

# Key to Nearctic species of *Trissolcus* Ashmead (Hymenoptera, Scelionidae), natural enemies of native and invasive stink bugs (Hemiptera, Pentatomidae)

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## Abstract

*Trissolcus japonicus* (Ashmead) and *T. cultratus* (Mayr), **comb. rev.** are under study as classical biological agents to control the brown marmorated stink bug *Halyomorpha halys* (Stål) in North America. Here we present diagnoses for all Nearctic species of *Trissolcus*, including *T. japonicus* and *T. cultratus* **comb. rev.**, and identification keys to enable separation of these species from the existing fauna. *Trissolcus cultratus* **comb. rev.** is removed from synonymy with *T. flavipes*. Two new species are described, *Trissolcus valkyria* **sp. n.** and *T. zakotos* **sp. n.** A neotype is designated for *T. brochymenae* and a lectotype is designated for *T. basalis*.

## Keywords

*Trissolcus japonicus*, *Trissolcus cultratus*, *Trissolcus flavipes*, *Halyomorpha halys*, *Trissolcus*, Scelionidae, biological control, identification key, egg parasitoid

## Introduction

A decade after its introduction into the United States in 1999, the economically destructive brown marmorated stink bug (BMSB), *Halyomorpha halys* Stål (Heteroptera: Pentatomidae), has been detected in 39 US states and the District of Columbia, as well as Canada, Switzerland, Germany, France, and Italy, and has been intercepted in New Zealand (Xu et al. 2013). BMSB has an extraordinarily wide host range in both its native range (Asia) and invaded countries where it feeds on over 200 species of tree fruits, vegetables, field crops, ornamental plants, and native vegetation (Hoebeke and Carter 2003; Leskey et al. 2012). Some notable crops attacked include fruit trees (especially apples and pears), corn, wheat, soybean, and grape. In the US in 2010, \$37 million in losses to mid-Atlantic apples was recorded; in some pear orchards 100% loss was observed (Leskey et al. 2012). Further, BMSB is a well-known nuisance species, invading homes and businesses in the mid-Atlantic region, with over 25,000 individuals being recorded from a single household (Inkley 2012).

BMSB is difficult to manage with pesticides because it feeds on interior plant tissues via its proboscis, bypassing ingestion of pesticides that are deposited on the surfaces of plant tissues. As a result, increased pesticide applications to combat BMSB disrupt ecosystem services, resulting in secondary pest outbreaks (Leskey et al. 2012). Xu et al. (2013) determined that a single introduction to North America from the Beijing area of China, with secondary migration to the West Coast, is responsible for the presence of this destructive pest. Due to the difficulty and potential non-target effects of controlling this pest with pesticides, foreign exploration of natural enemies of BMSB began in earnest in 2008, with the Beijing area of China as a focal point of collections, followed by additional collecting in South Korea and Japan (Xu et al. 2013). These collections have identified two species with potential as classical biological control agents. Both species were initially referred to by incorrect names, and through the examination of primary type specimens, we have identified them as *Trissolcus japonicus* (Ashmead) and *Trissolcus cultratus* (Mayr), comb. rev. A community of extension agents, field scientists, and ARS scientists (at the Beneficial Insects Introduction Research Unit and Systematic Entomology Laboratory), are presently studying the host preferences of *T. japonicus*, *T. cultratus*, and native species of *Trissolcus*, and the ability of these species to successfully develop in BMSB eggs. However, such studies are ineffective unless the species can be distinguished reliably – a task that may be challenging for non-experts due to the small size of these insects and their defining characters, as well as historical taxonomic confusion of species.

This paper is presented as an updated synthesis of the works of Norman Johnson (1984, 1985a,b) with the addition of four species, *T. japonicus*, *T. cultratus* comb. rev., *T. valkyria* sp. n. and *T. zakotos* sp. n., and previously unexplored or unutilized character systems. Following the keys to species, an updated and expanded diagnosis section provides more nuanced discussions on sexual dimorphism and phenotypic plasticity. The authors hope that this publication will demonstrate the long-term relevance of primary taxonomic research. The concepts of the previously described spe-

cies presented here are based primarily on the works of Johnson (1984, 1985a,b), as are many of the characters used in the identification keys and character data reported in the diagnoses. Without these publications, preparation for the introduction of an exotic species would require revision of the Nearctic fauna to establish the characters by which the introduced species could be recognized. Production of the identification tools provided here would not have been possible within the time frame of the USDA-ARS biocontrol release project, nor is there sufficient funding for revisionary work on *Trissolcus* in both the Nearctic and the Eastern Palearctic, from which *T. japonicus* and *T. cultratus* comb. rev. originate. The revision of the latter is underway.

Although it may be impossible to fully predict which species will become introduced pests, educated decisions can be made about which species have the greatest potential, and similarly, which species have potential as biological control agents. While this paper was in review, a wild population of *T. japonicus* was discovered in Beltsville, Maryland (Talamas et al 2015), which we were able to rapidly identify with the tools we produced for exactly this purpose. We believe that this emphasizes the utility of alpha taxonomy and the need for continued revisionary work in Platygastridae.

The identification keys of Johnson (1984, 1985a,b) remain relevant for the Nearctic species and the dichotomous key presented here largely follows their structure. The goals of this publication are to document the Nearctic fauna as completely as possible, and to provide identification tools with high resolution color illustrations that should greatly facilitate species-level identification. Two formats for this identification key are given: a traditional dichotomous key, and a multi-choice Lucid key<sup>1</sup>.

The contributions of the authors are as follows: E.J. Talamas: character definition and coding, imaging, manuscript preparation; N.F. Johnson: character definition and coding, manuscript preparation; M. Buffington: manuscript preparation, project coordination.

## Materials and methods

The locality data reported for primary types are not literal transcriptions of the labels: some abbreviations are expanded; additional data from the collectors are also included. The numbers prefixed with “USNMENT” or “OSUC ” are unique identifiers for the individual specimens (note the blank space after some acronyms). Details on the data associated with these specimens may be accessed at the following link, <http://purl.oclc.org/NET/hymenoptera/hol>, and entering the identifier in the form. The taxonomic synopsis was generated by the Hymenoptera Online Database (<http://hol.osu.edu>).

Persistent URIs for each taxonomic concept were minted by xBio:D in accordance with best practices recommend by Hagedorn et al (2013).

Morphological terms were matched to concepts in the Hymenoptera Anatomy Ontology using the text analyzer function. A table of morphological terms and URI links is provided in Suppl. material 1.

Photographs were captured with a Z16 Leica<sup>®</sup>™ lens with a JVC KY-F75U digital camera using Cartograph<sup>™</sup> software, or a Leica<sup>®</sup>™ DMRB compound microscope with a GT-

Vision<sup>®</sup>™ Lw11057C-SCI digital camera attached. In both systems, lighting was achieved using techniques summarized in Buffington et al. (2005), Kerr et al. (2009) and Buffington and Gates (2009). Single montage images were produced from image stacks with the program CombineZP<sup>®</sup>™. In some cases, multiple montage images were stitched together in Photoshop<sup>®</sup>™ to produce larger images at high resolution and magnification. Full resolution images are archived at the image database at The Ohio State University (<http://purl.oclc.org/NET/hymenoptera/specimage>), MorphBank (<http://www.morphbank.net>), and Hymenoptera Holotypes of the Smithsonian Institution (<http://usnmhymtypes.com>).

High quality optics and bright, diffuse lighting are critical for observing the characters in this key. The authors recommend fluorescent desk lamps, or fiber optic lamps with mylar sleeves affixed to the tips of the light pipes, or a mylar ‘shield’ between the tip of the light pipes and the specimen. Direct illumination of the specimen should be avoided. Additionally, some characters are better observed with appendages moved (especially the legs in couplet 5 and the wings in couplet 6 of the *Trissolcus* species key). Fine forceps or a minuten pin achieve this effectively.

## Collections

This work is based on specimens deposited in the following repositories with abbreviations used in the text:

<b>BMNH</b>	Natural History Museum, London, England
<b>CNCI</b>	Canadian National Collection of Insects, Ottawa, Canada
<b>NHMW</b>	Naturhistorisches Museum Wien, Vienna, Austria
<b>NHRS</b>	Naturhistoriska riksmuseet, Stockholm, Sweden
<b>OSUC</b>	C.A. Triplehorn Insect Collection, Columbus, USA
<b>USNM</b>	Smithsonian National Museum of Natural History, Washington DC, USA
<b>UANL</b>	Facultad de Ciencias Forestales, Linares, Mexico
<b>LACM</b>	Los Angeles County Museum of Natural History, Los Angeles, USA
<b>UCRC</b>	Entomology Research Museum, Riverside, USA
<b>MEMU</b>	Mississippi State University
<b>MSWC</b>	M.S. Wasbauer Collection, Sacramento, USA
<b>ANIC</b>	Australian National Insect Collection, Canberra City, Australia
<b>RMCA</b>	Musee Royal de l’Afrique Centrale, Tervuren, Belgium
<b>FSCA</b>	Florida State Collection of Arthropods, Gainesville, USA

## Character discussion

### Axillar crescent

We coin this term to refer to the structure formed by the transaxillar, axillar, and axillar carinae located posterodorsal to the wing base (see Figs 1, 17, 19–20, 60, 62). The

transaxillar and axillar carinae are fused in *Trissolcus* and form the anterodorsal part of the axillar crescent. The axillular carina forms the posterior and ventral portion. Proper examination of this character may require removal or adjustment of the wings.

### **Clypeal setae**

In the Nearctic fauna, species in the *basalis* and *thyantae* species groups have 6 clypeal setae (Fig. 27). *Trissolcus cultratus* and native species of the *flavipes* group have 2 (Fig. 23), making it easy to separate *T. japonicus*, which has 4 clypeal setae (Fig. 25). Rarely, and usually in males, superfluous clypeal setae exist. These are typically much smaller and arise near the base of one of the “true” clypeal setae. We consider the number of these setae to be extremely useful for identification of *T. japonicus*, but this character is variable.

### **Episternal foveae**

The episternal foveae of the *thyantae* group are clearly defined; they extend from the dorsal limit of the acetabular carina to the mesopleural pit and are typically antero-posteriorly elongate. In the *basalis* group, the episternal foveae are often distinctly separate from the mesopleural pit, and with the exception of some *T. cosmopeplae*, are distinctly separate from the dorsal limit of the postacetabular sulcus. Nearctic species of the *flavipes* group tend to be variable in the external expression of this character. In most cases, the foveae are irregularly shaped and are at varying distances from both the mesopleural pit and acetabular carina. In the Eastern Palearctic species of the *flavipes* group the episternal foveae often appear as a continuation of the postacetabular sulcus and extend dorsally to the mesopleural pit as in *T. japonicus* (Fig. 70) and *T. cultratus*.

### **Facial striae**

The presence of striae on the frons is typically weakly indicated or entirely absent, with a few exceptions. In some species the striae are present as shallowly incised short lines arising from the anterior articulation of the mandible (eg. *T. cultratus*, Fig. 54), and in a few, *T. radix*, *T. solocis* and *T. zakotos*, the striae exist as rugulae that extend further toward the compound eye (Fig. 112).

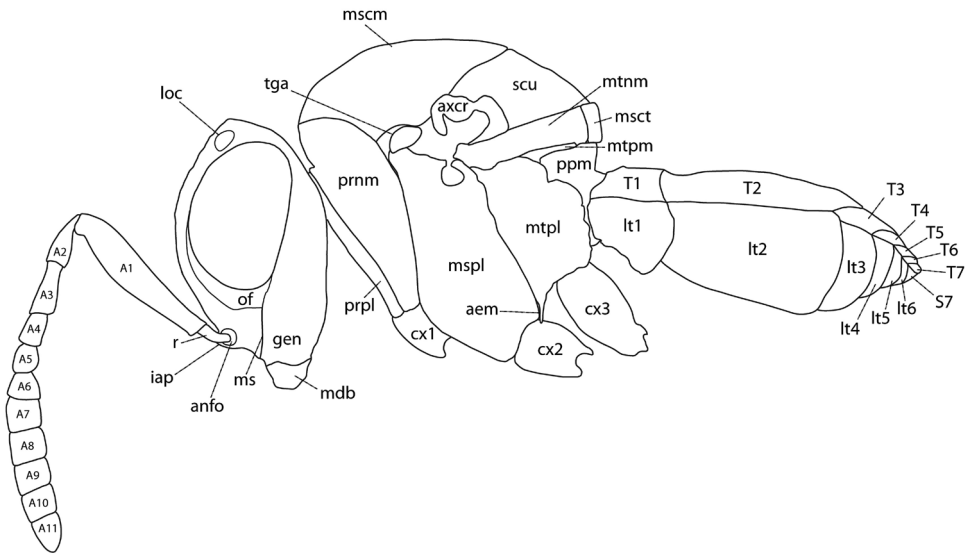
### **Mesopleural carina**

The mesopleural carina was used more extensively for species identification in the key of Johnson (1984) than it is here. Specifically, we observed that in *T. edessae* this carina may be present (Fig. 58) and we no longer use its absence to separate this species. In the *thyantae* and *basalis* groups this character exhibits far less intraspecific variability than in the *flavipes* group and we use it for the identification and delimitation of *T. valkyria*.

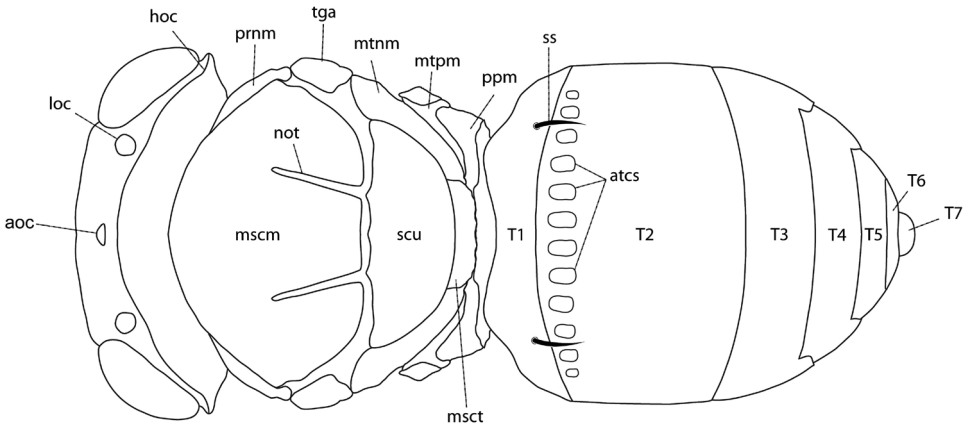
### **Mesoscutal humeral sulcus**

Among the published descriptions and diagnoses, we have not encountered previous use of this character for species-level delimitation in *Trissolcus*. In all but one species,

*T. cosmopeplae*, the form of this character is fixed. As stated by Johnson (1985), *T. cosmopeplae*, as currently understood, is a highly variable species. We point out that most specimens of *T. cosmopeplae* examined for this key have a mesoscutal humeral sulcus present as a smooth furrow, and that in the holotype specimen this sulcus is comprised of distinct cells.



1



2

Figures 1–2. 1 *Trissolcus*, lateral view 2 *Trissolcus*, dorsal view.

**Characters annotations**

A1–12	antennomeres 1–12 (Fig. 1)
ac	acetabular carina (Figs 43–44, 70)
aem	anteroventral extension of metapleuron (Figs 1, 43, 58, 82, 88)
anfo	antennal foramen (Fig. 1)
aoc	anterior ocellus (Fig. 2)
as	antennal scrobe (Figs 13, 26, 54)
atcs	antecostal sulcus (Figs 2, 29, 61)
ats	postacetabular sulcus (Figs 42, 70, 82)
axcr	axillar crescent (Figs 1, 17, 19–20, 60, 62)
bs	basiconic sensilla (Figs 8–9)
cs	clypeal setae (Fig. 23, 25, 27)
ctk	central keel (Figs 7, 10, 79)
cx1	procoxa (Fig. 1)
cx2	mesocoxa (Fig. 1)
cx3	metacoxa (Fig. 1)
eps	episternal foveae (Figs 35, 43, 48, 70, 82)
fs	facial striae (Figs 7, 10, 54, 112)
gc	genal carina (Figs 48, 112)
gen	gena (Fig. 1)
hoc	hyperoccipital carina (Figs 2, 19, 29)
iap	interantennal process (Fig. 1)
loc	lateral ocellus (Figs 1–2)
lt(s)	laterotergite(s) (Figs 2, 11–12)
mc	mesopleural carina (Fig. 43, 45, 58, 107)
mdb	mandible (Fig. 1)
mmc	median mesoscutal carina (Fig. 39, 63)
mms	median mesoscutal sulcus (Fig. 93)
mpp	mesopleural pit (Figs 35, 43, 82)
ms	malar sulcus (Figs 1, 24, 26, 28)
mscm	mesoscutum (Figs 1–2)
msct	metascutellum (Figs 1–2, 21–22)
mshs	mesoscutal humeral sulcus (Figs 29, 30, 46, 49)
mspl	mesopleuron (Fig. 1)
mtnm	metanotum (Figs 1–2, 21–22)
mtpl	metapleuron (Fig. 1)
mtpm	metapostnotum (Figs 1–2, 21–22)
nes	netrion sulcus (Figs 44, 48)
not	notaulus (Figs 2, 29)
of	orbital furrow (Figs 1, 24, 26, 28–29, 71)
pcxs	paracoxal sulcus (Figs 82, 109)

ppm	propodeum (Figs 1–2, 21–22)
prnm	pronotum (Figs 1–2)
prpl	propleuron (Fig. 1)
pvm	posteroventral portion of metapleuron (Figs 17, 18, 20, 74, 106)
r	radicle (Figs 1, 37, 80, 112)
scu	mesoscutellum (Figs 1–2)
ss	sublateral seta (Figs 2, 30, 89)
T1–6	mediotergite (Figs 1–2)
tga	tegula (Figs 1–2)

### Key to genera of Nearctic Platygastroidea known to attack pentatomoid eggs

The following key includes platygastroids with host records indicating emergence from pentatomoid eggs. More associations are certain to exist, particularly in *Telenomus*, which contains many species with undocumented biology, and many undescribed species.

- 1 Metasoma with laterotergites tightly appressed to sternites, forming a sharply angled lateral margin (Fig. 11); female antenna with 12 antennomeres (Fig. 11)..... ***Gryon obesum* Masner**
- Metasoma with laterotergites wide and loosely attached to sternites, metasoma without sharp lateral margin (Fig. 12); female antenna with 10 or 11 antennomeres ..... **2**
- 2 Frons with central keel extending from interantennal process to anterior ocellus (Figs 7, 10); frons with facial striae distinct, striae often extending along inner orbit of compound eye (Figs 7, 10)..... **3**
- Frons without central keel or keel short, not extending to anterior ocellus (Figs 54, 79); frons without facial striae or, if present, sinuate and usually attenuating before reaching inner orbit of compound eye (Figs 54, 112) ..... **4**
- 3 Mesoscutum with notauli (Fig. 5); base of metasoma usually yellow-orange and contrasting with dark color of posterior metasoma (Figs 3, 5); in lateral view, procoxa distinctly separated from mesocoxa (Fig. 3) ..... ***Paratelenomus saccharalis* (Dodd)**
- Mesoscutum without notauli (Fig. 6); base of metasoma never yellow-orange (Fig. 4); in lateral view, procoxa contiguous with mesocoxa (Fig. 4) ..... ***Psix tunetanus* (Mineo & Szabó)**
- 4 T2 longer than wide (Fig. 14); frons predominantly smooth and shining (Fig. 13); female antenna with basiconic sensilla on apical 4 (rarely 5 or 6) antennomeres (Fig. 9)..... ***Telenomus* (*T. astrictus*, *T. calvus*, *T. goliathus*, *T. grenadensis*, *T. persimilis*, *T. podisi*, *T. sanctiventris*, *T. scaber*)**
- T2 wider than long (Fig. 16); frons with microsculpture throughout, often superimposed on coarse surface sculpture (Fig. 15); female antenna with basiconic sensilla on apical 5 antennomeres (Fig. 8) ..... ***Trissolcus***

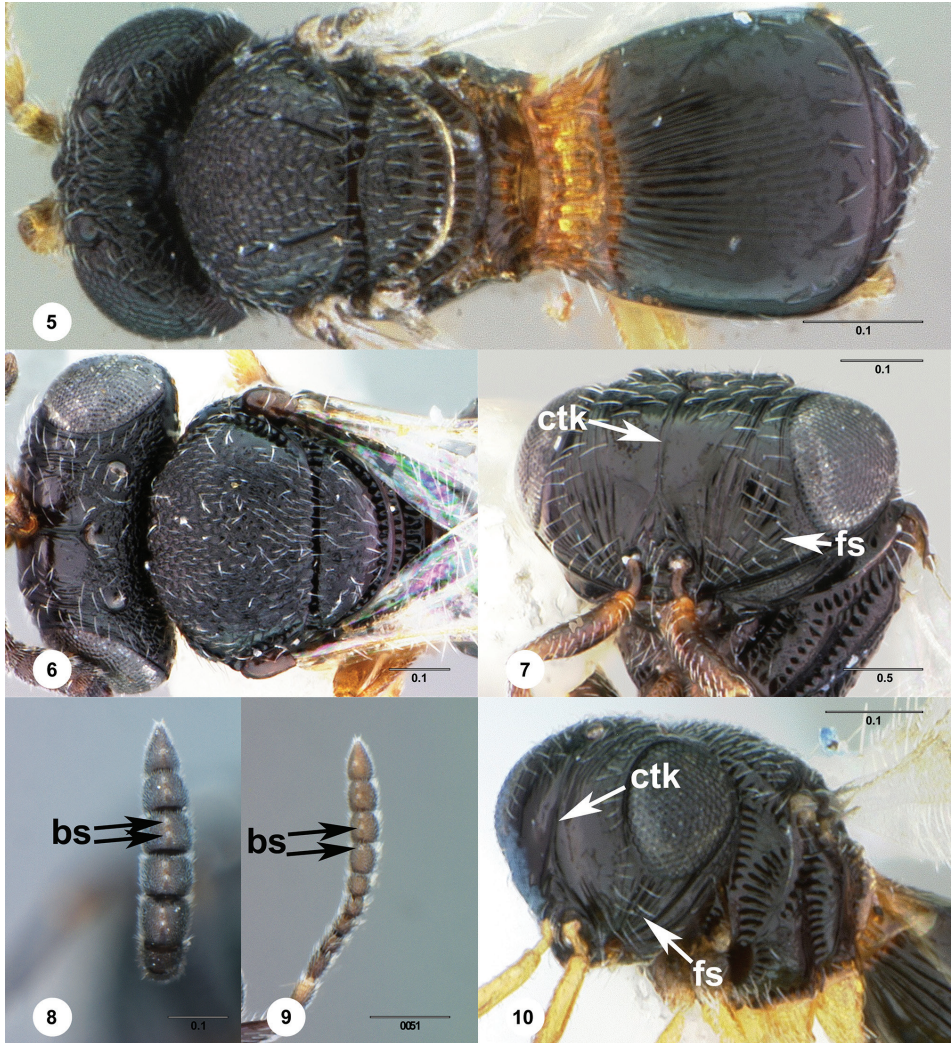




**Figures 3–4.** <sup>21</sup> **3** *Paratelenomus saccharalis*, female (USNMENT00896342), head, mesosoma, metasoma, lateral view **4** *Psix tunetanus* (USNMENT00989625), head, mesosoma, metasoma, lateral view. Scale bars in millimeters.

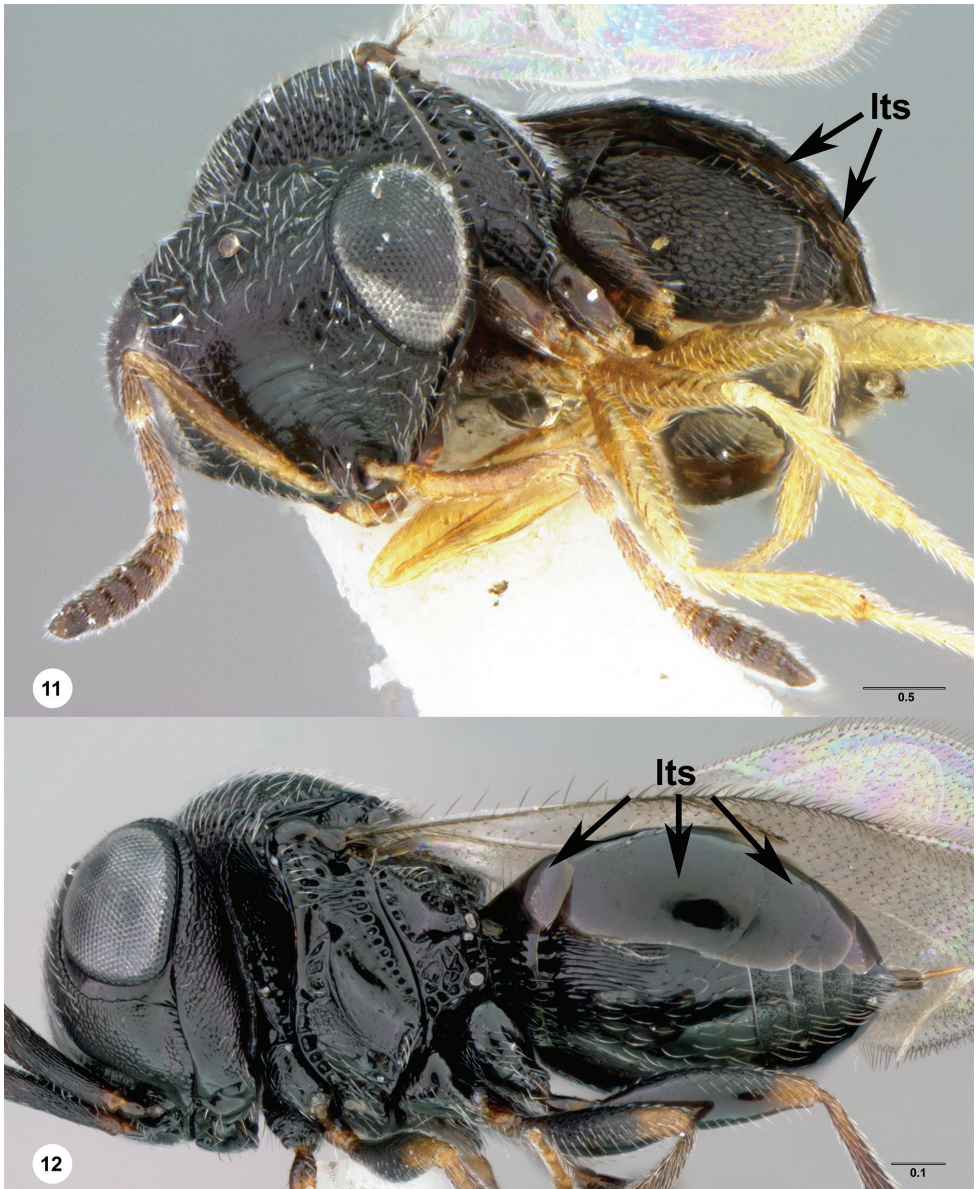
### Key to species of Nearctic *Trissolcus* (males and females)

- 1 Metapleuron with posteroventral portion glabrous (Figs 17, 19–20).....**2**
- Metapleuron with posteroventral portion setose (Figs 18, 73–74, 76, 106)...  
.....(*thyantae* group) **15**
- 2 Vertex with hyperoccipital carina (Figs 19, 29, 64); mesoscutum with notauli (Figs 21, 29); clypeus with 4 or fewer setae (Figs 23, 25); inner margin of eye with orbital furrow not uniform in width, usually expanded near malar sulcus (Figs 1, 12, 15, 28) ..... (*flavipes* group) **3**
- Vertex without hyperoccipital carina (Fig. 30); mesoscutum usually without notauli (Fig. 30); clypeus with 6 setae (Fig. 27); inner margin of eye with



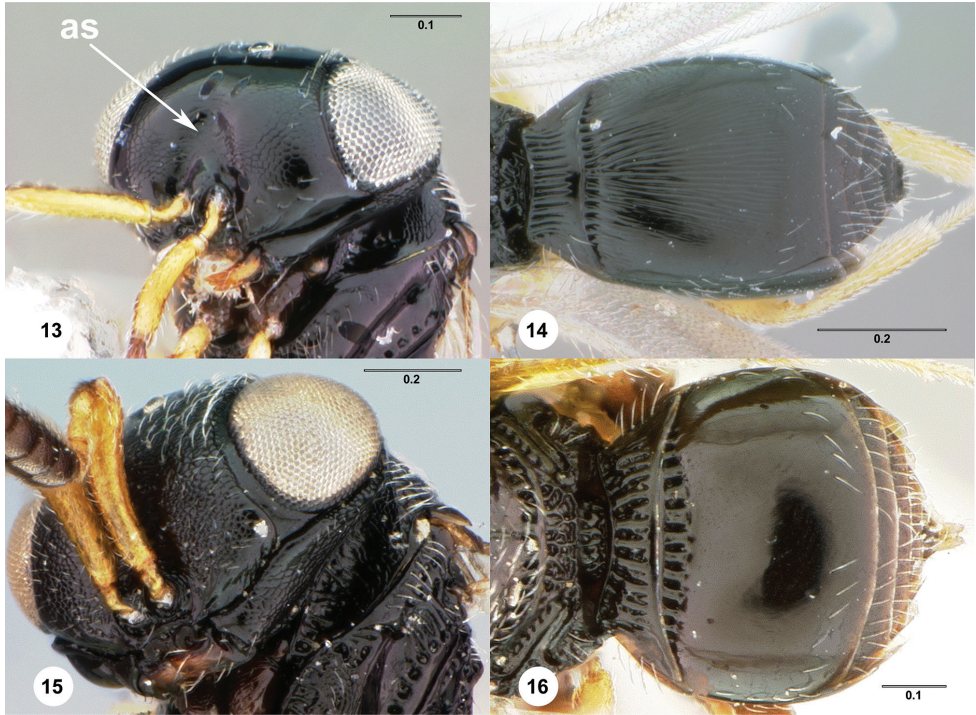
**Figures 5–10.** <sup>22</sup> *Paratelenomus saccharalis*, female (USNMENT00896342), female, head, mesosoma, metasoma, dorsal view **6** *Psix tunetanus*, female (USNMENT00989625), head and mesosoma, dorsal view **7** *Psix tunetanus*, female (USNMENT00877258), head, anterior view **8** *Trissolcus strabus*, female (USNMENT00954423), antennal clava, ventral view **9** *Telenomus* sp., female (OSUC 523925), antennal clava, ventral view **10** *Paratelenomus saccharalis*, female (USNMENT00896364), head and mesosoma, anterolateral view. Scale bars in millimeters.

- orbital furrow uniform in width, not expanded near malar sulcus (Fig. 24) ..  
 .....(basalis group) **8**
- 3** Frons between antennal scrobe and anterior ocellus with parallel, arched rugae (Figs 52, 54) ..... *T. cultratus* (Mayr), **comb. rev.**
- Frons between antennal scrobe and anterior ocellus smooth or with rugae that are not parallel and arched (Figs 26, 40, 55, 59, 65) ..... **4**



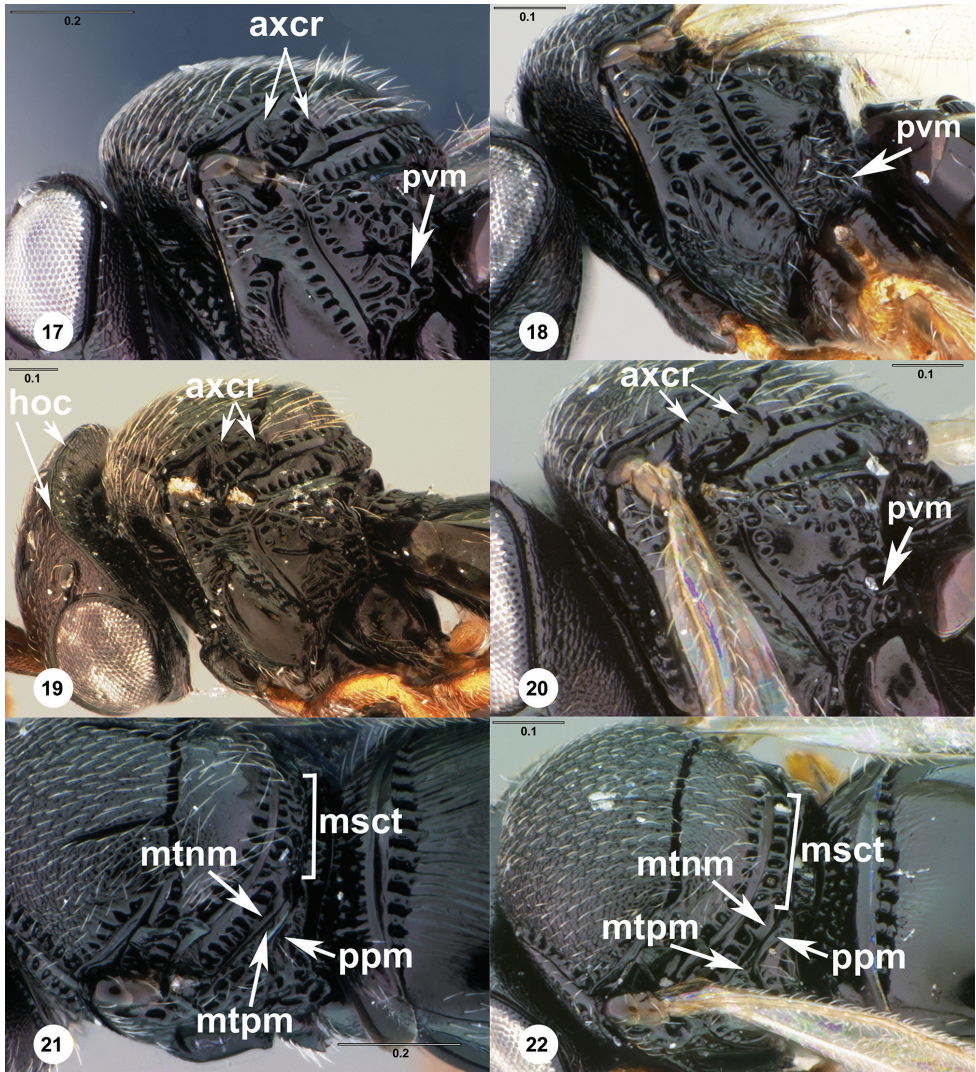
**Figures 11–12.**<sup>23</sup> **11** *Gryon obesum*, female paratype (USNMENT00989078), head, mesosoma, metasoma, anterolateral view **12** *Trissolcus euschisti*, female (OSUC 404912), head, mesosoma, metasoma, ventrolateral view. Scale bars in millimeters.

- 4 Inner margin of eye with orbital furrow constricted ventrally (Fig. 26); mesoscutellum rugose, at least laterally and usually throughout (Fig. 32); first laterotergite usually with setae (Fig. 92); mesoscutum often with median mesoscutal sulcus (Fig. 93) ..... *T. strabus* Johnson



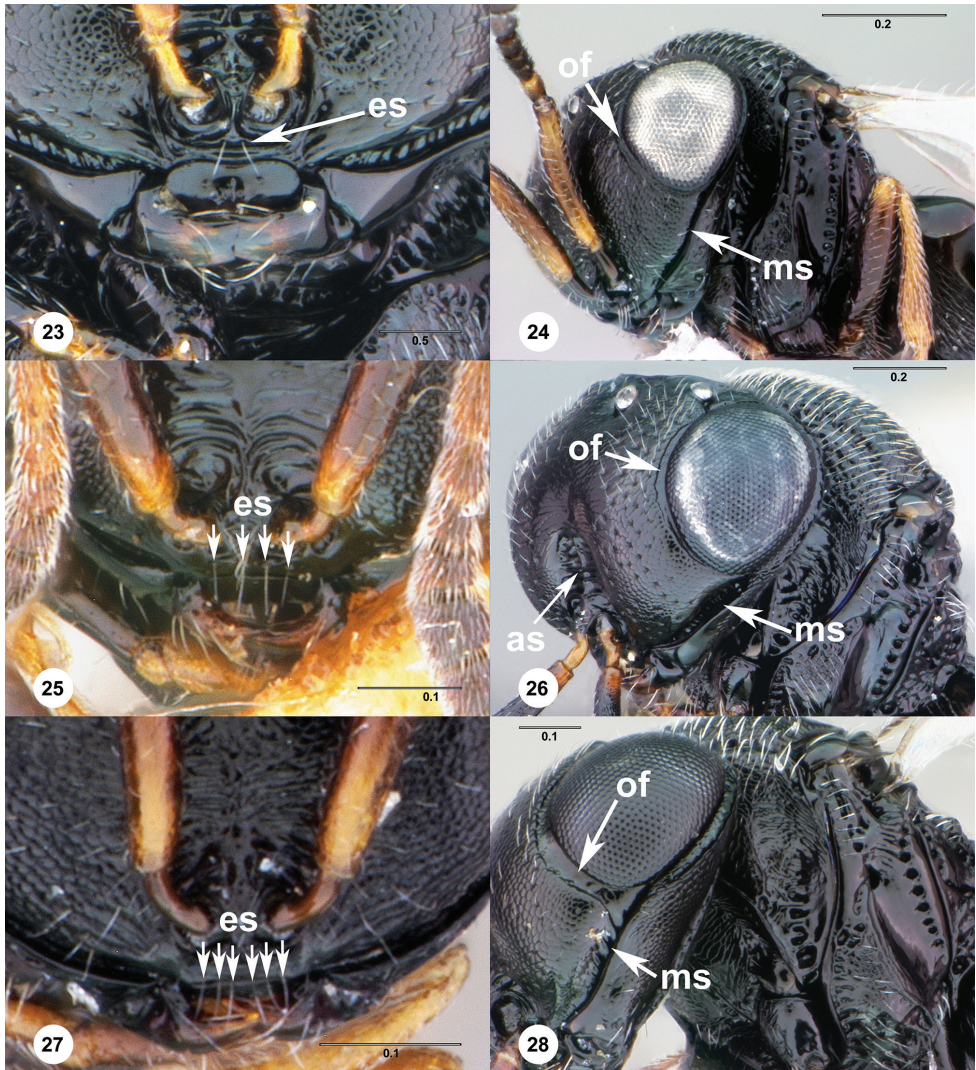
**Figures 13–16.** <sup>24</sup> **13** *Telenomus* sp., female (USNMENT00872628), head, anterolateral view **14** *Telenomus* sp., female (USNMENT00903997), metasoma, dorsal view **15** *Trissolcus urichi*, female holotype (USNMENT00989070), head, anterolateral view **16** *Trissolcus urichi*, female (USNMENT00896405), metasoma, dorsal view. Scale bars in millimeters.

- Inner margin of eye with orbital furrow expanded near intersection with malar sulcus (Figs 12, 15, 28); mesoscutellum smooth (Fig. 34) or with coriaceous microsculpture (Fig. 33); first laterotergite without setae (Figs 62, 68); mesoscutum without median mesoscutal sulcus Fig. 69)..... **5**
- 5** Clypeus with 4 setae (Fig. 25); mesopleuron with episternal foveae well-defined and deep, forming a continuous line of cells from postacetabular sulcus to mesopleural pit (Fig. 70); mesoscutum without median mesoscutal carina (Fig. 69)..... ***T. japonicus* (Ashmead)**
- Clypeus with 2 setae (Fig. 23); mesopleuron with episternal foveae poorly defined, often shallow, irregular (Figs 42–45) and typically distant from postacetabular sulcus; mesoscutum often with median mesoscutal carina (Figs 39, 63) ..... **6**
- 6** Female with antennal flagellum distinctly bicolored: A3–A6 yellow, A7–A11 dark brown (Fig. 59, as in Fig. 68); area bounded by axillar crescent (axcr Fig. 1) striate (as in Figs 17, 19)..... ***T. edessae* Fouts**
- Female with antennal flagellum (A3–A11) infusate throughout (Fig. 38); area bounded by axillar crescent (axcr Fig. 1) with cells visible only along dorsal margin (Figs 20, 62) ..... **7**



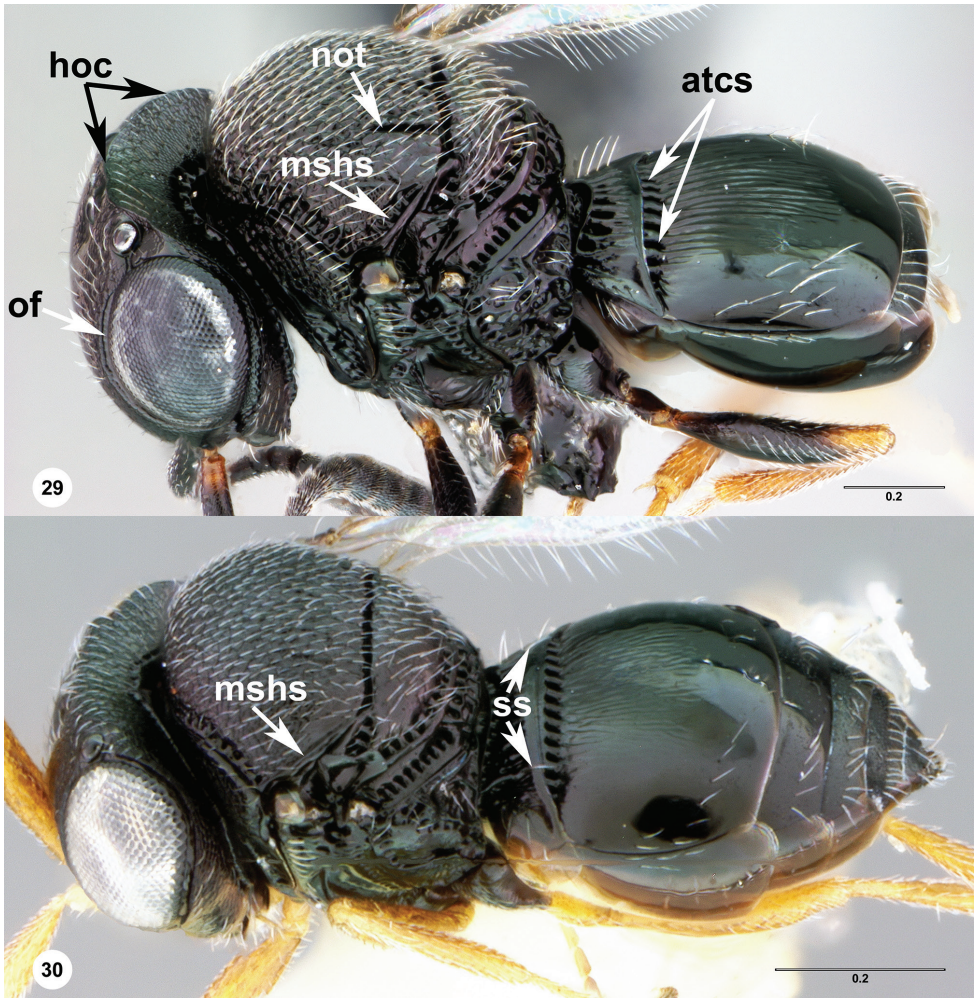
**Figures 17–22.** <sup>25</sup> **17** *T. japonicus*, female (USNMENT00675989), mesosoma, lateral view **18** *T. occiduus*, female (USNMENT00764995), mesosoma, lateral view **19** *Trissolcus cultratus*, female (USNMENT00764850), head and mesosoma, dorsolateral view **20** *T. euschisti*, female (OSUC 523871), mesosoma, lateral view **21** *T. japonicus*, female (USNMENT00675989), mesosoma, posterolateral view **22** *T. bullensis*, female (OSUC 523881), mesosoma, dorsolateral view. Scale bars in millimeters.

- 7 Mesopleuron with anteroventral portion rugulose (Figs 41, 44–45)..... *T. brochymenae* (Ashmead)
- Mesopleuron with anteroventral portion smooth or with shallowly impressed microsculpture (Figs 12, 42–43)..... *T. euschisti* (Ashmead)
- 8 Mesoscutellum coarsely rugose (Figs 80–81, 90); vertex sharply angled onto occiput (Fig. 81)..... **9**



**Figures 23–28.** <sup>26</sup> **23** *T. strabus*, female (BMSB 1203), mouthparts, anterior view **24** *T. hullensis*, female, (OSUC 523881), head and mesosoma, anterolateral view **25** *T. japonicus*, female holotype, (USNMENT00831865), mouthparts, anterior view **26** *T. strabus*, female, (BMSB 1202), head mesosoma, anterolateral view **27** *T. erugatus*, female, (OSUC 523929), head mesosoma, anterolateral view **28** *T. euschisti*, female, (BMSB 1223), head mesosoma, anterolateral view. Scale bars in millimeters.

- Mesoscutellum smooth or with coriaceous microsculpture (Figs 33–34); vertex rounded onto occiput (Figs 30, 66) ..... **10**
- 9 Radicle yellow (Fig. 80, 83); metapleuron with paracoxal sulcus indicated by line of distinct foveae in ventral half (Fig. 82) ..... ***T. radix* Johnson**
- Radicle dark brown to black (Fig. 91); metapleuron with paracoxal sulcus absent or obscured by rugae in ventral half (Fig. 88) ..... ***T. solocis* Johnson**



**Figures 29–30.** <sup>27</sup> **29** *T. strabus*, female (BMSB 1202), head mesosoma, metasoma, dorsolateral view  
**30** *T. basalis*, female, (USNMENT00954022), head, mesosoma, metasoma, dorsolateral view. Scale bars in millimeters.

- 10 Metapleuron with paracoxal sulcus visible in ventral half (Fig. 109); frons with facial striae extending as rugulae from anterior mandibular articulation toward compound eye (Fig. 112) ..... ***T. zakotos* Talamas, sp. n.**
- Metapleuron with paracoxal sulcus absent or obscured by coarse rugae in ventral half (Figs 35, 46, 67); frons without facial striae (Fig. 37) ..... **11**
- 11 T2 smooth or with faintly impressed striation posterior to antecostal sulcus (Figs 61, 66) ..... **12**
- T2 with pronounced striae posterior to antecostal sulcus (Figs 30, 51, 101).... **13**
- 12 Metapostnotum invaginated near propodeal spiracle, not separating propodeum from metanotum near metascutellum (Figs 22, 66) ..... ***T. bullensis* (Harrington)**

- Metapostnotum invaginated near metascutellum, separating propodeum from metanotum near metascutellum (as in Fig. 21).... ***T. erugatus* Johnson**
- 13 Mesoscutellum with distinct coriaceous microsculpture and setal bases usually pustulate (Fig. 31); mesopleuron with episternal foveae shallowly impressed and distinctly separated from mesopleural pit (Fig. 35); netrion sulcus incomplete (as in Fig. 44)..... ***T. basalis* (Wollaston)**
- Mesoscutellum entirely smooth and setal bases not strongly raised (Fig. 34); mesopleuron with episternal foveae extending dorsally to proximity of mesopleural pit (Fig. 48); netrion sulcus complete (Fig. 48) ..... **14**
- 14 Gena in lateral view bulging (Fig. 102), without genal carina (Fig. 102); mesoscutum without notauli (Fig. 100); anteroventral extension of metapleuron short, not extending to mesocoxa in lateral view (Fig. 102); lateral mesoscutum with mesoscutal humeral sulcus present as a smooth furrow (as in Fig. 30)..... ***T. utahensis* (Ashmead)**
- Gena in lateral view narrow, often with genal carina extending dorsally from base of mandible (Fig. 48); mesoscutum with notauli sometimes indicated; anteroventral extension of metapleuron usually long and extending to base of mesocoxa in lateral view (Fig. 46, as in Fig. 43); lateral mesoscutum with mesoscutal humeral sulcus present as a smooth furrow (Fig. 49) or comprised of cells (Fig. 46) ..... ***T. cosmopeplae* (Gahan)**
- 15 Mesoscutellum covered with shallowly impressed coriaceous microsculpture (Fig. 33)..... **16**
- Mesoscutellum entirely smooth, without microsculpture (Fig. 34) ..... **17**
- 16 Frons outside of antennal scrobes with raised, irregular rugulae (Fig. 86); mesoscutum between notauli often with longitudinal rugulae (Fig. 87) ..... ***T. ruidus* Johnson**
- Frons outside of antennal scrobes coriaceous, without raised rugulae but with more or less well-defined setigerous punctures, (Fig. 79); mesoscutum without longitudinal elements in sculpture (Fig. 77)..... ***T. parma* Johnson**
- 17 Gena in lateral view bulging (Fig. 74) ..... ***T. occiduus* Johnson**
- Gena in lateral view narrow (Figs 95, 106) ..... **18**
- 18 Mesopleural carina absent ventrally (Fig. 97) ..... ***T. thyantae* Ashmead**
- Mesopleural carina complete (Fig. 107) ..... ***T. valkyria* Johnson & Talamas, sp. n.**

**Multi-choice Lucid key**

Lucid Key Server edition (only web browser required):

<http://keys.lucidcentral.org/key-server/key.jsp?keyId=127>

Applet edition (requires installation of Java Runtime Environment):

[http://keys.lucidcentral.org/keys/v3/Nearctic\\_Trissolcus/](http://keys.lucidcentral.org/keys/v3/Nearctic_Trissolcus/)



## Taxonomy

### *Trissolcus basalis* (Wollaston)

[http://bioguid.osu.edu/osuc\\_concepts/3189](http://bioguid.osu.edu/osuc_concepts/3189)

Figures 30–31, 35–37; Morphbank<sup>2</sup>

*Telenomus Maderensis* Wollaston, 1858: 25 (original description, synonymized by Nixon (1935)).

*Telenomus basalis* Wollaston, 1858: 25 (original description); Kieffer 1926: 39 (description).

*Telenomus megacephalus* Ashmead, 1894: 203, 212 (original description, synonymized by Nixon (1935)); Ashmead 1896: 790 (keyed); Ashmead 1900: 326 (distribution); Nixon 1935: 100 (junior synonym of *Microphanurus basalis* (Wollaston)).

*Telenomus megaloccephalus* Schulz: Schulz 1906: 152 (emendation).

*Telenomus picipes* Dodd, 1920: 354 (original description, synonymized by Nixon (1935)); Nixon 1935: 100 (junior synonym of *Microphanurus basalis* (Wollaston)).

*Liophanurus megacephalus* (Ashmead): Kieffer 1926: 65, 76 (description, generic transfer, keyed).

*Telenomus maderensis* Wollaston: Kieffer 1926: 39 (description); Nixon 1935: 100 (junior synonym of *Microphanurus basalis* (Wollaston)).

*Microphanurus basalis* (Wollaston): Nixon 1935: 96, 100 (description, generic transfer, synonymy, keyed); Nixon 1943: 138 (keyed); Risbec 1950: 570, 571 (variation, keyed).

*Asolcus basalis* (Wollaston): Delucchi 1961: 44, 57 (description, keyed); Voegelé 1962: 155 (variation, diagnosis); Voegelé 1964: 28 (keyed); Voegelé 1965: 96, 108 (variation, diagnosis, keyed); Voegelé 1969: 151 (keyed).

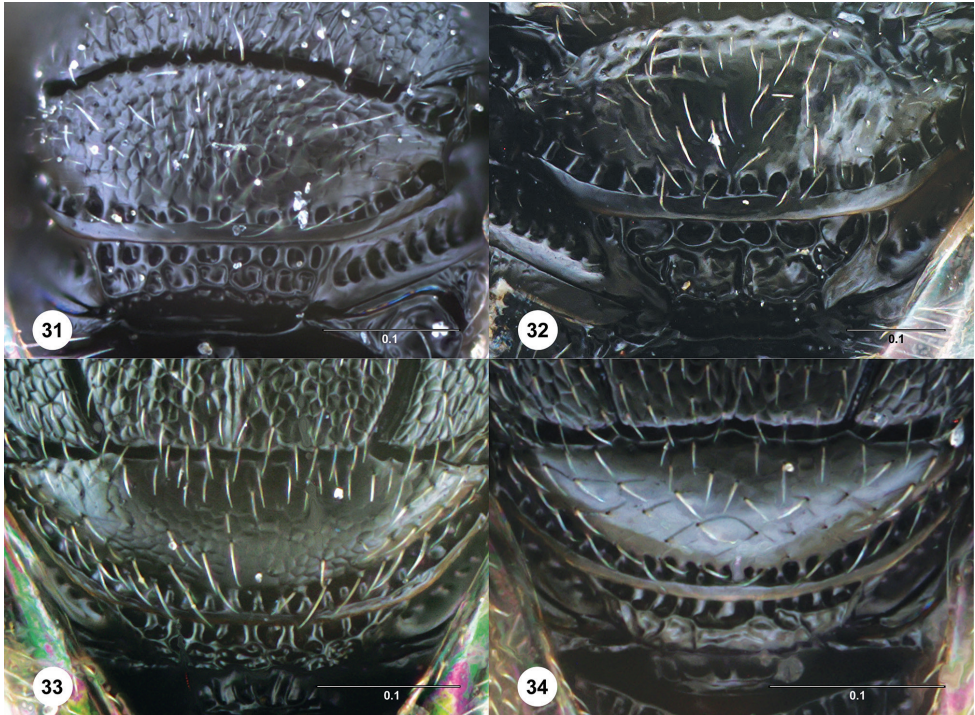
*Trissolcus basalis* (Wollaston): Masner 1965: 125 (type information, generic transfer); Safavi 1968: 415 (keyed); Fabritius 1972: 31 (keyed); Kozlov and Lê 1977: 516 (keyed); Kozlov 1978: 637 (description); Kozlov and Kononova 1983: 121 (description); Graham 1984: 100 (variation); Johnson 1985b: 432, 434 (description, keyed); Johnson 1991: 212, 213, 214, 216 (diagnosis, keyed); Ghahari, Buhl and Kocak 2011: 594 (listed); Mao, Valerio, Austin, Dowton and Johnson 2012: 194 (presentation of mitochondrial genome, phylogenetic position); Fusu, Bin and Popovici 2013: 263 (description of chromosomes).

*Trissolcus maderensis* (Wollaston): Masner 1965: 126 (type information, generic transfer).

*Trissolcus picipes* (Dodd): Masner 1965: 127 (type information, generic transfer).

*Trissolcus megacephalus* (Ashmead): Johnson 1983: 448 (type information).

**Lectotype designation.** Masner (1965) did not mention the type status of the specimen labeled “Type H.T.” in his treatment of the types in BMNH, and Johnson (1985) referred to this specimen of the holotype, although it was originally part of a syntype series. Consequently, a lectotype was not actually designated for *T. basalis*. We here designate the specimen mentioned by Masner (1965) (B.M. TYPE HYM. 9.304) as the lectotype of this species.



**Figures 31–34.**<sup>28</sup> **31** *T. basalis*, female (USNMENT00954023), mesoscutellum, dorsal view **32** *T. strabus*, female (OSUC 523850), mesoscutellum, dorsal view **33** *T. ruidus*, (OSUC 76431), mesoscutellum, dorsal view **34** *T. occiduus*, female (OSUC 76430), mesoscutellum, dorsal view. Scale bars in millimeters.

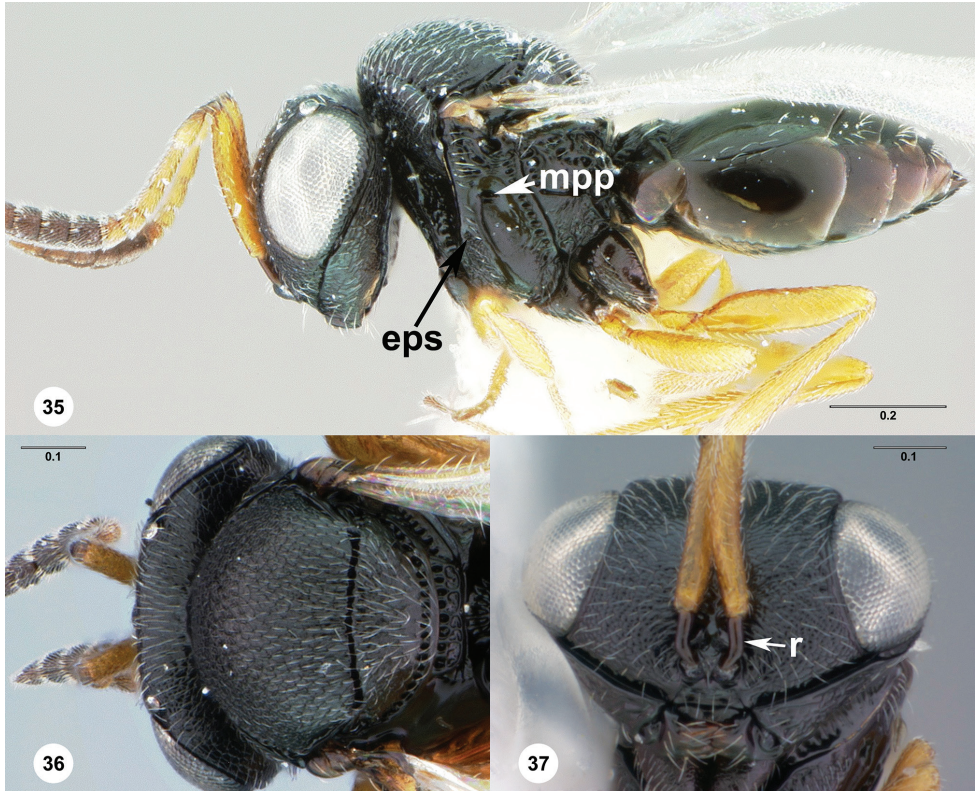
**Diagnosis.** Within the New World species of the *basalis* group, the combination of the broadly rounded vertex, wide gena, and rugose T2 is found only in *T. basalis* and *T. utahensis*. *Trissolcus basalis* may be distinguished by its coriaceous mesoscutellum, incomplete netrion sulcus and weakly developed episternal foveae. *Trissolcus basalis* may be dark in color, but typically can be distinguished by the yellow scape (sharply contrasting in color with the dark radicle) and abruptly bicolored antennae.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3189>]

**Associations.** Emerged from egg of *Aelia* Fabricius: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Aelia acuminata* (Linnaeus): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Aelia cognata* Fieber: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Aelia germari* Küster: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Agonoscelis rutila* (Fabricius): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Asopinae* Spinola: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Calidea* Laporte: [Hemiptera: Heteroptera: Pentatomoidea: Scutelleridae]; emerged from egg of *Calidea dregelii* Germar: [Hemiptera: Heteroptera: Pentatomoidea: Scutelleridae]; emerged from egg of *Carpocoris fuscispinus* (Boheman): [Hemiptera: Heteroptera: Pentato-

moidea: Pentatomidae]; emerged from egg of *Coleotichus blackburniae*: [Hemiptera: Heteroptera: Pentatomoidea: Scutelleridae]; emerged from egg of *Cuspicona simplex* Walker: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Dolicoris baccharum* (Linnaeus): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Dolicoris baccarum* (Linnaeus): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Eurydema ornata* (Linnaeus): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Eurygaster austriaca* (Schrank): [Hemiptera: Heteroptera: Pentatomoidea: Scutelleridae]; emerged from egg of *Eurygaster integriceps* Puton: [Hemiptera: Heteroptera: Pentatomoidea: Scutelleridae]; emerged from egg of *Euschistus* Dallas: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; solitary egg parasitoid of *Euschistus servus* (Say): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; solitary egg parasitoid of *Euthyrhynchus floridanus* (Linnaeus): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Graphosoma semipunctata* (Fabricius): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Halymorpha annulicornis* (Signoret): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Nezara* Amyot & Serville: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; solitary egg parasitoid of *Nezara* Amyot & Serville: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; egg parasite of *Nezara viridula* (Linnaeus): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from *Nezara viridula* (Linnaeus): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Nezara viridula* (Linnaeus): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; parasite of *Nezara viridula* (Linnaeus): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; solitary egg parasitoid of *Nezara viridula* (Linnaeus): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; solitary egg parasitoid of *Nezara viridula* (Linnaeus): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Odontotarsus grammicus* (Linnaeus): [Hemiptera: Heteroptera: Pentatomoidea: Scutelleridae]; egg ectoparasite of *Ooechalia* Stål: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Ooechalia schellenbergi* Guérin-Ménéville: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Pentatomidae*: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; solitary egg parasitoid of *Pentatomidae*: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Piezodorus hybneri* (Gmelin): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Plautia affinis* (Dallas): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Raphigaster* Laporte: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; collected on *Solanum nigrum* L.: [Solanales: Solanaceae]; collected on bokhara: [Fabales: Fabaceae]; collected on buehner: [Capparales: Brassicaceae]; collected on cotton: [Malvales: Malvaceae]; collected on hore: [Lamiales: Lamiaceae]; collected on mint: [Lamiales: Lamiaceae]; collected on mung: [Fabales: Fabaceae]; collected in drilled soybean: [Fabales: Fabaceae]; collected on soybean: [Fabales: Fabaceae]

**Material examined.** Lectotype, female, *T. basalis*: **PORTUGAL**: Madeira Reg. Autó., Madeira Island, VII–1855, Wollaston, B.M. TYPE HYM. 9.304 (deposited in



**Figures 35–37.** <sup>29</sup> *Trissolcus basalis* **35** female (USNMENT00903007), head, mesosoma, metasoma, lateral view **36** female (USNMENT00872109), head and mesosoma, dorsal view **37** female (OSUC 75271), head, anterior view. Scale bars in millimeters.

BMNH). Holotype, female, *T. megacephalus*: **SAINT VINCENT AND THE GRENADINES**: Saint Vincent Island, no date, H. H. Smith, USNM Type No. 2525 (deposited in USNM). *Other material*: (58 females, 15 males, 393 sex unrecorded) **AUSTRALIA**: 8 females, 4 males, 149 sex unrecorded, ANIC DB 32-020991, 32-020992, 32-020993, 32-020994, 32-020996–32-020999 (ANIC); OSUC 17738 (BMNH); OSUC 75398–75424 (OSUC); OSUC 145814, 78027–78147 (QDPC); USNMENT00872088, USNMENT00872089, USNMENT00872090, USNMENT00903007 (USNM). **BRAZIL**: 67 sex unrecorded, OSUC 75299–75365 (OSUC). **CHINA**: 10 sex unrecorded, OSUC 75366, 75389–75397 (OSUC). **DEMOCRATIC REPUBLIC OF THE CONGO**: 3 females, OSUC 182081–182083 (RMCA). **DOMINICAN REPUBLIC**: 3 sex unrecorded, OSUC 398658–398659, 398667 (CNCI). **EGYPT**: 2 females, 4 sex unrecorded, OSUC 144795–144796, USNMENT00872006, USNMENT00872007, USNMENT00872008, USNMENT00872009 (USNM). **ERITREA**: 1 female, OSUC 17736 (BMNH). **FIJI**: 16 sex unrecorded, OSUC 77661–77676 (BPBM). **FRENCH POLYNESIA**: 2 sex unrecorded, OSUC 77659–77660 (BPBM). **GREECE**: 1 sex unrecorded, OSUC 398669 (CNCI). **IRAN**: 1 sex unre-

corded, OSUC 144797 (CNCI). **ITALY**: 2 females, 1 male, OSUC 173847–173849 (OSUC). **JAMAICA**: 2 sex unrecorded, OSUC 398660–398661 (CNCI). **JAPAN**: 1 sex unrecorded, OSUC 144391 (CNCI). **MONTSERRAT**: 12 sex unrecorded, OSUC 398662 (CNCI); OSUC 145281 (FSCA); OSUC 75289–75298 (OSUC). **MOROCCO**: 1 sex unrecorded, OSUC 17743 (BMNH). **NEW CALEDONIA**: 1 sex unrecorded, OSUC 77624 (BPBM). **OCEANIA**: 5 sex unrecorded, OSUC 77625–77628 (BPBM); OSUC 75425 (OSUC). **SAINT VINCENT AND THE GRENADINES**: 3 sex unrecorded, OSUC 143816–143818 (LACM). **SENEGAL**: 1 female, OSUC 17737 (BMNH). **SOUTH AFRICA**: 6 sex unrecorded, OSUC 145553, 75384–75388 (OSUC). **TANZANIA**: 1 sex unrecorded, OSUC 17741 (BMNH). **TONGA**: 31 sex unrecorded, OSUC 77629–77658 (BPBM); OSUC 75427 (OSUC). **TRINIDAD AND TOBAGO**: 2 sex unrecorded, USNMENT00764950, USNMENT00764951 (USNM). **TURKEY**: 3 females, OSUC 17739–17740, 17742 (BMNH). **UNITED STATES**: 38 females, 9 males, 49 sex unrecorded, ANIC DB 32-020995 (ANIC); OSUC 398668 (CNCI); OSUC 131149–131186, 154353, 157486–157487, 157542–157549, 157563–157566, 7339, 75256–75288 (OSUC); USNMENT00872103, USNMENT00872104, USNMENT00872105, USNMENT00872106, USNMENT00872107, USNMENT00872108, USNMENT00872109 (USNM). **VANUATU**: 1 male, 1 sex unrecorded, ANIC DB 32-020997 (ANIC); OSUC 75426 (OSUC). **ZIMBABWE**: 17 sex unrecorded, OSUC 75367–75383 (OSUC).

***Trissolcus brochymenae* (Ashmead)**

[http://bioguid.osu.edu/osuc\\_concepts:3195](http://bioguid.osu.edu/osuc_concepts:3195)

Figures 38–41, 44–45; Morphbank<sup>3</sup>

*Telenomus Crochymenae* Ashmead, 1881: 181 (original description, spelling error).

*Telenomus brochymenae* Ashmead: Ashmead 1887: 118 (emendation).

*Trissolcus brochymenae* (Ashmead): Ashmead 1893: 162, 164 (generic transfer, description, keyed); Brues 1916: 549, 550 (description, keyed); Kieffer 1926: 127, 129 (description, keyed); Masner 1964: 146 (variation); Masner and Muesebeck 1968: 72 (lectotype designation); Johnson 1984: 799 (description, synonymy, keyed); Johnson 1987: 289, 298 (diagnosis, variation, synonymy, keyed).

*Trissolcus murgantiae* Ashmead, 1893: 162, 163 (original description, keyed, synonymized by Johnson (1984)); Brues 1916: 549, 550 (description, keyed); Kieffer 1926: 127, 128 (description, keyed); Masner and Muesebeck 1968: 73 (lectotype designation); Johnson 1984: 799 (junior synonym of *Trissolcus brochymenae* (Ashmead)).

*Trissolcus rufiscapus* Ashmead, 1893: 162, 163 (original description, keyed, synonymized by Johnson (1984)); Kieffer 1926: 127, 129 (description, keyed); Masner and Muesebeck 1968: 73 (type information); Johnson 1984: 799 (junior synonym of *Trissolcus brochymenae* (Ashmead)).

*Trissolcus laticeps* Ashmead, 1894: 212 (original description, synonymized by Johnson (1987)); Ashmead 1900: 326 (distribution); Kieffer 1926: 127, 130 (descrip-

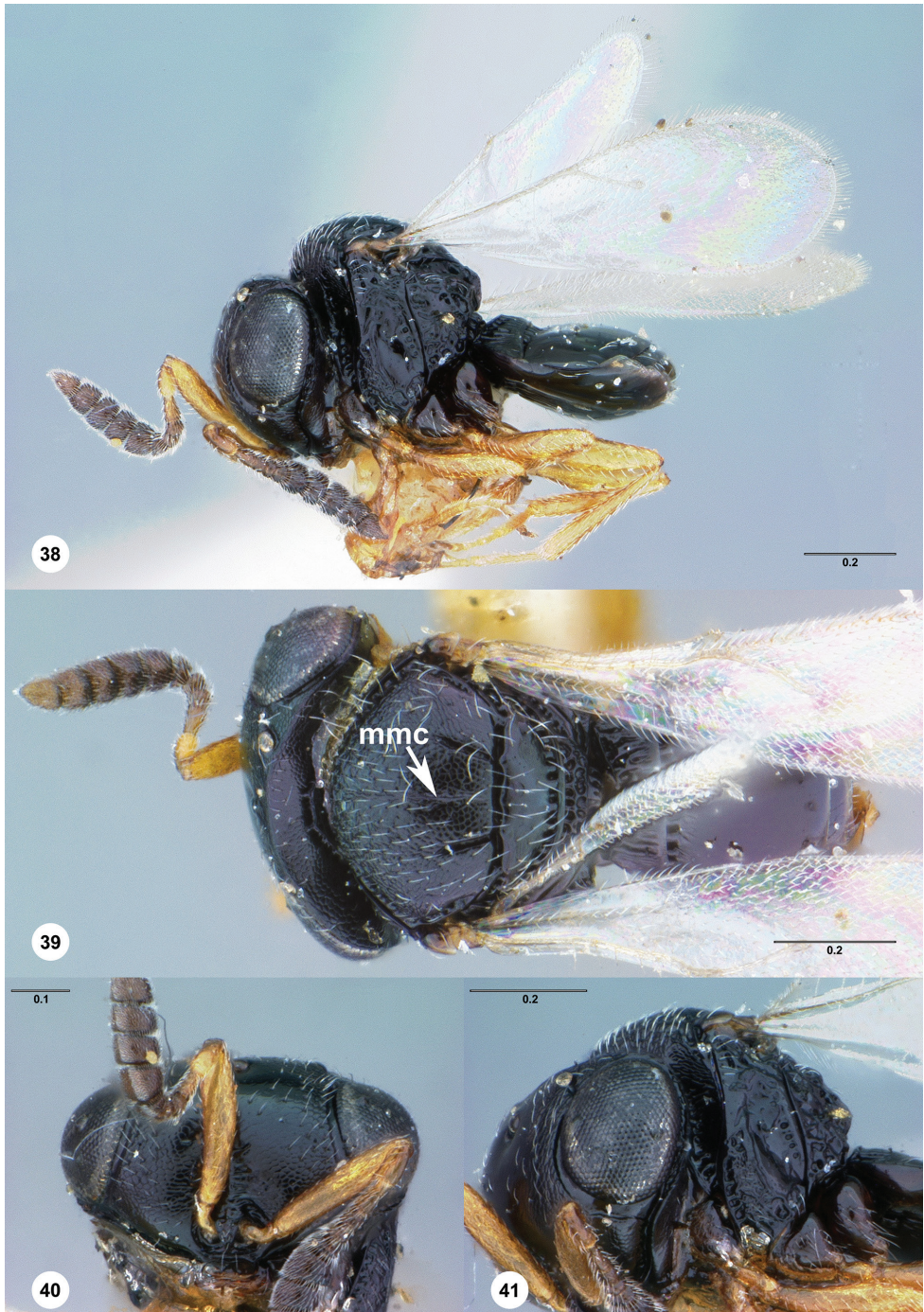
tion, keyed); Masner 1965: 126 (type information); Johnson 1983: 448 (lecto-type designation); Johnson 1987: 298 (junior synonym of *Trissolcus brochymenae* (Ashmead)).

**Neotype designation.** The last known examination of the lectotype of *T. brochymenae* was by Johnson (1984) in his revision of the *flavipes* species group. The specimen was returned to USNM intact but presently consists of a pin, labels, and an empty point. *Trissolcus brochymenae* is the type species of *Trissolcus* and we consider the designation of a neotype to be important for the stability of both the genus and species names. Additionally, *T. brochymenae* is a morphologically variable species with a geographic distribution that spans the United States. A case study of cryptic species within *Trissolcus* was recently presented by Matsuo et al. (2014) and a similar phenomenon may exist in other species, including *T. brochymenae*. *Trissolcus brochymenae* is morphologically very close to *T. euschisti*, separable by only a few characters, and in our opinion this increases the need for an objective neotype. The specimen selected for this purpose was originally a syntype, reared from the same egg mass as the lectotype and is consistent with Ashmead's original description and the most thorough treatment of the species (Johnson 1984). In accordance with article 75 of The Code we hereby designate specimen USNMENT00965611 (Figs 38–41) as the neotype of *Trissolcus brochymenae*, deposited in the insect collection of the National Museum of Natural History (USNM).

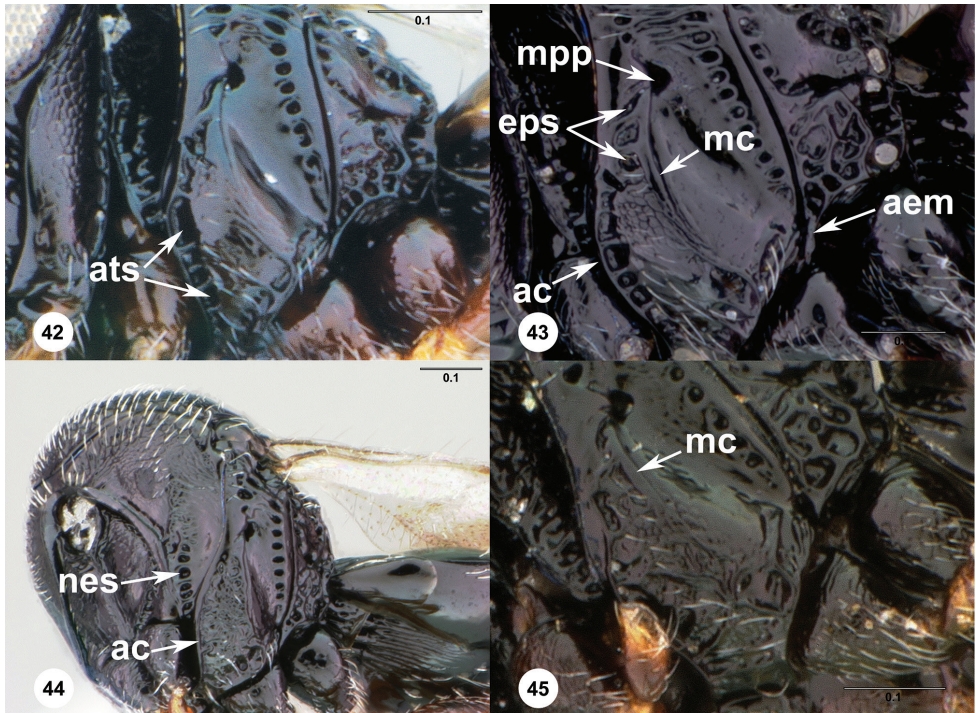
**Diagnosis.** *Trissolcus brochymenae* is most similar to *T. euschisti* and may be distinguished from it by the strongly rugulose ventral portion of the mesepisternum anterior to the mesopleural carina (Figs 44–45). This species is also similar to *T. euschisti* in that it shows a great deal of variability, presumably in association with its wide geographic distribution and host range.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3195>]

**Associations.** emerged from *Acrosternum bilare* (Say): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Acrosternum impicticorne* (Stål): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Brochymena arborea* (Say): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; collected on *Hydrangea* L.: [Rosales: Hydrangeaceae]; emerged from *Murgantia histrionica* (Hahn): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Murgantia histrionica* (Hahn): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Piezodorus guildini* (Westwood): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Piezodorus guildinii* (Westwood): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from sentinel egg mass of *Podisus maculiventris* (Say): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Podisus nigrolimbatus* (Spinola): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; collected on *Prosopis* L.: [Fabales: Fabaceae]; collected on cotton: [Malvales: Malvaceae]; collected on rose: [Rosales: Rosaceae]; collected on soybean: [Fabales: Fabaceae]; living in soybean: [Fabales: Fabaceae]; emerged from egg of stink bug: [Hemiptera: Heteroptera: Pentatomoidea:



**Figures 38–41.** <sup>30</sup> *Trissolcus brochymenae*, female neotype (USNMENT00954611) **38** lateral habitus **39** dorsal habitus **40** head, anterior view **41** head and mesosoma, anterolateral view. Scale bars in millimeters.



**Figures 42–45.**<sup>31</sup> **42** *T. euschisti* female (OSUC 523902), mesosoma, ventrolateral view **43** *T. euschisti* female (OSUC 404912), mesosoma, ventrolateral view **44** *T. brochymenae* (BMSB 1216), mesosoma, anterolateral view **45** *T. brochymenae* (USNMENT00896401), mesosoma, ventrolateral view. Scale bars in millimeters.

Pentatomidae]; collected on turnip greens: [Capparales: Brassicaceae]; collected on wax myrtle: [Myricales: Myricaceae]

**Material examined.** Neotype, female, *T. brochymenae*: **UNITED STATES**: FL, Duval Co., Jacksonville, no date, reared from egg, W. H. Ashmead, USNMENT00965611 (deposited in USNM). Lectotype, female, *T. laticeps*: **SAINT VINCENT AND THE GRENADINES**: Saint Vincent Island, no date, H. H. Smith, USNM Type No. 2526 (deposited in USNM). Lectotype, female, *T. murgantiae*: **UNITED STATES**: LA, East Baton Rouge Parish, Baton Rouge, no date, reared from egg, H. A. Morgan, USNMENT00989032 (deposited in USNM). Holotype, female, *T. rufiscapus*: **UNITED STATES**: Washington, 12.IV.1885, USNMENT00989047 (deposited in USNM). *Paralectotype*: **UNITED STATES**: 1 female, USNM Type No. 2231 PLT (USNM). *Other material*: (71 females, 2 males, 236 sex unrecorded) **BRAZIL**: 159 sex unrecorded, OSUC 398724–398725 (CNCI); OSUC 373344–373345, 495206–495305, 75445–75499 (OSUC). **COLOMBIA**: 1 sex unrecorded, OSUC 398719 (CNCI). **COSTA RICA**: 7 sex unrecorded, OSUC 398702–398703, 398714 (CNCI); OSUC 142482–142485 (OSUC). **DOMINICAN REPUBLIC**: 4 sex unrecorded, OSUC 398710–398712,



398716 (CNCI). **GUATEMALA:** 1 sex unrecorded, OSUC 398718 (CNCI). **HONDURAS:** 1 sex unrecorded, OSUC 398717 (CNCI). **JAMAICA:** 3 sex unrecorded, OSUC 398708–398709, 398713 (CNCI). **TRINIDAD AND TOBAGO:** 2 sex unrecorded, OSUC 398706–398707 (CNCI). **UNITED STATES:** 71 females, 2 males, 45 sex unrecorded, OSUC 17821 (BMNH); OSUC 398679–398688 (CNCI); OSUC 436701 (LACM); OSUC 145555, 157494–157503, 266797, 413700–413703, 413709–413713, 523852–523855, 523857–523861, 523864–523865, 523904–523923, 523931, 523933, 523935–523937, 523940, 523942, 523944, 542440, 542442, 542445, 542450, 542453–542454, 62796, 70464–70465, 75434–75444, 76425–76426 (OSUC); BMSB 1216–1217, OSUC 145648, USNMENT00872091, USNMENT00872092–USNMENT00872095, USNMENT00989146–USNMENT00989149, USNMENT00989160–USNMENT00989170, USNMENT00989173 (USNM). **VENEZUELA:** 5 sex unrecorded, OSUC 398704, 398720–398723 (CNCI). **VIRGIN ISLANDS:** 2 sex unrecorded, OSUC 398705, 398715 (CNCI).

### *Trissolcus cosmopeplae* (Gahan)

[http://bioguid.osu.edu/osuc\\_concepts:3206](http://bioguid.osu.edu/osuc_concepts:3206)

Figures 46–49; Morphbank<sup>4</sup>

*Telenomus cosmopeplae* Gahan, 1926: 67 (original description).

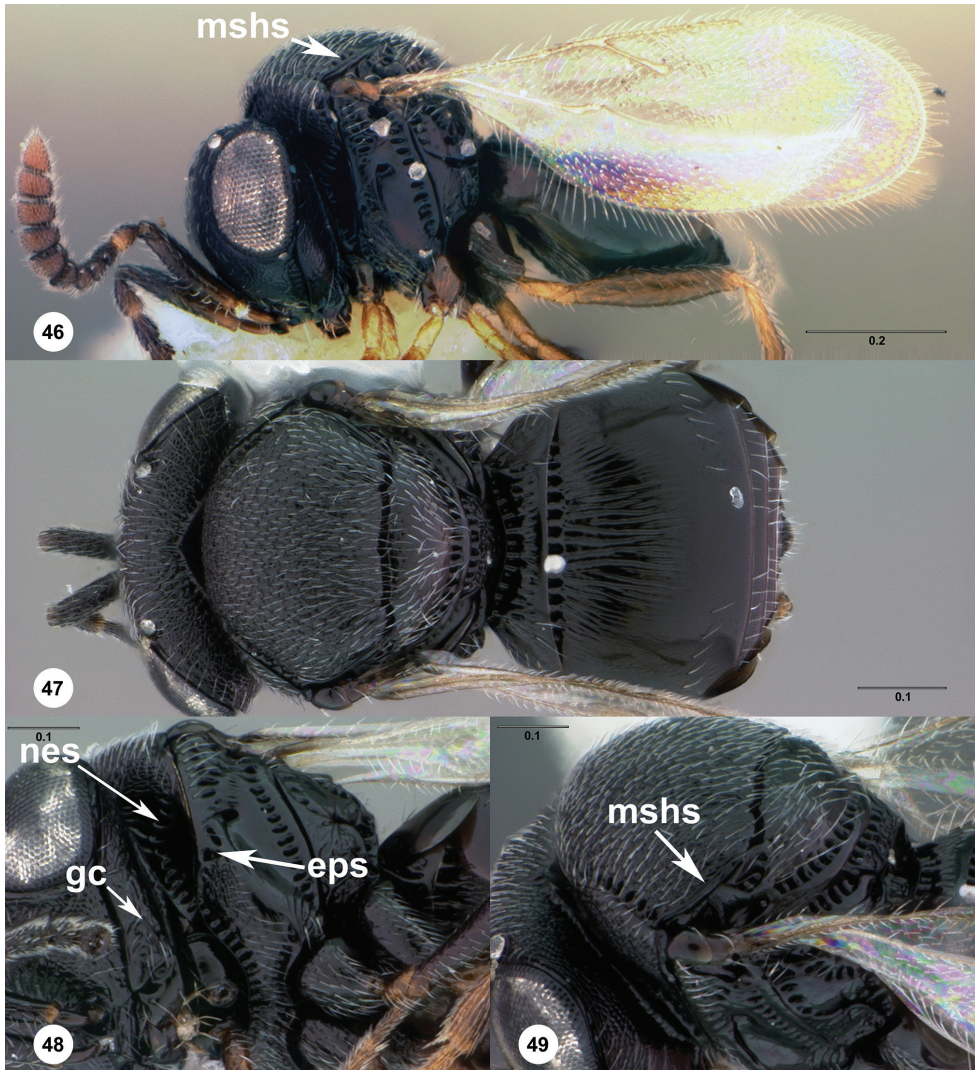
*Trissolcus cosmopeplae* (Gahan): Krombein and Burks 1967: 297 (generic transfer);

Masner and Muesebeck 1968: 72 (type information); Johnson 1985b: 432, 436 (description, keyed).

**Diagnosis.** *Trissolcus cosmopeplae* may be distinguished from other species that have sublateral setae and a narrow gena (*T. erugatus*, *T. hullensis*, *T. radix*, *T. solocis*, and *T. zakotos*) by the presence of extensive rugulae on T2 and the mesoscutellum without macrosculpture. This is also the only New World species outside the *thyantae* and *flavipes* groups in which notauli may be visible. All other species with sublateral setae and a narrow gena usually have the posterior region of the mesoscutum longitudinally rugulose and the notauli, if present, are thus obscured.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3206>]

**Associations.** Emerged from egg of *Cosmopepla bimaculata* (Thomas): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Euschistus conspersus* Uhler: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Pentatomidae*: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Perillus bioculatus* (Fabricius): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; collected on alfalfa: [Fabales: Fabaceae]; collected on bitterbrush: [Rosales: Rosaceae]; collected on blackberry: [Rosales: Rosaceae]; collected on brome: [Cyperales: Poaceae]; collected on red-osier dogwood: [Cornales: Cornaceae]



**Figures 46–49.**<sup>32</sup> *Trissolcus cosmopeplae* **46** female holotype (USNMENT00989096), head, mesosoma, metasoma, lateral view **47** female (OSUC 77129), head, mesosoma, metasoma, dorsal view **48** female (OSUC 77129), head and mesosoma, ventrolateral view **49** female (OSUC 77129), head and mesosoma, dorsolateral view. Scale bars in millimeters.

**Material examined.** Holotype, female, *T. cosmopeplae*: **UNITED STATES:** IL, Champaign Co., Urbana, 8.VIII.1925, reared from egg, USNMENT00989096 (deposited in USNM). *Other material:* (9 females, 1 male, 74 sex unrecorded) **CANADA:** 16 sex unrecorded, OSUC 145181, 398732–398743 (CNCI); OSUC 145556, 75612–75613 (OSUC). **UNITED STATES:** 9 females, 1 male, 58 sex unrecorded, OSUC 398744–398747 (CNCI); OSUC 413941, 75606–75611, 76429, 77122–77177 (OSUC).

***Trissolcus cultratus* (Mayr), comb. rev.**[http://bioguid.osu.edu/osuc\\_concepts:13182](http://bioguid.osu.edu/osuc_concepts:13182)Figures 19, 50–52, 54; Morphbank<sup>5</sup>

*Telenomus cultratus* Mayr, 1879: 699, 701, 703 (original description, keyed, synonymized by Kozlov (1968)); Kozlov 1968: 200 (junior synonym of *Trissolcus flavipes* (Thomson)).

*Aphanurus Cultratus* (Mayr): Kieffer 1912: 70 (description, generic transfer).

*Microphanurus cultratus* (Mayr): Kieffer 1926: 91, 95 (description, generic transfer, keyed); Nixon 1939: 130, 133 (description, keyed); Rjachovsky 1959: 83 (keyed).

*Asolcus cultratus* (Mayr): Masner 1959: 378 (diagnosis, variation); Delucchi 1961: 44, 51 (description, keyed).

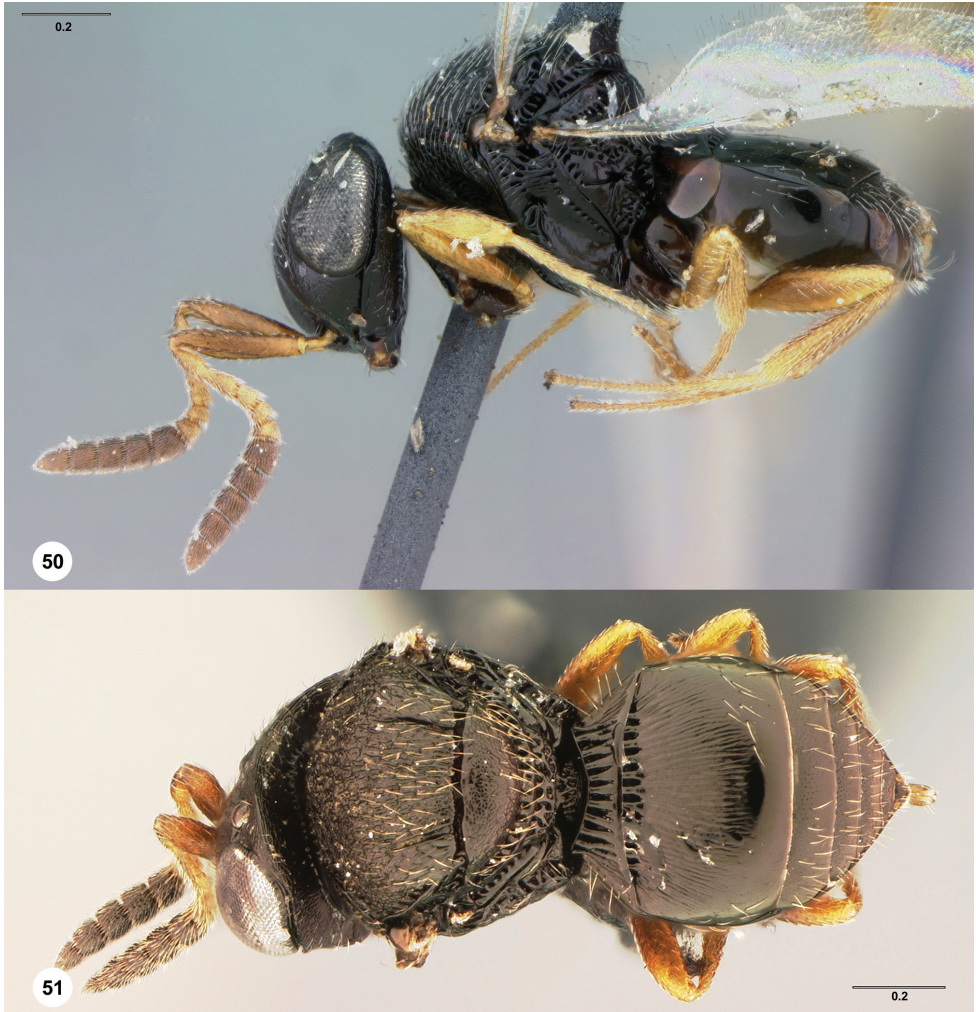
*Trissolcus cultratus* (Mayr): Safavi 1968: 414 (keyed); Szabó 1975: 266, 267 (description, lectotype designation, keyed).

**Diagnosis.** *Trissolcus cultratus* is easily distinguished from other members of the *flavipes* group treated here by the parallel arched rugae on the frons between the anterior ocellus and the antennal scrobe. This species also lacks a well-developed orbital furrow near the malar sulcus, and by this character it may be separated from *T. brochymenae*, *T. edessae*, *T. euschisti*, and *T. japonicus*.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=13182>]

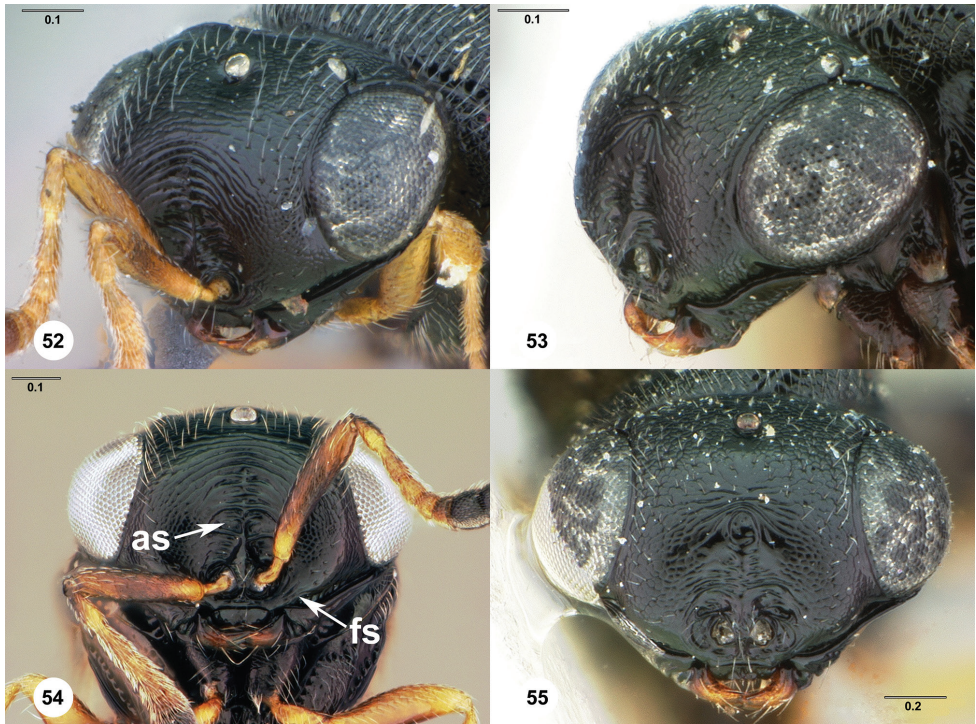
**Associations.** Emerged from egg of *Carpocoris pudicus* (Poda): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Eurygaster* Laporte: [Hemiptera: Heteroptera: Pentatomoidea: Scutelleridae]; collected near eggs of *Raphigaster nebulosa* (Poda): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Raphigaster nebulosa* (Poda): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; on leaf of maple: [Sapindales: Aceraceae]; collected near mulberry: [Urticales: Moraceae]

**Material examined.** Lectotype, female: *Other material:* (122 females, 13 males, 4 sex unrecorded) **AUSTRIA:** 5 females, 2 sex unrecorded, USNMENT00979612, USNMENT00979613 (CUIC); OSUC 75765–75767 (OSUC); USNMENT00675943, USNMENT00675944 (USNM). **CHINA:** 2 females, UCRC ENT 142635, 143817 (UCRC). **CZECH REPUBLIC:** 1 female, 3 males, USNMENT00896311, USNMENT00896312, USNMENT00896313, USNMENT00896314 (CNCI). **FRANCE:** 4 females, OSUC 75753–75756 (OSUC). **HUNGARY:** 3 females, 1 sex unrecorded, OSUC 75771–75773, 75783 (OSUC). **JAPAN:** 32 females, 5 males, OSUC 144472–144480, 542363, 542374, 542412, 542415, USNMENT00896136, USNMENT00896138, USNMENT00896140, USNMENT00896305, USNMENT00896307–USNMENT00896309, USNMENT00896315, USNMENT00896339, USNMENT00896341 (CNCI); OSUC 75784, 75786–75788 (OSUC); UCRC ENT 297012 (UCRC); USNMENT00675730–USNMENT00675737, USNMENT00764849 (USNM). **RUSSIA:** 34 females, USNMENT00896048, USNMENT00896049, USNMENT00896050–USNMENT00896054,



**Figures 50–51.** <sup>33</sup> *Trissolcus cultratus* **50** female lectotype (NHMW 0008A), head, mesosoma, metasoma, lateral view **51** female (USNMENT00764850), head, mesosoma, metasoma, dorsal view. Scale bars in millimeters.

USNMENT00896074, USNMENT00896075, USNMENT00979282–  
 USNMENT00979286, USNMENT00979289 (CNCI); UCRC ENT 110944, 110951,  
 110963, 110983, 110985, 110992, 111001–111003, 111009, 111011, 111066, 111078,  
 133622, 297001–297003, 297009, 297013 (UCRC). **SOUTH KOREA:** 29 females,  
 3 males, OSUC 144470–144471, USNMENT00896011, USNMENT00896015,  
 USNMENT00896016, USNMENT00896018, USNMENT00896019,  
 USNMENT00896029, USNMENT00896032, USNMENT00896044  
 – USNMENT00896046, USNMENT00896112, USNMENT00896113  
 – USNMENT00896116, USNMENT00896118, USNMENT00896119,  
 USNMENT00896121, USNMENT00896122, USNMENT00896134,



**Figures 52–55.**<sup>34</sup> **52** *T. cultratus*, female lectotype (NHMW 0008A), head, anterolateral view **53** *T. flavipes*, female lectotype (NHRS-HEVA 000002617), head, anterolateral view **54** *T. cultratus*, female (USNMENT00675734), head, anterior view **55** *T. flavipes*, female lectotype (NHRS-HEVA 000002617), head, anterior view. Scale bars in millimeters.

USNMENT00896135, USNMENT00896157, USNMENT00979237, USNMENT00979246–USNMENT00979250, USNMENT00979253, USNMENT00979280 (CNCI). **SWITZERLAND:** 4 females, 1 male, USNMENT00979222–USNMENT00979226 (CNCI). **TAIWAN:** 1 female, UCRC ENT 112210 (UCRC). **UNITED KINGDOM:** 1 female, USNMENT00916251 (BMNH).

**Comments.** Kozlov (1968) designated a lectotype for *T. flavipes* and simultaneously treated *T. cultratus* as a junior synonym. However, the concept of *T. flavipes* presented in the key and description of his publication was that of *T. cultratus*, and not of *T. flavipes*, which in our assessment is a distinctly different species; the two may easily be separated by the presence of parallel arched rugae on the frons of *T. cultratus*, contrasting with absence of large rugae and presence of a circular impression on the frons of *T. flavipes* (see Figs 52–55). The arched rugae on the frons of *T. cultratus* make the species particularly easy to identify, and the erroneous use of this character to identify *T. flavipes* was propagated throughout subsequent literature because Kozlov's treatment was followed, and the primary type of *T. cultratus* was not re-examined. An unfortunate consequence of this error is that undoubtedly most, if not all, specimens of *T. cultratus* and *T. flavipes* have been misidentified.

***Trissolcus edessae* Fouts**

[http://bioguid.osu.edu/osuc\\_concepts:3221](http://bioguid.osu.edu/osuc_concepts:3221)

Figures 56–59; Morphbank<sup>6</sup>

*Trissolcus edessae* Fouts, 1920: 65 (original description); Masner and Muesebeck 1968: 72 (type information); Johnson 1984: 799, 801 (description, keyed); Johnson 1987: 289, 300 (diagnosis, keyed).

**Diagnosis.** *Trissolcus edessae* may be distinguished from the native species of Nearctic *Trissolcus* in the *flavipes* group (*T. brochymenae*, *T. euschisti*, and *T. strabus*) by the abruptly bicolored female antennae. It may be separated from *T. japonicus* by the presence of 2 clypeal setae and the episternal foveae that do not form a continuous line from the postacetabular sulcus to the mesopleural pit. It may be separated from *T. cultratus* by the absence of parallel arched rugae on the frons. In *T. edessae* a median mesoscutal carina is often present, and this is absent in *T. cultratus* and *T. japonicus*.

Johnson (1984) used the absence of a mesopleural carina in *T. edessae* as a diagnostic character. Our examination included a specimen in which the mesopleural carina is present (Fig. 58) and thus we prefer not to use this character for identification. A result of this is that unambiguous identification of male specimens may require movement or removal of the wings to properly evaluate the surface sculpture within the axillar crescent.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3221>]

**Associations.** Emerged from egg of *Acrosternum hilare* (Say): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Edessa bifida* (Say): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; parasite of *Edessa bifida* (Say): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Euschistus* Dallas: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from *Pachycoris torridus* (Scopoli): [Hemiptera: Heteroptera: Pentatomoidea: Scutelleridae]

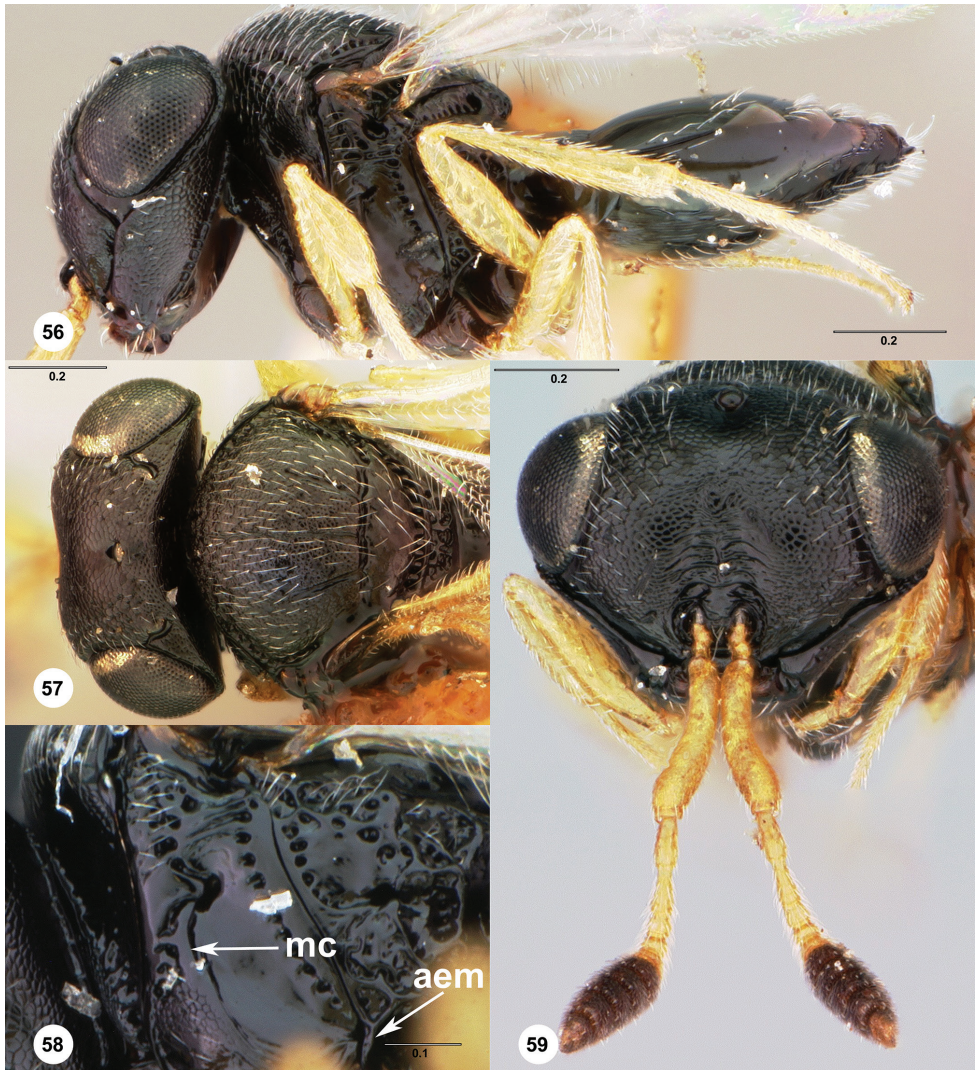
**Material examined.** Holotype, female: **UNITED STATES:** LA, Orleans Parish, New Orleans, 23.VII.1919, C. E. Smith, USNM00872412 (deposited in USNM). *Other material:* (2 females, 1 male, 29 sex unrecorded) **EL SALVADOR:** 3 sex unrecorded, USNM00764980, USNM00764981, USNM00764993 (USNM). **NICARAGUA:** 2 sex unrecorded, OSUC 398762–398763 (CNCI). **UNITED STATES:** 2 females, 1 male, 24 sex unrecorded, OSUC 17814 (BMNH); OSUC 398760–398761 (CNCI); OSUC 523872 (MEMU); OSUC 145559, 542444, 75617–75636 (OSUC); OSUC 145649 (USNM).

***Trissolcus erugatus* Johnson**

[http://bioguid.osu.edu/osuc\\_concepts:3228](http://bioguid.osu.edu/osuc_concepts:3228)

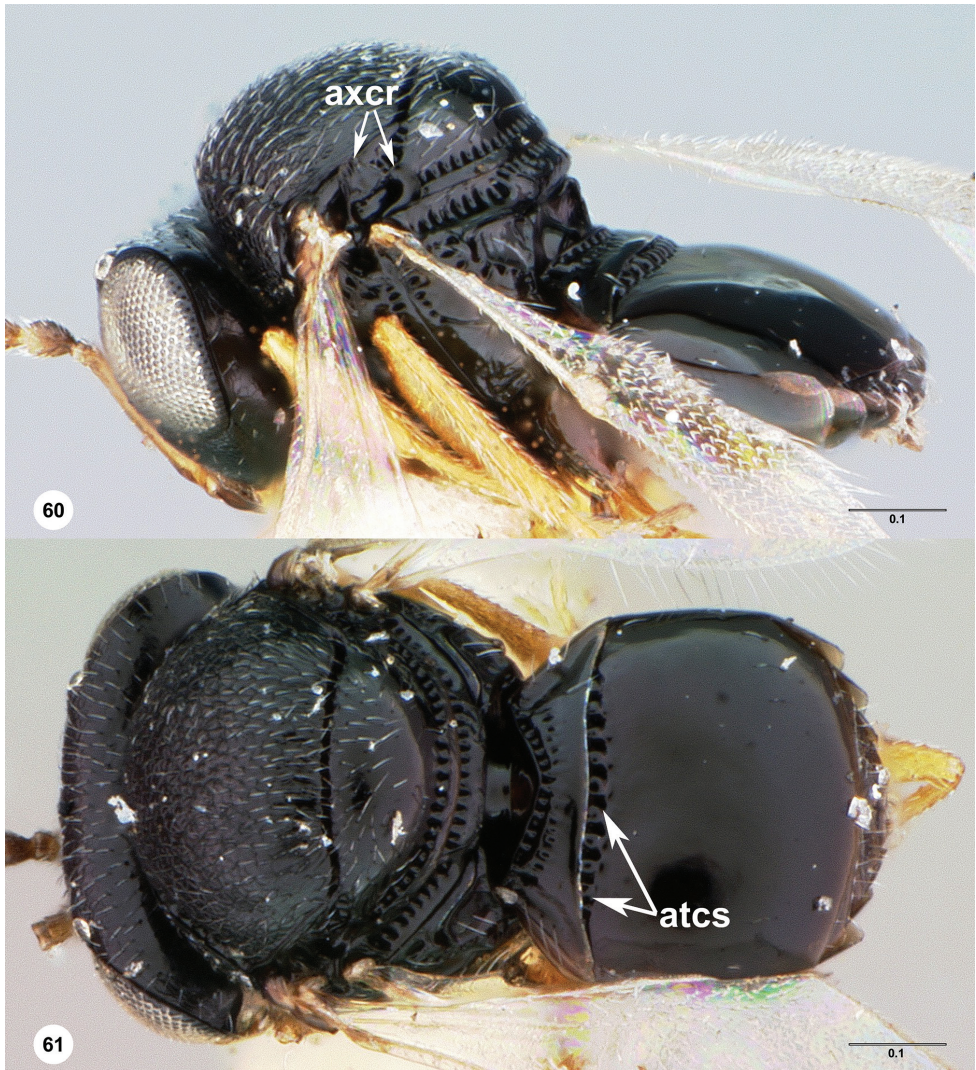
Figures 27, 60–61; Morphbank<sup>7</sup>

*Trissolcus erugatus* Johnson, 1985b: 433, 436 (original description, keyed); Sarazin 1986: 980 (type information).



**Figures 56–59.**<sup>35</sup> *Trissolcus edessae* **56** female holotype (USNMENT00872412) head, mesosoma, metasoma, lateral view **57** female holotype (USNMENT00872412) head, mesosoma, dorsal view **58** (USNMENT00764981), mesopleuron, metapleuron, lateral view **59** female holotype (USNMENT00872412), head, anterior view. Scale bars in millimeters.

**Diagnosis.** *Trissolcus erugatus* may be distinguished from the most common Southwestern species of *Trissolcus* discussed here, *T. utahensis*, by its strongly narrowed gena, angulate vertex, and the lack of rugulae on T2 (occasionally rugulae are present, but these are very short in comparison with those of *T. utahensis*). It may be distinguished from *T. hullensis* by the following characters: metapostnotum invaginated near metascutellum and separating metanotum from propodeum, anterior extension of metapleuron short, not reaching mesocoxa, mandibular teeth shallowly incised; mesopleural



**Figures 60–61.** <sup>36</sup> *Trissolcus erugatus* female paratype (USNMENT00903009) **60** head, mesosoma, metasoma, lateral view **61** head, mesosoma, metasoma, dorsal view. Scale bars in millimeters.

carina absent; legs and A1–A6 usually yellow. *Trissolcus cosmopeplae* may usually be separated from *T. erugatus* by the strong development of rugulae on T2 and the long anteroventral extension of the metapleuron toward the mesocoxa in the former species.

*Trissolcus erugatus* seems to be a rather isolated species within the New World fauna of the genus. The narrowed gena allies it with *T. hullensis*, *T. solocis*, *T. radix*, and *T. cosmopeplae*, but the condition of the metapostnotum, mandibular teeth, and metapleural extension usually distinguish it quite clearly. Specimens from the Southwest are easily identifiable, but variation in color and sculpture in the northern part of its range may result in confusion between this species and *T. cosmopeplae*.



**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3228>]

**Associations.** collected on *Larrea tridentata* (Sessé & Moc. ex DC.) Coville: [Sapindales: Zygophyllaceae]; emerged from egg of *Thyanta custator* (Fabricius): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; collected on alfalfa: [Fabales: Fabaceae]; collected on lodgepole pine: [Pinales: Pinaceae]

**Material examined.** *Paratypes*: (1 female, 1 male, 11 sex unrecorded) **CANADA**: 1 female, OSUC 17813 (BMNH). **UNITED STATES**: 1 male, 11 sex unrecorded, OSUC 398779–398780 (CNCI); OSUC 77860–77862 (MSWC); OSUC 145560, 75668–75672 (OSUC); USNMENT00903009 (USNM). *Other material*: (3 females, 2 males, 9 sex unrecorded) **CANADA**: 4 sex unrecorded, OSUC 398784–398787 (CNCI). **UNITED STATES**: 3 females, 2 males, 5 sex unrecorded, OSUC 398781–398783, 398788 (CNCI); OSUC 436700 (LACM); OSUC 413943, 523926–523927, 523929, 75667 (OSUC).

### *Trissolcus euschisti* (Ashmead)

[http://bioguid.osu.edu/osuc\\_concepts:3232](http://bioguid.osu.edu/osuc_concepts:3232)

Figures 12, 20, 28, 42–43, 62–65; Morphbank<sup>8</sup>

*Telenomus euschristus* Ashmead, 1888: ii (original description, spelling error).

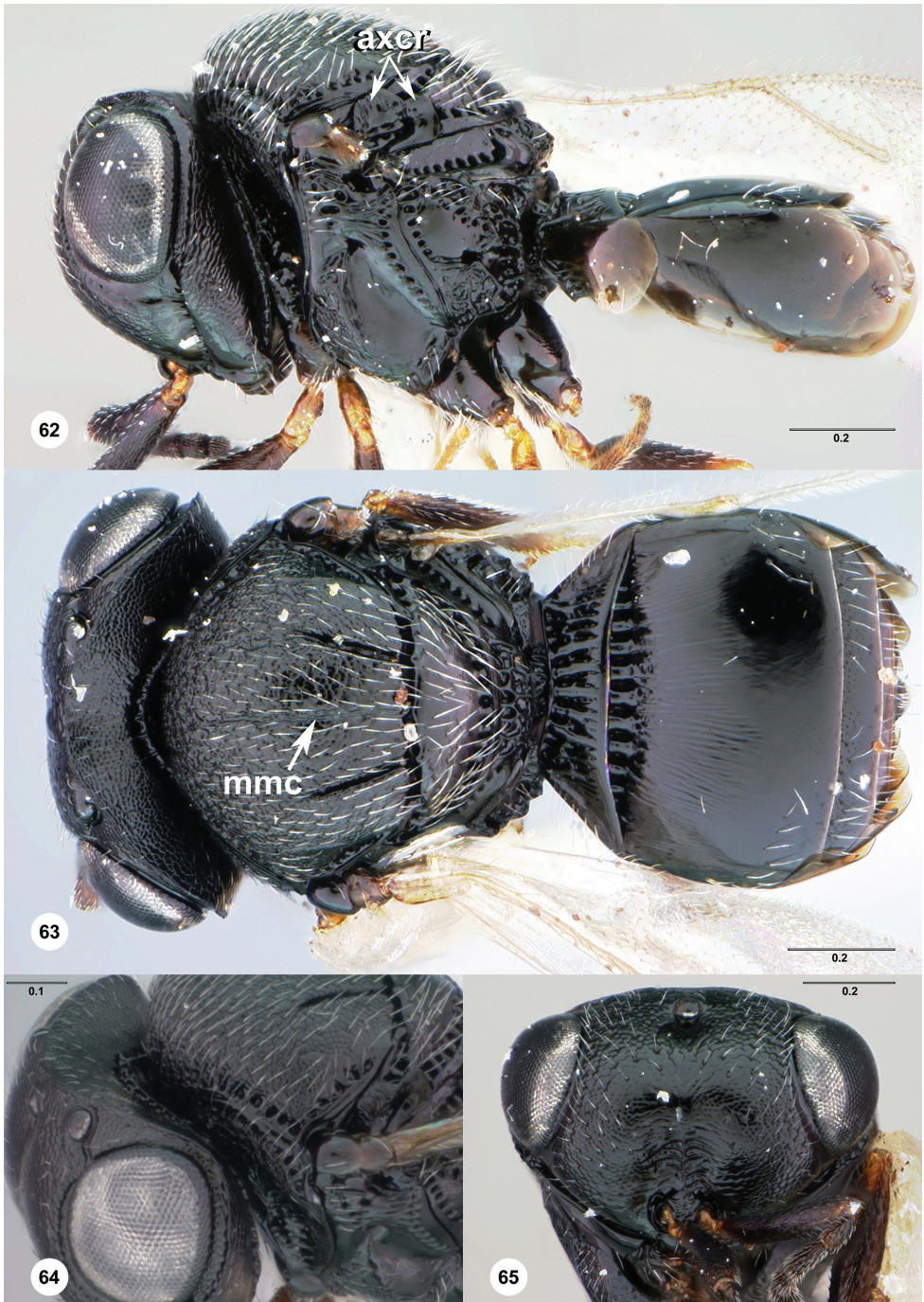
*Trissolcus euschisti* (Ashmead): Ashmead 1893: 161, 162 (emendation, description, generic transfer, keyed); Harrington 1900: 183 (variation); Brues 1916: 549, 550 (description, keyed); Kieffer 1926: 127, 129 (description, keyed); Johnson 1984: 799, 801 (lectotype designation, synonymy, description, keyed); Johnson 1987: 289, 301 (diagnosis, keyed).

*Trissolcus podisi* Ashmead, 1893: 161, 162 (original description, keyed, synonymized by Johnson (1984)); Brues 1916: 550 (description, keyed); Kieffer 1926: 127, 129 (description, keyed); Masner and Muesebeck 1968: 73 (lectotype designation); Johnson 1984: 801 (junior synonym of *Trissolcus euschisti* (Ashmead)).

*Trissolcus rufitarsis* Kieffer, 1906: 262 (original description, synonymized by Johnson (1984)); Kieffer 1926: 127, 128 (description, keyed); Hoebeke 1980: 27 (type information); Johnson 1984: 801, 803 (lectotype designation, junior synonym of *Trissolcus euschisti* (Ashmead)); Zuparko and Hamai 1994: 314 (type information).

*Trissolcus euschisti* (Ashmead): Brues 1908: 11 (emendation); Golin, Loiácono, Margaría and Aquino 2011: 618 (host association).

**Diagnosis.** *Trissolcus euschisti* may be distinguished from the similar *T. brochymenae* by the smooth or shallowly impressed sculpture on the ventral portion of the mesopleuron anterior to the mesopleural carina. The smaller specimens of *T. euschisti* are often quite distinct from the larger ones in the following characters: number of lateral setae on T1, extent of fine wrinkles on T2, extent of rugae on S2, extent of S1 setation, number of setae on the mesopleuron above the mesocoxa, sculpture of the upper



**Figures 62–65.** <sup>37</sup> *Trissolcus euschisti* **62** female (USNMENT00872098), head, mesosoma, metasoma, lateral view. **63** female (USNMENT00872098), head, mesosoma, metasoma, dorsal view **64** female (OSUC 334007), head and mesosoma, dorsolateral view **65** female (USNMENT00872098), head, anterior view. Scale bars in millimeters.

portion of the frons, extent of transverse striae within the antennal scrobe, and the presence of a shallow groove below the anterior ocellus.

The separation of *T. euschisti* and *T. brochymenae* may be difficult with specimens that exhibit an intermediate state of faint rugosity on the anteroventral mesopleuron. These specimens are not common in our experience and the situation reflects the need for molecular data to further test the hypotheses of species delimitation presented here and in the revisions of Nearctic *Trissolcus* by Johnson (1984, 1985a,b).

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3232>]

**Associations.** Collected on *Acer saccharum* Marshall: [Sapindales: Aceraceae]; emerged from egg of *Acrosternum hilare* (Say): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; on leaf of *Catalpa* Scop.: [Scrophulariales: Bignoniaceae]; emerged from egg of *Edessa mediatubunda* (Fabricius): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of / host egg of *Euschistus* Dallas: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Euschistus conspersus* Uhler: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Pentatomidae*: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of / host egg of *Pentatomidae*: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; unspecified association *Pentatomidae*: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Podisus maculiventris* (Say): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from sentinel egg mass of *Podisus maculiventris* (Say): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; parasite of *Podisus maculiventris* (Say): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; unspecified association *Podisus maculiventris* (Say): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Podisus serieiventris* Uhler: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Podisus spinosus* (Dallas): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; collected on *Quercus agrifolia* Nee.: [Fagales: Fagaceae]; emerged from sentinel egg mass of *Thyanta accerra custator* (Fabricius): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; collected on alder: [Fagales: Betulaceae]; on young maple: [Sapindales: Aceraceae]; collected on pecan: [Juglandales: Juglandaceae]; collected on red pine: [Pinales: Pinaceae]; collected on wax myrtle: [Myricales: Myricaceae]

**Material examined.** Lectotype, female, *T. euschistus*: **UNITED STATES**: Riley Co., VI, Marlatt, OSUC 256926 (deposited in OSUC). Lectotype, female, *T. rufitarsis*: **UNITED STATES**: Ormsby Co., VII, Baker, Cornell U. No. 388.1 (deposited in CUIC). Lectotype, female, *T. rufitarsis*: **UNITED STATES**: Ormsby Co., VII, Baker, USNMENT00979614 (deposited in CUIC). Lectotype, female, *T. podisi*: **UNITED STATES**: PA, Philadelphia Co., Philadelphia, no date, Cresson, USNMENT00989033 (deposited in USNM). **Paratypes**: **UNITED STATES**: 2 sex unrecorded, OSUC 398789, 398823 (CNCI). **Other material**: (71 females, 10 males, 243 sex unrecorded) **BRAZIL**: 3 sex unrecorded, OSUC 75746–75748 (OSUC). **CANADA**: 1 female, 1 male, 32 sex unrecorded, OSUC 145426–145427, 398793–398798, 398800–398803, 398805–398817, 398836–398840, 398844–398847 (CNCI). **FRENCH GUIANA**:

1 sex unrecorded, OSUC 248138 (OSUC). **MEXICO:** 1 sex unrecorded, OSUC 75745 (OSUC). **NORTH AMERICA:** 1 female, OSUC 398799 (CNCI). **UNITED STATES:** 69 females, 9 males, 201 sex unrecorded, OSUC 17808 (BMNH); OSUC 145178, 145409–145410, 398790–398792, 398818–398822, 398824–398835, 398841–398843 (CNCI); USNMENT00979600, USNMENT00979603, USNMENT00979605 (CUIC); OSUC 436702 (LACM); OSUC 523870–523871, 523874 (MEMU); OSUC 145411–145418, 145421–145425 (MSWC); IRREC 1794, IRREC834, OSUC 143837, OSUC 143838–OSUC 143850, OSUC 145177, OSUC 145561, OSUC 157488–OSUC 157493, OSUC 181546, OSUC 248134, OSUC 248139, OSUC 334007, OSUC 402728, OSUC 404912, OSUC 409995, OSUC 413680, OSUC 413681, OSUC 413682–OSUC 413699, OSUC 413729–OSUC 413748, OSUC 413940, OSUC 523862, OSUC 523863, OSUC 523866–OSUC 523868, OSUC 523883–OSUC 523903, OSUC 523924, OSUC 523928, OSUC 523934, OSUC 523939, OSUC 523941, OSUC 542439, OSUC 542441, OSUC 542443, OSUC 70463, OSUC 75678–OSUC 77202, OSUC 79805 (OSUC); OSUC 145419–145420 (UCRC); BMSB 1218, 1220–1230, 1232, OSUC 523851, USNMENT00872096–USNMENT00872102, USNMENT00989171, USNMENT00989172, USNMENT00989174–USNMENT00989179 (USNM).

### *Trissolcus hullensis* (Harrington)

[http://bioguid.osu.edu/osuc\\_concepts:3244](http://bioguid.osu.edu/osuc_concepts:3244)

Figures 22, 24, 66–67; Morphbank<sup>9</sup>

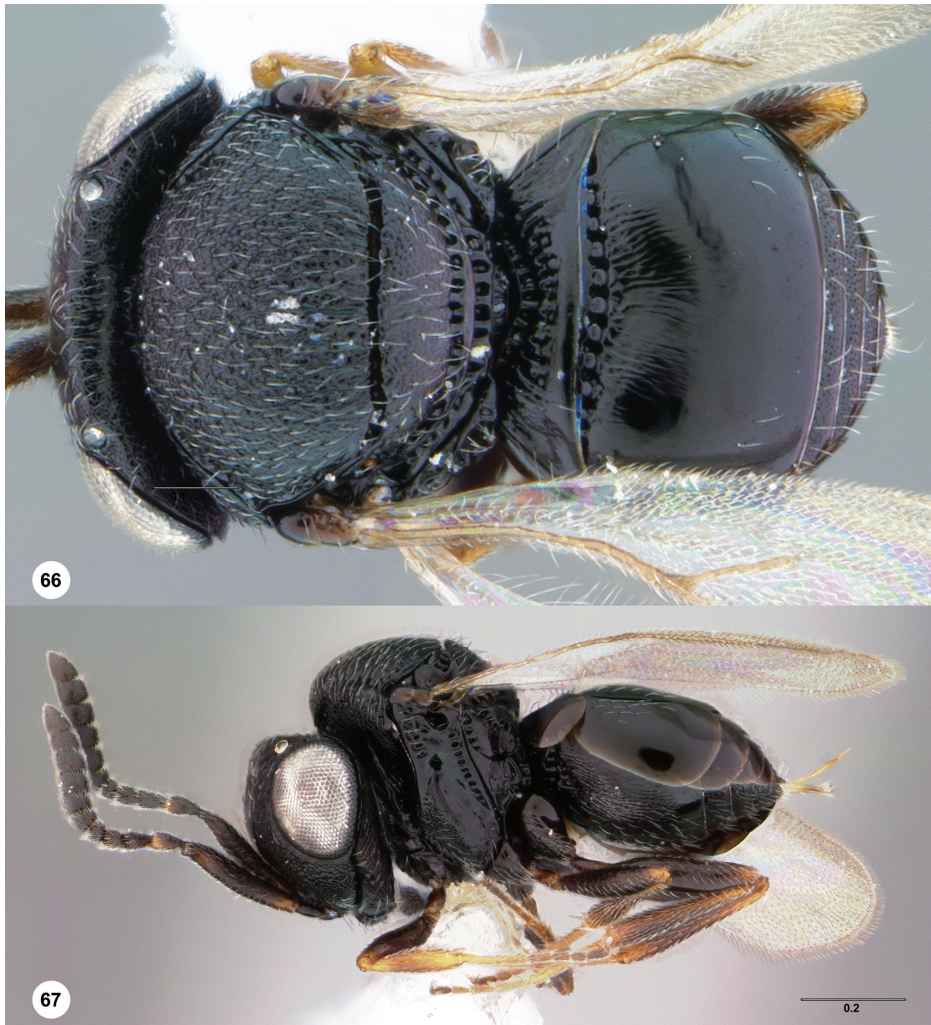
*Telenomus hullensis* Harrington, 1900: 182 (original description); Kieffer 1926: 27, 40 (description, keyed).

*Trissolcus hullensis* (Harrington): Johnson 1984: 10 (generic transfer); Johnson 1985b: 433, 438 (description, keyed); Sarazin 1986: 981 (type information).

**Diagnosis.** *Trissolcus hullensis* is most closely related to *T. solocis*, *T. radix* and *T. zakotos*. *Trissolcus hullensis* may be distinguished from these by the anteriorly invaginated metapostnotum. Additional characters useful for identification are: the paracoxal sulcus in the ventral half of the metapleuron, absent in *T. hullensis*, present in *T. radix* and *T. zakotos*; sculpture of the mesoscutellum, coriaceous or smooth in southern specimens of *T. hullensis*, coarsely areolate in *T. solocis* and *T. radix*; the color of the radicle, black in *T. hullensis*, *T. zakotos* and *T. solocis*, yellow in *T. radix*; and the rounded vertex, sharply angled in *T. radix* and *T. solocis*.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3244>]

**Associations.** Emerged from *Euschistus servus* (Say): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Pentatomidae*: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Podisus maculiventris* (Say): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from *Recurvaria milleri* Busck: [Lepidoptera: Glossata: Gelechioidea: Gelechiidae].



**Figures 66–67.**<sup>38</sup> *Trissolcus hullensis* **66** female (OSUC 523881), head, mesosoma, metasoma, dorsal view **67** female (USNMENT00903008), head, mesosoma, metasoma, lateral view. Scale bars in millimeters.

**Material examined.** *Non-type:* **UNITED STATES:** 1 female, OSUC 266782 (OSUC). *Other material:* (17 females, 1 male, 64 sex unrecorded) **CANADA:** 1 female, 5 sex unrecorded, OSUC 17815 (BMNH); OSUC 145179, 145392–145393, 398853 (CNCI); OSUC 75837 (OSUC). **MEXICO:** 11 sex unrecorded, OSUC 398854 (CNCI); OSUC 77870–77877 (MSWC); OSUC 75838–75839 (OSUC). **UNITED STATES:** 16 females, 1 male, 48 sex unrecorded, OSUC 145391, 398855–398857, 542438 (CNCI); OSUC 523873, 523875–523882 (MEMU); OSUC 77865–77869 (MSWC); OSUC 142487–142491, 143851, 145369–145373, 145389, 145562, 523856, 523946, 542456, 62453, 70529, 75826–75836, 76427–76428 (OSUC); OSUC 145374–145378, 145380–145388, 145390 (UCRC).

***Trissolcus japonicus* (Ashmead)**

[http://bioguid.osu.edu/osuc\\_concepts:3249](http://bioguid.osu.edu/osuc_concepts:3249)

Figures 17, 21, 25, 68–71; Morphbank<sup>10</sup>

*Dissolcus japonicus* Ashmead, 1904: 73 (original description); Kieffer 1926: 124, 125 (description, keyed).

*Trissolcus japonicus* (Ashmead): Masner and Muesebeck 1968: 72 (type information, generic transfer); Hirashima and Yamagishi 1981: 153 (description, synonymy); Ryu and Hirashima 1984: 37, 43 (description, keyed); Talamas, Buffington and Hoelmer 2013: 114 (description, synonymy, type information).

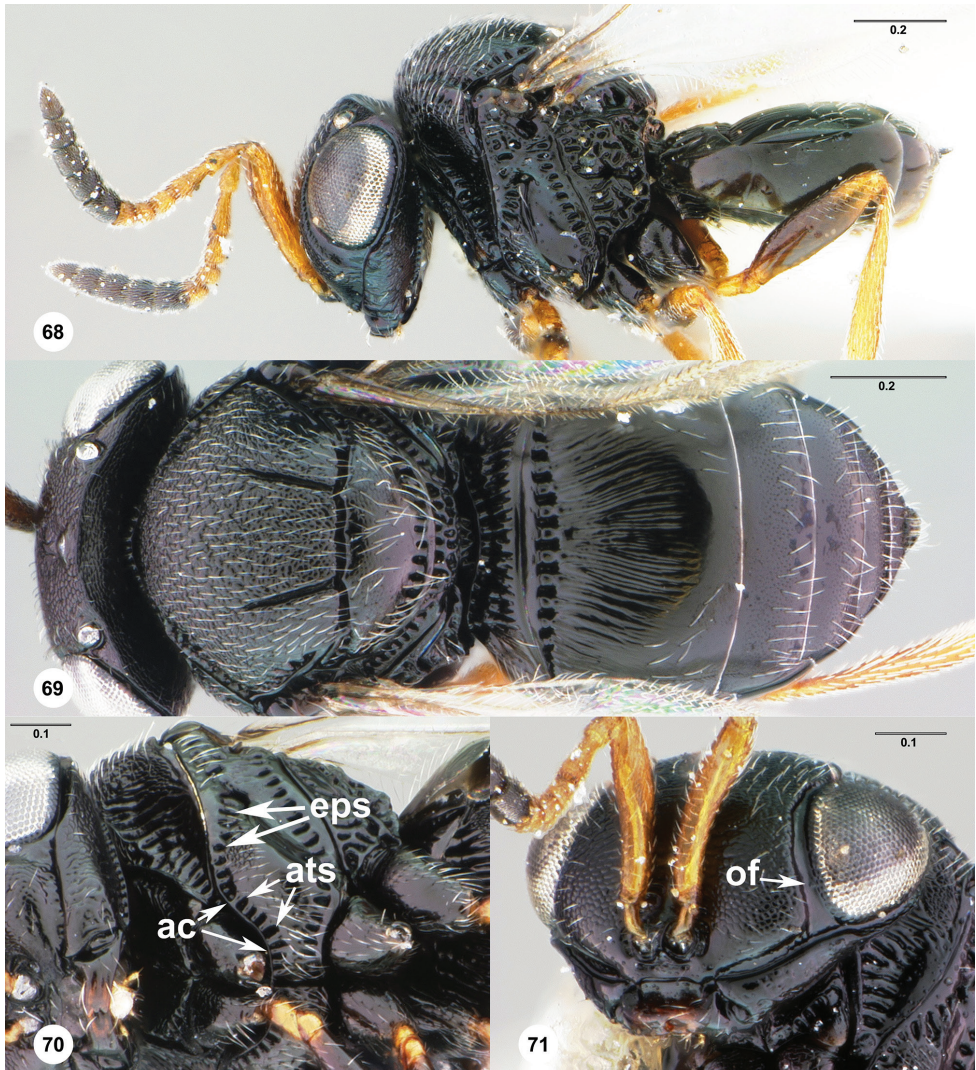
*Trissolcus halyomorphae* Yang: Qiu, Yang and Tao 2007: 62 (unavailable: nomen nudum); Yang, Yao, Qiu and Li 2009: 40 (original description); Talamas, Buffington and Hoelmer 2013: 114 (junior synonym of *Trissolcus japonicus* (Ashmead)).

**Diagnosis.** As previous authors have stated (Yang et al. 2009), *T. japonicus* belongs to the *flavipes* species group, first recognized by Kozlov and Lê (1976) and refined by Johnson (1984). *Trissolcus japonicus* may be separated from other species of the *flavipes* group *Trissolcus* in the Nearctic by the following characters: orbital furrow expanded near intersection with malar sulcus; postacetabular and mesopleural epicoxal sulci formed by lines of closed cells (Fig. 70); episternal foveae extending from dorsal apex of postacetabular carina to mesopleural pit (Fig. 68); 4 clypeal setae (Fig. 25).

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3249>]

**Associations.** Emerged from egg of *Halyomorpha halys* (Stål): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from *Plautia stali* Scott: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; collected on mulberry: [Urticales: Moraceae]; emerged from stink bug: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of stink bug: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]

**Material examined.** Holotype, female, *D. japonicus*: **JAPAN**: Kanagawa Pref., Ashigarashimo Dist., Hakone Town, no date, Koebele, USNMMENT00831865 (deposited in USNM). *Paratypes*: **CHINA**: 2 females, USNMMENT00872401, USNMMENT00872402 (USNM). *Other material*: (44 females, 16 males, 12 sex unrecorded) **CHINA**: 32 females, 11 males, 1 sex unrecorded, USNMMENT00979190, USNMMENT00979191, USNMMENT00979192–USNMMENT00979198, USNMMENT00979200, USNMMENT00979201–USNMMENT00979221 (CNCI); USNMMENT00675704, USNMMENT00675738, USNMMENT00675739, USNMMENT00675743, USNMMENT00675747, USNMMENT00675925, USNMMENT00764940, USNMMENT00764941, USNMMENT00764944, USNMMENT00764948, USNMMENT00764949, USNMMENT00764984, USNMMENT00916255 (USNM). **JAPAN**: 8 females, 4 males, 10 sex unrecorded, OSUC 144481–144482, 398858, USNMMENT00896340 (CNCI); OSUC 145632, 75843–75848 (OSUC); US-



**Figures 68–71.** <sup>39</sup> *Trissolcus japonicus* **68** female (USNMENT00872402), head, mesosoma, metasoma, lateral view **69** female (USNMENT00675989), head, mesosoma, metasoma, dorsal view **70** female (USNMENT00675989), head, mesosoma, ventral view **71** female (USNMENT00872402), head, anterolateral view. Scale bars in millimeters.

USNMENT00675755, USNMENT00675770, USNMENT00872125–USNMENT00872133 (USNM). **RUSSIA:** 1 female, USNMENT00979287 (CNCI). **SOUTH KOREA:** 3 females, 1 male, USNMENT00979251, USNMENT00979254 (CNCI); USNMENT00675705, USNMENT00675708 (USNM).

***Trissolcus occiduus* Johnson**

[http://bioguid.osu.edu/osuc\\_concepts:3275](http://bioguid.osu.edu/osuc_concepts:3275)

Figures 18, 34, 72–75; Morphbank<sup>11</sup>

*Trissolcus occiduus* Johnson, 1985a: 109, 111 (original description, keyed).

**Diagnosis.** This species may be distinguished from other species in the *thyantae* group by the expanded gena. It may also be separated from *T. thyantae* by the complete mesopleural carina, and from *T. parma* and *T. ruidus* by the entirely smooth mesoscutellum and absence of a genal carina.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3275>]

**Associations.** Collected on *Abronia maritima* Nutt. ex S. Watson: [Caryophyllales: Nyctaginaceae]; emerged from egg of *Chlorochroa norlandorum* Buxton & Thomas: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Chlorochroa sayi* (Stål): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from *Pentatoma sayii* (Stål): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]

**Material examined.** Holotype, female: **UNITED STATES:** CA, Ventura Co., area 2, Point Mugu Naval Air Station, 31.VII–24.VIII.1981, C. D. Nagano & J. N. Hogue, CNCI 0004 (deposited in CNCI). *Paratypes:* **UNITED STATES:** 4 females, 5 sex unrecorded, OSUC 17811 (BMNH); OSUC 145180 (CNCI); OSUC 143814 (LACM); OSUC 77864 (MSWC); OSUC 145564, 76216–76217 (OSUC); USNMENT00764995, USNMENT00877675 (USNM). *Other material:* **UNITED STATES:** 3 females, 1 male, 1 sex unrecorded, OSUC 145365, 76430 (OSUC); USNMENT00954754, USNMENT00979294, USNMENT00979295 (USNM).

***Trissolcus parma* Johnson**

[http://bioguid.osu.edu/osuc\\_concepts:3284](http://bioguid.osu.edu/osuc_concepts:3284)

Figures 76–79; Morphbank<sup>12</sup>

*Trissolcus parma* Johnson, 1985a: 110, 111 (original description, keyed); Sarazin 1986: 981 (type information).

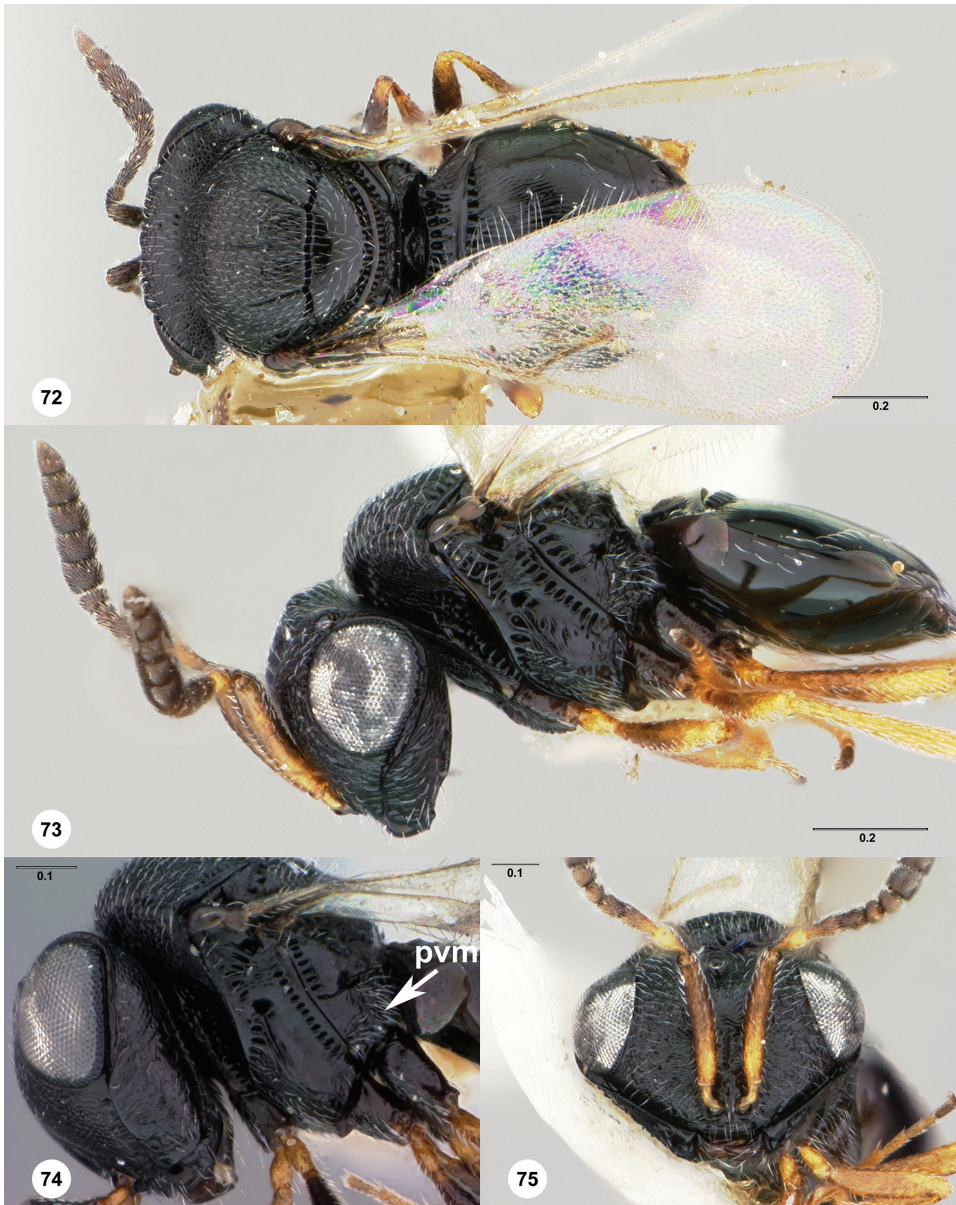
**Diagnosis.** *Trissolcus parma* may be distinguished from *T. ruidus* by the lack of rugulae outside of the antennal scrobe and the lack of longitudinal elements in the sculpture of the posterior portion of the mesoscutum. It may be separated from the other members of the *thyantae* group by the presence of microsculpture on the mesoscutellum.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3284>]

**Associations.** Collected on *Medicago sativa* L.: [Fabales: Fabaceae]; collected under *Vaccinium uliginosum* L.: [Ericales: Ericaceae]

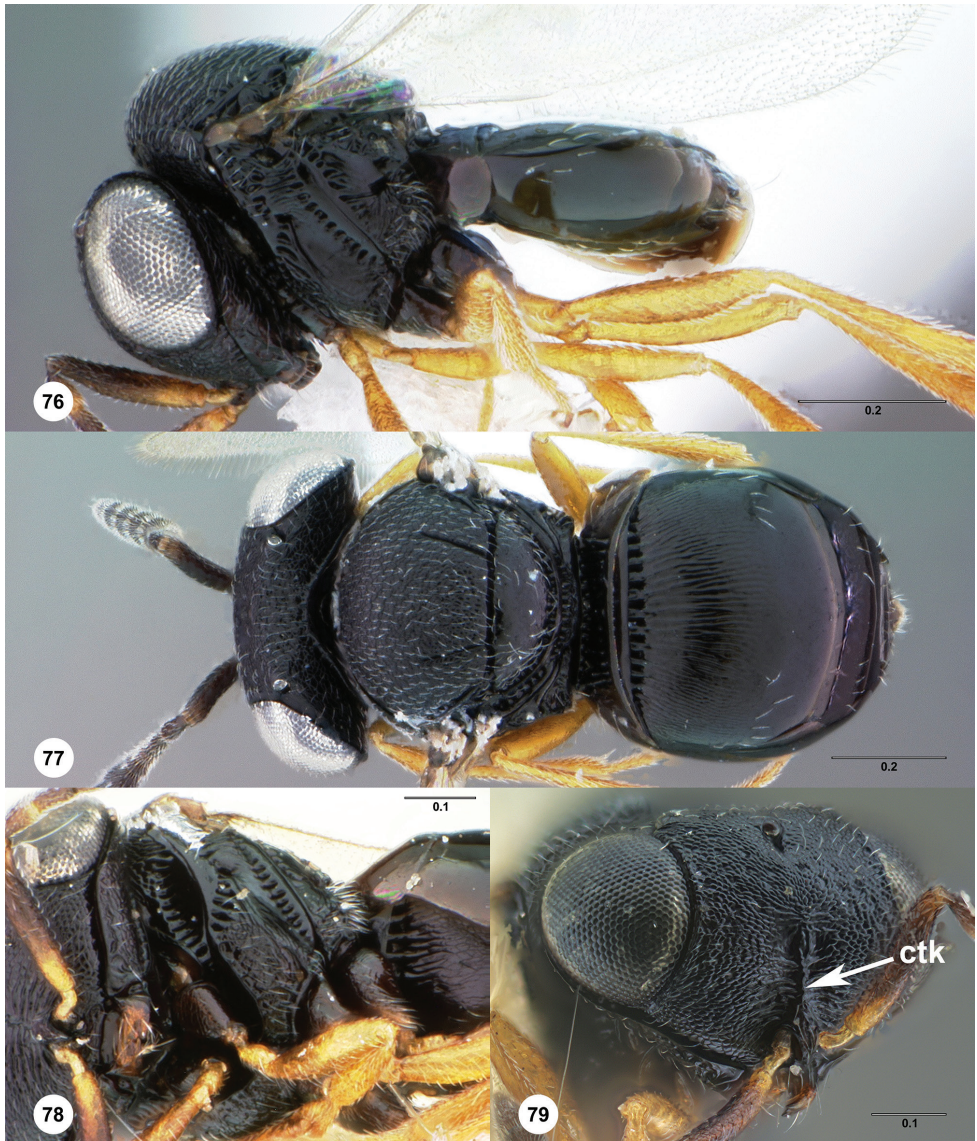
**Material examined.** Holotype, female: **CANADA:** AB, Scandia, 2.VII.1956, sweeping, O. Peck, CNC No. 18339 (deposited in CNCI). *Paratypes:* (1 female, 1 male, 1 sex unrecorded) **CANADA:** 1 female, 1 sex unrecorded, OSUC 17809 (BMNH);





**Figures 72–75.** <sup>40</sup> *Trissolcus occiduus* **72** female (USNMENT00877675), head, mesosoma, metasoma, dorsal view **73** female (USNMENT00764995), head, mesosoma, metasoma, lateral view **74** female (OSUC 76126), head and mesosoma, lateral view **75** female (USNMENT00764995), head, anterior view. Scale bars in millimeters.

OSUC 145565 (OSUC). **UNITED STATES:** 1 male, USNMENT00764990 (USNM). *Other material:* (2 females) **CANADA:** 1 female, OSUC 76264 (OSUC). **UNITED STATES:** 1 female, OSUC 62481 (OSUC).



**Figures 76–79.** <sup>41</sup> *Trissolcus parma* **76** female (OSUC 76432), head, mesosoma, metasoma, lateral view **77** female (OSUC 62481), head, mesosoma, metasoma, dorsal view **78** female (USNMENT00765990), head and mesosoma, ventral view **79** female (USNMENT00765990), head, anterior view. Scale bars in millimeters.



**Figure 80.** <sup>42</sup> *Trissolcus radix* female (USNMENT00764955), head, mesosoma, metasoma, lateral view. Scale bar in millimeters.

***Trissolcus radix* Johnson**

[http://bioguid.osu.edu/osuc\\_concepts:3295](http://bioguid.osu.edu/osuc_concepts:3295)

Figures 80–83; Morphbank<sup>13</sup>

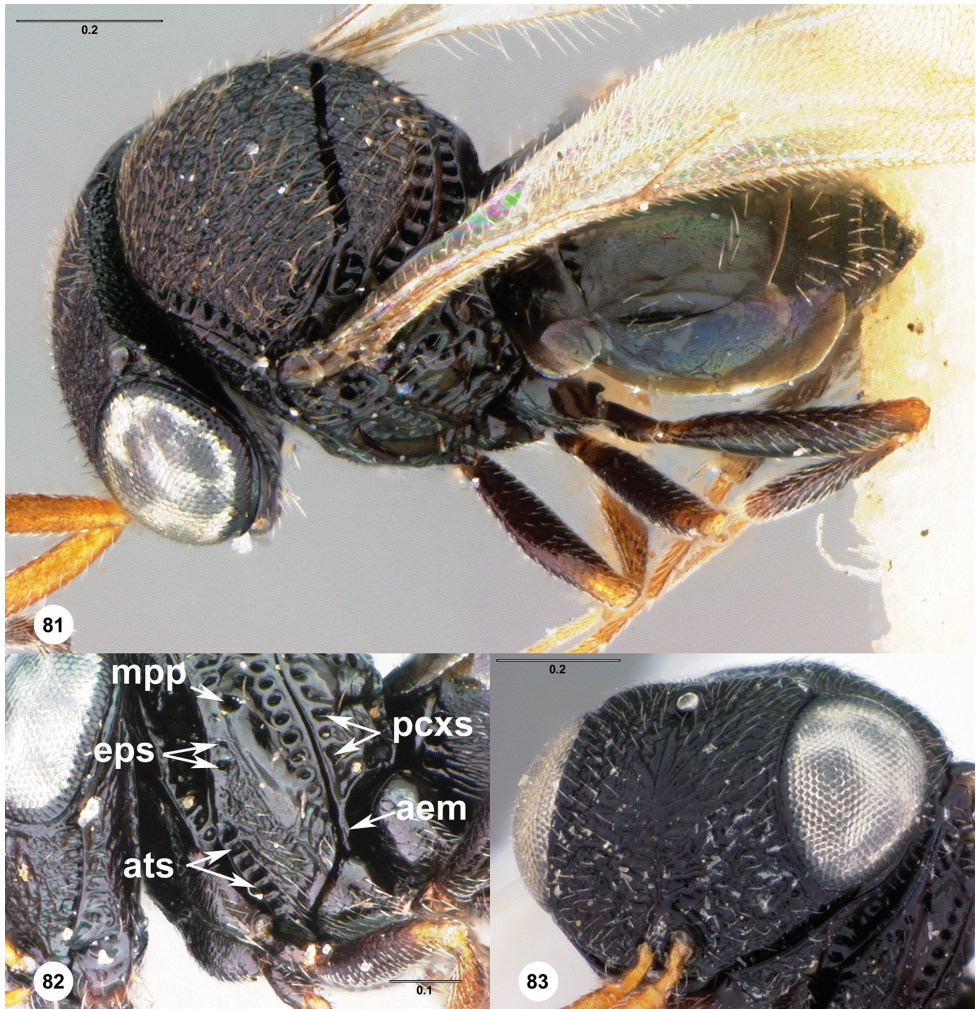
*Trissolcus radix* Johnson, 1985b: 432, 440 (original description, keyed).

**Diagnosis.** *Trissolcus radix* is most closely related to *T. hullensis*, *T. solocis*, and *T. zakotos*, from which it may be distinguished by the bright yellow radicle. The well defined paracoxal sulcus in the ventral half of the metapleuron serves to separate this species from *T. hullensis* and *T. solocis*, and the rugose sculpture of the mesoscutellum will separate it from *T. hullensis* and *T. zakotos*.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3295>]

**Associations.** Emerged from egg of *Euthyrhynchus floridanus* (Linnaeus): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; collected on coffee: [Rubiales: Rubiaceae]

**Material examined.** *Paratypes*: (1 female, 4 sex unrecorded) **COSTA RICA**: 1 sex unrecorded, OSUC 76272 (OSUC). **GUATEMALA**: 1 sex unrecorded, USNMENT00764955 (USNM). **UNITED STATES**: 1 female, 2 sex unrecorded, OSUC 145567, 76270–76271 (OSUC). *Other material*: **MEXICO**: 2 sex unrecorded, USNMENT00896395, USNMENT00896396 (UANL).



**Figures 81–83.**<sup>43</sup> *Trissolcus radix* **81** female paratype (USNMENT00764955), head, mesosoma, metasoma, dorsal view **82** female (USNMENT00764955), head and mesosoma, lateral view **83** female (OSUC 76271), head, anterolateral view. Scale bars in millimeters.

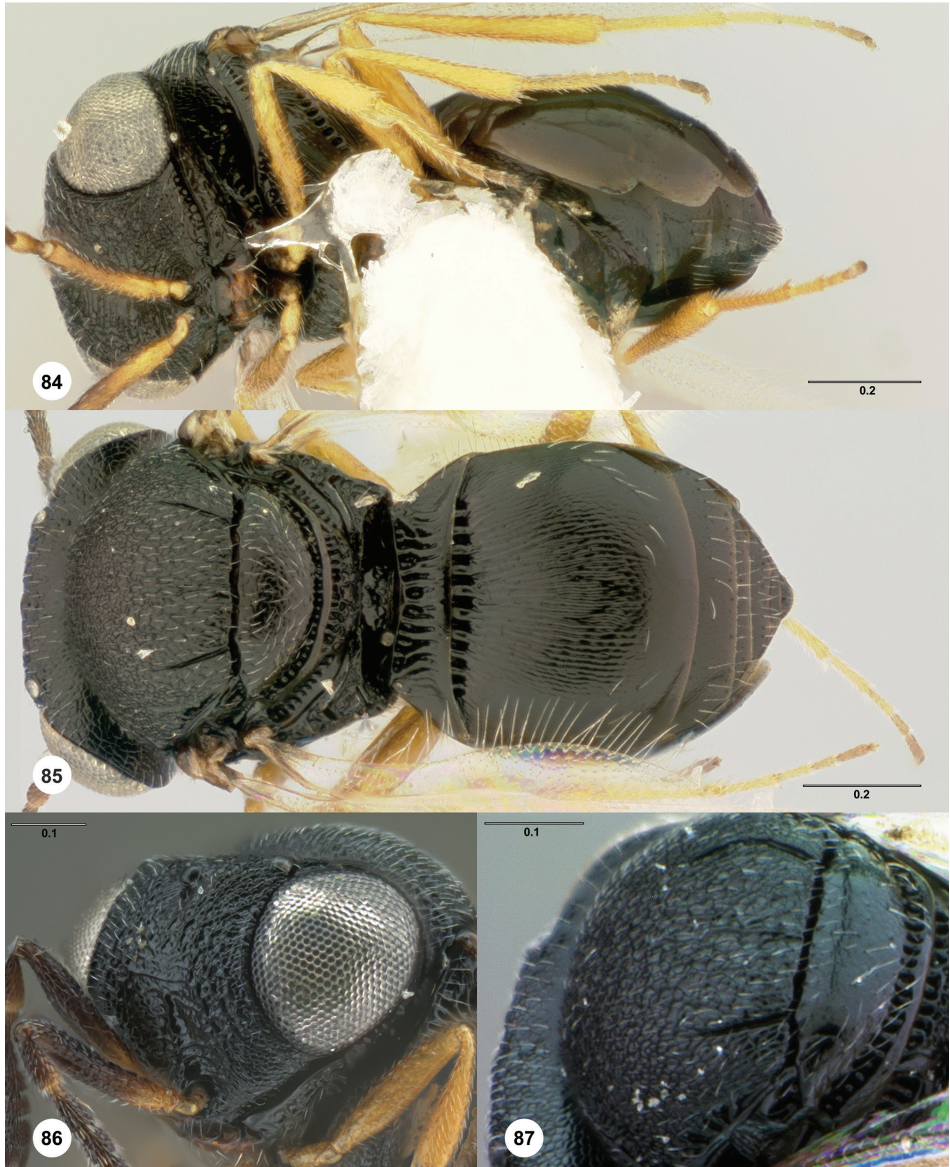
***Trissolcus ruidus* Johnson**

[http://bioguid.osu.edu/osuc\\_concepts:3299](http://bioguid.osu.edu/osuc_concepts:3299)

Figures 33, 84–87; Morphbank<sup>14</sup>

*Trissolcus ruidus* Johnson, 1985a: 111 (original description, keyed); Sarazin 1986: 981 (type information).

**Diagnosis.** *Trissolcus ruidus* may be separated from *T. parma* by the presence of rugae on the lateral frons (Fig. 86) and longitudinal elements that are often present in the sculpture of the mesoscutum between the notauli. Like *T. parma*, it may be separated



**Figures 84–87.** <sup>44</sup> *Trissolcus ruidus* female paratype (OSUC 145568) **84** head, mesosoma, metasoma, ventrolateral view **85** head, mesosoma, metasoma, dorsal view **86** head mesosoma, anterolateral view **87** head, anterior view. Scale bars in millimeters.

from the other members of the *thyantae* group by the presence of microsculpture on the mesoscutellum.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3299>]

**Material examined.** Holotype, female: **UNITED STATES:** AZ, Cochise Co., Portal, Southwestern Research Station (SWRS), 19.X.1978, Masner & Gibson, CNC

No. 18341 (deposited in CNCI). *Paratype*: **UNITED STATES**: 1 sex unrecorded, OSUC 145568 (OSUC). *Other material*: **UNITED STATES**: 2 females, 1 male, OSUC 76431–76432 (OSUC); OSUC 144847 (USNM).

***Trissolcus solocis* Johnson**

[http://bioguid.osu.edu/osuc\\_concepts:3311](http://bioguid.osu.edu/osuc_concepts:3311)

Figures 88–91; Morphbank<sup>15</sup>

*Trissolcus solocis* Johnson, 1985b: 433, 441 (original description, keyed).

**Diagnosis.** *Trissolcus solocis* may be distinguished from the closely related *T. hullensis* and *T. zakotos* by the coarse sculpture of the mesoscutellum. From *T. radix* it may be most easily separated by its black radicle and the absence of a well-defined paracoxal sulcus in the ventral half of the metapleuron.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3311>]

**Associations.** Emerged from egg of *Acrosternum marginatum* (Palisot): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Alcaeorrhynchus grandis* (Dallas): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Hemiptera*: [Hemiptera]

**Material examined.** *Paratypes*: (1 female, 1 male, 9 sex unrecorded) **MEXICO**: 4 sex unrecorded, USNMMENT00764956, USNMMENT00764957, USNMMENT00764958, USNMMENT00764959 (USNM). **UNITED STATES**: 1 female, 1 male, 5 sex unrecorded, OSUC 398866 (CNCI); OSUC 145569, 76309–76313 (OSUC).

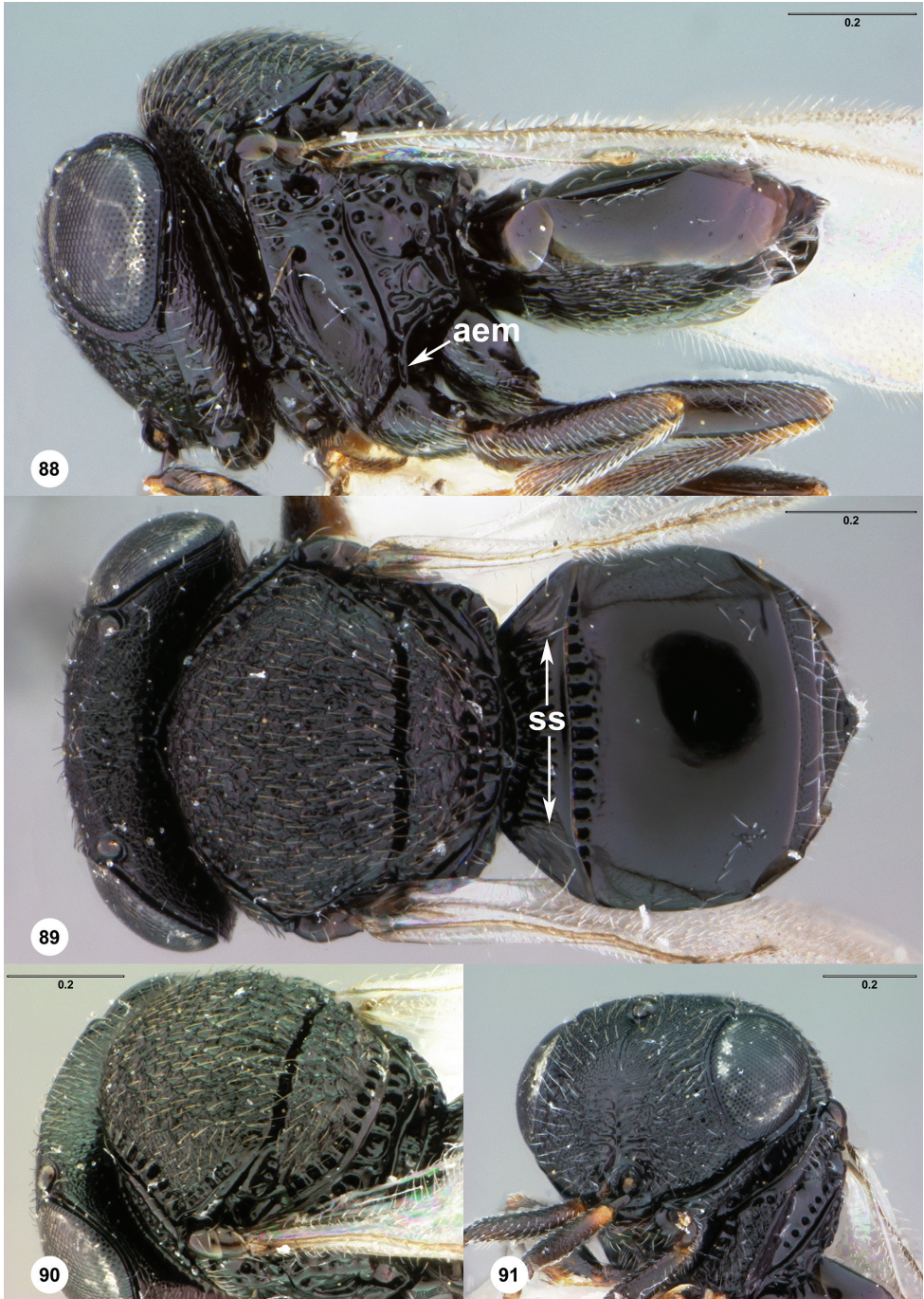
***Trissolcus strabus* Johnson**

[http://bioguid.osu.edu/osuc\\_concepts:3313](http://bioguid.osu.edu/osuc_concepts:3313)

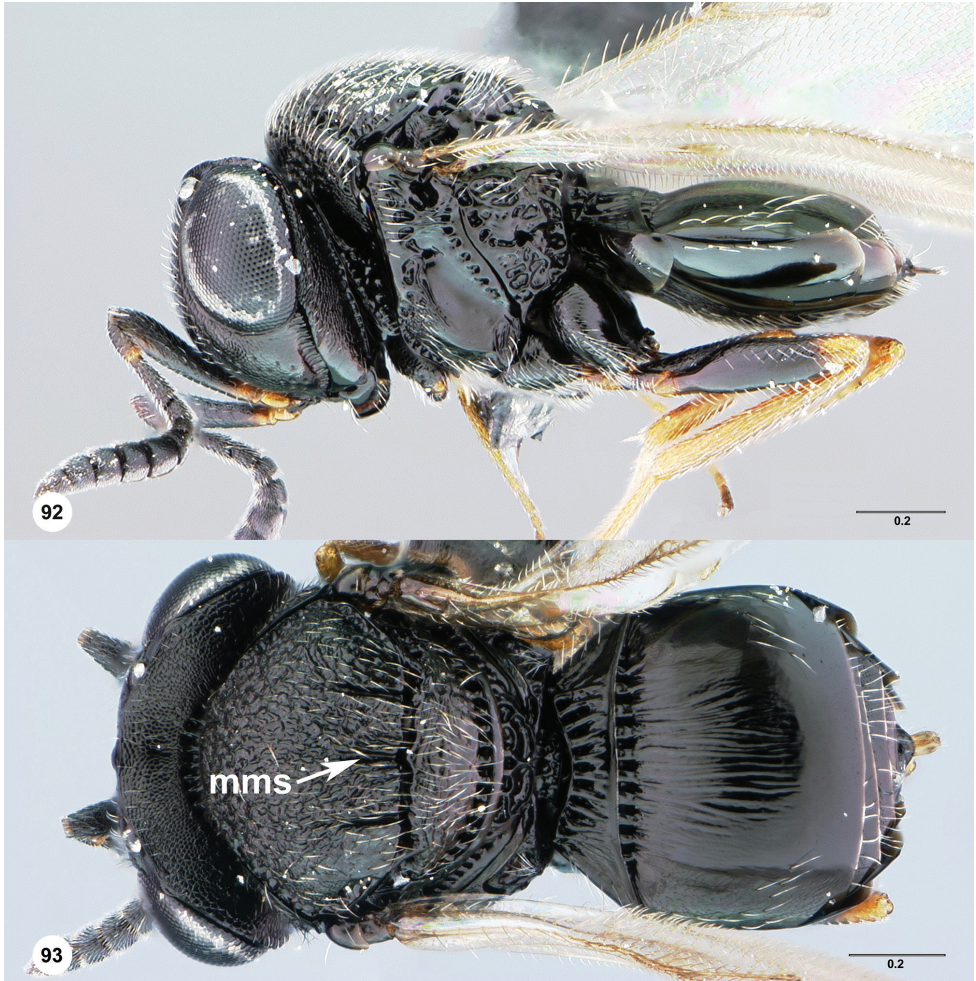
Figures 8, 23, 26, 29, 32, 92–93; Morphbank<sup>16</sup>

*Trissolcus strabus* Johnson, 1984: 798, 806 (original description, keyed); Sarazin 1986: 981 (type information); Johnson 1987: 286, 296 (diagnosis, keyed).

**Diagnosis.** *Trissolcus strabus* may be distinguished from species of the *flavipes* group in the Nearctic by the ventral constriction of the orbital furrow and the relatively coarse sculpture of the mesoscutellum. Most specimens have setae present on the first laterotergite, a character found among some *flavipes* group species of the Neotropics, but not elsewhere in the Nearctic. The rugose mesoscutellum can be used as a diagnostic character in most cases, but the degree of rugosity is variable. In some specimens the mesoscutellum is almost completely smooth with faint hints of rugae along the anterior margin. In others, the rugosity is confined to the lateral portions of the sclerite. In the latter case, rugose sculpture exists where there is setation, and in specimens



**Figures 88–91.** <sup>45</sup> *Trissolcus solocis* female paratype (OSUC 76312) **88** head, mesosoma, metasoma, lateral view **89** head, mesosoma, metasoma, dorsal view **90** head and mesosoma, dorsolateral view **91** head, anterolateral view. Scale bars in millimeters.



**Figures 92–93.** <sup>46</sup> *Trissolcus strabus*, female (BMSB 1203) **92** head, mesosoma, metasoma, lateral view **93** head, mesosoma, metasoma, dorsal view. Scale bars in millimeters.

with an entirely rugose mesoscutellum, the entire surface is setose. This leads us to hypothesize that, at least on the mesoscutellum of *T. strabus*, the rugose sculpture and setation are linked. The specimens with reduced macrosculpture on the mesoscutellum also have reduced sculpture on the lateral mesoscutum (lateral of the notaulus), revealing coriaceous microsculpture.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3313>]

**Associations.** Emerged from egg of / host egg of *Brochymena* Amyot & Serville: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; on leaf of apple: [Rosales: Rosaceae]



**Material examined.** Holotype, female: **CANADA:** ON, Hamilton, 31.VII.1980, malaise trap, M. Sanborne, CNC No. 18342 (deposited in CNCI). *Paratypes:* (1 female, 3 sex unrecorded) **CANADA:** 1 sex unrecorded, OSUC 145570 (OSUC). **UNITED STATES:** 1 female, 2 sex unrecorded, OSUC 17810 (BMNH); OSUC 76314 (OSUC); USNMENT00764998 (USNM). *Non-type:* **UNITED STATES:** 1 female, OSUC 248187 (OSUC). *Other material:* (14 females, 1 male, 13 sex unrecorded) **UNITED STATES:** 14 females, 1 male, 12 sex unrecorded, IRREC 1469–1470, 1472, 1521, 1587, 1595, 1787, 1789, 1797, IRREC1582, IRREC1584 (OSUC); BMSB 1202–1215, OSUC 145650, OSUC 523850 (USNM).

### *Trissolcus thyantae* Ashmead

[http://bioguid.osu.edu/osuc\\_concepts:3321](http://bioguid.osu.edu/osuc_concepts:3321)

Figures 94–98; Morphbank<sup>17</sup>

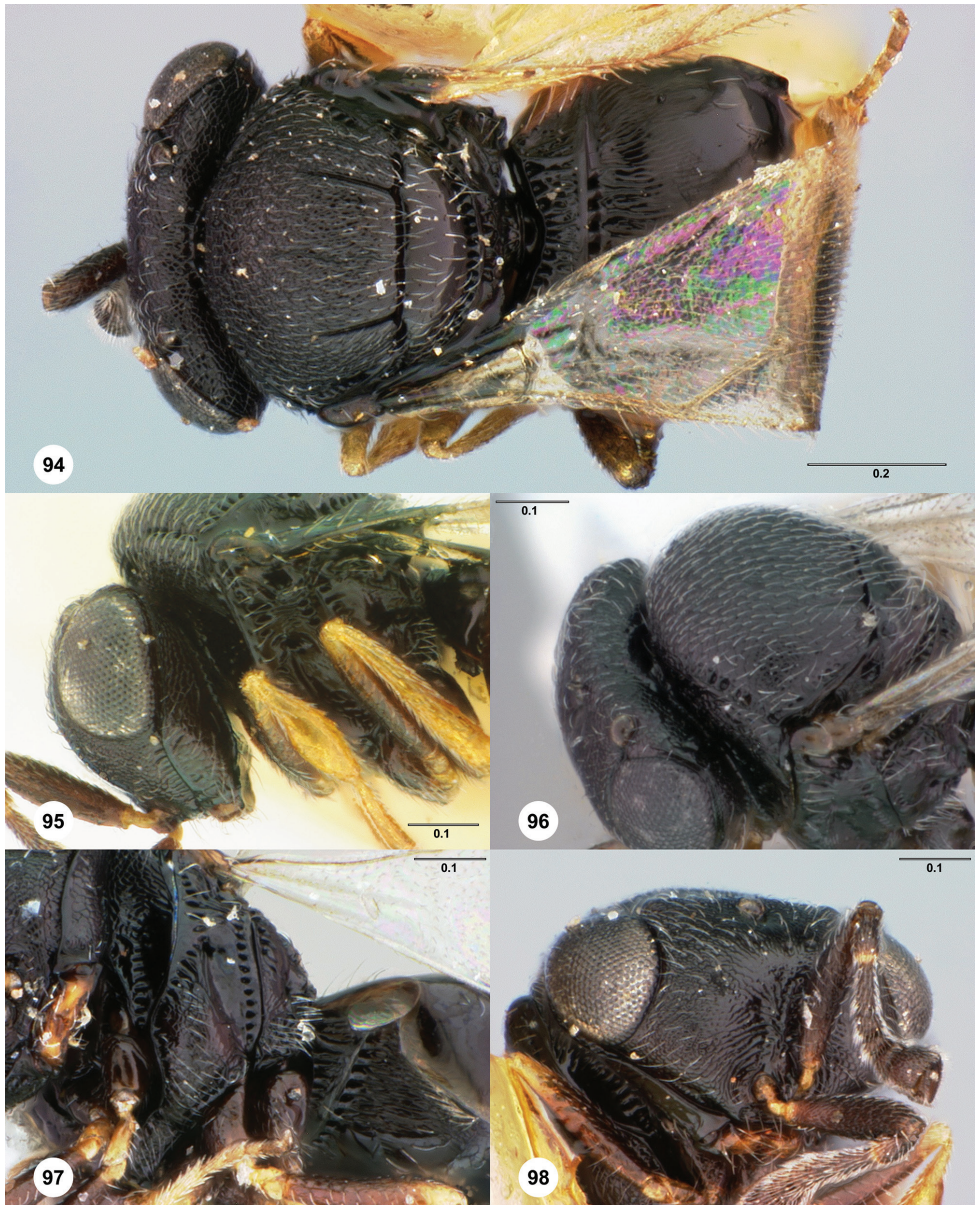
*Trissolcus thyantae* Ashmead, 1893: 162, 163 (original description, keyed); Brues 1916: 550 (description, keyed); Kieffer 1926: 127, 128 (description, keyed); Masner and Muesebeck 1968: 74 (lectotype designation); Johnson 1985a: 108, 111 (description, keyed).

**Diagnosis.** *Trissolcus thyantae* is most similar to *T. occiduus* and *T. valkyria*. It may be separated from *T. occiduus* by the narrow malar region and from both by the lack of a complete mesopleural carina.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3321>]

**Associations.** Emerged from egg of *Euschistus* Dallas: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Euschistus variolarius* (Palisot de Beauvois): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Panthea furcilla* (Packard): [Lepidoptera: Glossata: Noctuoidea: Noctuidae]; emerged from egg of *Pentatomidae*: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Pinaceae*: [Pinales: Pinaceae]; emerged from egg of *Thyanta custator* (Fabricius): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; collected on pine: [Pinales: Pinaceae]; emerged from egg of pine: [Pinales: Pinaceae]; collected on soybean: [Fabales: Fabaceae]

**Material examined.** Lectotype, female: **UNITED STATES:** AL, Dallas Co., Selma, IX-1880, reared from egg, E. A. Schwarz, USNMENT00989048 (deposited in USNM). *Non-type:* **UNITED STATES:** 1 female, OSUC 266773 (OSUC). *Other material:* (2 females, 27 sex unrecorded) **CANADA:** 1 female, 6 sex unrecorded, OSUC 17812 (BMNH); OSUC 145196, 145368, 398870–398871 (CNCI); OSUC 145572, 76328 (OSUC). **UNITED STATES:** 1 female, 21 sex unrecorded, OSUC 157505–157506, 157512–157520, 76320–76327 (OSUC); USNMENT00764991, USNMENT00764994, USNMENT00979296 (USNM).



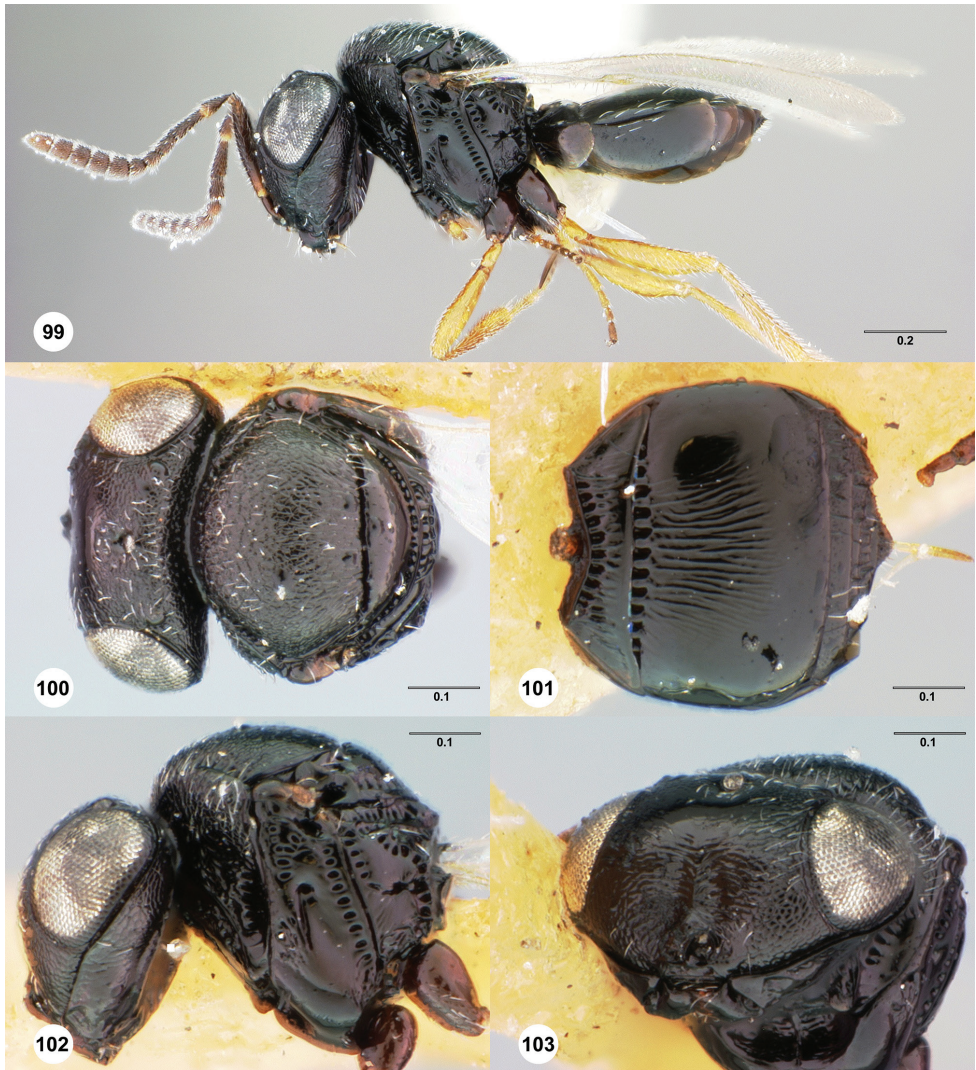
**Figures 94–98.** <sup>47</sup> *Trissolcus thyantae* **94** female holotype (USNMENT00989048), head, mesosoma, metasoma, dorsal view **95** female holotype (USNMENT00989048), head, mesosoma, lateral view **96** female (OSUC 76325), head and mesosoma, dorsolateral view **97** female (USNMENT00764991), mesosoma, ventrolateral view **98** female holotype (USNMENT00989048), head, anterolateral view. Scale bars in millimeters.

***Trissolcus utahensis* (Ashmead)**[http://bioguid.osu.edu/osuc\\_concepts:3327](http://bioguid.osu.edu/osuc_concepts:3327)Figures 99–103; Morphbank<sup>18</sup>*Telenomus utahensis* Ashmead, 1893: 143, 145, 148 (original description, keyed).*Hadronotus mesillae* Cockerell, 1897: 25 (original description, synonymized by Muesebeck & Walkley (1951)); Brues 1910: 47 (keyed); Kieffer 1926: 454, 464 (description, keyed); Muesebeck and Walkley 1951: 694 (junior synonym of *Telenomus utahensis* Ashmead).*Telenomus ashmeadi* Morrill, 1907: 419 (original description, synonymized with *Telenomus mesillae* (Cockerell) by Gahan (1932)); Kieffer 1926: 27, 48 (description, keyed); Gahan 1932: 757 (junior synonym of *Telenomus mesillae* (Cockerell)); Mani 1936: 335 (description of misidentified Indian specimen).*Liophanurus utahensis* (Ashmead): Kieffer 1926: 65, 73 (description, generic transfer, keyed).*Telenomus mesillae* (Cockerell): Gahan 1932: 757 (generic transfer, synonymy).*Trissolcus utahensis* (Ashmead): Krombein and Burks 1967: 297 (generic transfer); Masner and Muesebeck 1968: 74 (type information); Johnson 1985b: 432, 441 (description, keyed).*Trissolcus ashmeadi* (Morrill): Masner and Muesebeck 1968: 71 (lectotype designation).*Trissolcus mesillae* (Cockerell): Masner and Muesebeck 1968: 73 (type information).

**Diagnosis.** *Trissolcus utahensis* is a relatively dark-colored species, though some specimens from the southern part of its range have lighter-colored appendages. In the Nearctic region it is most similar to *T. basalis*. The two may be distinguished by the color of A1, usually dark, concolorous with the radicle in *T. utahensis*, and yellow, sharply contrasting with the dark radicle in *T. basalis*; and the mesoscutellar sculpture, smooth in *T. utahensis*, coriaceous in *T. basalis*.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=3327>]

**Associations.** Emerged from *Chlorochroa sayi* (Stål): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Chlorochroa sayi* (Stål): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from *Chlorochroa uhleri* (Stål): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; collected on *Fremontia* Torr.: [Malvales: Malvaceae]; emerged from egg of *Pentatoma ligata* Say: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from *Pentatoma sayii* (Stål): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; egg parasite of *Pentatomidae*: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from *Pentatomidae*: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; emerged from egg of *Pentatomidae*: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; unspecified association *Pentatomidae*: [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]; collected on *Pinus ponderosa* P. & C. Lawson: [Pinales: Pinaceae]; collected on *Prosopis* L.: [Fabales: Fabaceae]; living with *Rhyacionia neomexicana* (Dyar): [Lepidoptera: Glossata: Tortricidae]; collected on Russian thistle: [Caryophyllales: Chenopodi-



**Figures 99–103.** <sup>48</sup> *Trissolcus utahensis* **99** female (USNMENT00872111), head, mesosoma, metasoma, lateral view **100** female lectotype (USNMENT00), head and mesosoma, dorsal view **101** lectotype female (USNMENT00989049), metasoma, dorsal view **102** female lectotype (USNMENT00989049), head and mesosoma, lateral view **103** female lectotype (USNMENT00989049), head and mesosoma, anterolateral view. Scale bars in millimeters.

aceae]; emerged from *Thyanta pallidovirens* (Stål): [Hemiptera: Heteroptera: Pentatomidea: Pentatomidae]; collected on tomato: [Solanales: Solanaceae]; on leaf of tomato: [Solanales: Solanaceae]; collected on wild carrot: [Apiales: Apiaceae].

**Material examined.** Lectotype, female, *T. utahensis*: **UNITED STATES**: Wasatch Range, 27.VI.1891, E. A. Schwarz, USNMENT00989049 (deposited in USNM). *Paralectotype*: **UNITED STATES**: 1 male, USNMENT00764992 (USNM). Lecto-

type, female, *T. ashmeadi*: **UNITED STATES**: TX, Ward Co., Barstow, 12.IX.1905, reared from egg, A. W. Morrill, USNM Type No. 10364 (deposited in USNM). Holotype, female, *H. mesillae*: **UNITED STATES**: NM, Doña Ana Co., Las Cruces, no date, reared from egg, T. D. A. Cockerell, USNM Type No. 3696 (deposited in USNM). *Other material*: (10 females, 3 males, 142 sex unrecorded) **CANADA**: 5 sex unrecorded, OSUC 145192–145193, 398862 (CNCI); OSUC 76416–76417 (OSUC). **UNITED STATES**: 10 females, 3 males, 136 sex unrecorded, OSUC 17807 (BMNH); OSUC 143819–143823, 436690–436699 (LACM); OSUC 77878–77930 (MSWC); OSUC 145230–145252, 145635, 405748, 413942, 542448–542449, 542451–542452, 542455, 76383–76415, 77203–77212 (OSUC); OSUC 205760 (UCDC); USNMENT00872110–USNMENT00872114 (USNM).

***Trissolcus valkyria* Johnson & Talamas, sp. n.**

<http://zoobank.org/4DB6B48B-9DA2-47E0-98A5-A28103C42C15>

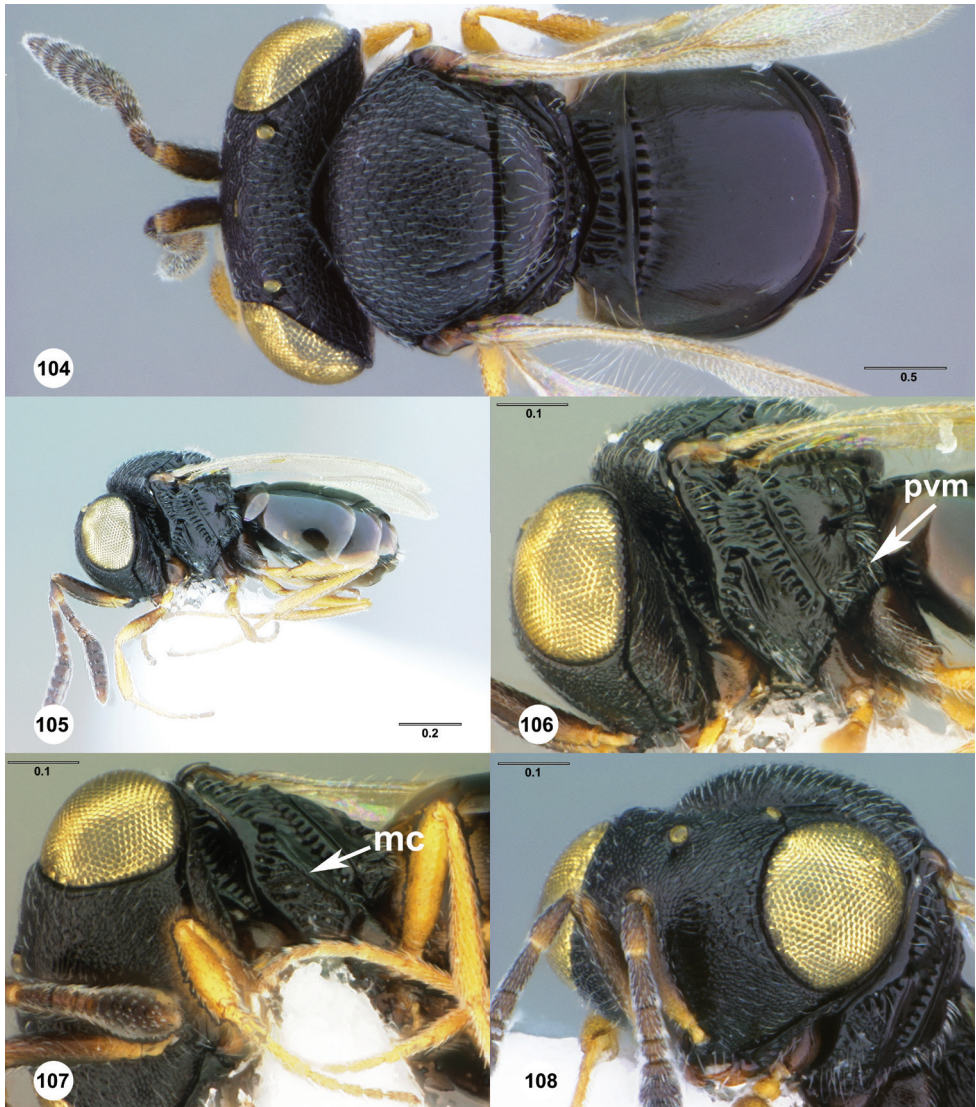
[http://bioguid.osu.edu/osuc\\_concepts:344497](http://bioguid.osu.edu/osuc_concepts:344497)

Figures 104–108; Morphbank<sup>19</sup>

**Description.** Female body length: 0.97–1.11 mm (n=6). Color of radicle: yellow; brown; pale brown. Number of mandibular teeth: three. Number of clypeal setae: 6. Facial striae: absent. Shape of gena in lateral view: receding posteriorly. Genal carina: extending dorsally from base of mandible. Macrosculpture of frons outside of antennal scrobe: absent; irregularly rugose. Orbital furrow: narrow to absent near malar sulcus. Hyperoccipital carina: absent. Preocellar pit: present.

Epomial carina: present. Netrion sulcus: complete. Mesoscutal suprahumeral sulcus: indicated by cells. Mesoscutal humeral sulcus: indicated by cells. Pattern of mesoscutal microsculpture: antero-posteriorly uniform. Macrosculpture of mesoscutum: coriaceous. Area bounded by axillar crescent: smooth. Parapsidal line: absent. Notaulus: present. Median mesoscutal carina: absent; present. Median mesoscutal sulcus: absent.

Sculpture of mesoscutellum: smooth. Postacetabular sulcus: comprised of cells. Shape of episternal foveae: round; antero-posteriorly elongate. Number of episternal foveae: 3–5. Course of episternal foveae ventrally: abutting cells of postacetabular sulcus. Course of episternal foveae dorsally: extending dorsally to mesopleural pit. Sculpture of anterior mesepisternum: smooth or with shallowly impressed microsculpture. Mesopleural epicoxal sulcus: comprised of cells. Mesopleural carina: complete. Speculum: transversely striate. Paracoxal sulcus in ventral half of metapleuron: absent or indistinguishable from sculpture. Anteroventral extension of metapleuron: short, not reaching mesocoxa. Line of pits along metapleural carina: present. Sensation of metapleuron: present. Metapostnotum: invaginated near edge of metascutellum and separating metanotum from propodeum. Color of legs beyond coxae: yellow; femora brown, otherwise variably yellow to brown. Metasomal depression: punctate or crenulate dorsally.



**Figures 104–108.**<sup>49</sup> *Trissolcus valkyria*, female holotype (OSUC 542457) **104** head, mesosoma, metasoma, dorsal view **105** lateral habitus **106** head and mesosoma, lateral view **107** head and mesosoma, ventrolateral view **108** head, anterolateral view. Scale bars in millimeters.

Sublateral setae on T1: absent. Setation of laterotergite 1: absent. Sculpture of T2 posterior to antecostal sulcus: smooth or with very faintly impressed striation; distinctly striate posterior to basal costae.

**Diagnosis.** *Trissolcus valkyria* is most similar to *T. thyantae* with which it shares a mesoscutellum without microsculpture and a narrow gena. *Trissolcus valkyria* may be separated *T. thyantae* and *T. occiduus* by the presence of a complete and well defined mesopleural carina. From *T. occiduus* it may also be separated by the narrow gena.

**Etymology.** The epithet “valkyria” is Old Norse for “chooser of the slain” and refers to the female figures in Norse mythology that selected which soldiers would die in battle. The name is to be treated as a noun in apposition.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=344497>]

**Material examined.** Holotype, female: **UNITED STATES:** WI, Juneau Co., North Rynearson site, Necedah National Wildlife Refuge, 21.VI–11.VII.1996, flight intercept trap, R. H. Williams, OSUC 542457 (deposited in OSUC). *Paratypes:* **UNITED STATES:** 5 females, OSUC 405747, 76433 (OSUC); OSUC 144848–144849, 145646 (USNM).

**Comments.** *Trissolcus valkyria*, was previously recognized by Johnson but remained undescribed due to a dearth of specimens. A small number of additional specimens are now known, providing in our opinion a sufficient basis for the description of this species.

***Trissolcus zakotos* Talamas, sp. n.**

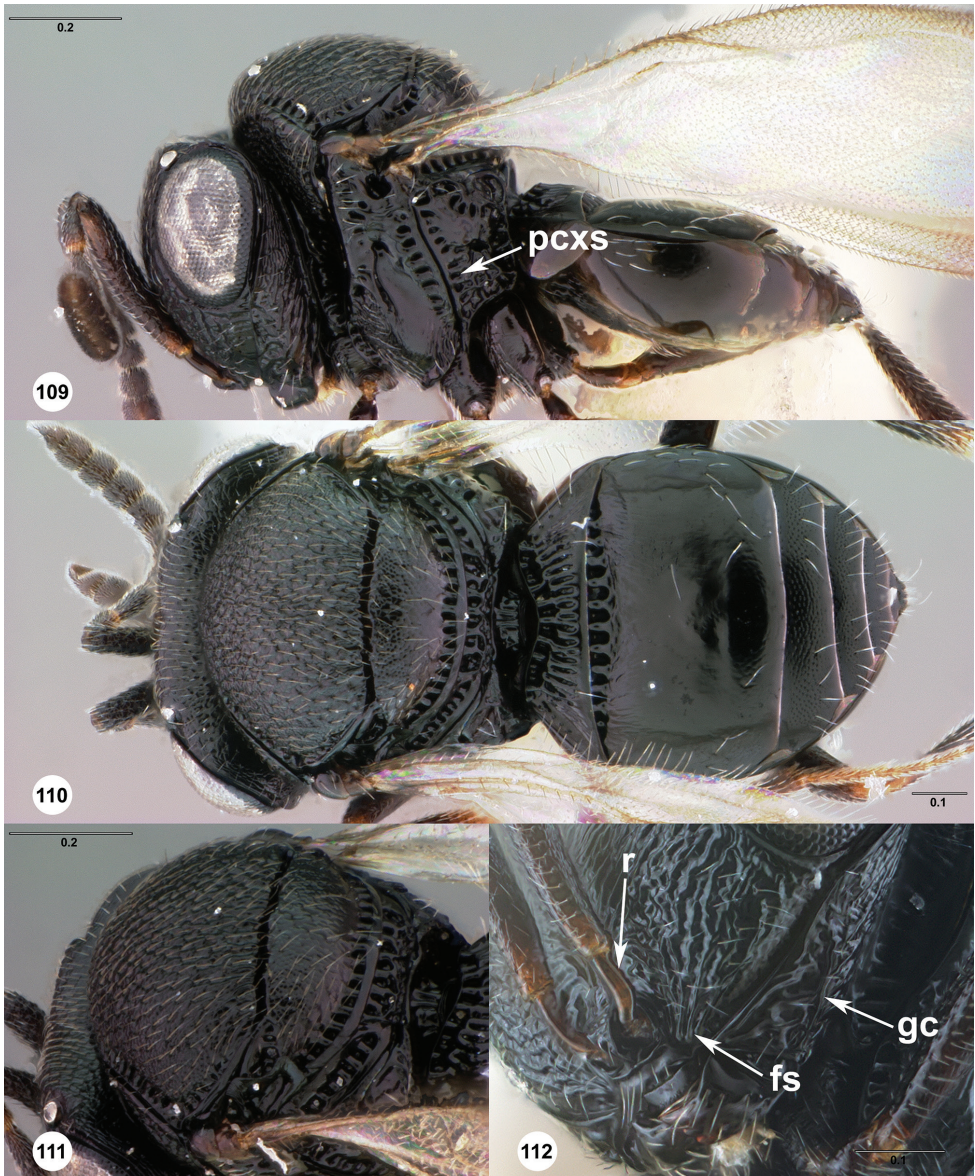
<http://zoobank.org/4E138794-6517-42FE-9AC7-B7D92CDB04B6>

[http://bioguid.osu.edu/osuc\\_concepts:345034](http://bioguid.osu.edu/osuc_concepts:345034)

Figures 109–112; Morphbank<sup>20</sup>

**Description.** Female body length: 1.28–1.41 mm (n=20). Male body length: 1.18 mm (n=1). Color of radicle: brown. Number of mandibular teeth: three. Number of clypeal setae: 6. Facial striae: present as 3 or more rugulae extending onto lateral frons. Shape of gena in lateral view: receding posteriorly. Genal carina: extending dorsally from base of mandible. Macrosculpture of frons outside of antennal scrobe: irregularly rugose. Orbital furrow: narrow to absent near malar sulcus. Hyperoccipital carina: absent. Preocellar pit: present.

Epomial carina: present. Netrion sulcus: complete. Mesoscutal suprahumeral sulcus: indicated by cells. Mesoscutal humeral sulcus: indicated by cells. Pattern of mesoscutal microsculpture: antero-posteriorly uniform. Macrosculpture of mesoscutum: reticulate anteriorly, longitudinally rugulose posteriorly. Area bounded by axillar crescent: smooth. Parapsidal line: absent. Notaulus: absent. Median mesoscutal carina: absent. Median mesoscutal sulcus: absent. Sculpture of mesoscutellum: coriaceous. Postacetabular sulcus: comprised of cells. Shape of episternal foveae: irregular; round. Number of episternal foveae: 1–2. Course of episternal foveae ventrally: distinctly separate from postacetabular sulcus. Course of episternal foveae dorsally: distinctly separated from mesopleural pit. Sculpture of anterior mesepisternum: faintly rugulose; finely reticulate. Mesopleural epicoxal sulcus: present as a smooth furrow; comprised of cells. Mesopleural carina: complete; well defined in anterior half, posterior half poorly defined to absent. Speculum: transversely striate. Paracoxal sulcus in ventral half of metapleuron: indicated by a line of distinct foveae. Anteroventral extension of metapleuron: long, extending to mesocoxa. Line of pits along metapleural carina: present. Setation of metapleuron: absent. Metapostnotum: invaginated near edge of metascutellum and separating metanotum from



**Figures 109–112.** <sup>50</sup> *Trissolcus zakotos* **109** female paratype (USNMENT00954596), head, mesosoma, metasoma, lateral view **110** female holotype (USNMENT00903008), head, mesosoma, metasoma, dorsal view **111** female holotype (USNMENT00903008), mesosoma, dorsolateral view **112** female paratype (USNMENT00954600), head, anterolateral view. Scale bars in millimeters. <sup>50</sup>

propodeum. Color of legs beyond coxae: femora and tibiae brown, otherwise variably yellow to brown. Metasomal depression: punctate or crenulate dorsally.

Sublateral setae on T1: absent; present. Setation of laterotergite 1: absent. Sculpture of T2 posterior to antecostal sulcus: smooth or with very faintly impressed striation.



**Diagnosis.** *Trissolcus zakotos* is closest to *T. radix*, with which it shares a well defined paracoxal sulcus. The two may be separated by the presence of of bright yellow radicle and coarse sculpture of the mesoscutellum in *T. radix*. In *T. zakotos* the radicle is brown and the mesoscutellum is covered by microsculpture, but without additional rugae. Additionally, *T. zakotos* has numerous (3–5) rugae radiating from the lateral edge of the clypeus. This character is present in both *T. radix* and *T. solocis* but is less pronounced and the number of rugae is smaller (1–2).

**Etymology.** The epithet “zakotos” is Greek for “angry” and is applied to this species because of the appearance of its frons. The name is treated as an appositional noun.

**Link to distribution map.** [<http://hol.osu.edu/map-large.html?id=345034>]

**Associations.** Emerged from *Apateticus bracteatus* (Fitch): [Hemiptera: Heteroptera: Pentatomoidea: Pentatomidae]

**Material examined.** Holotype, female: **UNITED STATES:** MT, Ravalli Co., Hamilton, V-1972, W. L. Jellison, USNMENT00903008 (deposited in USNM). *Paratypes:* **UNITED STATES:** 22 females, 1 male, USNMENT00954588–USNMENT00954589 (CNCI); USNMENT00954586–USNMENT00954587 (OSUC); USNMENT00903005, USNMENT00903006, USNMENT00954590–USNMENT00954606 (USNM).

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## Endnotes

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## **Supplementary material I**

### **URI table of HAO morphological terms**

Authors: Elijah J. Talamas, Norman F. Johnson, Matthew Buffington

Data type: Microsoft Excel Spreadsheet (.xls)

Explanation note: This table lists the morphological terms used in this publication and their associated concepts in the Hymenoptera Anatomy Ontology.

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