A NEW SPECIES OF *PEDIOBIUS* (HYMENOPTERA: EULOPHIDAE) PARASITIZING *CHYLIZA APICALIS* (DIPTERA: PSILIDAE) IN ASH TREES ATTACKED BY *AGRILUS PLANIPENNIS* (COLEOPTERA: BUPRESTIDAE)

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ABSTRACT

Pediobius chylizae, spec. nov. (Hymenoptera: Eulophidae), is described as new and illustrated. This parasitoid has been reared from the puparia of *Chyliza apicalis* Loew (Diptera: Psilidae) collected from under the bark of ash trees (Oleaceae: *Fraxinus* spp.) dying after attack by the emerald ash borer, *Agrilus planipennis* Fairmaire (Coleptera: Buprestidae), an invasive beetle from Asia. This species is compared with related species of *Pediobius* from the Holarctic Region.

In this paper we describe a new Nearctic species of *Pediobius* Walker (1846) (Hymenoptera: Eulophidae), compare it with species from the region, and place it within the context of published works addressing the world fauna. This cosmopolitan genus contains 32 Nearctic species among 215 nominal species worldwide (Noyes 2002). Although much taxonomic work concerning *Pediobius* is available (e.g., Burks 1966, Kerrich 1973, Bouček 1977, Kamijo 1983, Peck 1985, Kamijo 1986a, 1986b, Hansson 2002), many eulophids, including *Pediobius*, await discovery (Hansson 2002). Biologically, species of *Pediobius* are quite diverse, acting as primary or secondary parasitoids, utilizing eggs, larvae and/or pupae of species in the insect orders Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Mantodea and Thysanoptera, as well as eggs of Araneae (Burks 1966, Bouček and Askew 1968, Kerrich 1973, Peck 1985).

This new species possesses characters of the genus *Pediobius* as defined by Schauff et al. (1997; propodeum with two submedian, divergent carinae and distinct plicae) and subsequently modified by Hansson (2002) (propodeum with a median carina, groove, or pair of carinae; posterior margin of prepectus overlapped by extension of mesepisternum; lateral ocelli removed from posterior margin of vertex). Recent and extensive recent treatments of the genus by the aforementioned authors make unnecessary a redescription. Male and female specimens can be identified as *Pediobius* in the keys of Bouček (1965), Schauff et al. (1997), and Hansson (2002).

METHODS

In the descriptions, structures not visible on the holotype but shown in the figures are indicated by brackets ([ ]). The term glabrous refers to a smooth, glossy area of cuticle. A stereomicroscope (Nikon SMZ1500) with 10× (Nikon C-W10×22) and fiber optic light source (Chiu Technical Corp. Lumina 1 FO-150)

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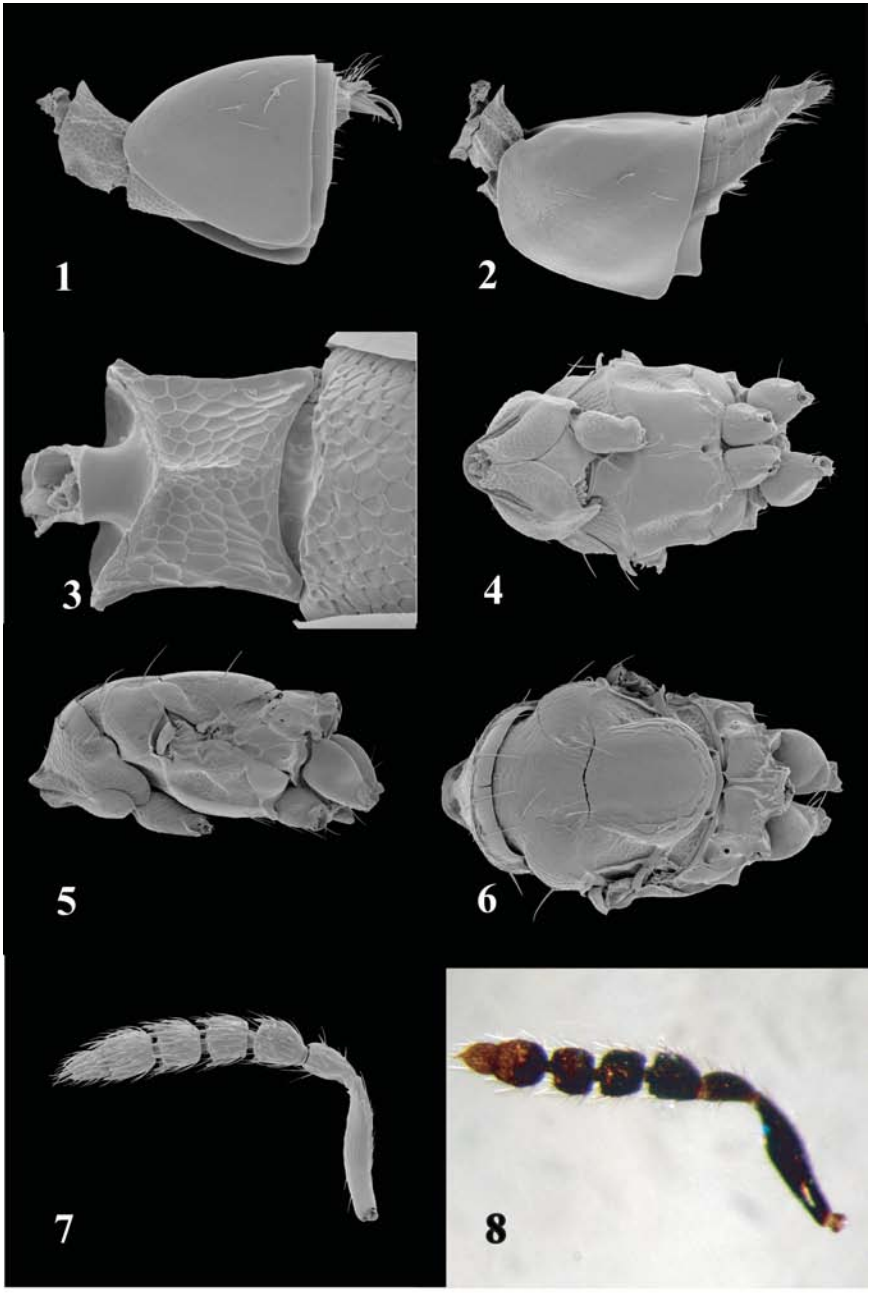
was used for card- and point-mounted specimen observation. Mylar film was placed over the ends of the light source to reduce glare from the specimen. Scanning electron microscope (SEM) images were taken with an Amray 1810 (LaB_6 source). Specimens were cleaned of external debris with bleach, following Bolte (1996), and affixed to 12.7 × 3.2 mm aluminum SEM stubs (Leica/Cambridge) with carbon adhesive tabs (Electron Microscopy Sciences, #77825-12). Stub-mounted specimens were sputter coated using a Cressington Scientific 108 Auto with a gold-palladium mixture from at least three different angles to ensure complete coverage (~20-30 nm coating). Wing images were prepared using an AutoMontage image capture system (Microbiology International, Synchroscopy). With this system, digital images were captured from a stereoscope (Leica M400) by using a JVC 3-CCD Color Video Camera (Model No. KY-F55B) affixed to the microscope phototube and connected to the AutoMontage computer system. Abbreviations used are F1-F3 (funicular segments 1, 2, or 3), Gt/s_n (gastral tergite/sternite$_{number}$), USNM (National Museum of Natural History, Smithsonian Institution, Washington, D.C.), MSUC (Michigan State University Collection, East Lansing).

Infested puparia of *Chyliza apicalis* Loew (Diptera:Psilidae) were obtained from two green ash trees (from Bicentennial Park, Livonia, MI) that had been marked for dissection the previous summer based upon *in situ* parasitoid activity in 2004. In 2005, these trees were felled, sectioned, and removed to Matthaei Botanical Garden (University of Michigan) in Ann Arbor, MI. An onsite workshop was made available for the authors to completely strip bark from both trees, during which all potential host material was set aside separately in gelatin capsules for emergence of parasitoids. Most materials obtained consisted of dipteran puparia (primarily *Chyliza apicalis* Loew (1860) (Diptera: Psilidae)), emerald ash borer *(Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae)), larvae/pupae, parasitoid pupae, occasional pompilid pupation chambers, scolytine pupae, etc. This material is currently being identified for use in another manuscript.

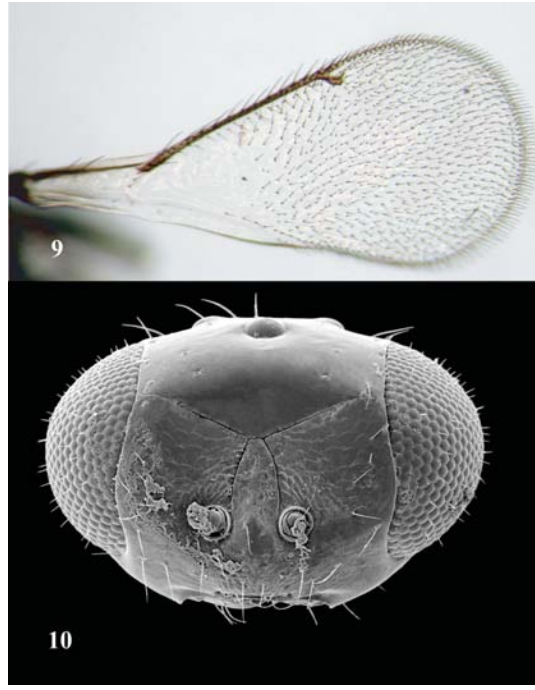
Pediobius chylizae Gates and Schauff, new species (Figs. 1-10)

Diagnosis. This species is most likely confused with the Nearctic species *Pediobius disparis* Peck. *P. chylizae* is differentiated from the latter by the glabrous upper frons (lightly reticulate in *P. disparis*), and the presence of three funiculars in males (four found in *P. disparis*). See Discussion.

Female holotype. Body length 1.85 mm. *Color*: black except as follows: extreme apices of tibiae and pretarsi brown; basal three tarsomeres yellowish brown; posterior half middle and lateral lobes mesoscutum, apical rim scutellum, propodeum, anterior third Gt_1 black with metallic greenish yellow reflections; flagellum, coxae, femur, tibia black with metallic greenish blue reflections; frons and vertex black with metallic purple reflections. *Sculpture*: face glabrous, scrobes indistinctly imbricate dorsad toruli, supraclypeal area faintly reticulate, genae glabrous. Pronotum reticulate on anterior two-thirds, apical third glabrous (Fig. 5); mesoscutum indistinctly imbricate anteriorly and laterally, smoother medially, prepectus reticulate, dorsal and posterior margins glabrous; mesepisternum glabrous, femoral depression reticulate but fading posteroventrally; mesepimeron glabrous with some finely imbricate-striate sculpturing; propodeum glabrous, paired median carinae divergent on apical half; incomplete (Fig. 6), irregular costulae extending from middle of median carinae toward posterolateral process, costulae convergent with plicae at base of process; irregular fine carinae extending from costulae; [prosternum diamond-shaped, finely reticulate]; procoxa convex anteriorly (Fig. 4), imbricate anteriorly and laterally, with a few sparse, subdecumbent setae along anterolateral surface; mesepisternum glabrous in ventral view, median groove extending length, with three pairs of setae; scutellum glabrous dorsally, indistinct reticulation becoming visible at



Figures 1-8. *Pediobius chylizae*, n. sp.: 1-2, lateral gaster, male (1), female (2). 3, ventral petiole, male. 4, ventral mesosoma, female. 5-6, lateral, dorsal mesosoma, female. 7-8, antenna, female (7), male (8).



Figures 9-10. *Pediobius chylizae*, n. sp.: 9, forewing, female. 10, head, female.

lateral and apical margins; meso- and metacoxae glabrous, with fine imbricate sculpturing. *Head*: 1.45× as high as broad, eye height 3.57× malar space; malar sulcus represented as line of fine sculpture; eye sparsely setose; scrobal depression shallow, scrobes meeting separately at frontal suture (Fig. 10); clypeal apex straight with shallow groove between anterior tentorial pits; relative lengths of lateral ocellus: ocellocular distance: postocellar distance 4:6:10. *Antenna*: scape not reaching midocellus; relative lengths of scape (minus radicle): pedicel: anellus: F1: F2: F3: club 18:7:1:6:6:5:10; flagellomeres globular, subequal in breadth (Fig. 7), clava symmetrical apically. *Mesosoma*: pronotum with six setae along carina on apical third (Figs. 5, 6); mesoscutum with two pairs of setae, scutellum with one pair apicolateral setae; prepectus triangular, > 2.0× size of tegula, surface sculpture similar to femoral depression; propodeal spiracle circular and positioned ~3.0× diameter from dorsellum; callus with 2 erect setae; relative lengths of marginal vein: postmarginal vein: stigmal vein 43:5:6; basal setal line consisting of three setae; cubital setal line absent on basal third; costal cell asetose (Fig. 9). *Metasoma*: Petiole cylindrical, reticulate, length and width subequal, anterior edge carinate (Fig. 2). Gaster subequal in length with mesosoma, Gt_1 glabrous with few macrosetae laterally, lineolate on ventral half, covering more than half length of gaster; Gt_{2-6} with few scattered setae dorsally and laterally, Gs_1 with transverse crest anteromedially, reticulate posteriad (Fig. 2). Gastral apex not acuminate. Ovipositor sheaths not exerted.

Male. Body length 1.15 mm. Similar to female in coloration and structure except as follows: flagellar setation more erect (Fig. 8); scape with ventral plaque indistinct; petiole 1.1× longer than broad; first gastral tergite covering

nearly entire length of gaster (Fig. 1), first gastral sternite with transverse carinae slightly less produced, distinctly imbricate posteriorly (Fig. 3); gaster lacking acuminate terminal segments.

Etymology. Named for the genus of rust fly from which it was reared.

Type Material. USA: Michigan: Washtenaw Co.: Matthaei Botanical Garden, U. of Michigan, 42°17.49N 83°39.49W, 3.ii.05, M. Gates, M. Metz; on *Fraxinus pennsylvanica* Marsh infested by *A. planipennis*; *Ex C. apicalis* puparia in bark cracks (Holotype f USNM). Forty-six paratypes, 38ff, 8mm, same data as holotype (19ff, 4mm USNM; 19ff, 4mm MSUC). **Wayne Co.:** Livonia, Bicentennial Park, SW central section, 5.II.2005, 42°25.77N 83°23.71W, L. Bauer, M. Gates, G. Gibson, H. Liu, M. Metz coll.; On *F. pennsylvanica* infested by *A. planipennis*; *Ex C. apicalis*. Fifty-one paratypes, 42ff, 9mm (21ff, 5mm USNM; 21ff, 4mm MSUC).

DISCUSSION

Pediobius chylizae is recognized by the glabrous upper frons, three funiculars in male, and medially glabrous scutellum. This species keys to couplet 7 in Peck's (1985) key to Nearctic species with *P. disparis* Peck, but *P. chylizae* has the upper frons glabrous, not lightly reticulate, and the male possesses three funiculars rather than four. Additionally, *P. disparis* attacks only egg masses of *Lymantria dispar* (L.) (Lepidoptera: Lymantriidae). When keyed in Bouček (1965), this species runs to *P. italicus* Bouček and *P. saulius* Walker, neither of which possesses a medially glabrous scutellum (coarsely or longitudinally striate). In Hansson (2002), *P. chylizae* runs to couplet 7 but has an angulate dorsellum (Fig. 6) as opposed to evenly rounded or tridentate. If one presumed to treat an angulate dorsellum as simply a state subsumed by the rounded condition, then this species runs to *P. furvus* (Gahan). However, *P. furvus* possesses both propodeal setae between the spiracular sulcus and plica and >2 setae on the callus. *P. chylizae* lacks propodeal setation and has two setae on the callus.

In 2003, *P. chylizae* adults emerged in the laboratory petri dishes with emerald ash borer eggs that were collected on flakes of ash bark. Initially suspected to parasitize EAB eggs, our dissections of infested ash trees in 2005 revealed the true host association for this species.

Variation. Little significant variation is apparent in the series of specimens examined. They are uniform in size and sculpturing, likely due to their gregarious biology and the sibling relationships among emergent *P. chylizae*. Coloration varies slightly, often with metallic greenish coloration on the mesoscutum supplanted by black. Those structures that are metallic may vary from yellowish green to greenish blue. The basal setal line may be represented by between 1-3 setae. Remnants of the cubital setal line, in the form of one or two setae, are sometimes present posterad the basal setal line.

Distribution. Michigan, USA.

Host. This gregarious endoparasitoid that emerged from puparia of *C. apicalis*, embedded in cracks or underneath bark of *F. pennsylvanica*. An average of twelve (Range is 5-17) *P. chylizae* emerged from eight host puparia (of 12 held for emergence) with 21% of the total emerged parasitoids male. The host range of *P. chylizae* is unknown. It is possible that this species may attack other dipterans (e.g., Otitidae, Lonchaeidae, Xylomyidae, Drosophilidae, etc.) occupying similar niches given that certain species of *Pediobius* are known to be polyphagous (e.g., *P. pyrgo* (Walker) attacks at least 19 families in 5 insect orders, *P. albipes* (Provancher) attacks 7 families in 4 orders, *P. foveolatus* (Crawford) attacks 7 families in 4 orders), although polyphagy is not always the case.

The biology of Nearctic *Chyliza* species is unknown, including that of *C. apicalis*. The genus currently has 57 species, and many are bulb and stem miners

(Iwasa 1989). In Europe, species of *Chyliza* tend to oviposit in existing wounds, causing phloem necrosis, such as reported for *C. annulipes* Macquart in pines (*Pinus* spp.) (Lyneborg 1987) and *C. leptogaster* (Panzer) in various trees and shrubs (Dengler 1997). The latter species is a potential biological control agent for French broom, *Genista monspessulana*, an invasive leguminous shrub in California, Oregon, and Australia (California Invasive Plant Council 2002). *C. leptogaster* larvae apparently kill host plants by tunneling under the bark and girdling branches or producing cambial necroses (Sheppard 2000).

In Michigan, adults of *C. apicalis* and *P. chylizae* are routinely reared from ash logs heavily infested with emerald ash borer (Liu and Bauer, personal communication). Unfortunately, specific information on numbers of each emerged during bulk rearing was not recorded. Based on field observations and laboratory dissections of infested ash trees, *C. apicalis* is generally believed to be saprophytic, feeding on fungi, frass, or other debris in the cambial layer just preceding or following tree death. We suggest further study to clarify the role of *C. apicalis* as a possible co-factor in postmortem ash deterioration following emerald ash borer attack in North America.

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