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A North American biodiversity hotspot gets richer: A new species of whirligig beetle from the Southeastern Coastal Plain of the United States

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Abstract

A new species of *Dineutus* Macleay, 1825 is described from the Southeastern Coastal Plain of the United Sates. Habitus and aedeagus images as well as illustrations of elytral apices, protarsus, palps, and male mesopretarsal claws are provided for *Dineutus shorti* **n. sp.** and compared to those of *D. discolor* Aubé, 1838. The importance of the Southeastern Coastal Plain as a biodiversity hotspot and the potential conservation concern of *D. shorti* **n. sp.** also are discussed.

Keywords

Aquatic beetle, new species, biodiversity, conservation, Southeastern Coastal Plain

Introduction

Whirligig beetles are commonly encountered aquatic beetles and are well known for their whirling swimming pattern (Tucker 1969) and propensity to form aggregates of hundreds to thousands of individuals (Heinrich and Vogt 1980). These beetles are especially abundant in the southeastern United States where all four genera known to occur in the U.S. can be found (Epler 2010). The genus *Dineutus* Macleay, 1825 contains the largest species of gyrinids within the United States, with most species regularly over 10 mm in length (Gustafson and Miller 2015). The North American species of *Dineutus* were recently reviewed by Gustafson and Miller (2015).

The Southeastern Coastal Plain region of the United States is one of five areas in the country recognized as biodiversity hotspots (Blaustein 2008). This area exhibits exceptional endemism in freshwater macroinvertebrates, especially among mollusks, but also aquatic insects groups such as Trichoptera, which are known to have 450 species in the region, 75 of which are endemic (Smock and Gilinsky 1992). In this paper we describe a new species of *Dineutus* from the Southeastern Costal Plain and provide a discussion of the importance of this region as a biodiversity hotspot and the potential conservation concern for this new species.

Materials and methods

This new species originally was discovered in a series of 11 specimens among undetermined *Dineutus* in the Enns Entomology Museum, University of Missouri. Additional specimens were then identified among material from a recent collecting trip taken by GTG to Florida and Alabama in April 2015.

Terminology of dineutine structures and measurements follows Gustafson and Miller (2015). Images were obtained by use of a Leica MZ16 stereo microscope coupled with the Leica Application Suite V4.4 Extended Depth of Focus module, followed by image preparation with Photoshop CS5 (Adobe Systems Inc., San Jose, California). Location information given in brackets [ ] here did not appear on the specimen labels, but were inferred from available data.

Repositories The holotype and some paratypes are deposited in the United States National Museum of Natural History (Washington D.C.); additional paratypes are deposited in the Enns Entomology Museum (University of Missouri), Florida State Collection of Arthropods (Gainesville, Florida), Museum of Southwestern Biology

Arthropod Division (University of New Mexico), The Snow Entomological Museum (University of Kansas), and the private collection of GTG.

Results

Taxonomy

Dineutus shorti Gustafson & Sites, NEW SPECIES
(Figs. 1, 2A, 3A – C, 4, 6)

Type material. HOLOTYPE ♂: **FLA [FLORIDA]**: Santa Rosa Co., 5 mi. WNW Holt, Coon Camp Br. of Blackwater R., 11/VI/74, D.A. Hurd. PARATYPES: same data as holotype (2♂, 1♀); same data except C.L. Smith (3♂, 1♀); 4 mi. NW Holt "Beck's Branch" - Blackwater R., 11/VI/74, C.L. Smith & D.A. Hurd (1♂). Okaloosa Co., 1.5 mi. S. Munson, Sweetwater Creek, 14/VI/74, C.L. Smith (1♂); same data except D.A. Hurd (1♂). **AL [ALABAMA]**: Covington Co. Conecuh Nat. For., trib. of Yellow Riv. 31.0929, -86.5183, 43 m, 27.iv.2015, leg. G. Gustafson & S.M. Baca GGSB042715C1 (5 ♂, 10♀).

Diagnosis. *Size*. Male: length = 10.7 – 12.3 mm, width = 6.2 – 7.0 mm; Female: length = 10.4 – 11.8 mm, width = 5.6 – 6.7 mm. Body form (Fig. 1A,C) narrowly elongate oval, males slightly laterally expanded at midlength, in lateral view strongly dorsoventrally depressed, evenly convex with greatest convexity at scutellar region; elytral apices (Fig. 2A) broadly rounded in both sexes, without produced sutural angle, apicolateral sinuation weak, serrations and/or irregularities absent, elytra with distinct triangular pruinose region medially; male profemur with medium sized sub-apicoventral tooth; protibia club-shaped; male protarsus (Fig. 3A) narrow and parallel sided; male mesopretarsal claw (Fig. 3B) with straight ventral margin, narrowed in apical 1/4; venter (Fig. 1B,D) light red.

Description. *Size.* Male: length = 10.7 – 12.3 mm, width = 6.2 – 7.0 mm; Female: length = 10.4 – 11.8 mm, width = 5.6 – 6.7 mm.
Habitus. Medium sized member of genus; body form narrowly elongate-oval, attenuated anteriorly and posteriorly, widest point at middle of elytra; in lateral view strongly dorsoventrally depressed, evenly convex with greatest convexity at scutellar region.
Coloration. Dorsally head, pronotum, and elytra bronzy green in color, pronotum strongly reticulate laterally producing bronzy appearance, medially weakly pruinose and more darkly colored, elytra with medial darkly-colored pruinose region in form of large triangle, laterally and apically bronzed in appearance due to strong reticulation; venter including legs mostly uniformly light reddish orange.
Head. Dorsal eyes widely set, separated by ca. 2 ¾ x diameter of a dorsal eye, vertex with reticulation paramedially composed of elongate rectangular sculpticells, medially replaced by a microreticulation creating pruinose appearance; frons evenly covered in strong reticulation composed of ovoid to round sculpticells, even and shallow punctation

almost imperceptible and mostly effaced by uniform covering of reticulation, punctures separated by 3 – 4x diameter of a puncture, apicolateral corners nearly unwrinkled; frontoclypeal suture with posterior margin weakly arcuate, nearly straight, with lateral margins obtusely angled, almost arcuate; clypeus shallowly emarginate anteriorly, with strong reticulation composed of round sculpticells, even covering of punctation, punctures separated by 2 – 3x diameter of a puncture; labrum with dense covering of punctation marginally, punctures well impressed, separated by ca. 1 – 2x diameter of a puncture, punctation absent basomedially in small circular area, replaced by faint microreticulation, composed of elongate ovoid cells, faintly impressed; maxillary palps with ultimate palpomere narrow, anterior margin weakly obliquely truncate; labial palps with ultimate palpomere narrow, anterior margin truncate, weakly bifid.
Thorax. Pronotum with strong even reticulation laterally extending dorsally to medial boundary of dorsal eye, reticulation composed of round sculpticells, medially reticulation becomes more weakly impressed, sculpticells become more elongate, creating a weakly pruinose region on pronotal disc, even covering of punctation, punctures deeply impressed, medially punctures separated by ca. 2 – 3x diameter of a puncture, pronotal transverse impressed line strongly effaced medially, lateral marginal depression of pronotum weak, not greatly depressed except anteriorly, posterior margin of pronotum strongly sinuate; profemora with numerous tubercles basally on posterior surface, tubercles continuing apicad along posteroventral margin, male with one medium-sized profemoral sub-apicoventral tooth on posteroventral margin; protibia club-shaped with undulate lateral margin, posterior surface with shallow tubercles along length, male distolateral corner distinct; male protarsus relatively narrow and parallel-sided, protarsomeres I – V similar in size, ultimate protarsomere ca. 1 ¼ x length of penultimate; elytra laterally and apically strongly reticulate, reticulation composed of ovoid sculpticells, medially replaced by fine microreticulation composed of elongate parallel-sided sculpticells forming strongly pruinose triangular region extending 5/6 of elytral length, punctation evenly distributed, punctation composed of large deep punctures separated by ca. 2 – 3x diameter of a puncture, punctation especially evident in pruinose region, dense even covering of secondary micropunctation, most evident in pruinose region, micropunctures separated by 1 – 2x diameter of a puncture, lateral marginal depression narrow in basal 1/3, then strongly expanded laterally, then narrowed again in apical 1/3, all elytral striae faintly evident, weak apicolateral sinuation, elytral apices broadly rounded, sutural angle not produced in either sex; male mesopretarsal claws similar in size, anterior claw strongly curved, ventral margin straight, strongly narrowed in apical 1/4, apex of claw weakly curved.

Genitalia. Aedeagus with median lobe short, 3/4 length of parameres, parallel-sided for 3/4 its length, narrowed in apical 1/4 with mostly straight lateral margins, apex with tip obtusely rounded, in lateral view apex weakly narrowed at tip, not dorsally curved; parameres with lateral margins mostly straight, apices narrowly rounded, weakly recurved medially, setose in apical 1/2.

Sexual dimorphism. Males are larger in size than are females, although this species exhibits very little sexual dimorphism relative to other North American species, especially in the elytral apices. The female has a slightly stronger apicolateral sinuation of the elytral apex. The male body form is slightly broader than that of the female and

weakly laterally expanded at midlength. The tuberosity of the prolegs and the undulate lateral margins of the protibia are much more exaggerated in males.

Etymology. The specific epithet honors American aquatic coleopterist Dr. Andrew E. Z. Short, who is passionate about biodiversity, conservation, and water beetles.

Differential diagnosis. *Dineutus shorti* n. sp. is most similar to *D. discolor* Aubé, 1838 in general appearance. *Dineutus shorti* n. sp. of both sexes can be distinguished from those of *D. discolor* in the form of the elytral apices. More specifically, in *D. shorti* n. sp. the elytral apices of both sexes are broadly rounded with weak apicolateral sinuation (Fig. 2A), whereas in *D. discolor* the elytral apices are flatly rounded with strong apicolateral sinuation (Fig. 2B). The sutural angle of the elytra of *D. shorti* n. sp. is never produced to a point as is often the case with *D. discolor*. The males of *D. shorti* n. sp. can further be distinguished from those of *D. discolor* by the form of the male mesopretarsal claw. In *D. shorti* n. sp. the male mesopretarsal claws have the anterior claw with straight ventral margins and the apices strongly narrowed in the apical 1/4 (Fig. 3C), compared to those of *D. discolor* which have the ventral margins weakly curved and a medial denticle (Fig. 3E). The male protarsus and palps also differ in shape between the two species, with those of *D. shorti* n. sp. (Fig. 3A,C) relatively narrower and more parallel-sided compared to those of *D. discolor* (Fig. 3D,E). The aedeagus unambiguously distinguishes the two species because the median lobe of *D. shorti* n. sp. (Fig. 4) is significantly shorter than the parameres, whereas that of *D. discolor* is as long as the parameres (Fig. 5).

Distribution. This new species currently is known only from a narrow region in the Florida panhandle and southern Alabama (Fig. 6).

Habitat. Based on Conecuh National Forest locality: Medium sized stream running through longleaf pine forest, partially exposed, fine white sand bottom with brownish red water, likely from tannins. A video of the locality and of *D. shorti* n. sp. in the field is available from the following URL: https://www.youtube.com/watch?v=P-a1yJ9Ysg4&feature=youtu.be

Taxonomic key

The key in Gustafson and Miller (2015) can be modified as follows to incorporate *D. shorti* n. sp. [note that figure references in the key refer to those in Gustafson and Miller (2015).

7 (2) Elytral apices regularly rounded (Fig.3A), sometimes flatly rounded/subtruncate (Fig. 3B), but without modifications and not truly truncate (Fig. 3D) ……..... 8

— Elytral apices variously modified, either with true truncation (Fig. 3D), spinosity (Fig. 3E), and/or sutural angles produced to a more or less developed point (Fig. 3C) ……..…….. 12

8 (7) Elytral striae well developed, all nine elytral striae easily visible.

Primarily found in Mexico and Central America, reaching the extreme southwestern United States ……..…….…… ***Dineutus sublineatus***

— Elytral striae not well developed, fewer than nine striae visible, only medial striae evident on elytral disc. …...…….…...……...……. 9

9 (8) Elytral apices with serration and/or irregularities apically, apices either regularly (Fig. 3A) or flatly rounded (Fig. 3B); mesopretarsal claws with ventral margins shallowly curved (Fig. 11F) or with a weak denticle (Fig. 38F) ……..…. 10

— Elytral apices without serration or irregularities apically, apices regularly rounded (Fig. 38A); mesopretarsal claws with ventral margins straight (Fig. 17C) or anterior claw mostly straight with a slight ventral expansion at about half its length (Fig. 43C) ……. 11**M**

11**M** Venter distinctly light red; body form elongate oval and more attenuated anteriorly; elytra with a distinct triangular pruinose region. Only known from a narrow region in panhandle of Florida and southern Alabama. ……..…. ***Dineutus shorti* n. sp.**

— Venter distinctly darkly colored; body form much more evenly oval, less attenuated anteriorly; elytra without a distinct triangular pruinose region. More widespread species. ……...…...……...… 11(9)

26 (25) Venter distinctly light red to orange. Uncommonly collected species that are narrowly endemic. ….…….……..…… 27

— Venter dark brownish to black. Commonly encountered and more widely distributed species. ……...……..…….. 28**M**

27 Larger (13.6 – 15.1 mm); Body form broadly oval. Known only from the Appalachian Mountains of northeastern Georgia and southwestern North and South Carolina …….....……...… ***Dineutus robertsi***

— Smaller (10.4 – 10.6 mm); Body form narrow and elongate oval. Known only from a narrow range in the panhandle of Florida and southern Alabama ……..…. ***Dineutus shorti* n. sp.**

28**M** Larger (11.5 – 14.6 mm); Body form broadly oval; elytra with a distinct lateral bronzy stripe ……...…...…….. ***Dineutus ciliatus***

— Smaller (8.9 – 10. 2 mm); Body form broadly oval to narrowly elongate oval; elytra without a distinct lateral bronzy stripe ……... 28 (26)

Discussion

Dineutus shorti is the first unequivocally new species of Gyrinidae to be described in the U.S. for nearly a quarter century (the last was *Gyrinus rugosus* Oygur and Wolfe, 1991 described from northern California and southern Oregon). This charismatic family of insects is rivaled by butterflies and dragonflies as one that attracts attention from scientists and casual observers. Although the discovery of a new species of Gyrinidae in the U.S. may be surprising, finding it in the Southeastern Costal Plain region is not. This region has recently been argued to be an overlooked biodiversity hotspot of global significance (Noss et al. 2014) after its exclusion from a recent expansion of the global biodiversity hotspots (Mittermeier et al. 2011) from the original 25 proposed by Myers et al. (2000).

Within this region the Florida panhandle in particular is considered one of North America's five richest biodiversity hotspots (Blaustein 2008). Northwestern Florida comprises at least 57 ecosystem types, including hammocks, steepheads, and terrestrial caves (Northwest Florida Environmental Conservancy 2015). Aquatic habitats of the panhandle also are diverse and include swamps, river systems, tidal marshes, bogs, seepage slopes, and savanna wetlands. Panhandle river systems harbor numerous endemic species (Blaustein 2008) many of which are listed for protection. Jackson County alone harbors 152 species of rare and endangered species (Northwest Florida Environmental Conservancy 2015) and the Nokuse Plantation harbors 44 species that are listed as either rare, threatened, or endangered (Nokuse 2015).

Despite the abundance of biodiversity of great concern, numerous misconceptions about this region are now being addressed, including geological youth, unstable climate, and inundation (Noss et al. 2014). There is certainly evidence for the age and stability of the region within the family Gyrinidae, as the Southeastern Coastal Plain is home to the intriguing and "primitive" *Spanglerogyrus albiventris* Folkerts, 1979 (Steiner and Anderson 1981, Epler et al. 2005). Recent phylogenetic analysis placed this species as sister to all the remaining Gyrinidae, holding the basal most position in the phylogeny and supporting its antiquity relative to the remaining Gyrinidae (Miller and Bergsten 2012). This monotypic subfamily is found nowhere else in the world. It is unclear to what extent the geology of the region has contributed to the dramatic diversity and endemism of the biota. James (1961) considered that only relatively few factors played a role in the origin of regional endemism in Florida, and that edaphic or other habitat factors probably were responsible for the regional endemism of plants. A broad geological transition occurs in the central panhandle, grading from the Chattahoochee Anticline laterally across the Gulf Trough into the St. Marks Formation (Scott 1986). This, in part, has likely resulted in some of the diversity in aquatic habitats and consequently in the endemism and diversity of the constituent biota. Misconceptions of a homogenous environment in this region have been further addressed by Noss et al. (2014).

This new species occurs in the Southern Pine Plains and Hills ecoregion of the Florida panhandle and southern Alabama (Griffith et al. 2012, 2015), a region previously recognized as being part of a freshwater ecosystem of critical importance, especially for invertebrates (Lydeard and Mayden 1995). The Conecuh National Forest in Alabama and Blackwater River State Park in Florida where the new species was collected (Fig. 6), is part of a natural stand of longleaf pine (*Pinus palustris* Miller) at least older than 40 years

(Trani 2002). Longleaf pine forests once dominated the southern coastal plains region, but have been severely diminished, negatively affecting endemic species (Trani 2002). Collecting from outside these older stands and the Southern Pine Plains and Hills ecoregion failed to produce additional specimens of *D. shorti*; instead the much more common and widespread *D. discolor* was encountered (Fig. 6). Thus, *D. shorti* may indeed be restricted to streams within this narrow corridor of old stand longleaf pine within the Southern Pine Plains and Hills ecoregion of Florida and Alabama (Fig. 6). In a recent paper predicting habitat loss in areas of biodiversity significance within the U.S., Martinuzzi et al. (2013) predicted this region could experience 10 – 20% habitat loss between the years 2001 and 2051. Given the already extremely reduced range of longleaf pine, further habitat loss poses a serious threat to species that appear restricted to relatively undisturbed longleaf pine stands, such as *D. shorti*. If *D. shorti* is restricted to areas of old-growth longleaf pine, and given the predicted loss of habitat within the region, this new species may already be worthy of formal protection status. That a large, charismatic beetle remained hereto undiscovered highlights the obvious need for increased surveys of the aquatic invertebrates of this region (Lydeard and Mayden 1995) in order to discover unrecognized biodiversity, including other species of conservation concern.

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Figure captions

Fig. 1. Habitus of *Dineutus shorti* n. sp. (A) Dorsal habitus ♀ paratype. (B) Ventral habitus ♀ paratype. (C) Dorsal habitus ♂ holotype. (D) Ventral habitus ♂ holotype. Scale bars = 5 mm.

Fig. 2. Right elytral apex of both sexes. (A) *Dineutus shorti* n. sp. (B) *Dineutus discolor*. Scale bars = 2 mm.

Fig. 3. Morphology of *Dineutus shorti* n. sp. A – C and of *Dineutus discolor* D – E. (A) Protarsus, scale bar = 1.4 mm. (B) ♂ mesopretarsal claw, scale bar = 0.2 mm. (C) Maxillary palp above, labial palp below, scale bar = 0.2mm. (D) Protarsus, scale bar = 1.3 mm. (E) ♂ mesopretarsal claw, scale bar = 0.2 mm. (F) Maxillary palp above, labial palp below, scale bar = 0.2mm.

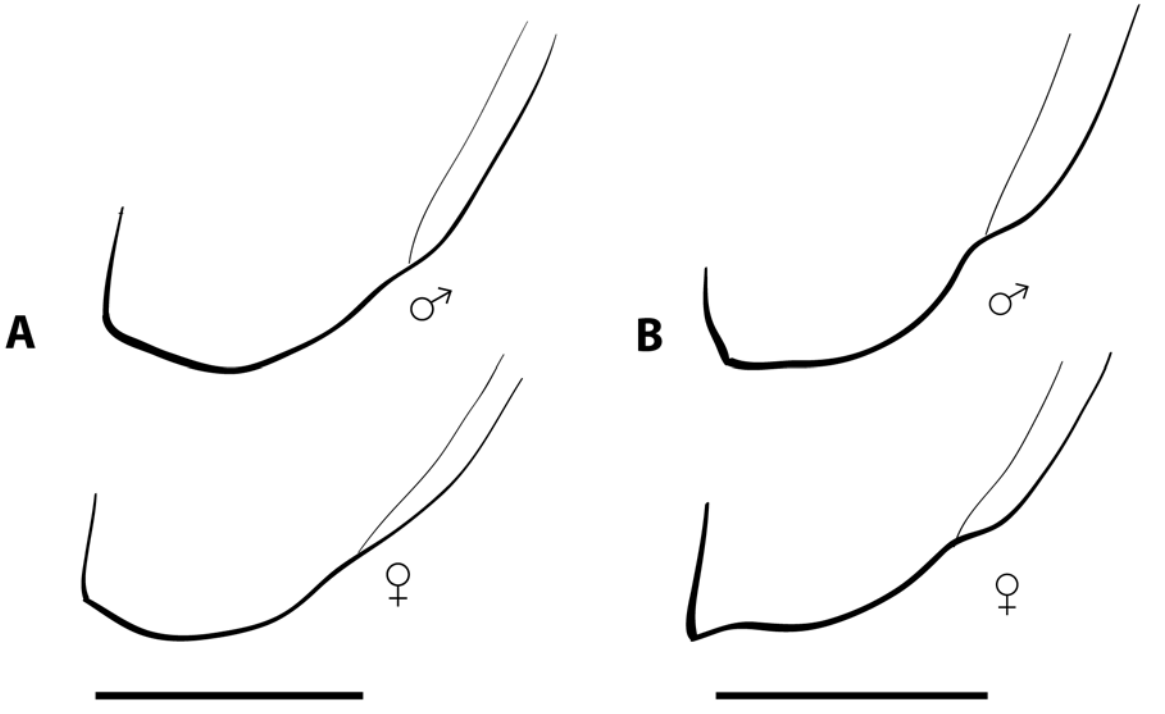
Fig. 4. Aedeagus of *Dineutus shorti* n. sp. holotype. (A) Dorsal view. (B) Ventral view. (**C**) Lateral view. Scale bar = 1 mm.

Fig. 5. Aedeagus of *Dineutus discolor*. (A) Dorsal view. (B) Ventral view. (C) Lateral view. Scale bar = 1 mm.

Fig. 6. Areas collected in April 2015 by GTG, including the type series localities. Circles = *Dineutus shorti* n. sp., triangles = *Dineutus discolor* collected during April, 2015, hatched region represents Southern Pine Planes Region as designated by Griffith et al.

(2012, 2015), lighter gray region is natural range of longleaf pine (*Pinus palustris*), darker gray is natural stands older than 40 years after Trani (2002).


A
B
C
D


A
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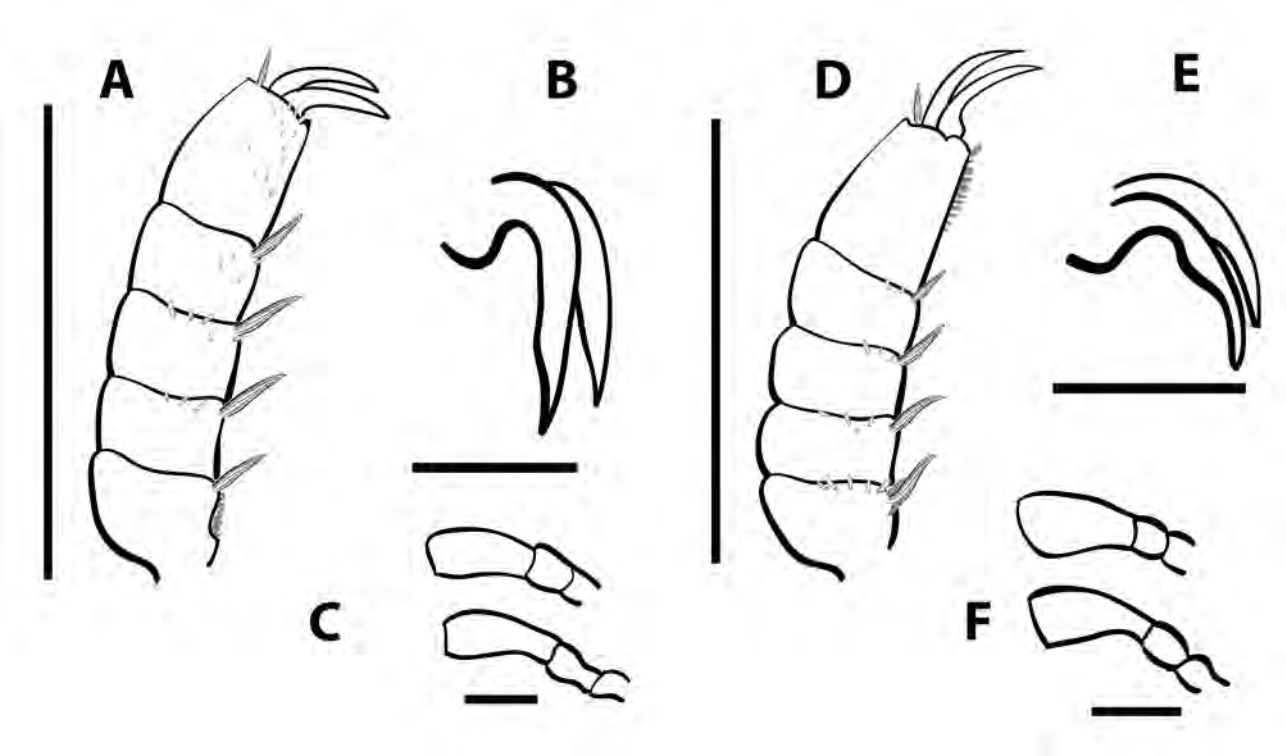
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A
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