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Horismenus species (Hymenoptera: Eulophidae) in a bruchid beetle parasitoid guild, including the description of a new species

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Abstract

Four species of *Horismenus* (Hymenoptera: Eulophidae) associated with *Acanthoscelides* spp. (Coleoptera: Bruchidae), three of which are also associated with *Phaseolus* spp., are treated. One of the species, *H. butcheri*, is described as new and the remaining three species are redescribed. All four species are diagnosed in a key. A lectotype is designated for *Holcopelte productus* Ashmead.

Key words: *Horismenus*, Eulophidae, *Acanthoscelides*, Bruchidae, species description, revision, *Phaseolus*

Introduction

This taxonomic work was triggered by an ongoing project studying the effects of plant variability on host-parasitoid interactions and consequences for the genetic population structure of these organisms. Female parasitoids are known to rely on volatile chemical cues emanating from the plant on which their host feeds to localise their hosts (Turlings & Wäckers 2004). While the parasitoid's host-location behaviour and performance can clearly be enhanced by the use of these chemical cues, the impact of plant features such as allelochemistry, nutritional quality or morphology can also alter the parasitoid reproductive success (Barbosa and Benrey 1998; Turlings and Benrey 1998; Karban and Huc 1999). The potential impact of plants on the parasitoids reproductive success raises the question whether plant quality could influence the genetic population structure of the parasitoid populations. A previous study has shown that the performance (parasitism rate, development time and sex ratio) and host-location behaviour of a parasitoid attacking bruchid beetles that feed on the seeds of the genus *Phaseolus* are greatly affected by the plant species and variety on which the bruchid host feeds (Benrey *et al.* 1998).

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For this study, wild bean samples (*Phaseolus vulgaris*, *P. lunatus* and *P. coccineus*) were collected during three consecutive years (2001-2003, between December and April) in Mexico. The samples (from a total of 49 populations) were found to be infested with bruchid beetles of two genera: *Acanthoscelides* (99.7%) and *Zabrotes* (0.3%) (Coleoptera: Bruchidae). Members of a parasitoid guild comprising the following families were reared from this material: Eulophidae (*Horismenus* spp., 59.1%), Eupelmidae (*Eupelmus* sp., 16.8%), Eurytomidae (*Chryseida* sp. 13.4%), Braconidae (*Stenocorse bruchivora*, 7.7%), Torymidae (*Microdontomerus* sp., 2.9%) and Pteromalidae (*Dinarmus* sp., 0.1%). The genus *Horismenus* was the most abundant parasitoid group and was selected for the second author's population genetic project.

Parasitoids often display plant specificity (Godfray 1994). As preliminary genetic data on a pool of undetermined *Horismenus* individuals showed that specimens originating from different *Phaseolus* species were highly genetically differentiated, we suspected that our initial sample contained several species. In order to avoid misinterpretation of further genetic results it was therefore necessary to ascertain the species identity of the specimens in our samples.

The new species *Horismenus butcheri* turned out to be important in understanding the impact of plant variability on the genetic structuring of parasitoid populations as it is the only species displaying plant-associated genetic differentiation and potential host-race formation (Aebi *et al*. unpublished data).

Beans are of great nutritional value in Central and South America. Bruchid beetles cause enormous economic losses to cultivated beans, 35% in Mexico and Central America, 7.4% in Colombia and 13% in Brazil (van Schoonhoven & Cardona 1986). As parasitoids of the genus *Horismenus* are the most abundant group in this system they might be good candidates for storage pest control. Indeed, several studies have documented the efficacy of endemic chalcidoid parasitoids in reducing storage bruchid infestations in Africa (Leveque *et al*. 1993; Sanon *et al*. 1998; Sanon *et al*. 1999; Van Huis *et al*. 2002). A recent study by Schmale *et al.* (2002) in Columbia showed that while *H. ashmeadii* Dalla Torre attacks bruchids (*A. obtectus*) in the field, it was unable to develop on bruchids under stored conditions (prior to this study the identity and nomenclature of some of the species included here has been very unclear and it is probable that the name *ashmeadii* has been wrongly interpreted in the past, see below “Remarks” under *H. productus*). However, we reared large numbers of *H. missouriensis* from cultivated beans collected on a monthly basis between December and February 2002 in various local markets. The continuance of parasitoid emergences during a period of 3 months confirmed that *H. missouriensis* can be successfully maintained under storage conditions. *H. missouriensis* was the only parasitoid reared from cultivated beans infested with the same bruchid genus as the wild beans. The fact that this parasitoid is also the most common *Horismenus* species found on wild bean samples, suggests that it most likely attacks cultivated beans in the field from where it gets transported by humans into storage facilities. The great species richness of this bruchid

Horismenus parasitoid complex highlights the importance of precise taxonomic identification of these and other beneficial insects for the success of biological control programs.

The genus *Horismenus* is predominantly a New World group, with its main distribution in the Neotropical region. Currently there are 53 species from the Americas (ten from the Nearctic, 39 from the Neotropics, and four from both regions), and one species from Europe. The species are parasitoids or hyperparasitoids on a variety of hosts, most commonly on larvae of Coleoptera, Diptera and Lepidoptera (LaSalle & Schauff 1995). Even though *Horismenus* is one of the most frequently encountered groups of Eulophidae in the Neotropical region very little is known of the genus from this biogeographical region. The majority of the species remain undescribed and the identities of many of the about 50 already described species are unclear due to poor original descriptions, missing type specimens, lack of revisions, etc.

FIGURE 1. *Horismenus missouriensis*, habitus, male.

Abbreviations of morphological terms

HE, height of eye; HW, height of forewing; LG, length of gaster; LM, length of marginal

vein in forewing; LW, length of forewing; MM, length of mesosoma; MS, length of malar space; OOL, shortest distance between one posterior ocellus and adjacent eye; PM, length of postmarginal vein in forewing; POL, distance between posterior ocelli; POO, distance between posterior ocelli and occipital margin; ST, length of stigmal vein in forewing; WH, width of head; WM, width of mouth opening; WT, width of thorax across "shoulders". See Hansson (2002) for illustrations of these terms.

Acronyms of museums

BMNH, Natural History Museum, London, England; CH, collection of Christer Hansson; CNC, Canadian National Collection of Insects, Ottawa, Canada; CNIN, Colección Nacional de Insectos, Instituto de Biología, Universidad Nacional Autónoma de México (UNAM), Mexico City, México; MHNN, Museum d'Histoire Naturelle de Neuchâtel, Switzerland; USNM, United States Natural History Museum, Smithsonian Institution, Washington, D.C, USA.

Key to *Horismenus* species from *Phaseolus* spp. in Mexico

1 Scutellum flat, posteromedian part of scutellum smooth and shiny (Figs 12–13) .... ***depressus* Gahan** (female, male)

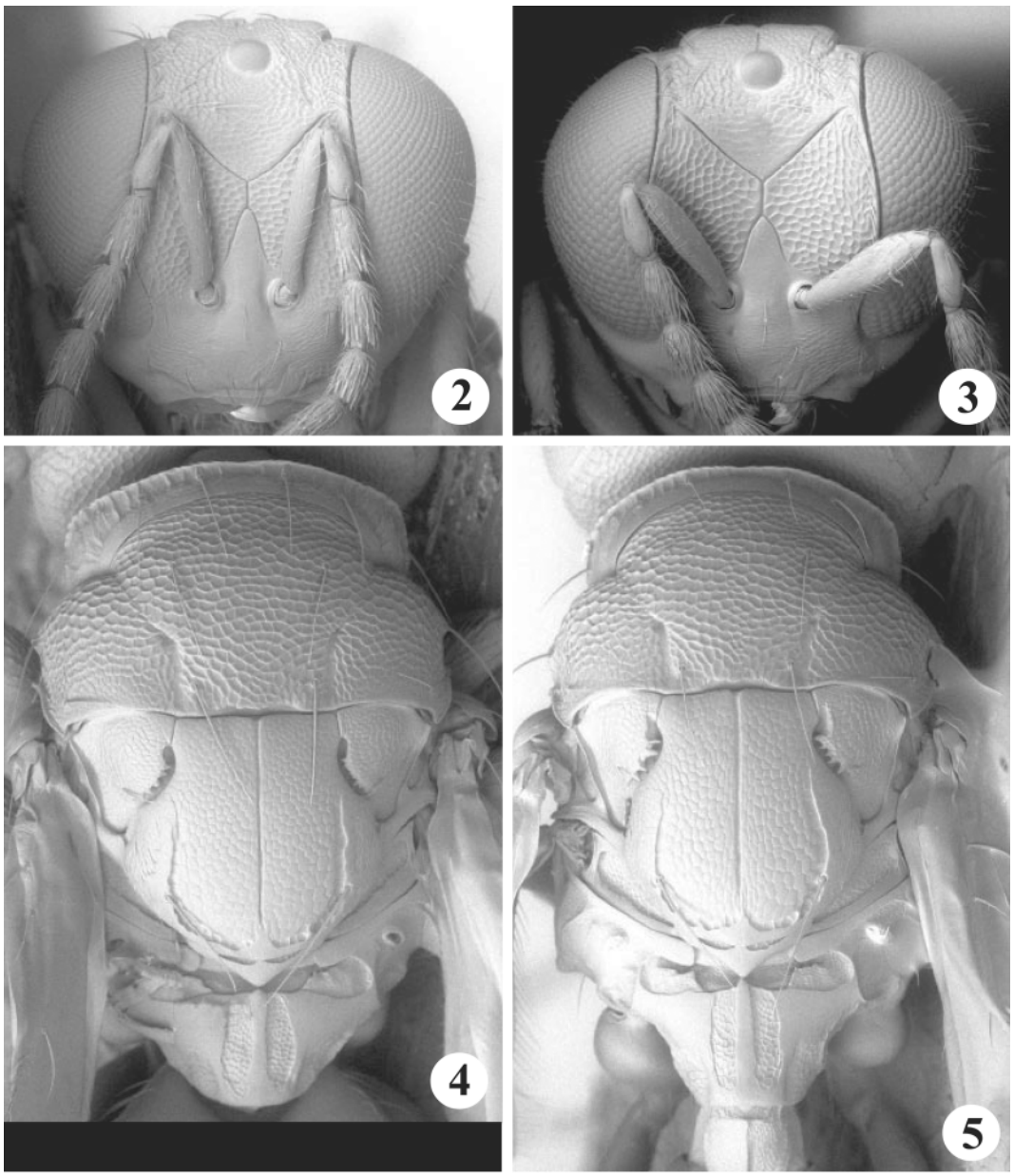
– Scutellum distinctly convex, posteromedian part of scutellum reticulate (Figs 4–5, 16–17) 2

2 Funicular segments longer (Figs 20–21), first funicular segment 3.5X as long as wide in female, 2.5–2.8X as long as wide in male; female gaster long, ratio length of mesosoma/length of gaster = 0.8–0.9 and with apex more pointed (Fig. 6) .... ***butcheri* sp.nov.** (female, male)

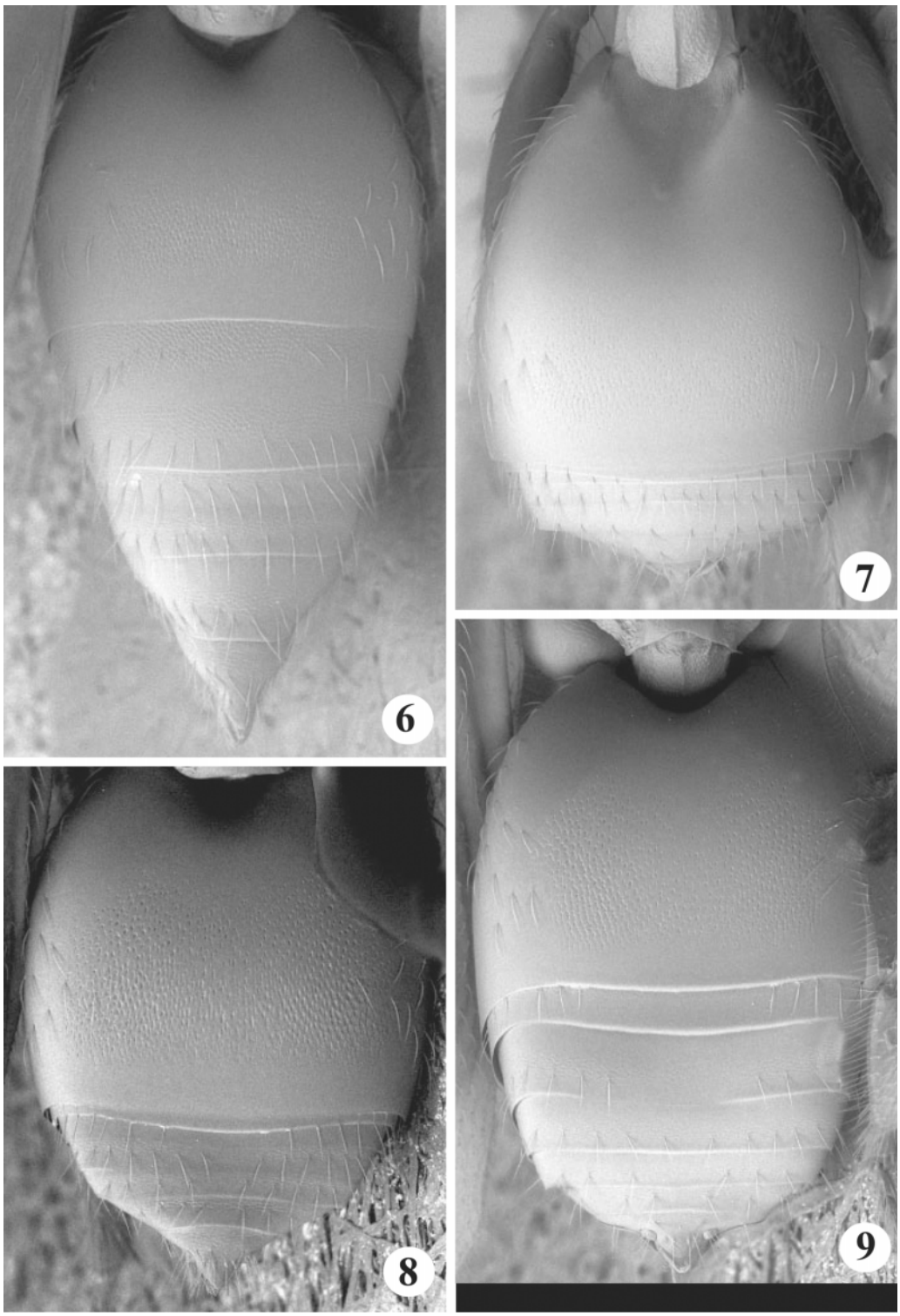
– Funicular segments short and stout (Figs 24–26), female with first funicular segment at most 1.8X as long as wide, male with first funicular segment 1.9X as long as wide (appearance of flagellum in male *productus* not known); female gaster short, ratio length of mesosoma/length of gaster = 1.1–1.8 and with apex more rounded (Fig. 18)33

3 Frons metallic bluish-green in female, metallic purple in male; female with first funicular segment 0.8X as long as second funicular segment (Fig. 24); female gaster longer than in alternate, ratio length of mesosoma/length of gaster = 1.1 .... ***missouriensis* (Ashmead)** (female, male)

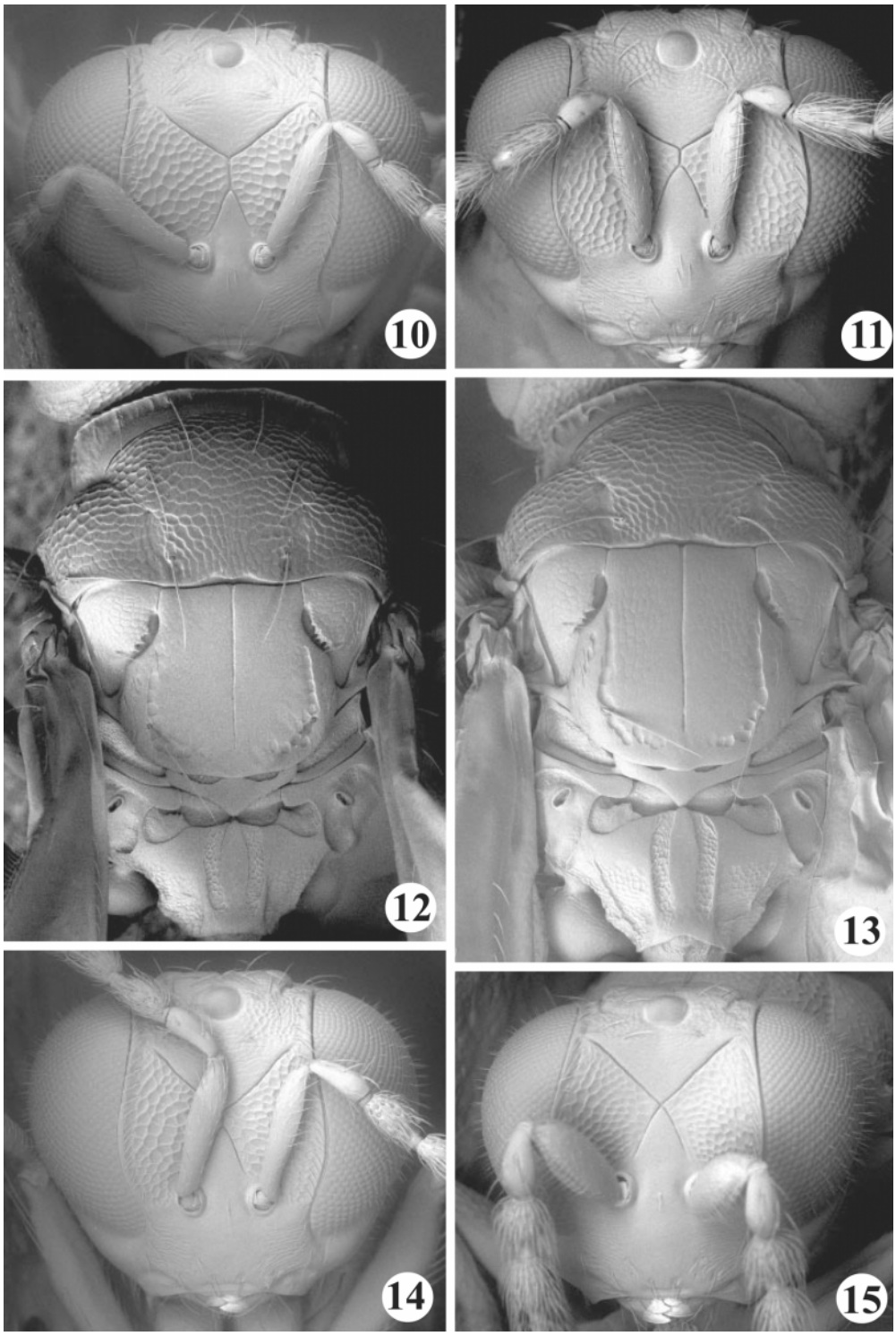
– Frons metallic purple in female, golden-green in male; female with first and second funicular segments equally long (Fig. 26); female gaster short, ratio length of mesosoma/length of gaster = 1.8..... ***productus* (Ashmead)** (female, male)



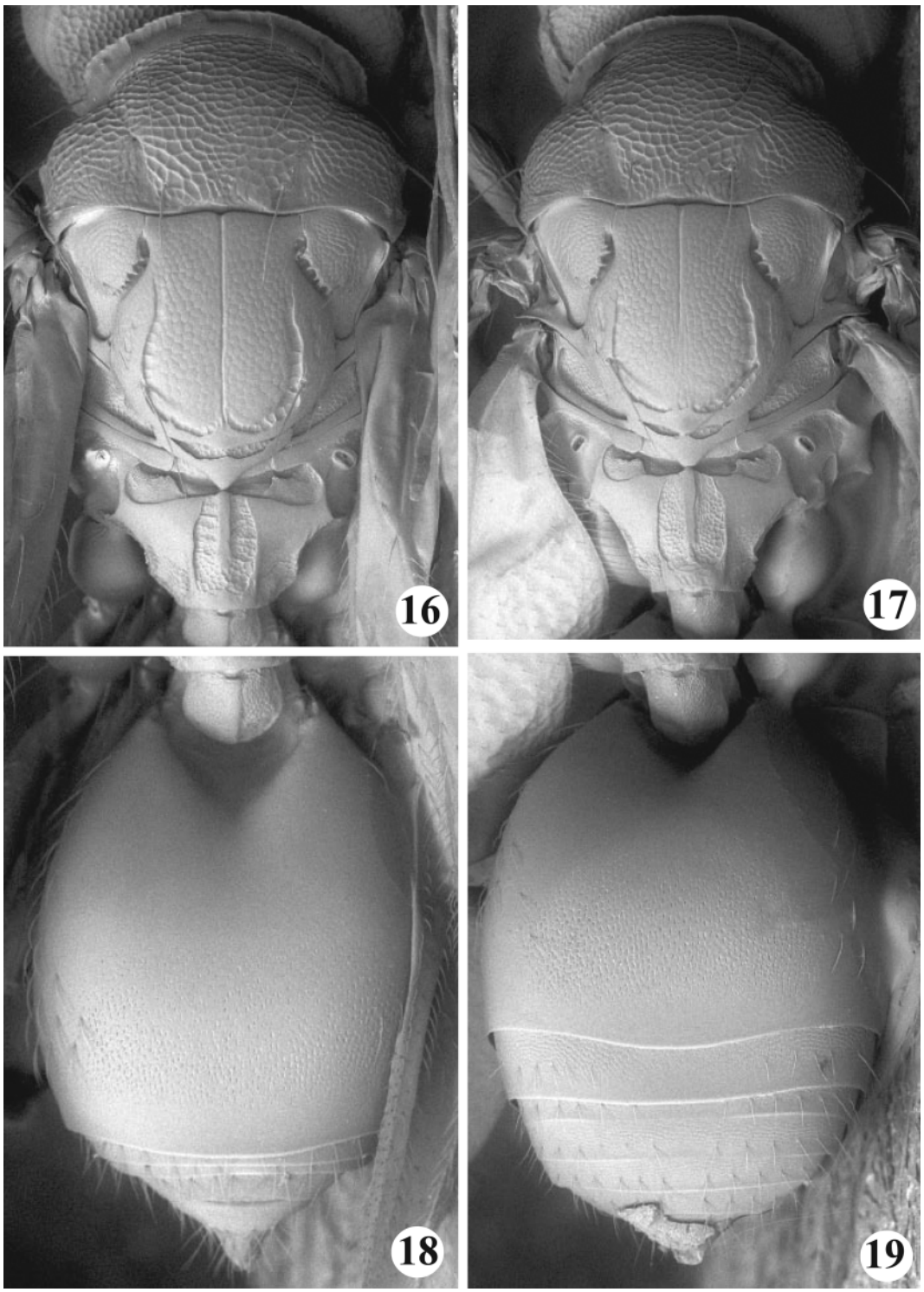
FIGURES 2–5. *Horismenus butcheri*. 2. Head frontal, female. 3. Head frontal, male. 4. Thoracic dorsum, female. 5. Thoracic dorsum, male.



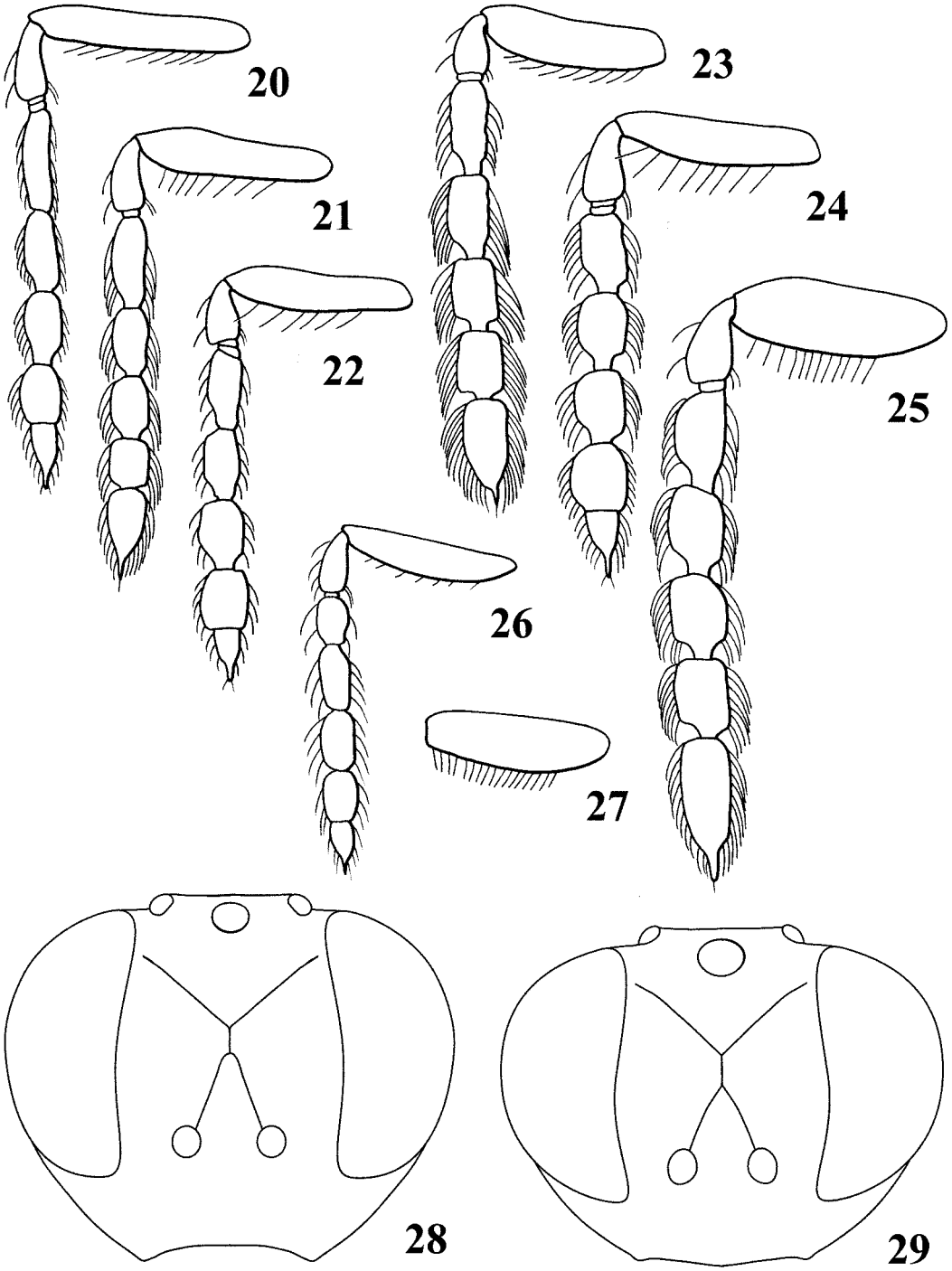
FIGURES 6–9. *Horismenus* spp., gaster dorsal. 6. *H. butcheri*, female. 7. *H. butcheri*, male. 8. *H. depressus*, female. 9. *H. depressus*, male.



FIGURES 10–15. *Horismenus* spp. 10. *H. depressus,* head frontal, female. 11. *H. depressus*, head frontal, male. 12. *H. depressus*, thoracic dorsum, female. 13. *H. depressus*, thoracic dorsum, male. 14. *H. missouriensis*, head frontal, female. 15. *H. missouriensis*, head frontal, male.



FIGURES 16–19. *Horismenus missouriensis*. 16. Thoracic dorsum, female. 17. Thoracic dorsum, male. 18. Gaster dorsal, female. 19. Gaster dorsal, male.



FIGURES 20–29. *Horismenus* spp. 20–26. Antenna lateral. 20. *H. butcheri*, female. 21. *H. butcheri*, male. 22. *H. depressus*, female. 23. *H. depressus*, male. 24. *H. missouriensis*, female. 25. *H. missouriensis*, male. 26. *H. productus*, female. 27. *H. productus*, scape lateral, male. 28. *H. productus*, head frontal, female. 29. *H. productus*, head frontal, male.

***Horismenus butcheri* sp.nov. Hansson & Aebi**
Figs 2–7, 20–21

Diagnosis. Female gaster elongate (MM/LG = 0.8–0.9) (Fig. 6); female funicular segments long (Fig. 20), e.g. first funicular segment 3.5X as long as wide; male scape narrow, 4.5X as long as wide (Fig. 21).

Description. Length of body female 2.6–2.8 mm, male 2.2–2.6 mm.

Scape yellowish-white with apical 1/4 metallic bluish-green; pedicel and flagellum metallic bluish-green. Frons golden-green in female, metallic purple in male. Vertex metallic bluish-green in female, golden-green with purple tinges in male. Mesosoma metallic bluish-green with purple tinges to golden-green, propodeum metallic bluish-green to golden-green with sunken and reticulate parts dull golden-purple. Coxae metallic bluish-green; femora, tibiae and tarsi yellowish-white. Wings hyaline. Petiole dull golden-purple. First gastral tergite metallic bluish-green in anterior 1/3, dull golden-purple in posterior 2/3.

Antennae as in Figs 20–21. Frons with strong small-meshed reticulation, reticulation weaker above frontal suture, interscrobal area and clypeal region smooth and shiny; frontal suture V-shaped, terminating before reaching eyes; antennal scrobes join below frontal suture. Vertex with strong, engraved and small-meshed reticulation; with a median groove in posterior half, groove continues down on occiput. Occipital margin rounded. Ratios of HE/MS/WM female 3.6/1.0/2.3, male 4.3/1.0/2.8; POL/OOL/POO 6.0/1.3/1.0; WH/WT 1.1.

Mesoscutum with strong large-meshed reticulation; notauli indistinct and wide in posterior 1/3. Scutellum with strong and engraved reticulation. Dorsellum smooth, with two large foveas anterolaterally, foveas reticulate. Coxae with weak reticulation. Fore wing speculum open below. Propodeum smooth and shiny, with sunken parts reticulate; propodeal callus with two setae. Petiole 1.1X as long as wide in female, 1.4X as long as wide in male. Ratios of LW/LM/HW 1.8/1.1/1.0; PM/ST 0.9.

First tergite smooth and shiny in anterior 1/3, posterior 2/3 with micropunctures. Ratios of MM/LG female 0.8–0.9, male 1.0–1.1.

Distribution. Mexico, USA (New Mexico).

Hosts. *Acanthoscelides* sp. on *Phaseolus vulgaris* L. and *Bruchus amicus* Horn, both hosts are Bruchidae (Coleoptera).

Material examined. Holotype female labeled “Mexico: Est. Mexico, Temascaltepec, 100º02´ W, 19º02´ N, 1750m, 21.xii.2001–2.iii.2002, A. Aebi, ex *Acanthoscelides* sp. on *Phaseolus vulgaris*” (BMNH). Paratypes: 3 females, 4 males with same label data as holotype (BMNH, USNM); 13 females 12 males from same locality as holotype but collected 5.i–20.ii.2003 (CH, CNIN, MHNN); 2 females, 1 male from same locality as holotype but collected 27.i–21.ii.2001 and from 1700m altitude (CNC); 3 females, 4 males from same locality as holotype but collected 16.xii.2001–3.ii.2002 and from 1700m altitude (BMNH, CNC); 5 females, 5 males “Mexico: Est. Mexico, Valle de Bravo, 100º09´ W, 18º56´ N,

1950m, 1.i–15.ii.2002, A. Aebi, ex *Acanthoscelides* sp. on *Phaseolus vulgaris*" (CH, CNC, USNM). Non-type material: a female included in the type material of *Horismenus productus* (Ashmead) (see below) from *Bruchus amicus* in New Mexico (USNM) is conspecific with *butcheri*. This specimen is not included in the type material because it is damaged.

Etymology. This species is named in honour of Dr. Robert D.J. Butcher, for guidance and support throughout the dissertation research of Alexandre Aebi.

***Horismenus depressus* Gahan**

Figs 8–13, 22–23

Horismenus depressus Gahan, 1930:8. Holotype female in USNM, not examined.

Diagnosis. Scutellum flat and with posteromedian part smooth and shiny (Figs 12–13); female gaster short (MM/LG = 1.1) and ovate (Fig. 8); female funicular segments short and stout (Fig. 22), e.g. first funicular segment 2.4X as long as wide; male scape 3.7X as long as wide (Fig. 23).

Description (of Mexican specimens). Length of body female 2.0–2.1 mm, male 1.9–2.0 mm.

Scape yellowish-white with apical 1/3 metallic bluish-green; pedicel and flagellum metallic bluish-green. Frons metallic bluish-green in female, metallic purple in male. Vertex metallic bluish-green in female, golden-green in male. Mesosoma metallic bluish-green with purple tinges, propodeum metallic bluish-green with sunken and reticulate parts dull golden-purple. Coxae metallic bluish-green; femora, tibiae and tarsi yellowish-white. Wings hyaline. Petiole dull golden-purple. First gastral tergite metallic bluish-green in anterior 1/3, dull golden-purple in posterior 2/3.

Antennae as in Figs 22–23. Frons with strong small-meshed reticulation, reticulation weaker above frontal suture, interscrobal area smooth and shiny, clypeal region with weak transverse meshes; frontal suture V-shaped, terminating before reaching eyes; antennal scrobes join below frontal suture. Vertex with strong, engraved and small-meshed reticulation; with a median groove in posterior half, groove continues down on occiput. Occipital margin rounded. Ratios of HE/MS/WM female 3.6/1.0/2.2, male 3.2/1.0/2.0; POL/OOL/POO 5.7/1.3/1.0; WH/WT 1.1.

Mesoscutum with strong large-meshed reticulation; notauli indistinct and wide in posterior 1/3. Scutellum flat, with weak and engraved reticulation, partly to predominantly smooth. Dorsellum smooth, with two large foveas anterolaterally, foveas reticulate. Coxae smooth and shiny. Fore wing speculum open below. Propodeum smooth and shiny with sunken parts reticulate; propodeal callus with 2–3 setae. Petiole 1.1X as long as wide in female, 1.4X as long as wide in male. Ratios of LW/LM/HW 1.7/1.0/1.0; PM/ST 0.8.

First tergite smooth and shiny in anterior 1/3, posterior 2/3 with micropunctures. Ratios of MM/LG female 1.1, male 1.2.

Distribution. Mexico (De Santis 1989) and the U.S.A. (California (Gahan 1930), Texas (Burks 1971)).

Hosts. *Acanthoscelides* sp. on *Phaseolus* spp. (new record), *A. obtectus* (Say) (De Santis 1989), "*Bruchus* sp." in *Acacia* seeds (Burks 1971), *Stator pruininus* (Horn) from seeds of *Acacia* and *Olneya* (Gahan 1930). All hosts are Bruchidae (Coleoptera).

Material examined. 22 females, 21 males from Mexico (Mexico, Michoacan, Morelos) from *Acanthoscelides* sp. on *Phaseolus vulgaris* (CH).

***Horismenus missouriensis* (Ashmead)**
Figs 1, 14–19, 24–25

Holcopelte missouriensis Ashmead, 1888:101. Lectotype female in USNM, designated by Burks (1971), examined.
Holcopelte popenoei Ashhmead, 1888:101. Synonymized by Girault (1934).
Horismenus missouriensis (Ashmead), Schmiedeknecht (1909).

Diagnosis. Female gaster short (MM/LG = 1.1) and ovate (Fig. 18); female funicular segments short and stout (Fig. 24), e.g. first funicular segment 1.7X as long as wide; male scape swollen (Fig. 25), 2.8X as long as wide.

Description (of Mexican specimens). Length of body female 2.2–2.5 mm, male 2.0–2.2 mm.

Female scape yellowish-white with apical tip dark brown, male scape with basal half yellowish-white and apical half metallic bluish-purple; pedicel and flagellum metallic bluish-green in female, metallic bluish-purple in male. Frons metallic bluish-green in female, metallic purple in male. Vertex metallic bluish-green in female, golden-green in male. Mesosoma metallic bluish-green with purple tinges, propodeum metallic bluish-green with sunken and reticulate parts dull golden-purple. Coxae metallic bluish-green; femora, tibiae and tarsi yellowish-white. Wings hyaline. Petiole dull golden-purple. First gastral tergite metallic bluish-green in anterior 1/3, dull golden-purple in posterior 2/3.

Antennae as in Figs 24–25. Frons with strong small-meshed reticulation, reticulation weaker above frontal suture, interscrobal area smooth and shiny, clypeal region with weak transverse meshes; frontal suture V-shaped and complete; antennal scrobes join below frontal suture. Vertex with weak, engraved and small-meshed reticulation; with a median groove in posterior half, groove continues down on occiput. Occipital margin rounded. Ratios of HE/MS/WM female 4.2/1.0/2.5, male 2.9/1.0/2.4; POL/OOL/POO 3.2/1.0/1.0; WH/WT 1.0.

Mesoscutum with strong large-meshed reticulation; notauli distinct and more or less wide in posterior 1/3. Scutellum with strong and engraved reticulation. Dorsellum smooth, with two large foveas anterolaterally, foveas reticulate. Coxae predominantly smooth and shiny with very weak reticulation at base. Fore wing speculum open below. Propodeum smooth and shiny with sunken parts reticulate; propodeal callus with two setae. Petiole

1.1X as long as wide in female, 2.1X as long as wide in male. Ratios of LW/LM/HW 1.8/1.1/1.0; PM/ST 1.0.

First tergite smooth and shiny in anterior 1/3, posterior 2/3 microreticulate with isodiametric meshes and with micropunctures, or predominantly with micropunctures. Ratios of MM/LG female 1.1, male 1.4.

Distribution. Brazil (De Santis 1980, Sari et al. 2002), Mexico (new record), U.S.A. (Ashmead 1888) (from New York and southward (Burks 1979)).

Hosts. *Acanthoscelides* sp. on *Phaseolus* spp. (new record), *A. floridae* Horn (Brett 1946), *A. submuticus* (Sharp) (Peck 1963), *Amblycerus robiniae* (Fabricius) (Peck 1951), *Ctenocolum crotonae* (Fåhraeus) (Sari et al. 2002), *Gibbobruchus* sp. (Burks 1971). All hosts are Bruchidae (Coleoptera).

Material examined. 25 females, 21 males from Mexico (Distrito Federal, Mexico, Michoacan, Morelos) from *Acanthoscelides* sp./*Zabrotes* sp. on *Phaseolus vulgaris* and *P. coccineus* (CH).

***Horismenus productus* (Ashmead)**
Figs 26–29

Holcopelte productus Ashmead, 1894a:342. Lectotype female in USNM, here designated, examined.
Horismenus productus (Ashmead), Schmiedeknecht (1909).

Diagnosis. Female gaster short (MM/LG = 1.8) and round; female funicular segments short and stout (Fig. 26), e.g. first funicular segment 1.5X as long as wide; male scape swollen (Fig. 27), 3.2X as long as wide.

Description. Length of body female 1.8 mm, male 1.6 mm.

Scape yellowish-brown, pedicel and flagellum dark brown with metallic tinges. Frons metallic purple in female, golden-green in male. Vertex golden-green. Mesosoma golden-green, propodeum golden-green tinged with blue. Coxae golden-purple; femora, tibiae and tarsi yellowish-white. Wings hyaline. Petiole dull golden-purple. First gastral tergite golden-green in anterior half, dull golden-purple in posterior half.

Female antenna as in Fig. 26, male scape as in Fig. 27 (flagellum missing in male antenna). Frons with strong small-meshed reticulation, reticulation weaker above frontal suture, interscrobal area and clypeal region smooth and shiny; frontal suture V-shaped and complete; antennal scrobes join below frontal suture. Vertex with weak small-meshed reticulation; with a median groove in posterior half, groove continues down on occiput. Occipital margin rounded. Ratios of HE/MS/WM female 3.1/1.0/1.8, male 3.8/1.0/2.2; POL/OOL/POO 2.3/1.0/1.3; WH/WT 1.2.

Mesoscutum with strong large-meshed reticulation. Scutellum with strong and engraved reticulation. Dorsellum smooth, with two large foveas anterolaterally. Coxae

predominantly smooth and shiny with very weak reticulation at base. Fore wing speculum open below. Propodeal callus with two setae. Ratios of LW/LM/HW 1.8/1.1/1.0; PM/ST 1.4.

First tergite smooth and shiny in anterior half, posterior half microreticulate with elongate meshes, remaining tergites hidden in first tergite. Ratios of MM/LG female 1.8, male 2.0.

Hosts. *Bruchus amicus* Horn (Ashmead 1894a). Host records published after the original description remain uncertain due to the difficulties of species identification and the confused nomenclature associated with this species.

Distribution. USA (New Mexico).

Material examined. Lectotype female "N. Mex.", "Type No. 2144, U.S.N.M." (USNM). Paralectotypes: 3 females, 1 male with same label data as lectotype (USNM). The lectotype and the paralectotypes are designated here (see below under "Remarks").

Remarks. The type material of *Horismenus productus* Ashmead (1894a) consists of five specimens on three pins, two females, a male and a female, and a female. The single female, the male and the female on the same pin, and one of the females (the smaller female) on the pin with two females, are conspecific. The larger female on the pin with the two females belongs to a different species. The original description of *productus* is brief and not especially informative, but from the size range of the specimens given in the description (2–2.6 mm) it is obvious that *productus* was described from all specimens mentioned here. Possibly more specimens were included in the original description, specimens that subsequently have been lost – Ashmead states "several specimens" in the description. Since there are two species in the type material of *productus*, the question is which species shall bear the name "productus". The description is of no help here so either one will do. We choose the species represented by most specimens, and also represented by both sexes, to carry the name *productus*. To maintain the nomenclatural stability we select the (smaller) female on the pin with the two females as lectotype for *Horismenus productus*. The large female on the same pin as the lectotype belongs to *H. butcheri* which is described above. The remaining type specimens mentioned here are designated as paralectotypes.

Ashmead described another species with the same name (*productus*), and during the same year (1894b), but this latter species was from St. Vincent. The "St. Vincent-species" has subsequently been renamed, "*ashmeadii*" (Dalla Torre 1898), and is not conspecific with *productus* from New Mexico (which retains the name *productus*). Both species were originally described in genus *Holcopelte*, but both have subsequently been transferred to *Horismenus*.

The gastral tergites and sternites 2–7 have been retracted into the first tergite in all type specimens. The single male has lost the flagellum on both antennae.

Acknowledgements

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