REVIEW OF *EUSTOCHUS*, A RARELY COLLECTED GENUS OF MYMARIDAE (HYMENOPTERA)

J. T. HUBER[1, 2] and E. BAQUERO[3]
Canadian Forestry Service, Natural Resources Canada

Abstract

J. ent. Soc. Ont. 138: 3–31

The four nominal species of *Eustochus* are reviewed. Four new species, *E. confusus* from Spain, *E. pengellyi* and *E. yoshimotoi* from North America, and *E. nipponicus* from Japan are described and a key to the eight species is given.

Résumé
Nous revisons les quatre espèces nominales d'*Eustochus*. Nous décrivons quatre nouvelles espèces, *E. confusus* d`Espagne, *E. pengellyi* et *E. yoshimotoi* d'Amérique du Nord, et *E. nipponicus* du Japon, et pourvoyons une clé d'identification aux huit espèces.

Published November 2007

Introduction

The Holarctic genus *Eustochus* was established by Haliday (1833) for a species described by Curtis (1832) in a key as a species of *Mymar*–*M. atripennis* (which he attributed to Walker). Curtis's laconic description, abstracted here from his key, reads: 'abdomen petiolated, wings ciliated and perfect, ovipositor exserted, longer than the abdomen'. The collection information given next to the name *atripennis* states simply 'June, amongst grass in a wood'. Graham (1982) suggested that perhaps only one specimen had been collected by Walker, probably at or near Southgate, Middlesex (England). Haliday (1833) redescribed *E. atripennis* (Curtis) in more detail, and included it as the only species within his new genus *Eustochus*. He mentioned that the species occurred 'in autumn, among trees, but very rare'. Since then, the genus has been mentioned infrequently in the literature and only three more species have been described, based on very few specimens each. Here, we review the described species and describe four new ones from Spain, Canada, USA, and Japan.

[1] Author to whom all correspondence should be addressed.
[2] Correspondence address: Systematic Entomology, K.W. Neatby Building, 960 Carling Avenue, Ottawa, Ontario, Canada K1A 0C6, email: huberjh@agr.gc.ca
[3] Departamento de Zoología y Ecología, Faculdad de Ciencias, Universidad de Navarra, 31080, Pamplona, Spain

Materials and Methods

This study is based on recent examination of about 115 specimens from the institutions listed below.

Eustochus species all appear to be very similar to one another so long descriptions for each species, as for *E. besucheti* Bakkendorf, would be repetitious; therefore, diagnoses only are given. The new species are described and illustrated based on females because males are known for only two species and are exceedingly rare (7 specimens known). Specimens from Japan were dissected and gold coated for the scanning electron micrographs (Figs. 1–15).

Morphological terms used follow Gibson (1997). Measurements, from slide-mounted specimens unless otherwise indicated, are given in micrometers (µm), and are as described in Huber (1987). The range is followed by the number of specimens measured, in parentheses. Primary type data is recorded as found on each label, with slashes indicating the beginning of each new line. Data from other specimens is given in a standardized format to simplify retrieval or comparison. Abbreviations used are: Fl_1–Fl_6=funicle segment one to six, FWL or FWW=forewing length or forewing width, Fl_x L (W)=flagellar segment length (width).

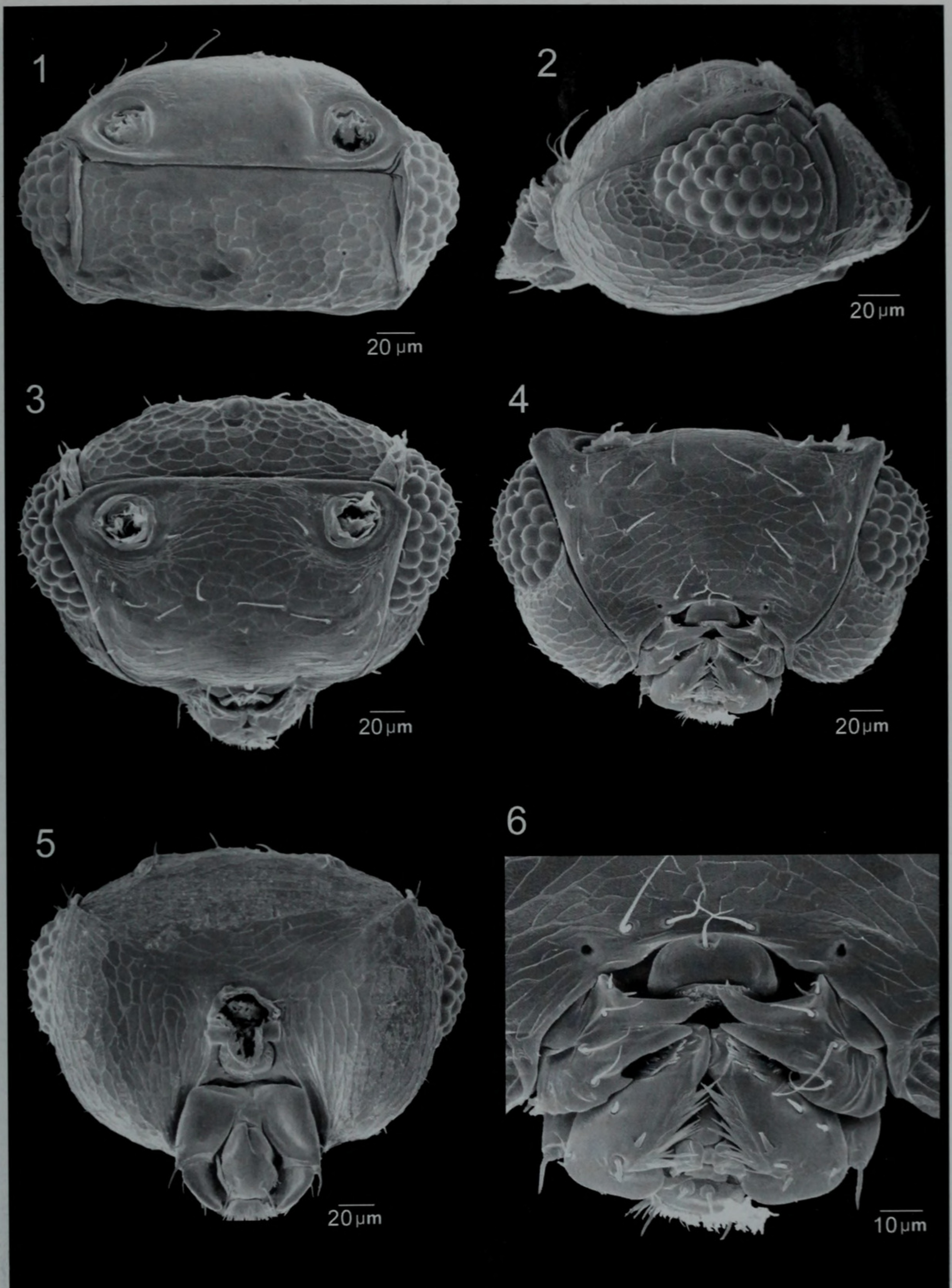
Acronyms of repositories: CNC–Canadian National Collection of Insects, Ottawa, Canada, J. Huber; FAFU–Biological Control Research Institute, Fujian Agricultural and Forestry University, Fuzhou, China, N.-Q. Lin; MRSN–Museo Regionale di Scienze Naturali (Spinola Collection), Turin, Italy, G. Pagliano; MZNA–Museo de Zoología, Universidad de Navarra, Pamplona, Spain, E. Baquero; MHNG–Museum d'Histoire Naturelle, Geneva, Switzerland, C. Besuchet; UCRC–University of California, Riverside, CA, USA, S. Triapitsyn; USNM–National Museum of Natural History, Washington, DC, USA, M. Gates.

Eustochus Haliday

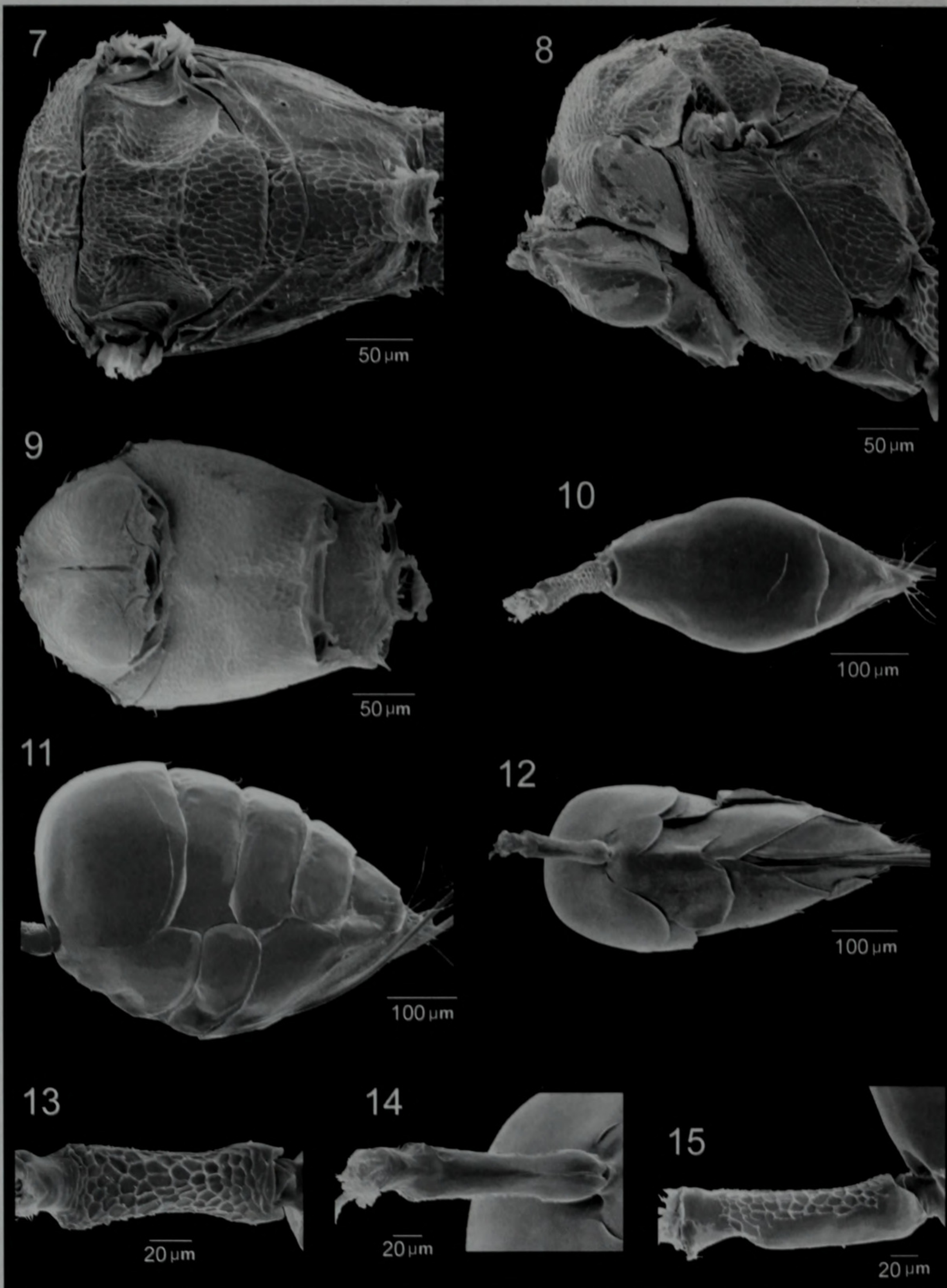
Eustochus Haliday, 1833: 269 (key), 349 (description); Westwood, 1839: 78 (diagnosis); Walker, 1846: 50 (diagnosis); Foerster, 1847: 225 (diagnosis); Foerster, 1856: 117 (key); Blanchard, 1840: 293 (diagnosis); Dalla Torre, 1898: 428 (catalogue); Ashmead, 1904: 363 (key); Schmiedeknecht, 1909: 494 (key), 495 (diagnosis); Gahan and Fagan, 1923: 64 (type species designation); Schmiedeknecht, 1930: 450 (key); Kryger, 1950: 61 (description); Annecke and Doutt, 1961: 24 (generic comment); Debauche, 1948: 200 (description); Schauff, 1984: 50 (diagnosis, phylogeny); Yoshimoto, 1990: 57 (diagnosis); Xu and Lin, 2003: 65 (diagnosis).

Type species: *Mymar atripennis* Curtis, by monotypy.

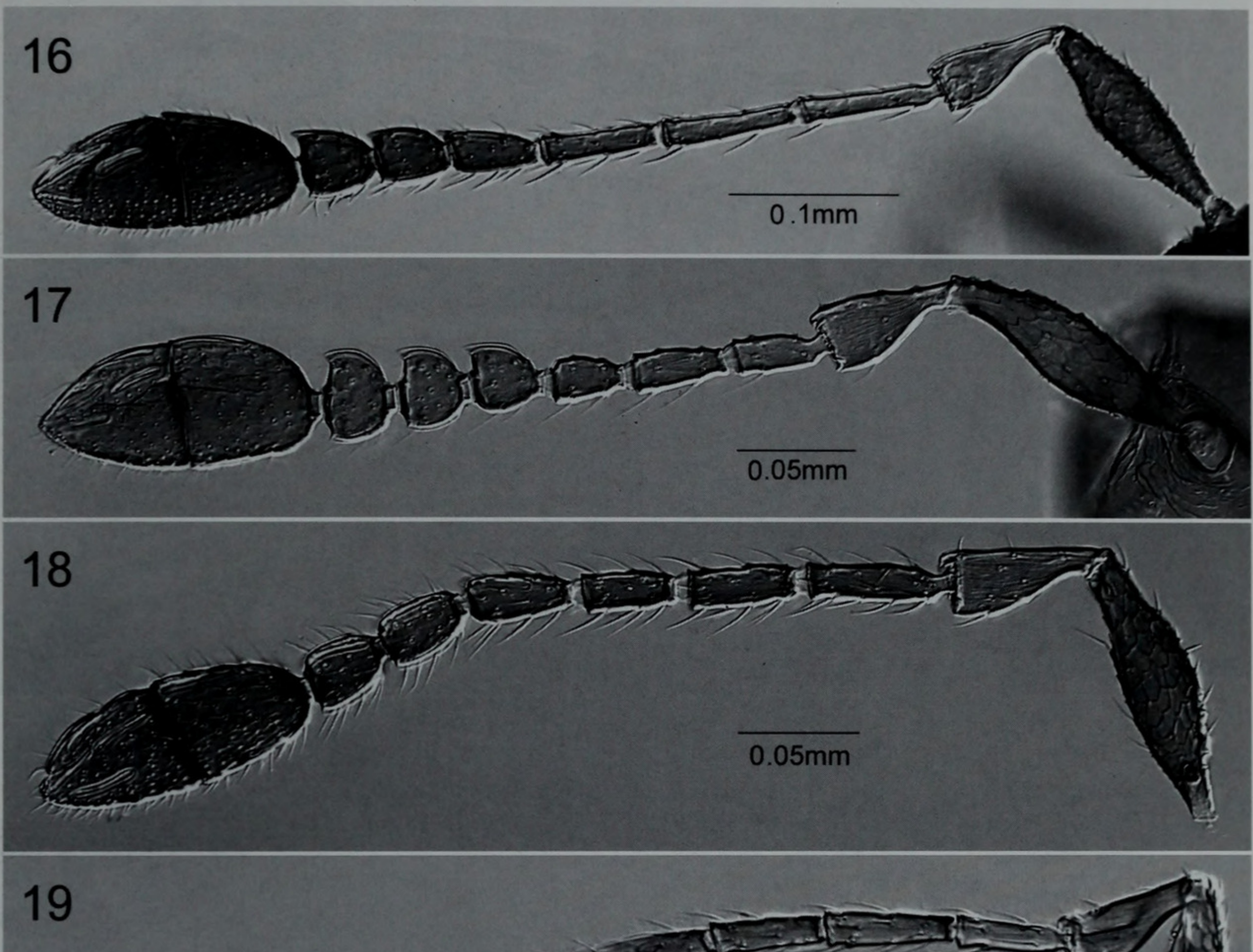
Diagnosis. Body 670-1330 µm in length (critical point or air dried specimens); brown to dark brown, with appendages somewhat lighter in colour. Head (except face) and mesosoma, scape, dorsal surface of gastral petiole, coxae and femora with distinct reticulate sculpture (Figs. 1–5, 7–10, 13, 15, 35, 36, 38–43); gaster, underside of petiole, and remainder of legs



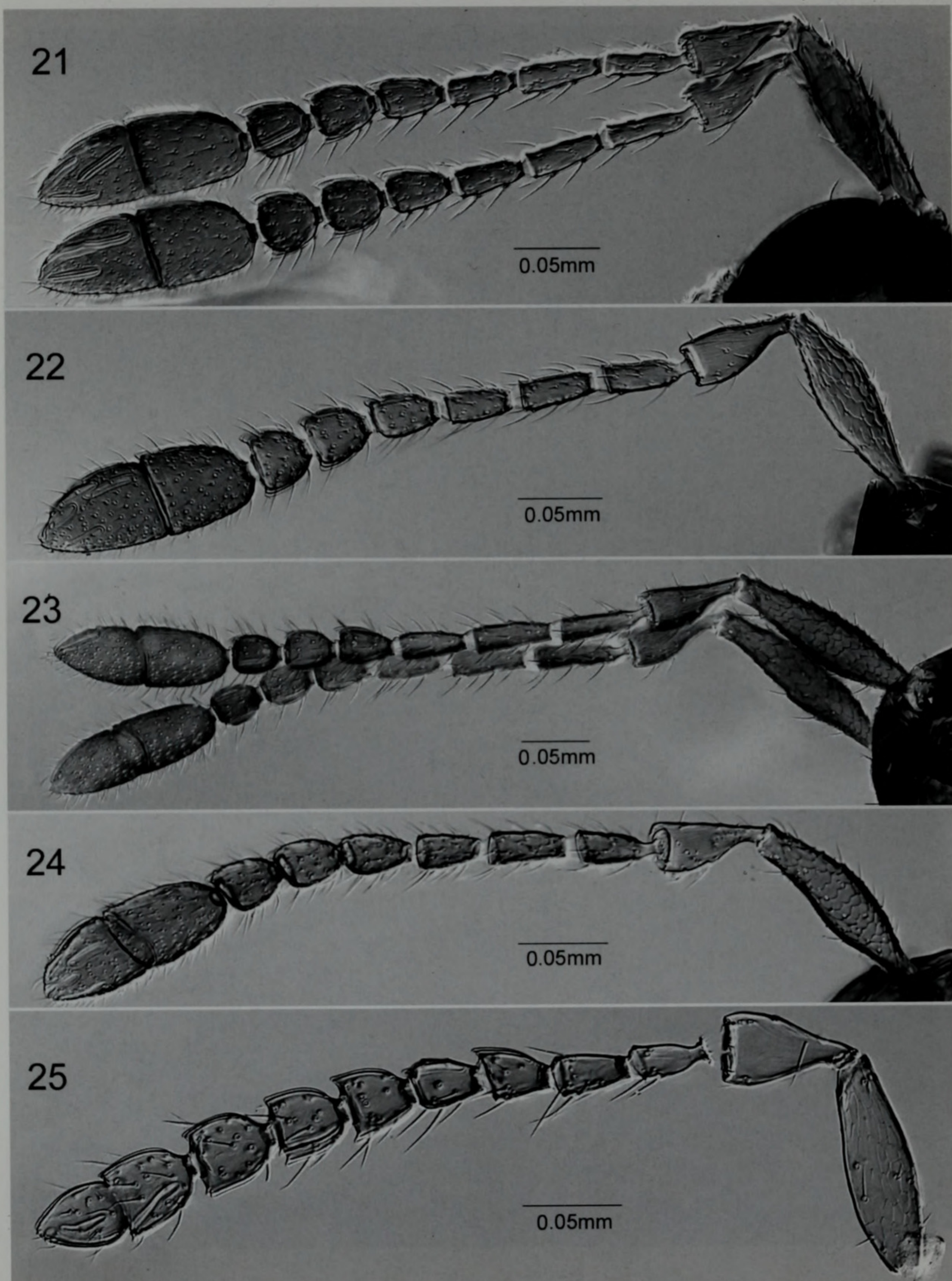
FIGURES 1–6. Head, *Eustochus* sp. probably *atripennis* (Japan, Mt. Tsukuba). 1–dorsal; 2–lateral 3–anterior; 4–ventral; 5–posterior; 6–mouthparts.



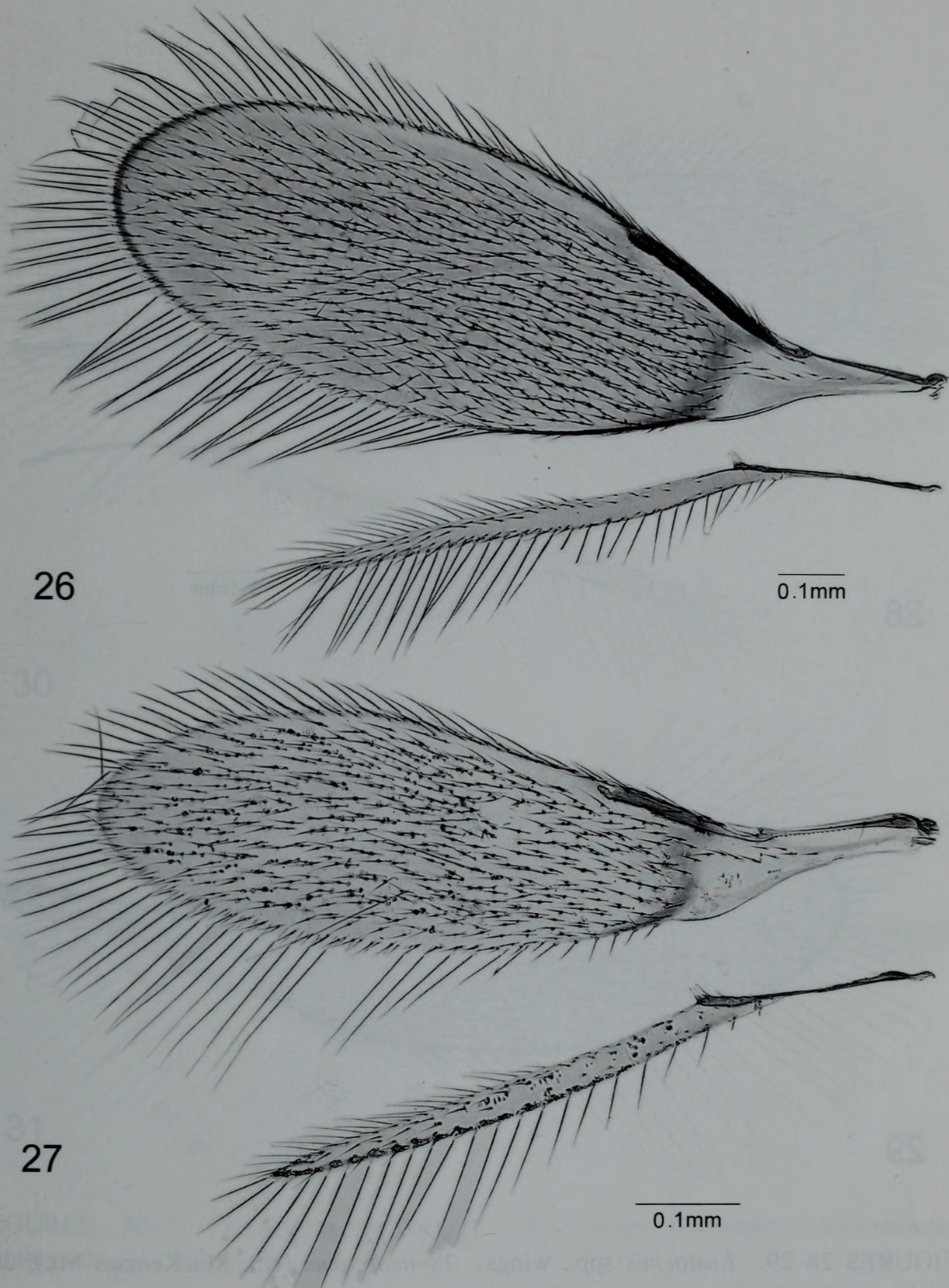
FIGURES 7–15. Mesosoma and metasoma, *Eustochus* sp. probably *atripennis* (Japan, Mt. Tsukuba). 7–mesosoma, dorsal; 8–mesosoma lateral; 9–mesosoma ventral; 10–metasoma, dorsal; 11–metasoma, lateral; 12–metasoma, ventral; 13–petiole dorsal; 14–petiole, ventral; 15–petiole, lateral.



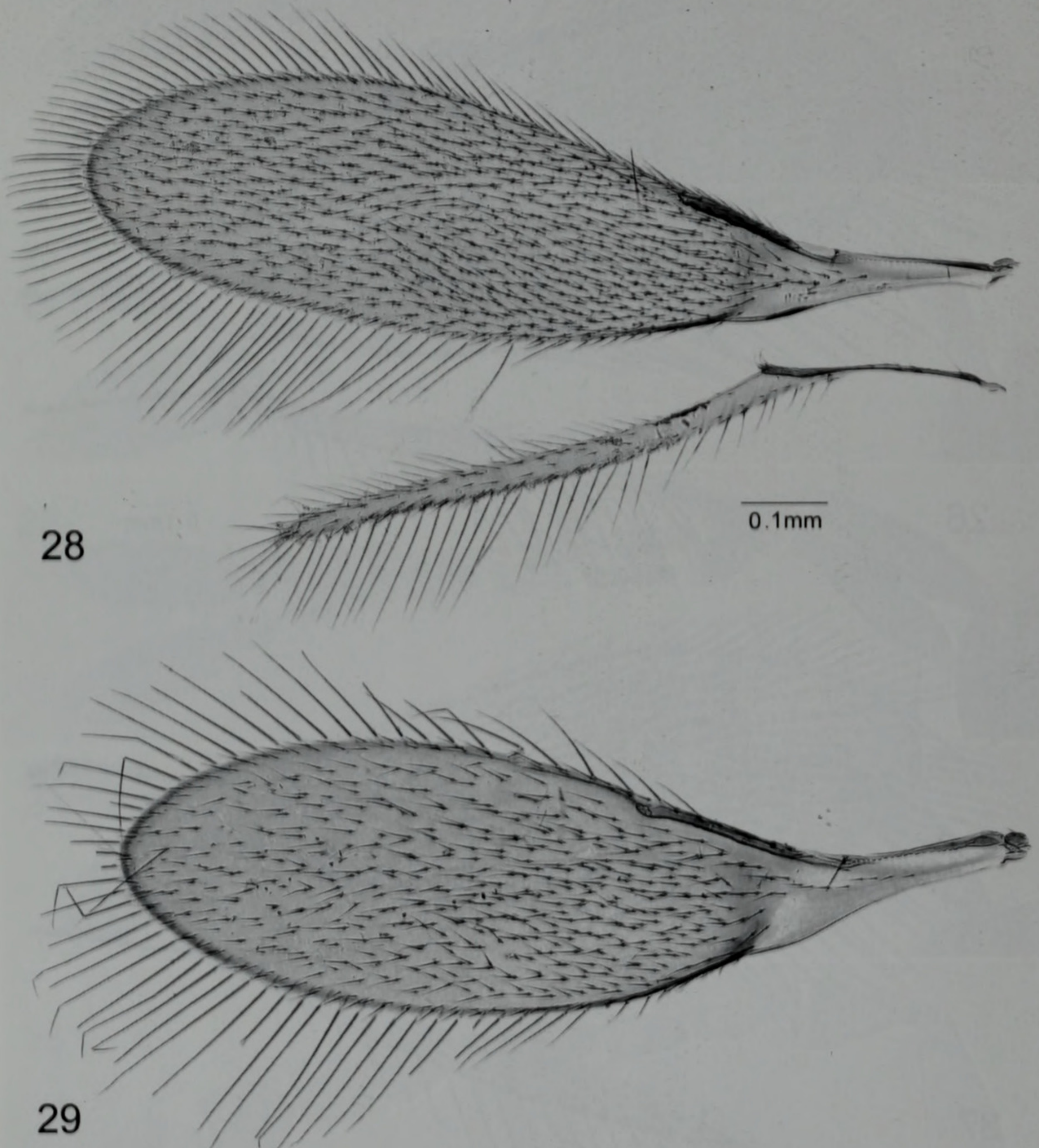
FIGURES 16–20. *Eustochus* spp., female antenna, lateral. 16–*atripennis* (Germany, Bornheim); 17–*besucheti* (Switzerland, Laquintal); 18–*nearcticus* (Canada, MacKenzies Mt.); 19–*triclavatus* (paratype); 20–*pengellyi* (holotype).



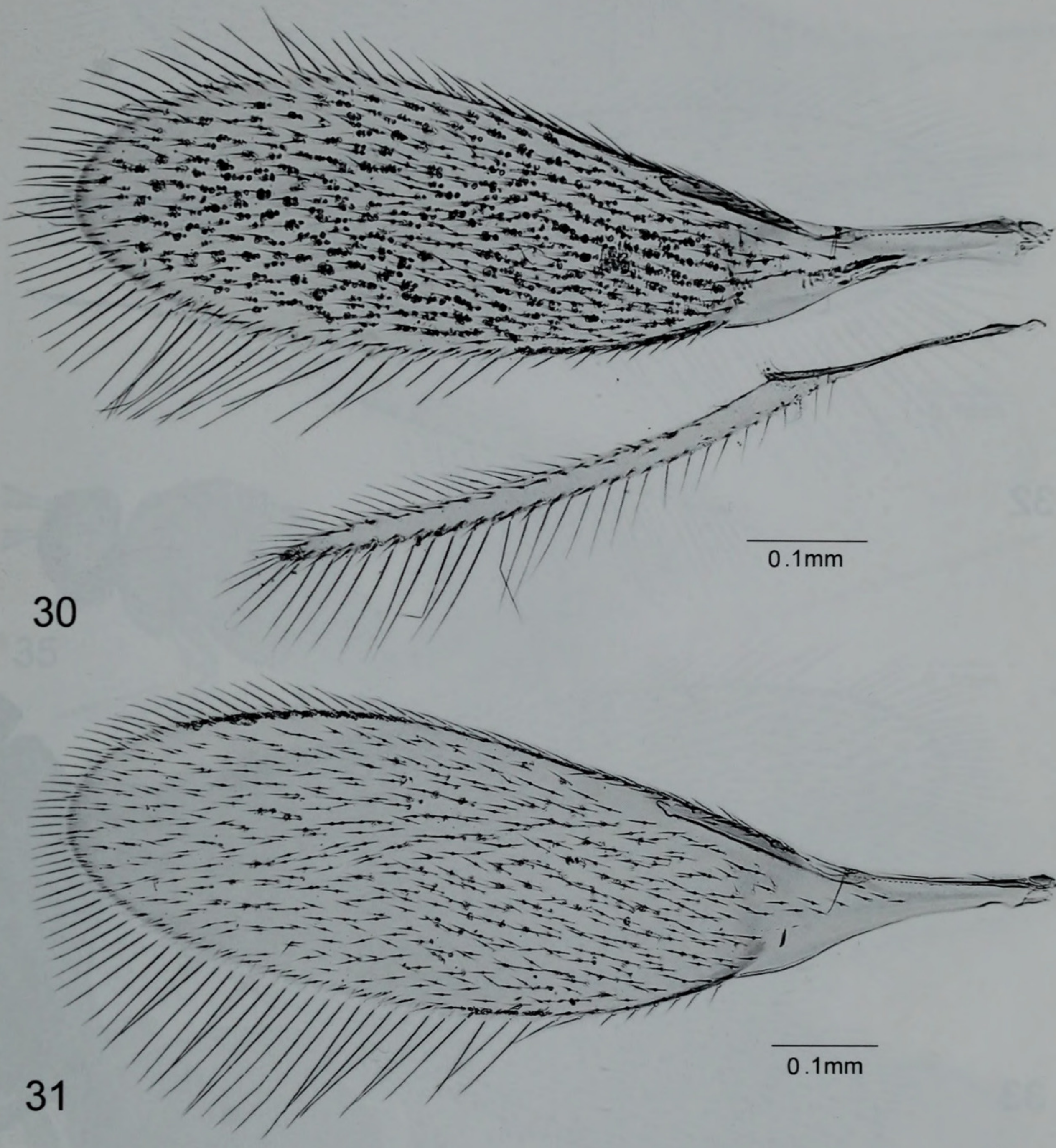
FIGURES 21–25. *Eustochus* spp., female antenna (except 25), lateral. 21–*yoshimotoi* (holotype); 22–?*nearcticus* (USA, Andrews Bald); 23–*confusus* (holotype); 24–*nipponensis* (holotype); 25–*atripennis*, male (Switzerland, Chancy).



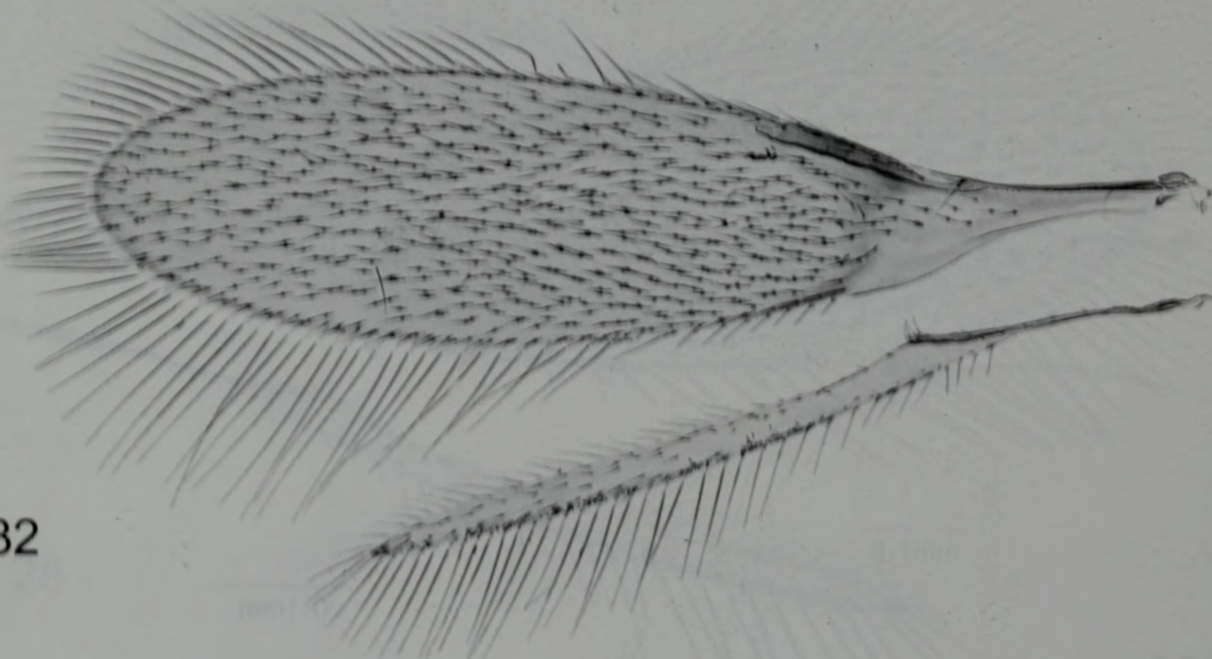
FIGURES 26–27. *Eustochus* spp., wings. 26–*atripennis* (Germany, Bornheim); 27–*besucheti* (Switzerland, Laquintal).



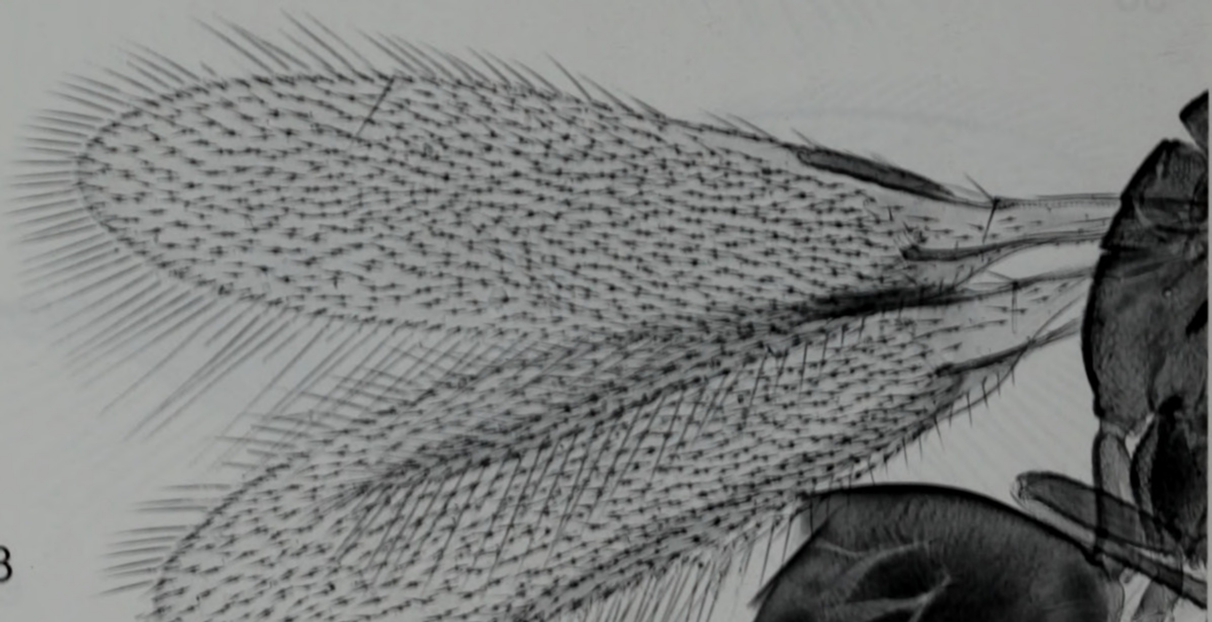
FIGURES 28–29. *Eustochus* spp., wings. 28–*nearcticus* (NS, MacKenzies Mt.); 29–*triclavatus* (paratype).



FIGURES 30–31. *Eustochus* spp., wings. 30–*pengellyi* (holotype); 31–*yoshimotoi* (holotype).

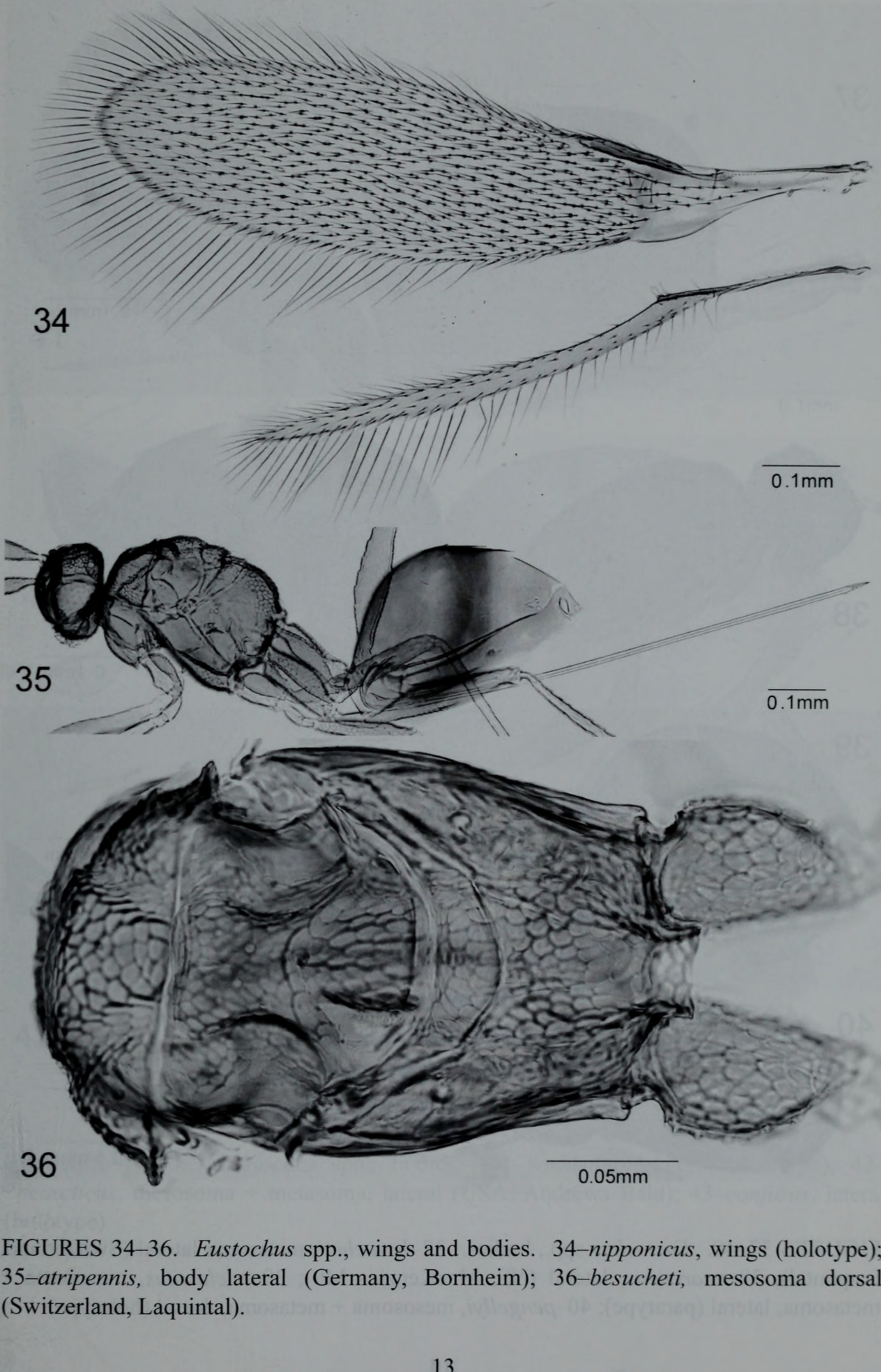


32

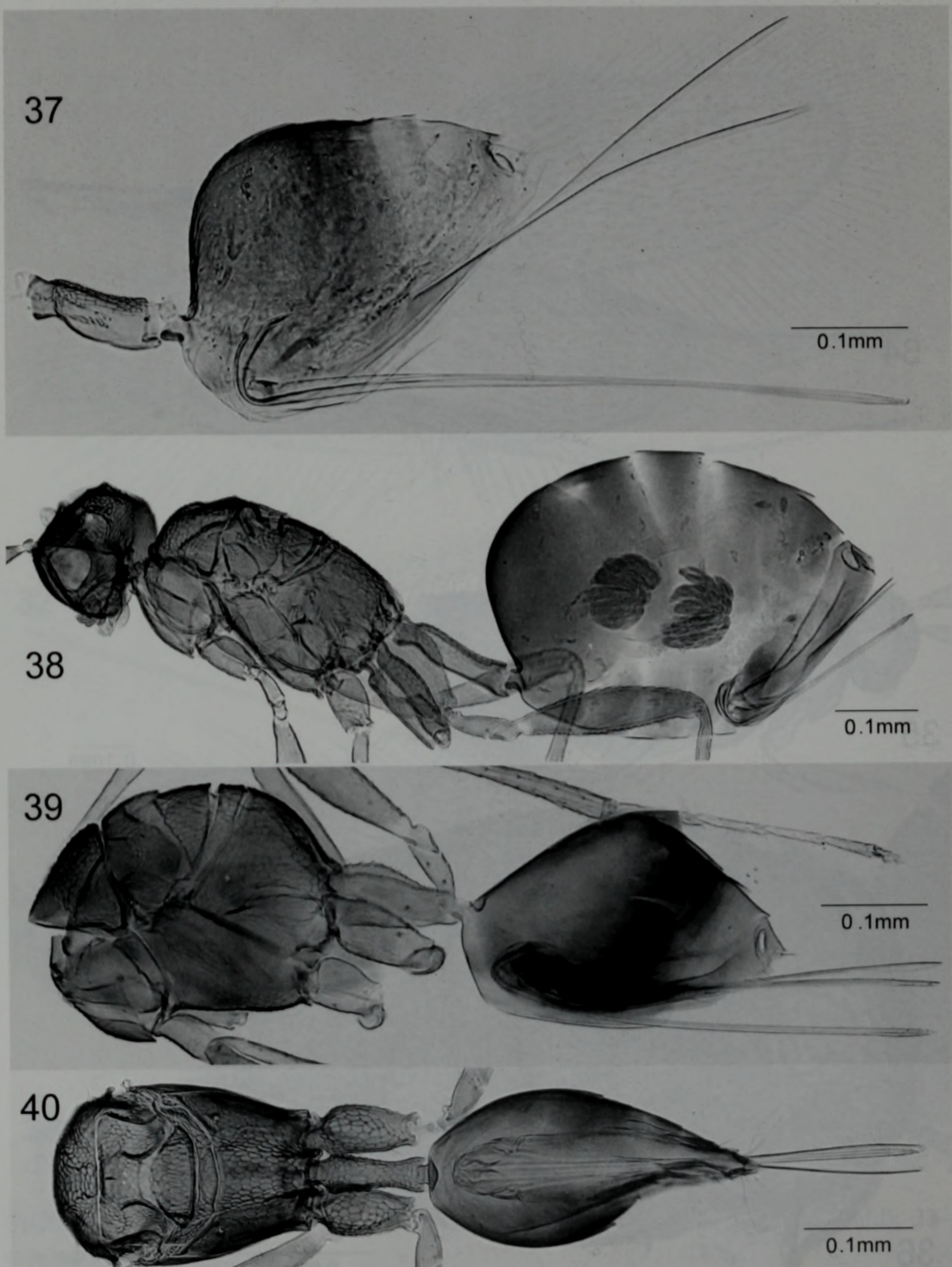


33

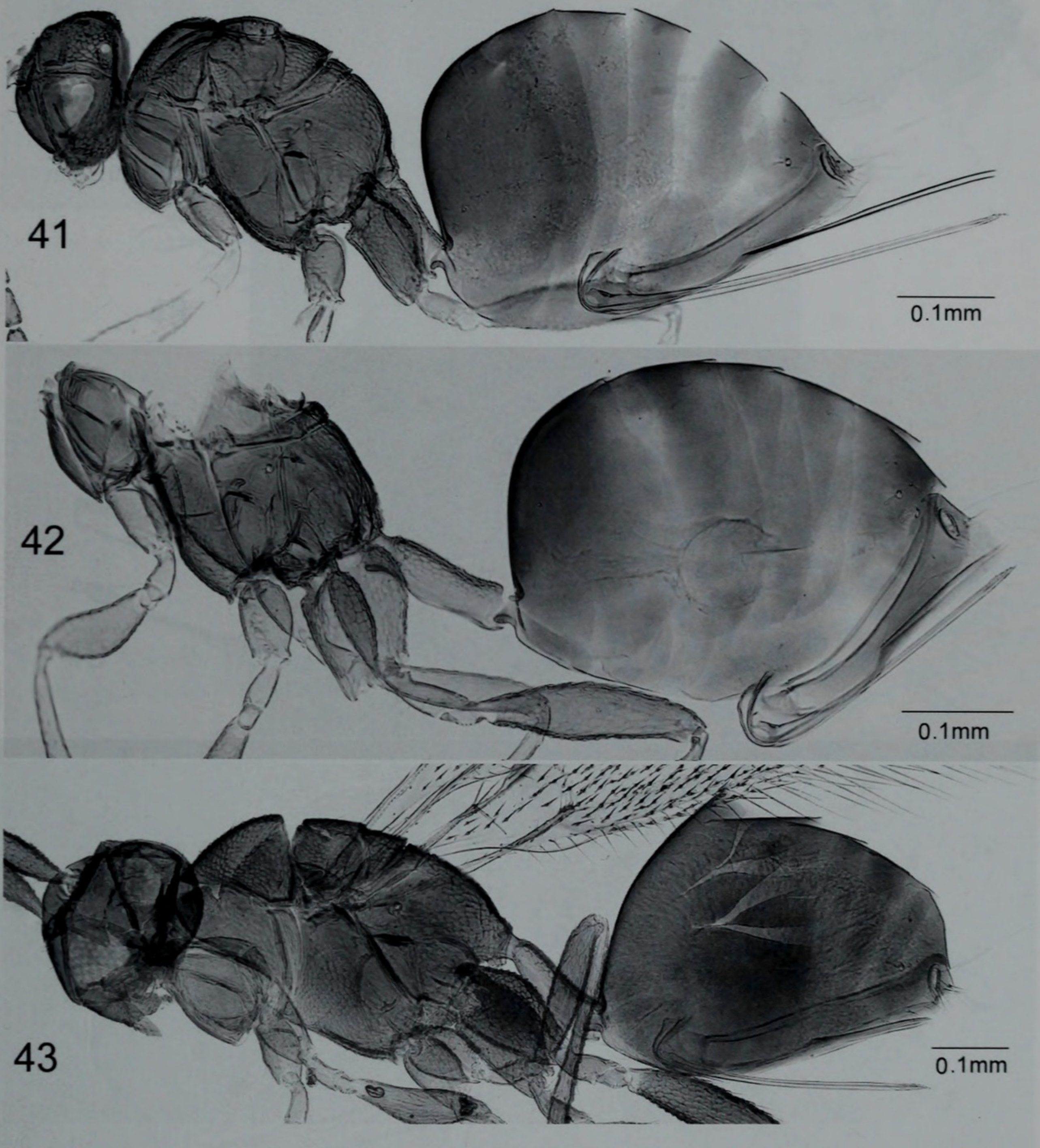
FIGURES 32–33. *Eustochus* spp., wings. 32–?*nearcticus* (USA, Andrews Bald); 33–*confusus* (holotype).



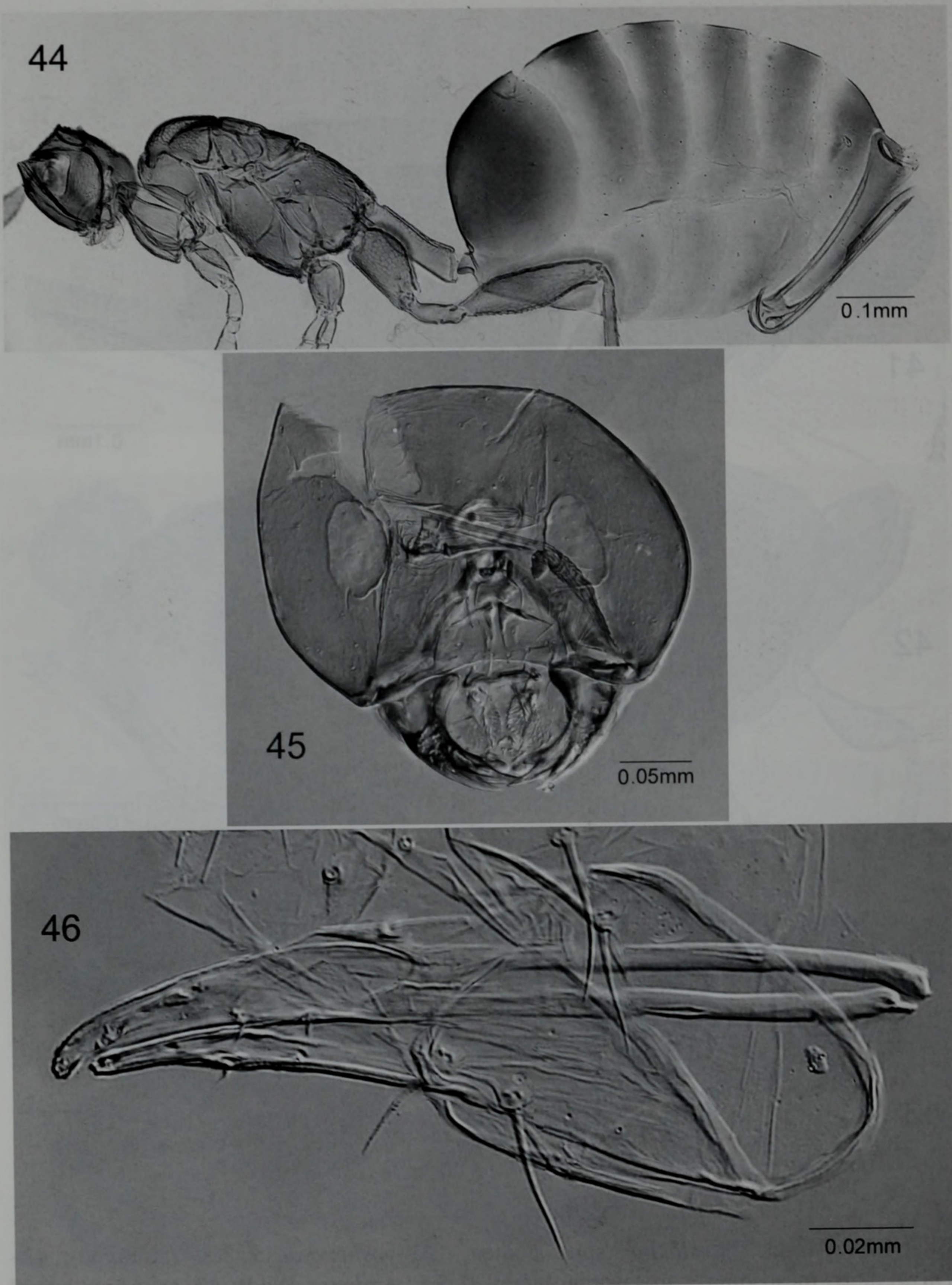
FIGURES 34–36. *Eustochus* spp., wings and bodies. 34–*nipponicus*, wings (holotype); 35–*atripennis,* body lateral (Germany, Bornheim); 36–*besucheti,* mesosoma dorsal (Switzerland, Laquintal).



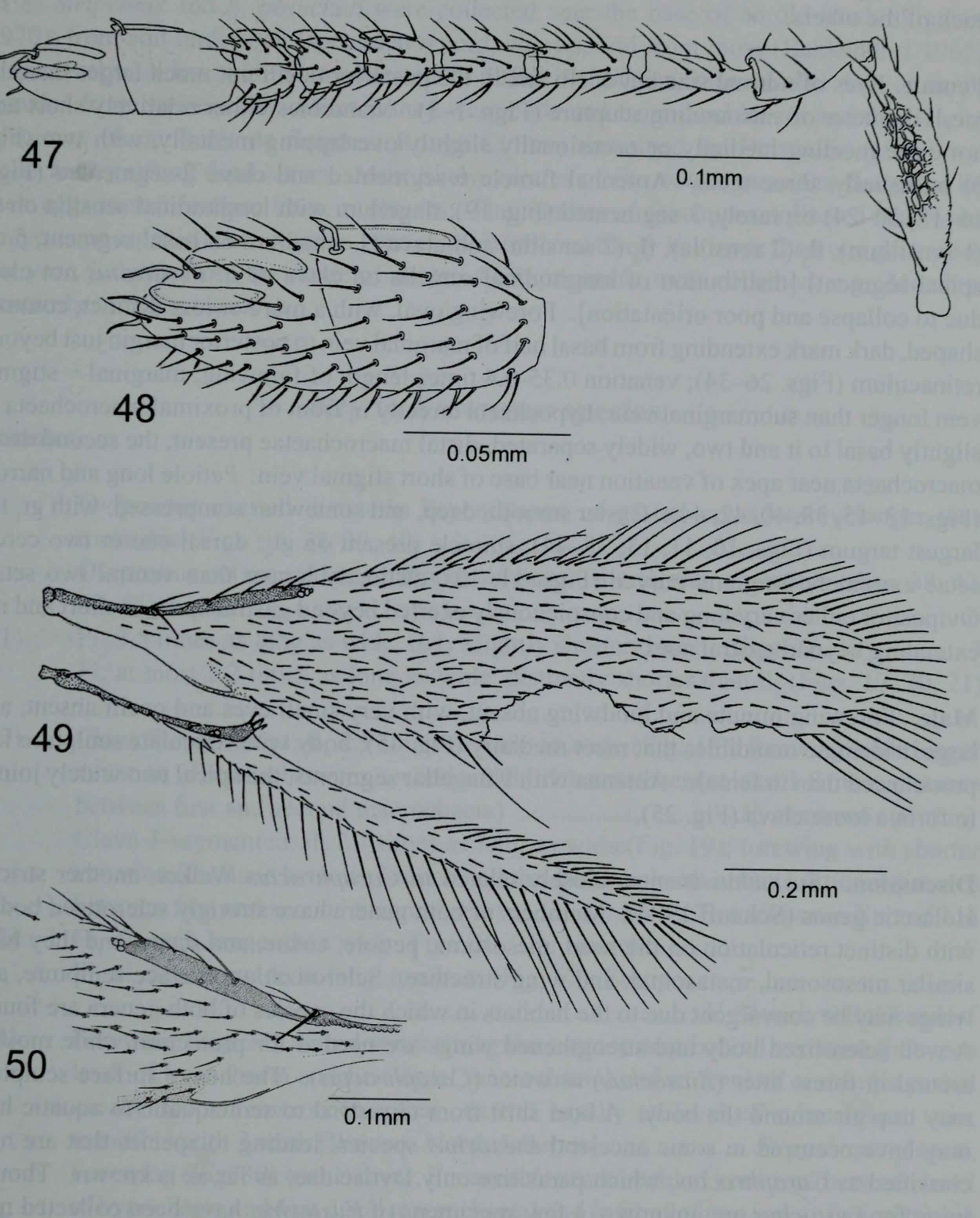
FIGURES 37–40. *Eustochus* spp., bodies. 37–*besucheti*, metasoma lateral (Switzerland, Laquintal), 38–*nearcticus*, lateral (NS, MacKenzies Mt.); 39–*triclavatus*, mesosoma + metasoma, lateral (paratype); 40–*pengellyi*, mesosoma + metasoma, dorsal (holotype).



FIGURES 41–43. *Eustochus* spp., bodies. 41–*yoshimotoi*, lateral (holotype); 42–*?nearcticus*, mesosoma + metasoma, lateral (USA, Andrews Bald); 43–*confusus*, lateral (holotype).



FIGURES 44–46. *Eustochus* spp. 44–*nipponensis*, body lateral (holotype); 45–*atripennis*, male head, anterior (Switzerland, Chancy); 46–*atripennis*, male genitalia, ventrolateral.



FIGURES 47–50. *Eustochus confusus* (paratype). 47–antenna; 48–clava; 49–wings (forewing damaged); 50–forewing venation.

smooth (Figs. 10–12, 14). Legs with 4 tarsal segments, the basal one not much longer than each of the others.

Female. Eyes of normal size but ocelli small, the posterior ocelli not much larger than the mesh diameter of surrounding scupture (Figs. 1–3). Mandibles either relatively short and not quite meeting medially or occasionally slightly overlapping medially, with two (Fig. 6) or, usually, three teeth. Antennal funicle 6-segmented and clava 2-segmented (Figs. 16–18, 20–24) or, rarely, 3-segmented (Fig. 19); flagellum with longitudinal sensilla on fl_4 (1 sensillum), fl_5 (2 sensilla), fl_6 (2 sensilla) and clava (1 sensillum on basal segment, 5 on apical segment) [distribution of longitudinal sensilla on clava of *E. triclavatus* not clear due to collapse and poor orientation]. Forewing oval, with a more or less distinct, comma-shaped, dark mark extending from basal half of marginal vein to posterior margin just beyond retinaculum (Figs. 26–34); venation 0.35-0.4 times length of forewing; marginal + stigmal vein longer than submarginal vein; hypochaeta directly in front of proximal macrochaeta or slightly basal to it and two, widely separated, distal macrochaetae present, the second distal macrochaeta near apex of venation near base of short stigmal vein. Petiole long and narrow (Figs. 13–15, 38, 40, 42, 44). Gaster smooth, deep, and somewhat compressed, with gt_1 the largest tergum (Figs. 10, 11, 13, 38–44); spiracle present on gt_6; dorsal one or two cercal setae extremely long and curved (Figs. 11, 13), distinctly longer than ventral two setae. Ovipositor either very long and conspicuously exerted beyond gastral apex, or short and not extending beyond gastral apex.

Male. Forewing minute and hindwing absent, with very small eyes and ocelli absent, and large, tridentate mandibles that meet medially (Fig. 45); body with reticulate sculpture less pronounced than in female. Antenna with 9 flagellar segments, the apical two widely joined to form a loose clava (Fig. 25).

Discussion. *Eustochus* is most closely related to *Caraphractus* Walker, another strictly Holarctic genus (Schauff 1984). Members of both genera have strongly sclerotized bodies with distinct reticulation on the head, mesosoma, petiole, coxae, and scape, and they have similar mesosomal, metasomal, and wing structure. Sclerotization, surface sculpture, and wings may be convergent due to the habitats in which the species of both genera are found. A well sclerotized body and strengthened wings are needed for protection while moving around in forest litter (*Eustochus*) or water (*Caraphractus*). The heavy surface sculpture may trap air around the body. A host shift from terrestrial to semiaquatic to aquatic host may have occurred in some ancestral *Eustochus* species, leading to species that are now classified as *Caraphractus*, which parasitize only Dytiscidae, as far as is known. Though hosts for *Eustochus* are unknown, a few specimens of *Eustochus* have been collected near water (see *E. atripennis*, below) and the change from hosts in forest litter or soil to hosts near and eventually in water may easily have occurred.

Biology. Hosts are unknown. Most specimens of *Eustochus* examined were collected from deciduous forests. A few were collected near water, and one specimen of *E. nearcticus* Yoshimoto from Alberta was collected from gravel in water. A few specimens appear to have been collected in more open habitats (heron rookery, edge of cornfield), though it is not possible to know exactly what microhabitat they were in. Females and the males of *E. atripennis* and *E. besucheti* were collected near the base of an old trunk (Viggiani 1970), from soil under oak (specimen record, below), and from moss (Bakkendorf 1965), respectively. A few were also collected in pitfall or Malaise traps. Label data on many females from Switzerland indicated they were collected from dead leaves and the Belgian specimen (from Forêt de Soignes, Rouge Cloître) described by Debauche (1948) was collected by sifting dead leaves. Most likely, species of *Eustochus* parasitize hosts that lay their eggs in soil, surface litter, or mosses. The number of specimens collected near water suggests an aquatic host. A given species of *Eustochus* likely has more than one generation per year, judging from the range of dates when specimens were collected, e.g., March to September for *E. atripennis*.

Key to *Eustochus* species

Females

1 Ovipositor exerted distinctly beyond apex of gaster, considerably longer than metatibia (Figs. 35, 37, 39, 40) 2

– Ovipositor not exerted beyond apex of gaster, shorter than metatibia (Figs. 38, 42, 43, 44) 6

2(1) Fl_3 3.5 times as long as wide, only slightly shorter than fl_2 (Figs. 16, 19) 3

– Fl_3 at most 2.2 times as long as wide, distinctly shorter than fl_2 (Figs. 17, 20, 21) 4

3(2) Clava 2-segmented; fl_4 2.1 times as long as wide (Fig. 16); forewing with longer venation (distance between second and third macrochaeta at least 1.8 times distance between first and second macrochaeta) .... *E. atripennis* (Curtis)

– Clava 3-segmented; fl_4 2.7 times as long as wide (Fig. 19); forewing with shorter venation (distance between second and third macrochaeta about 1.4 times distance between first and second macrochaeta) .... *E. triclavatus* Xu and Lin

4(2) Fl_4–fl_6 each longer than wide (Figs. 20, 21); Nearctic 5

– Fl_4–fl_6 each as wide as long, quadrate (Fig. 17); European .... *E. besucheti* Bakkendorf

5(4) Forewing (Fig. 31) with distinct triangular asetose area behind venation (between level of hypochaeta and first distal macrochaeta) and in front of one and a partial second row of microtrichia that extend basally to level of submarginal vein; mandible with 3 teeth [Western North America] .... *E. yoshimotoi* sp. n.

– Forewing (Fig. 30) with narrow, linear asetose area behind venation (between level of hypochaeta and first distal macrochaeta) and in front of two rows of microtrichia that extend basally to level of submarginal vein; mandible with 2 teeth [Eastern North America] .... *E. pengellyi* sp. n.

6(1) FWL/FWW less than 4.0; Nearctic .... *E. nearcticus* Yoshimoto

– FWL/FWW greater than 4.0; Palaearctic 7

7(6) Mesosoma deep, about 1.5 times as long as high and dorsum distinctly curved in lateral view (Fig. 43); forewing (Fig. 33) with about 8 microtrichia on blade behind apex of submarginal vein + base of marginal vein, arranged in 1-2 indistinct rows; asetose area behind these (and in front of retinaculum) relatively wide [area concealed behind wings in Fig. 33] .... *E. confusus* sp. n.

– Mesosoma shallow (Fig. 44), about 1.8 times as long as high and dorsum much flatter in lateral view; forewing (Fig. 34) with about 15 microtrichia on blade behind apex of submarginal vein + base of marginal vein, arranged in 2-3 indistinct rows; asetose area behind these (and in front of retinaculum) relatively narrow .... *E. nipponicus* sp. n.

Eustochus atripennis (Curtis)

(Figs. 1–15 [but see comments below], 16, 25, 26, 35, 45, 46)

Mymar atripennis Curtis, 1832: folio 411 (description in key); Haliday, 1833: 350 (list).

Eustochus atripennis Haliday, 1833: 349 (description, transfer to *Eustochus*); Walker, 1846: 54 (list); Foerster, 1847: 226 (description), 233 (German record from Aachen); Blanchard, 1840: 293 (diagnosis); Dalla Torre, 1898: 428 (list); Ashmead, 1904: 363 (mention in key); Schmiedeknecht, 1909: 495 (list); Kryger, 1950: 63 (description); Debauche, 1948: 201 (description); Bakkendorf, 1965: 122 (key); Viggiani, 1970: 135 (male description); Trjapitzin, 1978: 967 (duplicate of Bakkendorf key); Graham, 1982: 221 (type material); Schauff, 1984: 51 (type material lost); Viggiani, 1989: 146 (male genitalia); Ulrich, 1999: 388 (collection record).

Diagnosis. **Female.** Body length 978 (820-1330, air and critical point dried specimens). Head width 201-251 (n=6). Mandibles each with 3 teeth (2 teeth in specimens from Japan that may be *E. atripennis*, see additional material, below), the middle tooth slightly the largest, the dorsal tooth blunt. Mesosoma length/height 1.29-1.44 (n=2). Ovipositor length 746-1007 (n=9), 1.55-1.78 times length of hind tibia; distinctly exserted beyond apex of metasoma, the exserted part slightly less than hind tibial length.

Antenna (Fig.16). Segment L (W) (n=10): scape 136-169 (32-41), pedicel 66-81 (30-36), fl_1 65-95 (15-20), fl_2 64-83 (17-20), fl_3 56-77 (17-20), fl_4 49-60 (22-32), fl_5 42-51 (29-40), fl_6 38-45 (34-45), entire clava 130-157 (55-79). Ratios of L/W: scape 3.74-4.79, pedicel 1.84-2.48, fl_1 3.82-5.48, fl_2 3.53-4.45, fl_3 3.29-4.1, fl_4 1.69-2.26, fl_5 1.16-1.54, fl_6 0.86-1.04, entire clava 1.84-2.46.

Wings (n=10). FWL 948-1282, FWW 323-454, FWL/FWW ratio 2.88-3.06. Distance between first and second distal macrochaetae 1.85-2.15 (n=6) times distance between proximal and first distal macrochaeta. HWL 841-1044, HWW 33-43.

Male. Body length 1075 (critical point dried specimen). Head brown, distinctly darker than yellowish brown body. Head (Fig. 45) large, with height 208, length on midline 149, width 307, and 1.55 width of mesosoma. Face in lateral view forming a distinct rounded protrusion just below eye level, with toruli facing obliquely upward and lower face and mouthparts strongly sunken in, in lateral view not visible due to protruding gena; face in anterior view with a curved row of 6 setae above mouth margin. Vertex small, without ocelli (cf. Viggiani 1970), and widely separated from back of head by occiput. Eye small.

Malar space as long as eye and malar sulcus absent. Gena 3 times width of eye. Mouth about two-thirds width of head, with mandibles huge and capable of overlapping, each with three teeth, the dorsal one blunt and set back, not in line with the two ventral teeth. Labrum with one median seta. Mesosoma narrow and reduced. Pronotum visible in dorsal view, divided medially. Propleura visible in dorsal view as protruding 'shoulders' lateral to pronotum. Mesoscutum small, triangular, margined laterally by posterior of each pronotal lobe. Notauli absent. Scutellum apparently not divided into anterior and posterior portions and without placoid sensilla. Dorsellum narrow. Propodeum with small spiracle separated about 3 times its diameter from dorsellum; propodeal seta midway between anterior and posterior margins of propodeum, slightly more medial in position than spiracle. Pronotal lobe length (maximum) 46, mesoscutum length 45, scutellum length 47, dorsellum length 14, propodeum length 122. Metasoma with petiole length 122. Gastral terguml overhanging entire petiole, approximate relative lengths of gt_1-gt_7 (along dorsal margin, critical point dried specimens) 11, 15, 12, 9, 9, 9, 4. Spiracle apparently present. Cerci with two dorsal setae longer than ventral two and curved. Gaster length (critical point dried specimen) 614. Genitalia as in Fig. 46.

Forewing present (cf. Viggiani 1970) but minute and almost haltere-like. Hindwing absent.

Antenna (Fig. 25) with 9 flagellomeres, the apical two widely joined, clava-like. Relative proportions of segments L (W) [number of longitudinal sensilla, when present; if different between left and right antenna, both numbers are given]: scape 130 (35), pedicel 72 (38), fl_1 42 (22), fl_2 41 (22), fl_3 39 (27/24) [1/0], fl_4 41 (26/34) [1/2], fl_5 36 (36) [2], fl_6 36 (37) [2/3], fl_7 43 (38) [2], fl_8 42 (39) [3], fl_9 44 (35) [3]. The widths of fl_3 and fl_4 differ between the left and right antennae due to the different numbers of longitudinal sensilla.

Discussion. This species is distinguished from the other species with long ovipositors by proportions of the funicle segments, microtrichial pattern behind the forewing venation, and relatively longer marginal vein. No other described species has such a long venation (distance between first and second distal macrochaeta at least 1.8 times distance between proximal and first distal macrochaeta).

The type material of *E. atripennis* is lost (Graham 1982). Haliday sent specimens to Spinola in Turin (MRSN) and Graham examined the one specimen of *E. atripennis* there. He suggested that it could be designated as neotype, if no undoubted Walker specimen were found. This specimen was examined by JH. It is still in good condition, exactly as Graham (1982) described it (complete, except right pair of wings missing) but is not designated as a neotype here because *E. atripennis* is not a problematic taxon and an objective definition of it is not necessary (ICNZ, 1999, Article 75). The specimen (MRSN) is labelled: 1. "Museo Zoologia/Torino - Italia". 2. "Eustochus/ atripennis Haliday/ Lectotype ♀/ M de V. Graham, 1972". This lectotype designation is incorrect, because the specimen was not from the original material seen by Curtis. If desired, the specimen certainly serves as an example of what Haliday meant when redescribing the species but there are many, more recently collected, specimens in several museums that can serve as well.

Material examined. Forty-seven females and 1 male on cards or points, 10 female and one male on slides (58 additional Swiss and one French specimen were examined many years prior to the present study; they are listed here). **CZECH REPUBLIC, Bohemia:** Praha-Stomovka, 18-19August 1999, L. Masner, riparian, yellow pan trap (♀, CNC); Revnice environs, 20-21 August 1999, L. Masner, creek (♀, CNC). **ENGLAND, Avon:** Bristol, Hallen Wood, 22 July 1925 (♀, USNM); **Berkeshire,** Wytham, em., 8 September 1949, from soil under oak, G. C. Varley (2♀, BMNH); **Cornwall,** Scilly Is., Tresco, 21 September 1975, J. S. Noyes (♀, BMNH); **Devon,** Birchette Wood, 13-21 August 1980 (♀, BMNH); **Dorset,** Bournemouth, 13 July, 17 August, and September 1981, 28 June 1983, S. C. S. Brown (4♀, BMNH); **Greater London,** Richmond, 25 September 1907, C. Waterhouse (♀, BMNH); **Hampshire,** New Forest, 24 June 1954, J. Murgetroyd (♀, BMNH); Romsey, Awbridge, August, September 1981, June 1982. C. Vardy (9♀, BMNH). **FRANCE, Haute-Savoie:** Vongy, 11 June 1964, C. Besuchet, dead leaves (♀, MHNG). **GERMANY, North Rhine-Westphalia:** Bornheim-Brenig, no date, M. Boness, on red currant (♀, CNC). **HUNGARY, Somogy:** Mernye, 17 August–4 September 1985, N. D. Springate (3♀, CNC). **SPAIN, Navarra:** Artikutza, 29 May 1995, 600 m, 18 May 1997, 25 August–22 September, 6–20 October, and 20 October–17 November 1996, 590-610 m, L. Martinez de Murguia, Malaise trap (6♀, CNC, MZNA); Iratibizkar, 26 July 2000, E. Baquero, pitfall trap (2♀, CNC, MZNA). **SLOVENIA:** Bled, 5-12 August 1978, L. Huggert, luxuriant spruce forest, pan trap (♀, CNC); Rateče, 31 July–7 August 1978, L. Huggert, edge of marshy area, pan trap, (♀, CNC). **SWITZERLAND, Geneva:** Chancy, 8 May 1964, C. Besuchet, dead leaves (5♂, 23♀, CNC, MHNG); L`Allondon, 2 and 7 May 1959, C. Besuchet, sifting mosses (15♀, MHNG); **Ticino:** Rancate, 8 August 1963, C. Besuchet, dead leaves (28♀, CNC, MHNG); **Valais,** Euseigne, 1000 m, 10 July 1970, C. Besuchet, det. Viggiani, 1976 (5♀, MHNG); Vouvry, 27 March 1967, at base of old stump, det Viggiani, 1970 (♂, 2♀, MHNG); **Vaud,** Cossonay, 4 August 1953, C. Besuchet, in old stump (♀, MHNG).

Additional material (possibly *E. atripennis*). **JAPAN, Honshu:** Ibaraki, Mt. Tsukuba, 800 m, 18 September–2 October, 2-20 October 1989, M. J. Sharkey, pan trap (7♀, CNC). **SOUTH KOREA, Kangwon-Chucheon:** Nam-myeon, Hudong-li, 31 July–16 August 2003, Malaise trap in semi-shade, forest edge (♀, CNC). The South Korean specimen is as large as the European (especially British) specimens, but fl_4 is longer so it is only tentatively identified as *E. atripennis*. The Japanese specimens are smaller than *E. atripennis* from Europe and because we are not sure if they are conspecific with it, we list them separately here. The scanning electron micrographs were taken from the Mt. Tsukuba specimens and may be *E. atripennis*. They have a long marginal vein but bidentate, instead of tridentate, mandibles.

Eustochus besucheti Bakkendorf (Figs. 17, 27, 36, 37)

Eustochus besucheti Bakkendorf, 1965: 117 (description); Xu and Lin, 2003: 65 (list).

Diagnosis. **Female.** Body length 712-772 (n=3, critical point dried specimens). Head width 192 (n=1). Mandibles each with 3 teeth. Mesosoma length/height about 1.35. Ovipositor length 585, distinctly exserted beyond apex of metasoma and 1.85 times length of hind tibia.

Antenna (Fig. 17). Segment L (W) (n=1): scape 135 (32), pedicel 64 (31), fl_1 45 (18), fl_2 45 (18), fl_3 53 (20), fl_4 33 (30), fl_5 33 (36), fl_6 33 (39), entire clava 123 (58). Ratios of L/W: scape 4.21, pedicel 2.05, fl_1 2.48, fl_2 2.56, fl_3 2.68, fl_4 1.1, fl_5 0.92, fl_6 0.84, entire clava 2.15.

Wings (Fig. 27). FWL 810, FWW 229, FWL/FWW ratio 3.54. Distance between first and second distal macrochaetae 1.33 times distance between proximal and first distal macrochaeta. HWL 689, HWW 34.

Male. *Eustochus besucheti* is the only other species besides *E. atripennis* whose male is known, based on a single specimen from Laquintal, the type locality. Apart from apparently narrower fl_5 and fl_6 in *E. besucheti*, the males of the two species appear to be identical.

Discussion. This species is distinguished from *E. atripennis*, the only other European species with a long ovipositor, by its smaller size, shorter funicle segments, especially fl_4 (Fig. 17), shorter forewing venation, and less sclerotized posterior margin of the forewing just beyond the retinaculum.

Material examined. Three females on cards or point, one on slide. The holotype ♀ and allotype ♂ (MHNG) were not examined. **CZECH REPUBLIC, Bohemia:** Studnice near Jablonec nad Nison, 860 m, 14 July 1964, V. Martinek (♀, CNC). **SWITZERLAND, Turgau:** Unterwasser, 1440 m, 4 August 1984, L. Masner, screen sweeping (♀, CNC); **Valais,** Laquintal, 1400-1500 m, 1 July 1962, C. Besuchet, mosses (2♀, CNC). The Laquintal specimens examined were preserved in alcohol from the type locality, but not designated as paratypes by Bakkendorf (1965). They were critical point dried and point mounted by the senior author and distributed between MHNG and CNC, by permission of C. Besuchet.

Eustochus confusus Huber and Baquero, sp. nov. (Figs. 23, 33, 43, 47–50)

Diagnosis. Female. Body length 1100 (n=1, paratype on slide). Head width 230 (n=1). Mandibles tridentate, each with a small dorsal tooth and 2 larger teeth, the middle one thicker and longer than the ventral one. Mesosoma length/height about 1.5 (Fig. 43). Ovipositor length 338-356 (n=2), not exserted beyond apex of metasoma and less than (0.80-0.82 times) length of hind tibia.

Antenna (Figs. 23, 47, 48). Segment L (W) (n=2): scape 161-174 (38-40), pedicel 76-78 (32-33), fl_1 64-66 (20), fl_2 58-66 (21-24), fl_3 51-52 (20-21), fl_4 40-44 (28-31), fl_5 38-41 (29-35), fl_6 37-39 (29-41), entire clava 125-132 (46-48). Ratios of L/W: scape 4.21-4.39, pedicel 2.35-2.36, fl_1 3.24-3.29, fl_2 2.38-3.10, fl_3 2.54-2.60, fl_4 1.29-1.57, fl_5 1.08-1.38, fl_6 0.94-1.33, entire clava 2.58-2.87.

Wings (Figs. 33, 49). FWL 1083-1151, FWW 262, FWL/FWW ratio (n=1) 4.39. Distance between first and second distal macrochaetae 1.03-1.04 times distance between proximal and first distal macrochaeta (Fig. 50). HWL 857-916, HWW 33-41.

Discussion. This species is distinguished from the only other species with a non-exserted ovipositor in the Palaearctic region, *E. nipponicus*, by the deeper mesosoma that is dorsally more rounded in lateral view (Fig. 43) compared to a shallower mesosoma that is dorsally flatter in lateral view (Fig. 44) and the wider asetose area between the retinaculum and rows of microtrichia behind the venation (Fig. 33). In Europe, E. *confusus* is the only species with an ovipositor shorter than the hind tibial length. The other two, *E. atripennis* and *E. besucheti* have long, exserted ovipositors that are longer than the hind tibia. It differs from *E. nearcticus* by its narrower forewing (length/width ratio about 4.4).

Material examined. Two females on slides. **HOLOTYPE** ♀ (MZNA) on slide labelled: 1. "MZNAXA098a /Irati (Navarra, Spain), /18.IX.1982/ UTM:30TXN5460,/390 m, UNZYEC leg./ MUSEO DE ZOOLOGÍA/UNIV. DE NAVARRA". 2. "Eustochus confusus Huber and Baquero. Holotype ♀". The holotype is complete and was originally uncleared and mounted laterally in Hoyer`s medium under a single cover slip (Fig. 23, 33, 43). After being photographed it was cleared and remounted in Canada balsam. **PARATYPE.** Same data as holotype (♀, MZNA).

Species name. The species name, *confusus*, is Latin for confusing. It refers to the initial confusion we had as to whether *E. confusus* was the same as *E. nearcticus* or not. If it had been, it would be the first *Eutochus* species occurring in both Europe and North America. While this is possible, because soil brought to North America as ballast in ships may have contained parasitized hosts, it is unlikely, given the occurrence of both species in localities that are not particularly near ports and that consist of native vegetation rather than human altered habitats.

Eustochus nearcticus Yoshimoto (Figs. 18, 28, 38, possibly also 22, 32, 42)

Eustochus nearcticus Yoshimoto, 1990: 96 (description).

Diagnosis. Female. Body length 690-717 (n=2, critical point dried specimens). Head width 194 (n=1). Mandibles each with 3 teeth, the dorsal one smaller than the ventral two. Mesosoma length/height 1.55 (n=1) (Fig. 38). Ovipositor length 256-268 (n=2), 0.69-0.76 times length of hind tibia; not exserted beyond apex of metasoma.

Antenna (Fig. 18). Segment L (W) (n=2): scape 125-141 (30-32), pedicel 66-69 (29-30), fl_1 55-66 (15), fl_2 52 (19-20), fl_3 44-46(17-18), fl_4 41-47 (22-24), fl_5 38-40 (29), fl_6 36-37 (32-35), entire clava 124-129 (39-50). Ratios of L/W: scape 4.17-4.44, pedicel 2.30-2.33, fl_1 3.66-4.42, fl_2 2.62-2.76, fl_3 2.47-2.68, fl_4 1.73-2.09, fl_5 1.32-1.41, fl_6 1.05-1.12, entire clava 2.48-3.32.

Wings (Fig. 28). FWL 978-1048, FWW 278-283, FWL/FWW ratio 3.46-3.85. Distance between first and second distal macrochaetae 1.03-1.09 times distance between proximal and first distal macrochaeta. HWL 778-863, HWW 30-31.

Discussion. *Eustochus nearcticus* is the only described species with a short ovipositor (Fig. 38) in the Nearctic region. It is distinguished from the two Palaearctic species with short ovipositors by proportions of the forewing and mesosoma. *Eustochus nearcticus* differs from *E. nipponicus* by its deeper mesosoma (length/height ratio about 1.5 compared to about 1.8), with a more rounded dorsum in lateral view. It differs from *E. confusus* by its wider forewing (length/width ratio at most 4.08).

Several specimens from western North America (AB, BC, MT) and southeastern USA (NC) may belong to *E. nearcticus*. We exclude them because we are not sure that they really are conspecific. They are listed separately below. Minor differences in their antennal proportions (funicle segments relatively short, somewhat as in *E. confusus*, in those specimens slide mounted and measured) size of bare area in front of fore-wing retinaculum, and height of mesosoma (e.g., Figs. 22, 32, and 42, all from a specimen from NC), may reflect intraspecific variation within *E. nearcticus* but may also indicate that they are a separate species. A conservative approach is taken here and they are excluded from *E. nearcticus* until more material, especially from intervening areas, becomes available for detailed study. The antenna (Fig. 22) of the NC specimen resembles that figured by Yoshimoto (1990, fig 36) in that fl_1 is relatively short, compared to Fig. 18. Both of the latter figures are specimens from the type localities.

The specimens from British Columbia appear to have a flatter mesosoma, more resembling *E. nipponicus*, than the point-mounted paratypes of *E. nearcticus*. It is difficult to be sure how these specimens are distinguished from *E. nipponicus*. However, the western Nearctic specimens all appear to have fl_1 slightly longer than fl_2, whereas *E. nipponicus* has fl_1 shorter than fl_2. If they are indeed the same species as *E. nipponicus* then wider species limits would then have to be accepted. Similarly, *E. nearcticus* specimens from eastern Canada may be the same as *E. confusus*, but, if so, wider species limits would again have to be accepted. Finally, the western specimens may represent a different species from either *E. nipponicus*, *E. confusus*, or *E. nearcticus*, and possibly could be defined geographically as well as morphologically. But since several specimens, possibly of *E. nearcticus*, are from Ontario it is difficult to define the two populations geographically. It is also possible that *E. nipponicus* and *E. confusus* are the extremes of only one species occurring across the Palaerctic region, but so far no *Eustochus* resembling these two species has been collected between Spain and Japan.

We prefer to treat the specimens with short-ovipositors as three species, with *E. nearcticus* occurring in northeastern North America but not in the Palaearctic region, and *E. nipponicus* distinct from *E. confusus* in the Palaeactic region. Much more material of these species is required, especially from intervening areas, to verify their status relative to one another and determine how many species really are involved.

The craterlike pits on the propodeum, visible on the scanning electron micrograph in figure 148 of Yoshimoto (1990), are an artifact, presumably due to remnants of a liquid deposit on the specimen. Cleared, slide mounts prepared of two specimens from the type locality do not show these pits; the sculpture is uniformly reticulate.

Material examined. Three females on points, two on slides. The holotype (CNC) is complete and in good condition on a point. Three paratypes from Nova Scotia, as listed in the original description, were also seen. The fourth paratype, from British Columbia, is a different species, assigned here to *E. yoshimotoi*, sp. n. (see below). The paratype from MacKenzies Mt. was slide mounted for detailed study. An additional specimen from

MacKenzies Mt., listed below, was also slide mounted; it was not included in the type series by Yoshimoto (1990), for unknown reasons.

CANADA, Nova Scotia: Cape Breton Highlands Nat. Park, MacKenzies Mt., 9 August 1983, J. E. H. & R. J. Martin (♀, CNC).

Additional material. Thirteen other specimens that may be *E. nearcticus* were examined, 3 of them (MT and NC) are on slides. **CANADA, Alberta:** Waterton Lakes National Park, 2 August 1985, Cameron Creek on Akamina Parkway near mouth of Rowe Creek, gravel in riffle, I. M. Smith (♀, CNC). **British Columbia:** Kootenay National Park, Daer Pitts, 16-30 July 2000, G. Gareau, MT, aspen (2♀, CNC). **Ontario:** Brucedale Conservation Area near Port Elgin, 19 April–16 June 1988, C. Dondale and J. Redner, pit fall trap at edge of swamp (♀, CNC). **UNITED STATES: Montana, Flathead Co.**, Glacier National Park, N. Fork Flathead area, S. Big Prairie, 3560`, T35N R21W, sect. 16, 10-17 August 1993, M. A. Ivie, old growth light burn (2♀, CNC). **North Carolina: Jackson Co.**, Whiteside Mt., near Highlands, 1600 m, April–20 July 1987, CNC Hym. Team, oak forest (2♀, CNC); **Swain Co.**, Andrews Bald, pitfall 51, N 35° 20"32' W 83° 39"29', 10-24 May, 6-22 June, and 10-25 September 2001, Parker, Stocks, Petersen (5♀, CNC).

Eustochus nipponicus Huber and Baquero, sp. nov. (Figs. 24, 34, 44)

Diagnosis. Female. Body length 947-1100 (n=3, critical point dried specimens). Head width 188-198. Mandibles each apparently tridentate, with 2 large ventral teeth and a small, dorsal tooth. Mesosoma length/height 1.82 (Fig. 44). Ovipositor length 281 (holotype), not exserted beyond apex of metasoma and less than (0.91 times) length of hind tibia.

Antenna (Fig. 24). Segment L (W) (holotype): scape 138 (35), pedicel 69 (32), fl_1 51 (19), fl_2 51 (20) , fl_3 41 (20) fl_4 44 (24), fl_5 39 (29), fl_6 37 (32), entire clava 110 (54). Ratios of L/W: scape 3.89, pedicel 2.19, fl_1 2.71, fl_2 2.62, fl_3 2.01, fl_4 1.40, fl_5 1.36, fl_6 1.15, entire clava 2.03.

Wings (Fig. 34). FWL 974, FWW 232, FWL/FWW ratio 4.09. Distance between first and second distal macrochaetae 1.04 times distance between proximal and first distal macrochaeta. HWL 823, HWW 34.

Discussion. This species is distinguished from *E. confusus*, the only other Palaearcic species with a short ovipositor, by the shallower mesosoma with a flatter dorsum in lateral view, and the narrower asetose area between the retinaculum and rows of microtrichia behind the venation (Fig. 34).

Material examined. Four females, one on a slide. **HOLOTYPE** ♀ (CNC) on slide labelled: 1. "Japan: Honshu/, Iwate, Iwaizumi/ Hitsutori, 770m/11-17.viii.1991/ A. Smetana [J47]". 2. "Eustochus/ nipponicus/ Huber &/ Baquero/ Holotype ♀". The holotype is cleared and mounted laterally (Fig. 44) under a 6 mm cover slip, with the wings and one antenna under two additional cover slips. **PARATYPES.** Same locality data as holotype (2♀, CNC); Iwate, Kawai, Yoshibezawa, N 39° 37' E 141° 31', 500 m, 25 August 1996, L. Masner, screen sweeping (♀, CNC).

Species name. The species is named from the Japanese name for the country of origin, Nippon.

Eustochus pengellyi Huber and Baquero, sp. nov. (Figs. 20, 30, 40)

Diagnosis. **Female.** Body length 666-896 [up to 973 when gaster somewhat inflated] (n=8, critical point dried specimens). Head width 184 (holotype). Mandibles each with 2 teeth. Mesosoma length/height 1.33-1.44 (n=3, critical point dried specimens). Ovipositor length 439, 1.40 times length of hind tibia and distinctly exserted beyond apex of metasoma.

Antenna. Segment L (W) (holotype): scape 121 (30), pedicel 62 (27), fl_1 50 (14), fl_2 46 (17), fl_3 39 (20), fl_4 38 (23), fl_5 36 (27), fl_6 35 (29), entire clava 105 (54). Ratios of L/W: scape 4.08, pedicel 2.29, fl_1 3.63, fl_2 2.62, fl_3 1.97, fl_4 1.66, fl_5 1.33, fl_6 1.22, entire clava 1.93.

Wings. FWL 799, FWW 228, FWL/FWW ratio 3.51. Distance between first and second distal macrochaetae 1.15 (1.30 on other wing) times distance between proximal and first distal macrochaeta. HWL 668, HWW 26.

Discussion. This species is distinguished from *E. yoshimotoi*, the only other Nearctic species with a long, exserted ovipositor, by a narrower asetose area above the retinaculum that is separated from the venation by only one complete line of microtrichia (wider asetose area and at least a partial second line of microtrichia in *E. pengellyi*). It differs from *E. atripennis* by its shorter venation, from *E. besucheti* by antennal proportions, and from *E. triclavatus* by the number of claval segments. The specimens from Japan that we treat as possibly *E. atripennis* on the basis of a long venation, also have bidentate mandibles.

Material examined. Thirteen females, two on slides. **HOLOTYPE** ♀ (CNC) on slide labelled: 1. "CANADA: ON/, Flint Hill near/ Kemptville/, 19-20.vii.1983/, L. Dumouchel". 2. "Eustochus/ pengellyi/ Huber and Baquero ♀/ Holotype". The holotype is cleared and mounted dorsally in Canada balsam under one 6 mm cover slip and the wings, and head, antennae and prothorax are under two other coverslips. **PARATYPES. CANADA, Ontario: Frontenac Co.**, 5 km W. Chaffey's Locks, Skycroft Campground, 9-14 July 1987, B. Hubley, MT (2♀, CNC); Thetford, 10-13 October 1982, A. Tomlin, FIT (♀, CNC); Haliburton Forest and Wildlife Reserve, N 45° 15' W 78° 35', 12 July 2001, C. Vance, maple forest, MT (♀, CNC); 7 km SE Westport, 134 m, N 44° 37"727' W 76° 21"545', 1-31 August 2005, S. Peck, maple sugar bush, FIT (♀, CNC). **Quebéc,** Lac Jean-Venne, N 45° 41' W 76° 03', 15-20 June, *Osmunda* marsh, YPT and 14-21 August 1995, L. Masner & J. Denis, *Osmunda* marsh creek, YPT (2♀, CNC). **UNITED STATES, Indiana: Laporte Co.**, Indiana Dunes National Lakeshore, Heron Rookery, 29 July 1997, R. Grundel, MT (2♀, CNC, USNM). **Maryland: Prince George`s Co.**, Beltsville-Agricultural Research Centre, 1-9 July1980, K. Thorpe, Malaise trap on corn field edge (♀, USNM). **Tennessee: Blount Co.**, Cades Cove, N 35° 25"35' W 83° 17"50', 29 July1997, R. Grundel, MT (2♀, CNC).

Species name. The species is named in honour of Dr. David Pengelly, whose enthusiasm for teaching entomology encouraged several students to pursue insect taxonomy as a career.

Eustochus triclavatus **Xu and Lin** (Figs. 19, 29, 39)

Eustochus triclavatus Xu and Lin, 2003: 66 (description).

Diagnosis. **Female.** Body length about 720 (n=1, ?paratype on slide). Head width 193. Mandibles each with 3? teeth (not clearly visible). Mesosoma length/height 1.35. Ovipositor length 415, distinctly exserted beyond apex of metasoma and 1.16 times length of hind tibia.

Antenna (Fig. 19). Segment L (W) (?paratype): scape–[not measurable] (ca. 23), pedicel 63 (24), fl_1 47 (15), fl_2 52 (15), fl_3 47 (14), fl_4 52 (20), fl_5 45 (23), fl_6 41 (23), entire clava 137 (40). Ratios of L/W: pedicel 2.58, fl_1 3.14, fl_2 3.46, fl_3 3.25, fl_4 2.57, fl_5 1.96, fl_6 1.77, entire clava ca. 3.42.

Wings (Fig. 29). FWL 857, FWW 264, FWL/FWW ratio 3.25. Distance between first and second distal macrochaetae 1.41 times distance between proximal and first distal macrochaeta. HWL 731, HWW 31.

Discussion. This species is distinguished from all others described so far by the three-segmented clava (two segmented in other species). It belongs to the group of species with distinctly exserted ovipositors.

Material examined. One female on slide. **CHINA, Shanxi:** Fengxian, ♀, 4 September 1999, N.Q. Lin, CNC. The locality (Baoji) given in the original description differs from the specimen label, quoted here; it is not certain whether this specimen is a paratype. The holotype ♀ (FAFU) was not examined.

The paratype is uncleared, poorly oriented, and the clava of each antenna is slightly collapsed. It appears to have the division between claval segments 2 and 3 less distinct and perhaps incomplete, at least on one antenna.

Eustochus yoshimotoi **Huber and Baquero, sp. nov.** (Figs. 21, 31, 41)

Diagnosis. *Eustochus yoshimotoi* is one of two Nearctic species with a distinctly exserted ovipositor. It is distinguished from the other, *E. pengellyi*, by the wider, more distinct asetose area behind the marginal vein (narrower in *pengellyi*) and the tridentate mandible (bidentate in *E. pengellyi*).

Description. Female. Body length 845 (n=3, critical point dried specimens). Head width 211 (n=2). Mandibles each with 3 teeth. Mesosoma length/height 1.29-1.48. Ovipositor (Fig. 41) distinctly exserted beyond apex of metasoma, 485-525 (n=3) long and 1.24-1.32 times length of hind tibia.

Antenna (Fig. 21). Segment L (W) (n=2): scape 135-144 (32-33), pedicel 66-71 (32-33), fl_1 55-60 (17), fl_2 48-56 (17), fl_3 44-54 (19-20), fl_4 39-44 (27-29), fl_5 39-41 (34),

fl_6 39-40 (38), entire clava 121-138 (57-59). Ratios of L/W: scape 4.06-4.28, pedicel 2.07-2.10, fl_1 3.27-3.51, fl_2 2.80-3.19, fl_3 2.25-2.87, fl_4 1.43-1.55, fl_5 1.14-1.20, fl_6 1.05-1.06, entire clava 2.03-2.59.

Wings (Fig. 31). FWL 950-994, FWW 281-298, FWL/FWW ratio 3.33-3.44. Distance between first and second distal macrochaetae 0.90-1.02 times distance between proximal and first distal macrochaeta. HWL 739-809, HWW 38-41.

Material examined. Seven females, four of them on slides. **HOLOTYPE** ♀ (CNC) on slide labelled: 1. "USA, WA,/ Pierce Co./ Ashford/ 1-14.viii.1985/ L. Masner, Malaise trap". 2."*Eustochus/ yoshimotoi* ♀/ Huber and/ Baquero/ Holotype". The holotype is cleared and mounted laterally under one 6 mm cover slip in Canada balsam and the wings are under another coverslip. **PARATYPES.** Same data as holotype (4♀, CNC, USNM); **CANADA, British Columbia,** Vancouver Is., Mesache Lake, July 1984, MT, Sharkey–Johnson (♀, CNC). **UNITED STATES, California, El Dorado Co.**, Blodgett Forest, 27 August 1975, F. Andrews, M. Wasbauer, *Pinus ponderosa* log (♀, UCRC). The paratype from British Columbia was designated originally as a paratype of *E. nearcticus* by Yoshimoto (1990) and bears the paratype label "*Eustochus nearcticus*", as well as ours "*Eustochus yoshimotoi*".

Species name. The species is named in honour of Carl Yoshimoto, the senior author`s predecessor with the Canadian Forest Service, who was a taxonomist at the CNC and described the first North American species of *Eustochus*.

Acknowledgements

We thank K. Bolte for preparing the digital images and compiling the plates and the curators of the institutions listed above for loaning or donating material to us for study. B. Landry kindly checked the number of specimens of *E. atripennis* and E. *besucheti* in MHNG and provided their collection information. Through the kindness of G. Pagliano (MRSN), the senior author was able to borrow the Haliday specimen of *E. atripennis* in the Spinola collection, and an additional specimen of one species was found and brought to my attention by S. Triapitsyn (UCRC). The manuscript was critically reviewed by G. Gibson and A. Bennett (CNC).

References

Annecke, D. P. and R. L. Doutt. 1961. The genera of the Mymaridae. Hymenoptera: Chalcidoidea. Entomology Memoirs. Department of Agricultural Technical Services, Republic of South Africa 5: 1–71.

Ashmead, W. H. 1904. Classification of the chalcid flies of the superfamily Chalcidoidea, with descriptions of new species in the Carnegie Museum, collected in South America by Herbert H. H. Smith. Memoirs of the Carnegie Museum 1(4): 225–555.

Bakkendorf, O. 1965. Description of a new subterranean species including a male and female of *Eustochus* Hal. Mitteilungen der Schweizerischen Entomologischen Gesellschaft 37: 117–122.

Blanchard, E. 1840. Histoire naturelle des insectes Orthoptères, Névroptères, Hémiptères, Hyménoptères, Lépidoptères et Diptères. Paris: Duménil. 672 pp.

Curtis, J. 1832. British Entomology 9: folio 411. Plates 386–433 (with text).

Dalla Torre, C. G. de. 1898. Subfam. Mymarinae. pp. 422–431. Catalogus hymenopterorum hucusque descriptorum systematicus et synonymicus. Vol.5: Chalcididae et Proctotrupidae. Lipsiae [Leipzig]: Guilelmi Engelmann. 598 pp.

Debauche, H. R. 1948. Etude sur les Mymarommidae et les Mymaridae de la Belgique (Hymenoptera Chalcidoidea). Mémoires du Musée Royal d'Histoire Naturelle de Belgique 108: 1–248 + 24 plates.

Foerster, A. 1847. Ueber die Familie der Mymariden. Linnaea Entomologica 2: 195–233.

Foerster, A. 1856. Hymenopterologische Studien. II. Heft. Chalcidiae und Proctotrupii. Aachen: Ernst ter Meer. 152 pp.

Gahan, A. B. and Fagan, M. M.1923. The type species of the genera of Chalcidoidea or chalcid-flies. Bulletin of the United States National Museum 124: 1–173.

Gibson, G. A. P. 1997. Morphology and terminology. pp. 16–44 *In* Gibson, G. A. P., J. T. Huber, and J. B. Woolley (eds.), Annotated keys to the genera of Nearctic Chalcidoidea. Ottawa: NRC Research Press. 794 pp.

Graham, M. W. R. de V. 1982. The Haliday collection of Mymaridae (Insecta, Hymenoptera, Chalcidoidea) with taxonomic notes on some material in other collections. Proceedings of the Royal Irish Academy, B 82: 189–243.

Haliday, A. H. 1833. An essay on the classification of the parasitic Hymenoptera of Britain, which correspond with the Ichneumones minuti of Linnaeus. Entomological Magazine 1: 259–276, 333–350.

Huber, J. T. 1987. Review of *Schizophragma* Ogloblin and the non-Australian species of *Stethynium* Enock (Hymenoptera: Mymaridae). The Canadian Entomologist 119: 823–855.

ICZN. 1999. International Code of Zoological Nomenclature, Fourth Edition. London: International Trust for Zoological Nomenclature c/o The Natural History Museum. 306 pp.

Kryger, J. P. 1950. The European Mymaridae comprising the genera known up to c. 1930. Entomologiske Meddelelser 26: 1–97.

Schauff, M. E. 1984. The Holarctic genera of Mymaridae (Hymenoptera: Chalcidoidea). Memoirs of the Entomological Society of Washington 12. 67 pp.

Schmiedeknecht, O. 1909. Hymenoptera fam. Chalcididae. Genera Insectorum 97: 1–550 + 8 pls.

Schmiedeknecht, O. 1930. Die Hymenopteren Nord- und Mitteleuropas. Jena: Gustav Fischer. 1062 pp.

Trjapitzin, V. A. 1978. Hymenoptera II. Chalcidoidea 18. Mymaridae. Opred Nasek. Evrop. Chasti SSSR. 516–538. [In Russian.] [English translation: Family Mymaridae (Mymarids). pp. 942–982 *In* Keys to the Insects of the European Part of the USSR. III. Part 2., Medvedev, G. S. (ed.), 1987. Oxonian Press, New Dehli. 1341 pp.]

Ulrich, W. 1999. Phenology and life cycles of the parasitic Hymenoptera of a dry meadow on limestone. Polskie Pismo Entomologiczne 68: 383–405.

Viggiani, G. 1970. Description of the male of *Eustochus atripennis* Hal., 1833, and new terricolous spcies of *Cleruchus* Enock, with remarks on *Anagrella* Bkdf. (Hym., Mymaridae). Mitteilungen der Schweizerischen Entomologischen Gesellschaft 43: 135–142.

Viggiani, G. 1989 (1988). A preliminary classification of the Mymaridae (Hymenoptera: Chalcidoidea) based on the external male genitalic characters. Bollettino del Laboratorio di Entomologia Agraria "Filippo Silvestri" 45: 141–148.

Walker, F. 1846. Descriptions of the Mymaridae. Annals and Magazine of Natural History 18: 49–54.

Westwood, J. O. 1839. Synopsis of the genera of British insects: 78–79. [Issued with An Introduction to the Modern Classification of Insects. London: Longman, Orme, Brown, Green, and Longmans.]

Xu, M. and Lin, N.-Q. 2003. A new species of the genus *Eustochus* Haliday (Hymenoptera: Chalcidoidea: Mymaridae) in China. Entomologia Sinica 10: 65–68.

Yoshimoto, C. M. 1990. A review of the genera of New World Mymaridae (Hymenoptera: Chalcidoidea). Flora & Fauna Handbook no. 7. (Gainesville: Sandhill Crane Press). 166 pp.