneoneurus* and *Elasmosoma* as indicated in the key are few, therefore, we include *Sinoneoneurus* as a subgenus of *Elasmosoma*.

Elasmosoma (*Elasmosoma*) *pergandei* Ashmead, 1895

Elasmosoma pergandei Ashmead, 1895: 283; Muesebeck, 1922: 6; Huddleston, 1976: 222; Belokobylskij, 2000: 397; Shaw, 2007: 3.

Material examined. 1♀1♂, NE China, Heilongjiang, Mohe, 23.VII.2011, Xiaohui Dong.

Description. Specimen from NE China, ♀, length of fore wing 1.6 mm, body 2.3 mm.

Head. Antennomeres 13, antenna 0.5 × as long as fore wing, 0.3 × as long as body, and 0.7 × as long as head and mesosoma combined (Figs 10–11). First flagellomere 1.3 × as long as second flagellomere; first and second flagellomere 1.4 and 1.3 × as long as wide, respectively; penultimate flagellomere much shorter than other flagellomere, 0.7 × as long as wide (Fig. 12). Maxillary palp with 2 segments, labial palp with 1 segment. In dorsal view, eye 2.5 × as long as temple; temples roundly narrowed behind eyes (Fig. 13); ocelli medium-sized, almost in right triangle, OOL : OD : POL = 9 : 5 : 13 (Fig. 13); frons depressed, largely punctate, rugose in front of median ocellus; vertex punctate-striate (Fig. 14). Face 1.1 × wider than high, flat, sparsely setose, strigose (Fig. 14); clypeus rugulose, 3.1 × wider than high, 1.1 × as wide as face, ventral margin concave medially (Fig. 14); anterior tentorial pits large (Fig. 14); malar suture deep, wide and very short, almost touching base of mandible (Fig. 14); mandibles stout, straight, its first tooth much longer than second tooth and very acute (Fig. 14).

Mesosoma. Length of mesosoma 1.3 × as its height; side of pronotum coriaceous (Fig. 16); propleuron punctate-rugose (Fig. 16); mesopleuron dorsally rugose, ventrally largely (including precoxal sulcus) rugulose; prepectal carina completely present (Fig. 16); episternal scrobe short, wide and deep (Fig. 16); precoxal sulcus deep and wide (Fig. 16); mesonotum densely setose, flat, coriaceous; notauli absent (Fig. 15); scutellar sulcus smooth and deep, without crenulae (Fig. 15); scutellum convex, smooth (Fig. 15); metapleuron rugulose (Fig. 15); propodeum largely rugose.

Wings. Fore wing (Fig. 18): venation largely unpigmented; 1-R1 nearly as long as pterostigma; vein r issued in front of

middle of pterostigma; 1-M short, 0.8 × as long as r; cu-a oblique and distinctly longer than 1-CU1, cu-a : 1-CU1 = 7 : 4. Hind wing (Fig. 18): venation extremely reduced, without closed cell.

Legs. Fore tibia 3.4 × as long as wide, rather larger apically; fore tibial spur 1.2 × as long as basitarsus. Middle leg normal, tibia 5.7 × as long as wide; middle tibial spurs straighter. Hind tibia 5.6 × as long as wide, larger apically; inner hind tibial spur slightly longer than basitarsus, acute apically (Fig. 19).

Metasoma. First tergite 1.2 × longer than its maximum width, apically 1.8 × wider than its minimum width, with spiracular tubercles in front of middle, without dorsope, largely rugulose (Fig. 17); second and third tergites granulate-rugulose; first tergite with laterope, remaining segments smooth, compressed and shiny; hypopygium broad, finely setose, setae along apical margin short, with a moderately deep emargination (Figs 20–21); ovipositor very short, apically slightly curved (Fig. 21); ovipositor sheath robust and short, 2.2 × as long as wide, in apical half covered with long setae, largely smooth (Fig. 21).

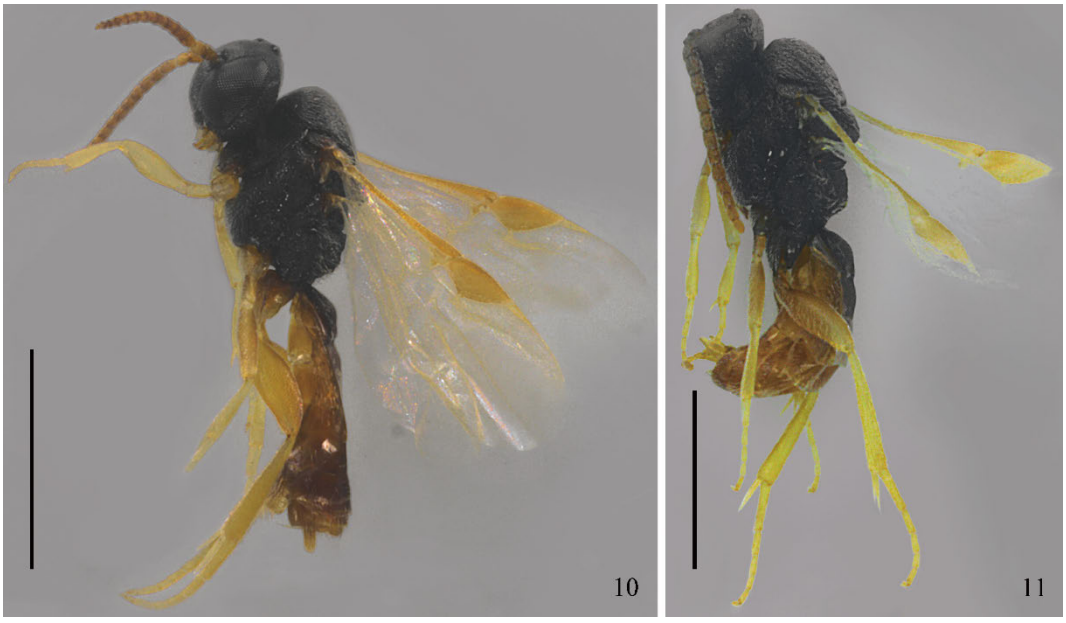
Colour. Mainly black; fore wings slightly darkened, veins light brown; mandible, fore leg, middle tarsus, hind tarsus and ovipositor yellowish brown; antenna, ventral margin of clypeus, middle and hind legs (except tarsus), ovipositor sheath brown.

Male. Length of body 2.7 mm; antenna with 13 segments; fore leg normal, tibia 4.4 × as long as wide; fore tibial outer spur 0.7 × as long as basitarsus. (Fig. 11).

Biology. Parasitoid of adult worker ants of *Camponotus castaneus*, *Formica integra*, *F. subsericea*. For details see Poinar (2004).

Distribution. East Palaearctic Region: China (new record), Mongolia, Tajikistan; Nearctic Region: Canada, U.S.A.

Remarks. The species is recorded in China for the first time. It is the widest spread species of *Elasmosoma*. The Chinese specimens examined in this study slight differ from original description by the hind tibial inner spur slightly longer than the hind basitarsus (the outer spur slightly shorter than basitarsus).



Figures 10–11. *Elasmosoma* (*Elasmosoma*) *pergandei* Ashmead, 1895, habitus, lateral view. 10. Female. 11. Male. Scale bar = 1.0 mm.

***Elasmosoma* (*Elasmosoma*) *taiwanense* Chou, 1985**

Elasmosoma taiwanense Chou, 1985: 477; He *et al.*, 2000: 327.

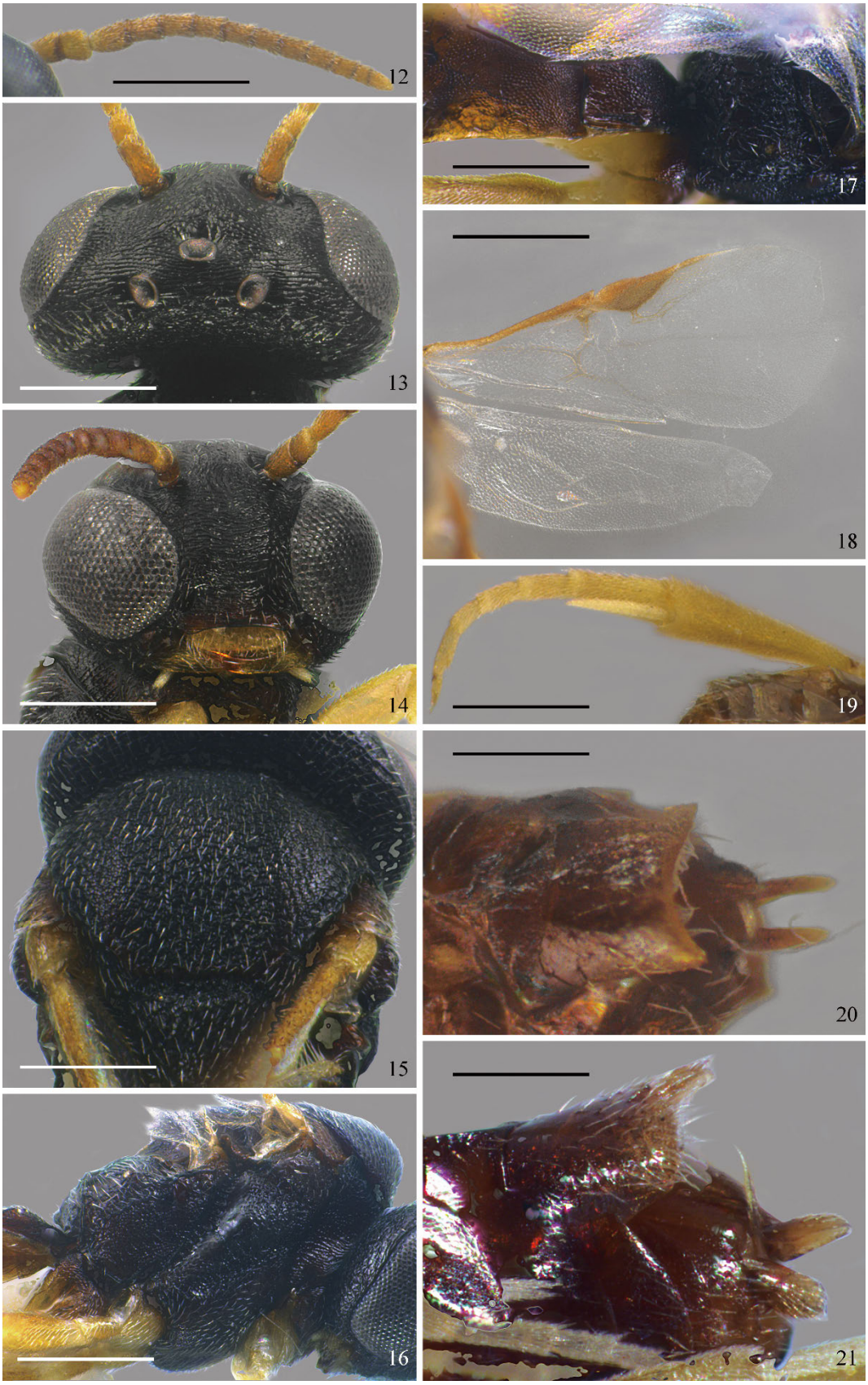
Biology. Unknown.

Distribution. Oriental Region: China.

***Elasmosoma* (*Sinoneoneurus*) *obscuripennis* (He, Chen & van Achterberg, 1997), comb. nov.**

Sinoneoneurus obscuripennis He, Chen & van Achterberg, 1997: 71; He *et al.*, 2000: 328.

Biology. Unknown.



Figures 12–21. *Elasmosoma* (*Elasmosoma*) *pergandei* Ashmead, 1895, ♀. 12. Antenna. 13. Head, dorsal view. 14. Head, anterior view. 15. Mesosoma, dorsal view. 16. Mesosoma, lateral view. 17. Basal part of metasoma, dorsal view. 18. Wings. 19. Hind tibial spur. 20. Hypopygium, dorsal view. 21. Hypopygium, lateral view. Scale bar = 0.5 mm.

Distribution. East Palaearctic Region: China.

***Elasmosoma* (*Sinoneoneurus*) *pallidipennis* (He, Chen & van Achterberg, 1997), comb. nov.**
Sinoneoneurus pallidipennis He, Chen & van Achterberg, 1997: 73; He *et al.*, 2000: 329.

Biology. Unknown.
Distribution. East Palaearctic Region: China.

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