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Source: Florida Entomologist, 94(2) : 145-150

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/024.094.0204

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CLARIFICATION OF THE TAXONOMIC STATUS OF *CUCUJUS CLAVIPES* WITH DESCRIPTIONS OF THE LARVAE OF *C. C. CLAVIPES* AND *C. C. PUNICEUS* (COLEOPTERA: CUCUJIDAE)

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ABSTRACT

The larvae of *Cucujus c. clavipes* Fabricius and *C. c. puniceus* Mannerheim are fully described and illustrated in detail for the first time. Based on larval and adult morphology the present recognition of two subspecies is maintained.

Key Words: taxonomy, *Cucujus*, larva, North America

RESUMEN

Por primera vez se describen e ilustran las larvas de *Cucujus c. clavipes* Fabricius y *C. c. puniceus* Mannerheim. Basándose en la morfología larval, se acepta el reconocimiento de las dos subespecies.

Translation provided by the authors.

Cucujus clavipes Fabricius (1781) was described from "America boreali." *Cucujus puniceus* Mannerheim (1843) was described from "insula Sitkha", now Baranof Island in southeastern Alaska and the site of the modern city of Sitka. Both descriptions are of adults only, are based on the adult stage and are brief and relatively uninformative. Of *C. clavipes*, Fabricius wrote: "*ruber, thorace fuscato, femoribus clavatis rufis*" (red, thorax dark, femora clavate, red); of *C. puniceus*, Mannerheim wrote: "*elongatus, depressus, laete sanguineus, antennis nigrofuscis, pectore abdomineque rufoferrugineis, thorax subrotundato, lateribus leviter denticulato, supra obsolete bisulcato*" (Elongate, depressed, rich red, antennae nigro-fuscus, abdomen rufo-ferrugineous; thorax rounded, laterally weakly denticulate, above obsoletely bisulcate).

LeConte (1854, 1861, 1863) consistently treated *C. puniceus* as a valid species. Casey (1884) reduced it to a variety of *C. clavipes* and said of it: "The body is more elongated, and usually of a brighter color. The first joint of the antennae is usually of a dark testaceous, while in *clavipes* it is black. The antennae are slightly longer, and the neck slightly narrower in *puniceus*." Leng (1920) treated *C. puniceus* as either a variety or subspecies of *C. clavipes* [In the Leng Catalogue, a lettered taxon following a numbered species name could be ". . . variety, subspecies, race, etc." (Leng 1920: v)] and Hetschko (1930) followed Casey in treating it as a variety of *C. clavipes*. Schaeffer (1931) described *Cucujus clavipes subnitens* as a variety from Arizona and Utah. Thomas (1993) in a list of Nearctic Cucujidae treated *C. puniceus* as a subspecies of *C. clavipes* and Schaeffer's taxon as a variety as previously described.

In an effort to resolve the status of *Cucujus clavipes* we examined adults and larvae from both eastern and western North America.

Larvae

Larvae of Japanese *Cucujus coccinatus* Lewis were described and illustrated by Hayashi (1980, 1986) and the larva of *C. mniszechi* Grouvelle was described by Lee and Sato (2007).

Larvae of *C. clavipes* Fabricius were briefly and partially illustrated (head and mandible) by Bøving and Craighead (1931) and Klausnitzer (2001). Peterson (1951) provided extensive illustrations of *C. clavipes* but provided only a brief description. In neither case was the origin of the specimen illustrated provided. Lawrence (1991) re-used Peterson's illustrations and added scanning electron micrographs of mouthparts of a specimen from California. The larva of both North American subspecies of *C. clavipes* Fabricius are fully illustrated and described for the first time in the present paper. The larva of *C. clavipes* is similar to *C. mniszechi* (Lee and Sato 2007), but can be distinguished by absence of a distinct epicranial stem and presence of a sharp prostheca. In *C. mniszechi* the epicranial stem is present and the prostheca is blunt.

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Larvae of *C. clavipes* are reported to be predaceous (Smith and Sears 1982) or facultatively predaceous (Lawrence 1991). Their extreme cold tolerance, which increases with increasing latitude, has been extensively studied (Sformo et al. 2010, and references therein).

Materials and Methods

The larvae were preserved in 70% ethyl alcohol, cleared in 10% KOH solution for 1 hour, rinsed in water, and dissected under a stereoscopic microscope (Leica® MS5). Slide mounting procedures were carried out according to LeSage (1984), and the larval terminology follows Lawrence (1991). Specimens were measured with an ocular micrometer and the measurements were transferred to graph paper. The illustrations were then sketched in pencil, the sketches inked, and assembled into plates, which were optically scanned and cleaned up in a graphics editor. Specimens examined are deposited in the Florida State Collection of Arthropods (FSCA) and the University of Alberta E. H. Strickland Entomological Museum (UASM).

Descriptions

Cucujus clavipes clavipes Fabricius, 1781 (Fig. 1 AJ)

Diagnosis**:** See this section under *C. c. puniceus*.

Material examined**:** 37 total from: INDIANA**:** Morgan Co.: Martinsville (10); Tippecanoe Co. (1); OHIO**:** Champaign Co. (1); Columbiana Co. (1); WISCONSIN**:** Calumet Co.: Forest Junction (1); Ingham Co.: Dansville State Game Area (1); Shawano Co.: Shawano (16); Shawnee Co.: Tilleda (6) (all deposited in the FSCA).

Description: Late instar (Fig. 1A). Body 22.0 - 26.0 mm long, elongate, subparallel, strongly dorsoventrally flattened with strongly forked median process at abdominal apex (Fig. 1A). Head and abdominal segment 8 moderately sclerotized, yellowishbrown to brown, tergite of abdominal segment 9 strongly sclerotized and brown.

Head (Fig. 1B): prognathous, strongly transverse and dorsoventrally flattened. Lateral margin rounded. Median endocarina absent; epicranial stem present but very short; frontal sutures lyriform, strongly curved; bases contiguous. Stemmata well-developed, 6 on each side of head (Peterson (1951) reported 5 on each side; we count 6 but 1 is small and difficult to see). Frontoclypeal suture absent. Fronotoclypeal region with 3 long setae anterior to angles of frontal arms, 1 pair anterior to the apex of the frontal arms on each side of the head, 1 pair medially between the frontal arms, and 1 pair at the apex of the frontoclypeal region near the clypeolabral suture. Clypeolabral suture complete. Labrum (Fig. 1G) free, with 3 pairs of setae and anterior border fimbriate. Epipharynx glabrous medially, with 5 anterior setae on each side. Antennae 3segmented, ratio of lengths of antennomeres 1, 2, and 3 about 1.0: 1.2: 1.0. Mandibles (Fig. 1H) heavily sclerotized, symmetrical, apices bidentate with a smaller subapical tooth; with 2 dorsolateral mandibular setae; prostheca acuminate, spinelike, with a broad base; mola with numerous setae medially and penicillus posteriorly (The scanning electron micrographs in Lawrence (1991: 464, figs. 34.528, c-f) show a conspicuous patch of microtrichia on both the dorsal and ventral surfaces of the mandible near the base; these are virtually invisible in liquid and are not illustrated here). Maxilla (Fig. 1E) with cardo triangular, divided by an internal ridge, basal portion trapezoidal, 1 moderately elongate seta near latero-basal margin; stipes elongate; mala falciform with 5 apical spines and a medial brush composed of several thick setae; maxillary palpus 3segmented, segment 1 asetose, segment 2 with 2 setae, segment 3 with 4 minute apical setae. Labium (Fig. 1F) with conspicuous mentum and prementum; mentum about as long as wide, with 2 pairs of setae and prementum with 1 pair of setae and 1 pair of sensilla; ligula rounded anteriorly, 1 pair of setae and microtrichia anteriorly; labial palpi 2-segmented and widely separated at base.

Thorax: Meso and metathorax tergites, and abdominal tergites and ventrites 18 each with 1 transverse ridge near anterior margin, ridge on ventral surface of abdominal segment 1 lightly sclerotized. Prothorax subquadrate, transverse, 0.5 times as long as wide, sides slightly curved, dorsal surface smooth; prosternal surface smooth, 3 setae (1 elongate) at anterolateral angles and 2 short setae at posterolateral angles; prosternum trapezoidal, sides oblique, posterior margin straight, pair of medial setae present posterior to posterior margin of presternum. Meso- and metathorax transverse, both 0.5 times as long as wide, sides curved, dorsal surface of both tergites smooth with 3 short setae at anterolateral angles and 2 short setae at posterolateral angles; both sterna without well-defined subdivisions, each smooth with a pair of discal setae near anterior margin; spiracular sclerite projecting strongly from lateral margin, spiracles (Fig. 1C) annular and angled posterolaterally. Legs (Fig. 1D) moderately long, 5segmented; claw falciform, large.

Abdomen: Segments 17 transverse, tergite surface smooth with 2 setae anterior to spiracles and 2 setae posterior to spiracles; ventrite surface with 3 setae, 2 anteriorly and 1 posteriorly. Segment 8 slightly enlarged, tergite (Fig. 1I) with a stout spicule at each posterolateral margin, posterolateral angles with 4 long and 4 short setae, 3 pairs of short setae anteromedially; sternite (Fig. 1J) with 7 pairs of setae and with large stout pro-

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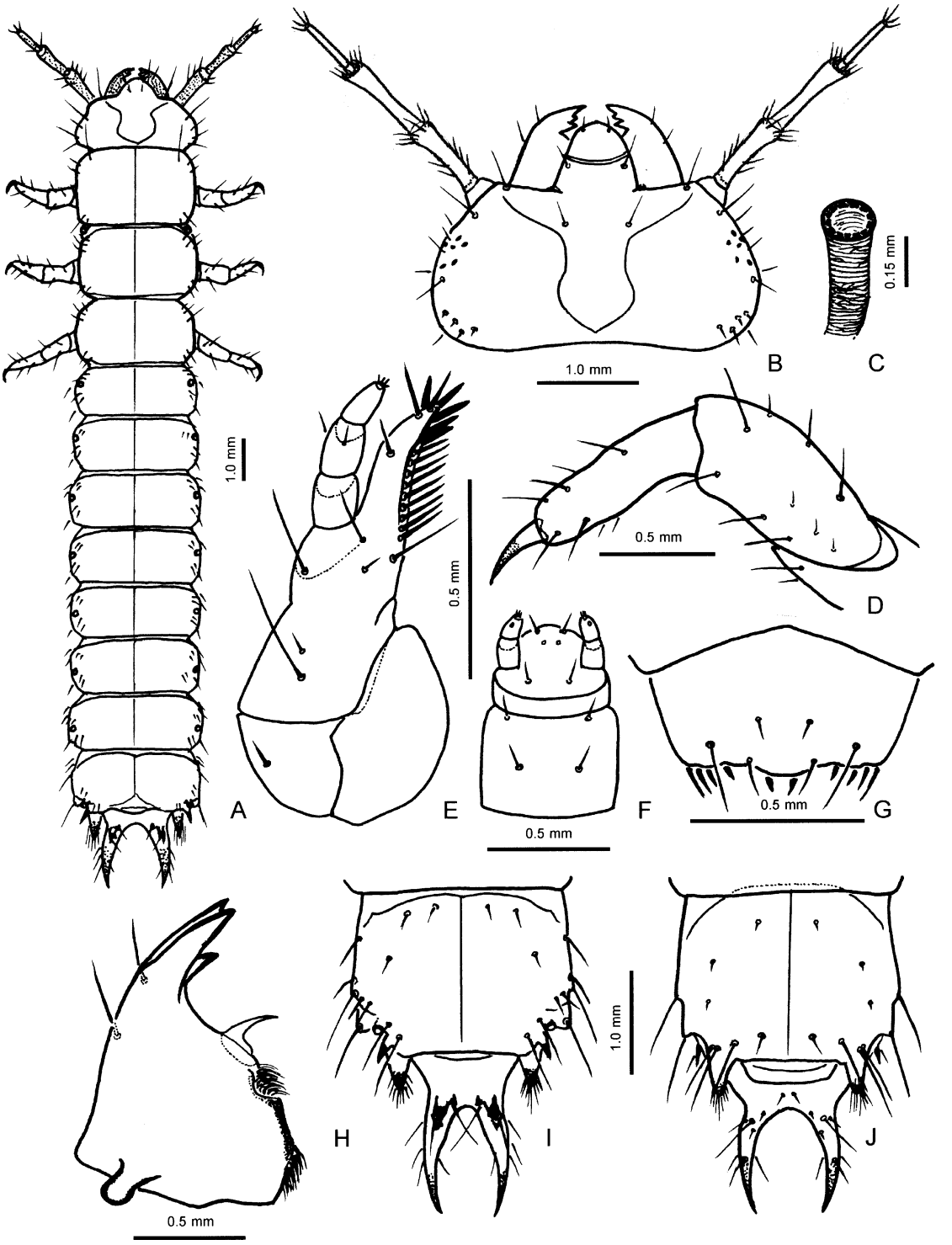


Fig. 1. Larva of *Cucujus c. clavipes*. A, habitus, dorsal view; B, head, dorsal view; C, A7 spiracle, D, prothoracic leg; E, left maxilla, dorsal view; F, labium, ventral view; G, labrum, dorsal view; H, left mandible, dorsal view; I, abdominal segments 89, dorsal view; J, same, ventral view.

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cess posteriorly with many minute setae apically. Tergum 9 with a basally forked process, directed dorsad; base of process with a pair of short, apically forked processes, 1 short seta at apex of forked process; anterior margin with laterally curved processes projecting from tergum 8; ventrite 9 reduced and concealed from above.

Cucujus clavipes puniceus Mannerheim
(Fig. 2 AJ)

Diagnosis. The larva of this species is very similar to that of *Cucujus c. clavipes*, but can be distinguished by the ratio of the 8th abdominal segment length vs length of the forked process (4:3 in *C. c. puniceus*; 1:1 in *C. c. Clavipes*), and the ratio of the 8th abdominal segment width vs the width of forked process (measured at tips) (5:3 in *C. c. puniceus*; 3:2 in *C. c. clavipes*).

Material examined: 7 total, from: CANADA: ALBERTA: George Lake (2, UASM); USA: CALIFORNIA: El Dorado Co.: Blodgett Forest (1, FSCA); Tulare Co.: Sequoia National Park, Stoney Cr. Picnic Area (2, FSCA);UTAH: Cache Co.: Logan Valley (2, FSCA)

Description: Late instar larva (Fig. 2A). Body 21.0-24.0 mm long, elongate, subparallel, strongly dorsoventrally flattened with forked median process at abdominal apex (Fig. 2A). Head and abdominal segment 8 moderately sclerotized, brown, tergum 9 strongly sclerotized and dark brown.

Head (Fig. 2B): prognathous, strongly transverse and dorsoventrally flattened. Lateral margin rounded. Hind corners of epicranium slightly produced posteriorly. Median endocarina and epicranial stem very short; frontal sutures lyriform, strongly curved; bases contiguous. Stemmata well-developed, 6 present on each side of head. Frontoclypeal suture absent. Fronotoclypeal region with 3 long setae anterior to angles of frontal arms, 1 pair anterior to the apex of the frontal arms on each side of the head, 1 pair medially between the frontal arms, and 1 pair at the apex of the frontoclypeal region near the clypeolabral suture. Clypeolabral suture complete. Labrum free (Fig. 2G), with 5 pairs of setae. Epipharynx medially glabrous, 6 anterior setae on each side. Antennae 3segmented, ratio of lengths of antennomeres 1, 2, and 3 about 1.0: 1.4: 1.0. Mandibles (Fig. 2H) heavily sclerotized, symmetrical, apices bidentate with a smaller subapical tooth; with 2 dorsolateral mandibular setae present; prostheca acuminate, spinelike, with a broad base; mola with numerous setae medially and posteriorly. Maxilla (Fig. 2E) with cardo, divided by an internal ridge, basal portion trapezoidal, with 1 moderately elongate seta near basal margin; stipes elongate; mala falciform, mala falciform with 5 apical spines and a medial brush composed of several thick setae; maxillary palpus 3segmented, segment 1 asetose, segment 2 with 3 setae, segment 3 with 1 seta and 4 minute apical setae. Labium (Fig. 2F) with conspicuous mentum and prementum; mentum about as long as wide, with 3 pairs of setae, prementum with 3 pairs of setae; ligula transverse, with anterior microtrichia; labial palpi 2 segmented.

Thorax: Meso and metathorax tergites, and abdominal tergites and ventrites 18 each with 1 transverse ridge near anterior margin, ridge on ventral surface of abdominal segment 1 smaller lightly sclerotized. Prothorax subquadrate, transverse, 0.5 times as long as wide, sides curved, dorsal surface smooth; prosternal surface smooth, 3 setae (1 elongate) at anterolateral angles and 2 short setae at posterolateral angles; prosternum trapezoidal, sides oblique, posterior margin straight, a pair of medial setae present posterior to posterior margin of presternum. Meso- and metathorax transverse, both 0.5 times as long as wide, sides curved, surface of both tergites smooth with 3 short seta at anterolateral angles and 2 short setae at posterolateral angles; both sterna without well- defined subdivisions, each smooth with a pair of discal setae near anterior margin; spiracular sclerite projecting strongly from lateral margin, spiracles (Fig. 2C) annular and angled posterolaterally. Legs (Fig. 2D) moderately long, 5segmented; claw falciform, with 2 setae.

Abdomen: Segments 17 transverse, tergite surface smooth with 2 setae anterior to spiracles and 2 setae posterior to spiracles; ventrite surface with 3 setae, 2 anteriorly and 1 posteriorly. Segment 8 enlarged, tergite (Fig. 2I) with a stout spicule at each posterolateral margin, posterolateral angles with 8 short setae, 3 pairs of short setae anteromedially, 2 pairs of short setae posteromedially. Ventrite (Fig. 2J) with 9 pairs of setae and large stout process posteriorly with numerous minute setae apically. Tergite 9 with a basally forked process, directed dorsad, as wide as long; base of process with a pair of short, apically forked processes, 1 short seta at apex of forked process; anterior margin with lateral curved processes projecting from tergite 8; sternite 9 reduced and concealed from above.

Adults

Given the differences discovered in the larvae of the 2 subspecies, we examined adults to determine if there were corresponding adult differences. We examined 120 adult specimens of *C. c. clavipes* in the FSCA from the following states and provinces: CANADA: Ontario; USA: Colorado, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Mississippi, Missouri, New York, New Jersey, North Carolina, Ohio, Pennsylvania, Virginia, Wisconsin. We examined 46 adult specimens of *C. c. puniceus* in the

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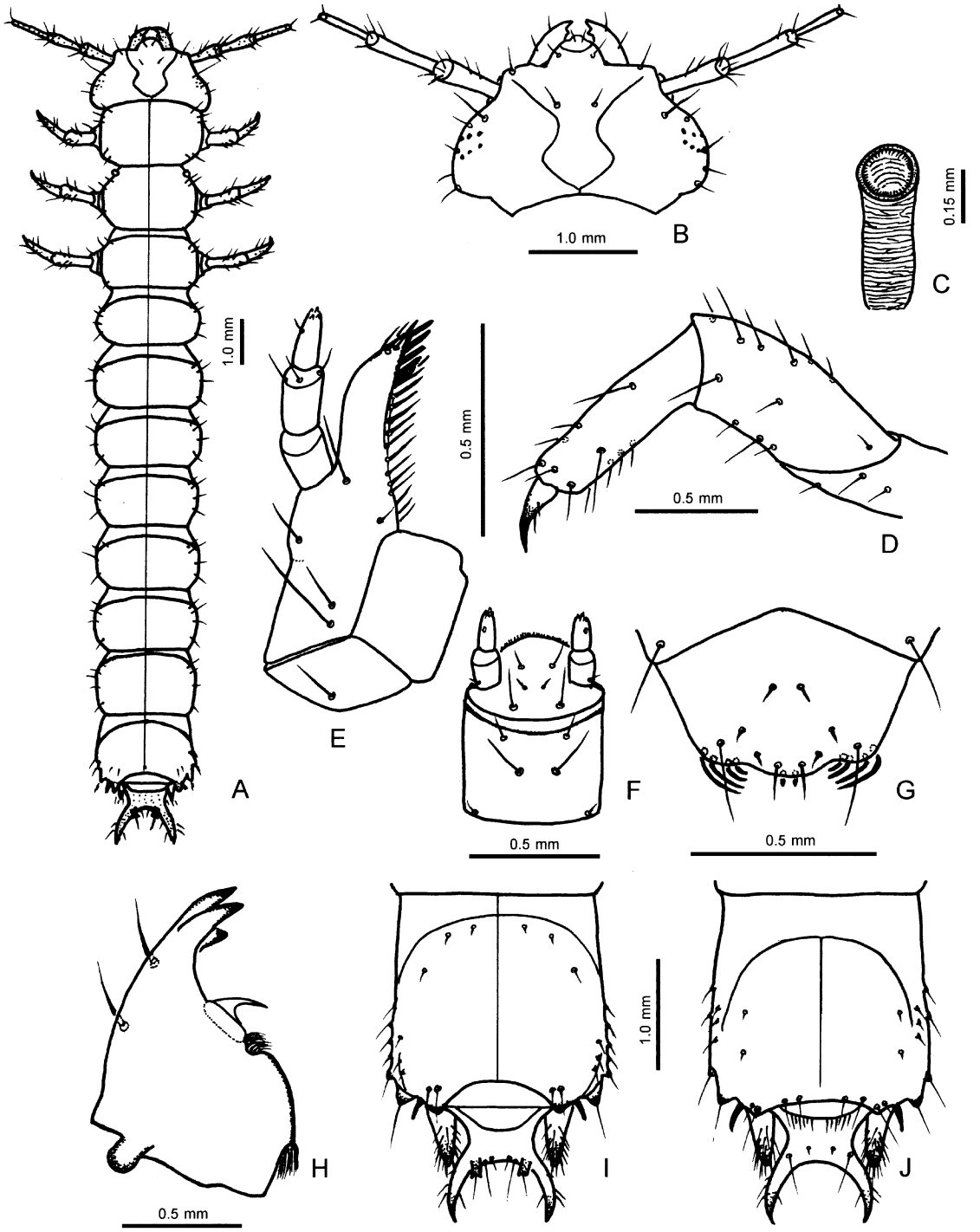


Fig. 2. Larva of *Cucujus c. puniceus*. A, habitus, dorsal view; B, head, dorsal view; C, A7 spiracle, D, prothoracic leg; E, left maxilla, dorsal view; F, labium, ventral view; G, labrum, dorsal view; H, left mandible, dorsal view; I, abdominal segments 89, dorsal view; J, same, ventral view.

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FSCA from the following states and provinces: CANADA: Alberta, British Columbia; USA: Alaska, California, Idaho, Oregon.

As noted in previous literature, *C. c. clavipes* has a black scape, while *C. c. puniceus* has a red scape. However, specimens of *C. c. puniceus* from Alaska have black scapes. We had formed the impression that individuals from the western U.S. were on average more elongate than those from the eastern part of the country. Measurements of series from both populations revealed considerable overlap in body proportions, with specimens of the *C. c. puniceus* slightly more elongate, ranging in size from 12.5mm to 16.6mm, while specimens of *C. c. clavipes* ranged in size from 9.5mm to 14.6mm.

Lee and Sato (2007) found taxonomically useful genitalic differences among Asian species of *Cucujus*. Male genitalia from specimens of *C. clavipes* from all parts of its distribution were examined and found to be indistinguishable.

Conclusions

Despite the larval differences, the lack of consistent and significant morphological differences in the adults suggests that at this point given the state of our knowledge, the present treatment of these 2 populations as subspecies of the same species is valid. Research into molecular differences may prove useful in understanding the limits of both taxa.

Acknowledgments

We thank Chi Feng Lee and John Marris and 2 anonymous reviewers for reviewing a previous draft of this manuscript. George Ball generously lent larvae from the University of Alberta collection. This is Entomology Contribution No. 1180 of the Bureau of Entomology, Nematology, and Plant Pathology, Florida Department of Agriculture and Consumer Services. This research was supported by a grant to the senior author from the 2008 Academic Exchange Program of Andong National University.

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