



TWO NEW SPECIES OF STONEFLIES IN THE *LEUCTRA FERRUGINEA* GROUP (PLECOPTERA: LEUCTRIDAE), WITH NOTES ON THE *LEUCTRA* SPECIES KNOWN FOR MISSISSIPPI AND ALABAMA, U.S.A.

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ABSTRACT

Leuctra colemanorum sp.n. and *L. hicksi* sp.n. are proposed from Mississippi specimens and compared to related members of the *L. ferruginea* (Walker) complex. *Leuctra colemanorum* is placed in the *L. ferruginea* subgroup and *L. hicksi* is placed in the *L. rickeri* James subgroup. Comparative SEM images are provided for *L. alabama* James, *L. ferruginea*, *L. paleo* Poulton & Stewart, *L. rickeri* and *L. szczytkoi* Stark & Stewart, and updates are provided for the *Leuctra* species lists for Mississippi and Alabama. The first records of *L. triloba* Claassen from Alabama, *L. ferruginea* for Louisiana and Tennessee, and *L. carolinensis* Claassen for Mississippi are presented. Potential synonymies of *L. rickeri* with *L. alabama* and *L. paleo* with *L. szczytkoi* are suggested.

Keywords: Plecoptera, Leuctridae, *Leuctra ferruginea* group, Mississippi, new species

INTRODUCTION

Genus *Leuctra* currently includes 198 species (DeWalt et al. 2010); 171 of these are Palearctic with most occurring in western Europe. The 26 species recognized in eastern North America in the 1990's were tentatively placed in five species groups [*L. biloba* Claassen group; *L. duplicata* Claassen group; *L. ferruginea* (Walker) group; *L. grandis* Banks group; *L. tenuis* (Pictet) group] by Harper & Harper (1997), and two species [*L. crossi* James; *L. moha* Ricker] were left unplaced. Subsequently, only *L. pinhoti* Grubbs & Sheldon, a member of the *L. biloba* group, has been added to the Nearctic *Leuctra* species list (Grubbs & Sheldon 2009).

Although James' studies (1974; 1976) resulted in recognition of five new regional species, *Leuctra* diversity has remained difficult to evaluate in the Gulf South region due, in part, to the restriction of most species to spring outflows which are often

inaccessible, and in part, to the lack of a comprehensive taxonomic revision of the species reported for eastern North America. Although nothing is likely to help the first problem, Harper & Harper (1997, 2003) have made valuable contributions which address the second.

Stark (1979) reported *L. cottaquilla* James, *L. rickeri* James and *L. tenella* Provancher from Mississippi and unpublished records of *L. ferruginea* (Walker) and *L. tenuis* (Pictet) are included in various internet versions of the list of North American stoneflies maintained by Stark et al. (2009). Stark & Harris (1986) list nine *Leuctra* species for Alabama and one was recently added by Grubbs & Sheldon (2009); most of the Alabama records are from James (1972) unpublished dissertation or from her two publications on the genus (James 1974, 1976). Unfortunately, the identities of several of these species have been confused, and this is especially

true for species of the *L. ferruginea* group.

James (1976) recognized *L. alabama* James, *L. ferruginea* and *L. rickeri* in the *L. ferruginea* complex, and two additional members, *L. paleo* Poulton & Stewart and *L. szczytkoi* Stark & Stewart have subsequently been added (Poulton & Stewart 1991; Stark & Stewart 1981). Harper & Harper (1997) recognized two subgroups in the complex; according to these authors, the *L. ferruginea* subgroup includes *L. alabama*, *L. cottaquilla*, *L. ferruginea* and (with question) *L. truncata* Claassen, whereas the *L. rickeri* subgroup includes *L. paleo*, *L. rickeri* and *L. szczytkoi*. James (1976) based her concept of *L. ferruginea* on specimens "...from New York in the INHS..."; these specimens were said to have "...setae rather than spurs..." on the tips of the inner lobes of the paraprocts, in addition to a rounded rather than triangular 8th tergal lobe. However, the true character of the paraproct armature is poorly documented for all these species.

This study was initiated when the senior author discovered a population of winter emerging stoneflies in the *L. ferruginea* complex in remote springs of Yalobusha Co., Mississippi. Using light microscopy the paraproct apices exhibit what appear as several small knobs along the ventrocaudal margins of the inner lobes, in addition to a grouping of three or more larger spines nearer the tips. A second, potentially new species in the *L. rickeri* subgroup was subsequently discovered among specimens collected in southeastern Mississippi. In order to determine the details of paraproct armature as precisely as possible, we examined specimens with scanning electron microscopy. In addition, specimens from other Mississippi populations clearly identified as members of this complex, along with specimens from Alabama, Arkansas, Louisiana, Illinois, Newfoundland, New Jersey, New York, Nova Scotia, Pennsylvania and Tennessee, were examined for comparison. We follow the terminology adopted by Pardo & Zwick (1993) for male genitalic structures.

MATERIALS AND METHODS

Specimens were hand collected from vegetation, or from a beating sheet, preserved in 80% ethanol and examined using an Olympus SZH10 or Wild M5 stereomicroscope. Comparative specimens were

obtained from R.W. Baumann, Monte L. Bean Life Sciences Museum, Brigham Young University (BYU), B.C. Kondratieff, C.P. Gillette Museum, Colorado State University (CSU), R.E. DeWalt, Illinois Natural History Survey (INHS), J.I. Earle, Mechanicsburg, Pennsylvania (JIE), P. Lago, University of Mississippi (UM) and T.L. Schiefer, Mississippi Entomological Museum, Mississippi State University (MEM), and additional material was obtained from the Stark collection, Mississippi College (BPS). Holotype specimens are placed in the Illinois Natural History Survey (INHS) and paratypes are placed in the University of Mississippi collection (UM), Stark collection (BPS) or the Harrison collection (AH).

Specimens selected for SEM study were placed in an ultrasonic cleaner for 15 seconds, dehydrated through a series of 90%, 95% and 100% ethanol solutions for 10 minutes each, and placed in Hexamethyldisilazane for 30 minutes. Dehydrated specimens were attached to aluminum stubs with double stick copper tape and coated with gold-palladium using a Humer sputter coater. Coated specimens were examined using an Amray 1810 scanning electron microscope and digital images were captured with an Orion system.

RESULTS AND DISCUSSION

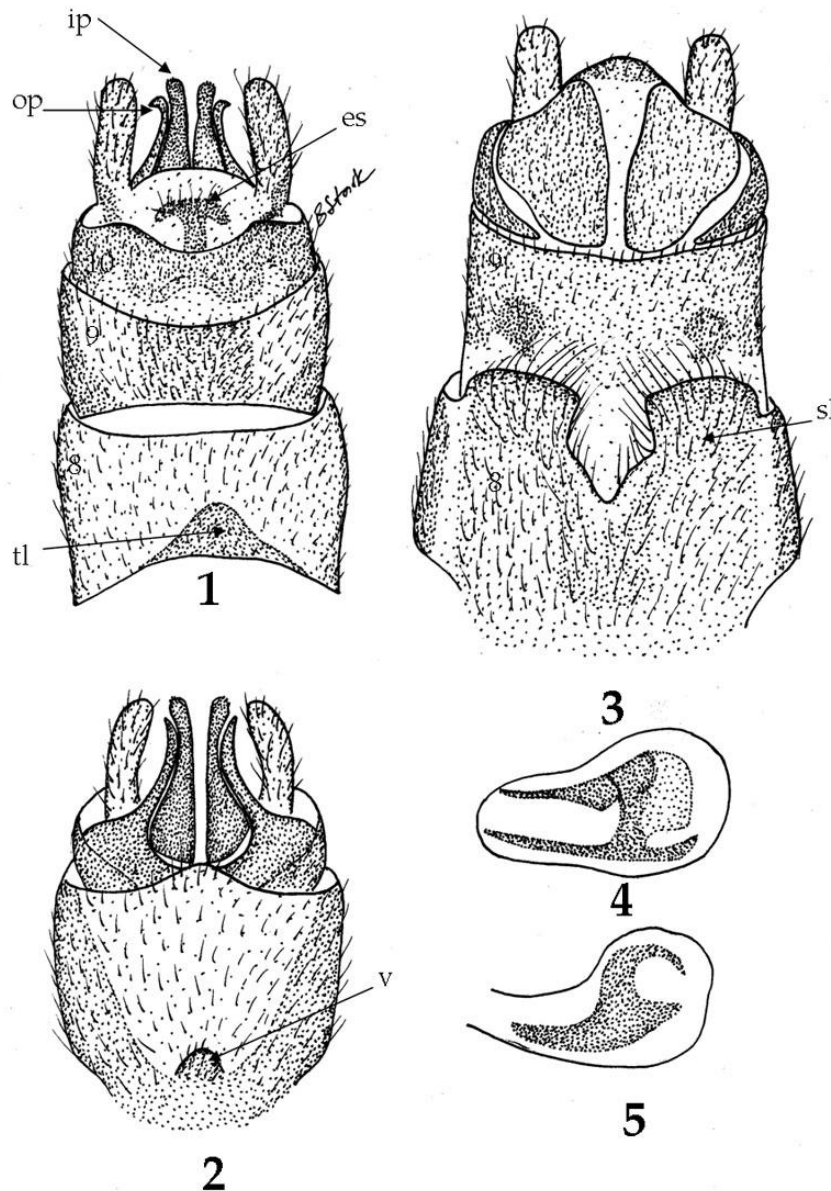
Leuctra colemanorum sp.n.

(Figs. 1-14, 41-44)

Material examined. Holotype ♂ and 16♂, 15♀ paratypes, Mississippi, Yalobusha Co., Denly Spring #2, Air Mount Road West, 33.96972° N, 89.56572° W, 24 October 2009, A. Harrison (holotype INHS, paratypes BPS, AH). Additional paratypes: Mississippi: Calhoun Co., spring 13 mi NW Bruce, 20 February 1981, J. Goddard, 2♂, 11♀ (UM). Yalobusha Co., Denly Spring #1, near Air Mount Road, 33.97216° N, 89.55018° W, 24 October 2009, A. Harrison, 10♂, 7♀ (INHS). Yalobusha Co., spring near Air Mount Road, 33.96986° N, 89.55762° W, 24 October 2009, A. Harrison, 1♀ (BPS). Yalobusha Co., spring near county road 215, Benwood, 33.97635° N, 89.55013° W, 24 October 2009, A. Harrison, 1♀ (BPS). Yalobusha Co., Rockhouse Spring, 33.53458° N, 89.30257° W, 8 February 2009, A. Harrison, 9♂, 5♀

(BPS). Yalobusha Co., Coleman Spring, 33.53147° N, 89.32648° W, 23 December 2008, 1♂ (AH). Same site, 16 January 2009, A. Harrison, 4♂, 3♀ (AH). Same site, 31 January 2009, A. Harrison, 6♂, 1♀ (BPS). Same site, 3 October 2009, A. Harrison, 7♂, 5♀ (BPS). Same site, 16 January 2010, A. Harrison, 1♂ (BPS). Yalobusha Co., 2nd

tributary of Coleman Spring, 21 September 2009, A. Harrison, 3♂, 3♀ (AH). Other material: Mississippi: Yalobusha Co., Coleman Spring, 23 December 2008, A. Harrison, 1 larva (AH). Same site, 3 October 2009, A. Harrison, 3 larvae (BPS). Same site, 16 January 2010, A. Harrison, 5 larvae (BPS).



Figs. 1-5. *Leuctra colemanorum*. 1. Male terminalia, dorsal. 2. Male terminalia, ventral. 3. Female terminalia, ventral. 4. Spermathecal sclerite, oblique dorsal aspect. 5. Spermathecal sclerite, lateral, anterior margin on right. (es = epiproct sclerite; ip = inner lobe of paraproct; op = outer lobe of paraproct; sl = lobe of subgenital plate; tl = tergal lobe; v = vesicle)

Adult habitus. General color dark brown without distinctive head pattern. Wings brown, legs pale brown. General appearance typical of genus.

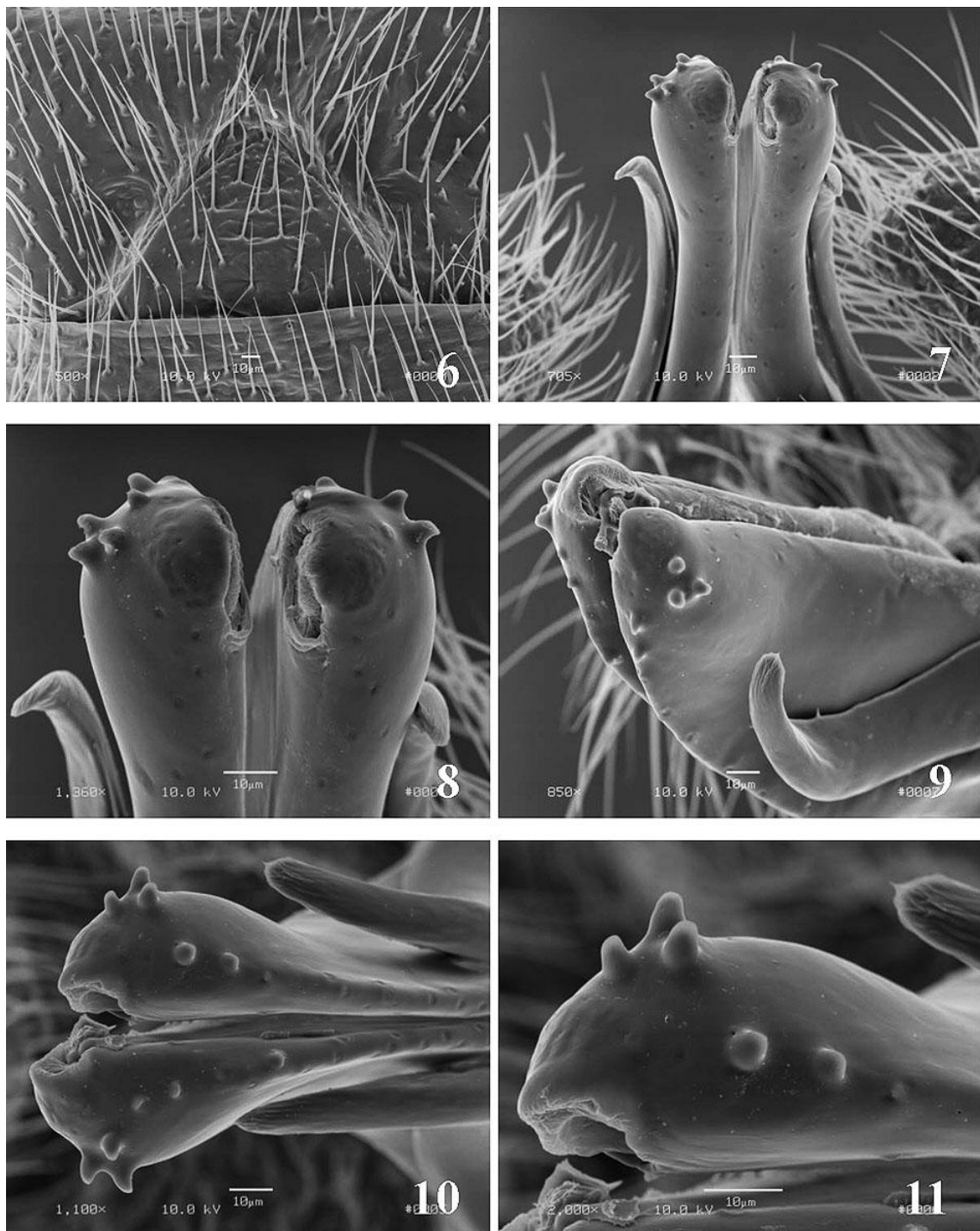
Male. Forewing length 6-6.5 mm (N=10). Epiproct sclerite mushroom shaped; median sclerite on tergum 9 large, covering most of field. Anterior margin of tergum 8 bearing a low, triangular lobe; posterior margin of lobe typically rounded (Figs. 1, 6). Outer lobes of paraprocts shorter than inner lobes, broad in basal third (Fig. 2), but narrowed in remainder and curved forward in apical third to form a blunt hook (Figs. 8-10). Inner paraproct lobes (specilla) somewhat cylindrical in anterior aspect (Fig. 1), widest basally and tapered to a bluntly rounded knob (ca. 38µm wide) (Figs. 1, 7); from lateral aspect (Fig. 9) the inner lobes are straight along their dorsal (anterior) margins and smoothly curved along their ventral margins to a bluntly rounded apex. Outer subapical margins of inner paraproct lobes bear a cluster (3-6) of low rounded tubercles (ca. 4.5-6 µm long), and caudoventral margins bearing a series (2-5) of slightly smaller, additional tubercles beginning near the apex and continuing along caudoventral keel (Figs. 7-11). Vesicle on sternum 9 small and triangular (Fig. 2).

Female. Forewing length 7-7.5 mm (N = 5). Subgenital plate projects over base of sternum 9 (Fig. 3). Posterior margin of plate bearing a median notch, slightly expanded mediolaterally; lobes truncate and conspicuously hairy. Spermathecal sclerite dark brown, semicircular in dorsal aspect with long, slender ventrolateral blade-like structures (Figs. 4-5).

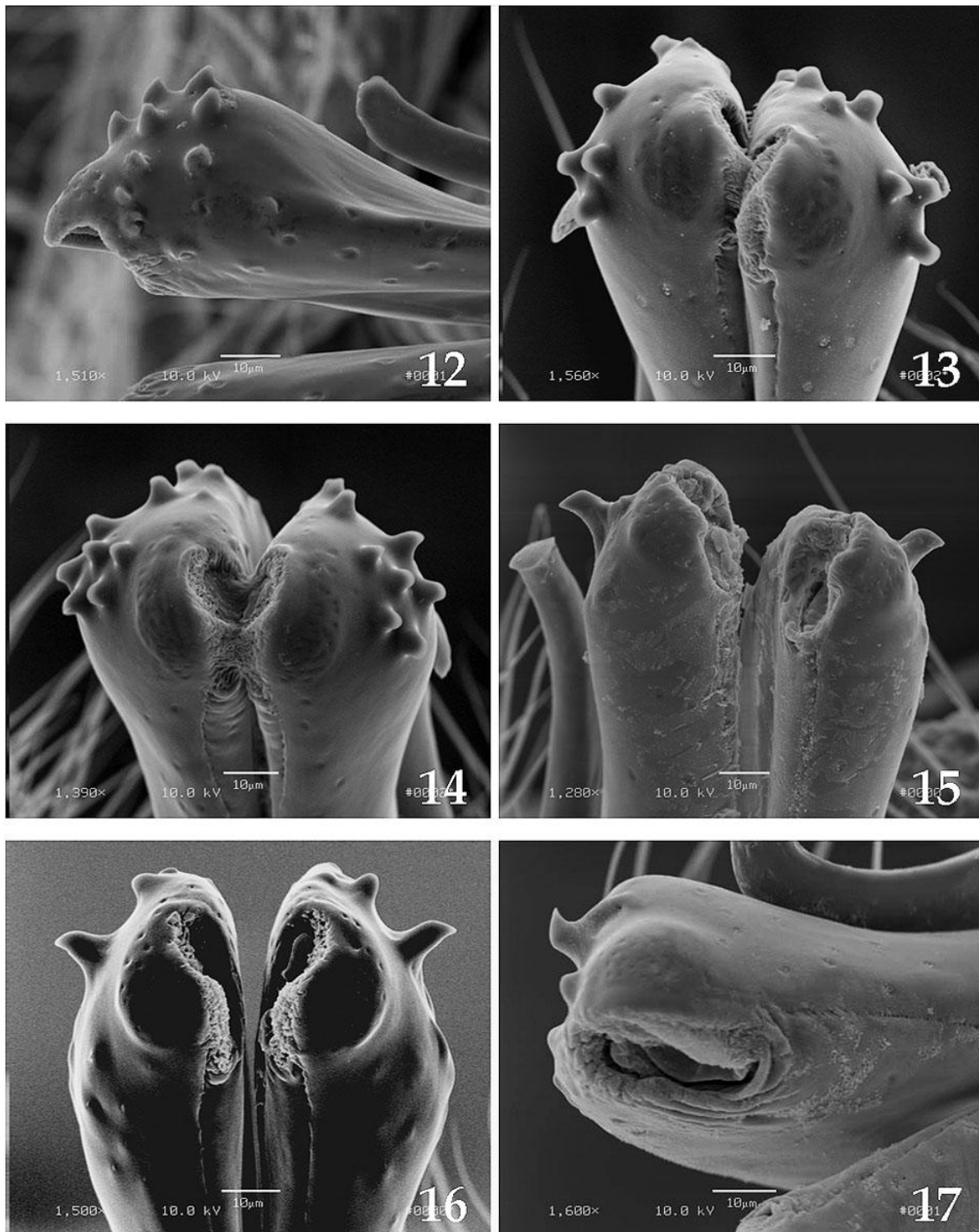
Larva. Pre-emergent body length 6-7 mm (N = 4). General color pale brown with obscure pattern on head; occiput with faint, irregularly elongate mottled areas and ocellar area often with a slightly darker median T-shaped line (Fig. 41). Pronotum bearing 4-6 mixed length setae at anterolateral corners and 1-2 finer setae at posterolateral corners (Fig. 41); mesonotum with a few short anterolateral setae, wingpads bare. Apical abdominal segments with posterolateral fringe row well developed and consisting of close-set, short thick setae (Fig. 42); intercalary setae short, thick and restricted to posterior half of each tergum, sterna typically bare except for a single long seta on sternum 9. Paraprocts with heavy fringe of short, thick marginal setae.

Cerci with ca. 20 segments; posterior margins of basal segments with apical fringe composed of short setae which become progressively longer through ca. segment 14, longer setae more numerous laterally; setal fringe on apical cercal segments consisting of a few, often only one, seta (Figs. 43-44).

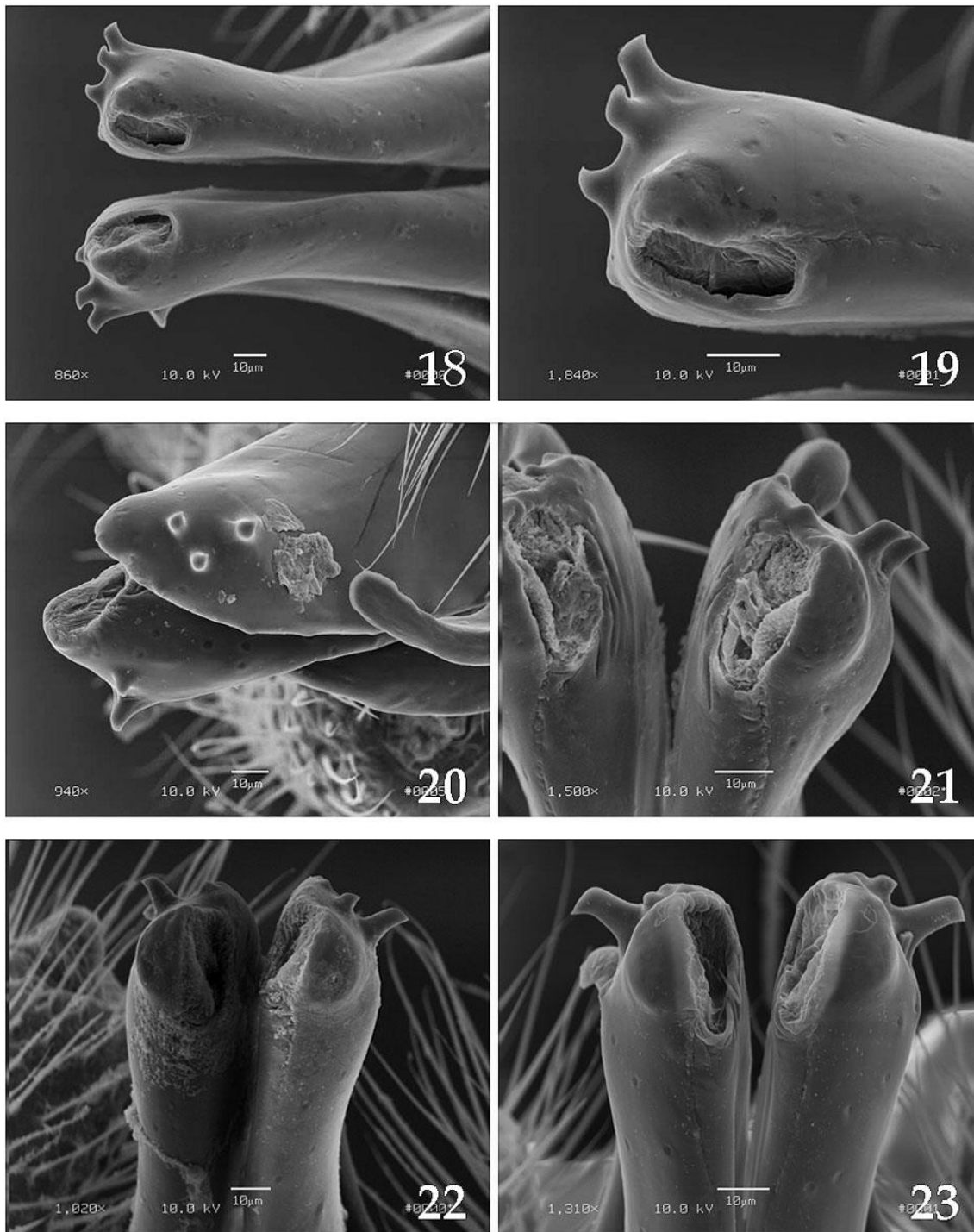
Diagnosis. This species is a member of the *L. ferruginea* subgroup and is difficult to distinguish from *L. ferruginea* proper using dissecting microscopes, but the two species may be resolved with compound microscopy (400X) or scanning electron microscopy. Because the lectotype (and two paralectotypes, Kimmins 1970) from Nova Scotia (British Museum of Natural History) of *L. ferruginea* are females designated by Ricker (1938), we sought male specimens of the *L. ferruginea* complex from Nova Scotia (the type locality) and other Canadian and New England localities to assist in resolving the identity of *L. ferruginea* (Walker 1852) and its synonym, *L. decepta* Claassen (1923) described from the Ithaca, New York area. R.W. Baumann, B.C. Kondratieff and J.I. Earle graciously provided specimens from Nova Scotia, Newfoundland, New York, New Jersey, Pennsylvania and Tennessee which we examined with SEM. Several images (Figs. 18-23), provided for comparison, indicate the paraprocts for *L. ferruginea* are similar in shape to those of *L. colemanorum* but the apical armature in the former species consists of 1-3 apicolateral, small spurs; typically these spurs are slightly longer and hooked laterad (as shown in Fig. 8 of Harper & Harper 2003) rather than consisting of low rounded tubercles of the type found in *L. colemanorum*. Nova Scotia specimens, presumed to be typical for the species, show 2 or 3 hooked apical spurs as in Figs. 18-19, and specimens from two New York localities (Figs. 21-22) are also similar in this respect. Some specimens from the northeast may also bear one or more caudoventral tubercles but the grouping, position and shape of the major spurs appears to be distinctive. Images are also provided for specimens of *L. ferruginea* found at Mississippi (Figs. 15-17) and Tennessee sites. These southern specimens, and those from Washington Parish, Louisiana, typically have only one major dorsoapical spur and often a smaller, distal spur or tubercle.



Figs. 6-11. SEM images, *Leuctra colemanorum* male structures, Coleman Spring, Yalobusha Co., Mississippi. 6. Process on abdominal tergum 8. 7. Paraprocts, anterodorsal aspect. 8. Apex of paraprocts, anterodorsal aspect. 9. Paraprocts, lateral aspect. 10. Paraprocts, caudoventral aspect. 11. Paraproct apex, caudoventral aspect.



Figs. 12-17. SEM images, *Leuctra* spp. male paraprocts. 12. *L. colemanorum*, 13 mi NW Bruce, Calhoun Co., Mississippi, caudoventral aspect. 13. *L. colemanorum*, Denly Spring #1, Yalobusha Co., Mississippi, anterodorsal aspect. 14. *L. colemanorum*, Denly Spring #2, Yalobusha Co., Mississippi, anterodorsal aspect. 15. *L. ferruginea*, tributary Tom Way Branch, Amite Co., Mississippi, anterodorsal aspect. 16. *L. ferruginea*, Woods Spring, Choctaw Co., Mississippi, anterodorsal aspect. 17. *L. ferruginea*, Mill Creek, Simpson Co., Mississippi, anterodorsal aspect.



Figs. 18-23. SEM images, *Leuctra ferruginea* male paraprocts. 18. NE Margaree River, Inverness Co., Nova Scotia, anterodorsal aspect. 19. Nova Scotia, Inverness Co., apex, anterodorsal aspect. 20. Nova Scotia, Inverness Co., apex, lateral aspect. 21. North Branch Saramac River, Franklin Co., New York, apex, anterodorsal aspect. 22. Governor Brook, Hamilton Co., New York, apex, anterodorsal aspect. 23. Doghobble Branch, Sevier Co., Tennessee, apex, anterodorsal aspect.

The larva (Figs. 41-44) is identified as *L. ferruginea* using Harper & Hynes (1971) but in the few specimens available, the new species has almost no setae on the basolateral margins of the mesonotum whereas *L. ferruginea* is shown with a small setal cluster in this position by Harper & Hynes (1971). In addition, *L. ferruginea* has at least one seta shown in profile on several ventral abdominal segments and in *L. colemanorum* specimens these are absent, except for sternum 9. Larvae of the new species are also quite similar to those of *L. szczytkoi*, but that species also has several basolateral setae on the mesonotum and a single ventral seta on sterna 8 and 9 (DeWalt & Stark 1996).

Etymology. The species name honors Elizabeth and Red Coleman, grandparents of the senior author, and landowners of the Coleman Spring site where the species was discovered.

Comments. Collections of the new species are from seven different springs (8 total sites) in Yalobusha and Calhoun counties, Mississippi, all located on private property. These springs drain into tributaries of the Skuna River or the Yalobusha River above Grenada Reservoir. The Yalobusha and Skuna are tributaries of the Yazoo River system of northwestern Mississippi. Adults were present between 21 September and 8 February.

Leuctra hicksi sp.n.
(Figs. 24-34)

Material examined. Holotype ♂ and 3♂, 7♀ paratypes, Mississippi, Perry Co., Cypress Creek, Hwy 29, Camp Shelby, 31.07194° N, 89.00775° W, 23 December 2009, B. Stark (holotype INHS, paratypes BPS). Additional paratypes: Same site, 26 December 2007, M. Hicks, 1♂, 2♀ (BPS, MH). Perry Co., Ashley Creek/Cypress Creek, FR 3500, ~ 2 mi E Paret Lot Work Center, T1N R10W, Sec 5, 20 November 1996, R.E. DeWalt, 1♂, 5♀ (INHS).

Adult habitus. General color dark brown without distinctive head pattern. Wings brown, legs pale brown. General appearance typical of genus.

Male. Forewing length 5-5.5 mm (N = 4). Epiproct sclerite spade shaped; tergum 9 with a median, quadrangular sclerite, tergum 8 with a small, median, triangular sclerite; anterior margin of

tergum 8 heavily sclerotized (Fig. 24). Anterior margin of abdominal tergum 8 bearing an obscure, low, arcuate lobe, or lobe absent (Figs. 24, 29). Outer lobes of paraprocts very slender for most of length, but base expanded around base of inner lobe; apex strongly curved near the tip to form a blunt hook (Figs. 30-31). Inner paraproct lobes broad at the base (ca. 70 µm wide) and abruptly narrowed to ca. 28 µm in apical third (Figs. 25, 32-33); apices of outer lobes bearing a single, apical, laterally-directed spine ca. 23 µm in length (Figs. 30-33). Vesicle on sternum 9 small and triangular (Fig. 25).

Female. Forewing length 6-7 mm (N = 5). Subgenital plate projects over base of sternum 9 (Figs. 26, 34). Posterior margin of plate bearing a median U-shaped notch; lobes of plate hairy along margin, gradually narrowed and ending in bluntly rounded tips; median and marginal areas of plate dark brown (Fig. 26). Spermathecal sclerite dark brown, with expanded lateral blade-like structures (Figs. 27-28).

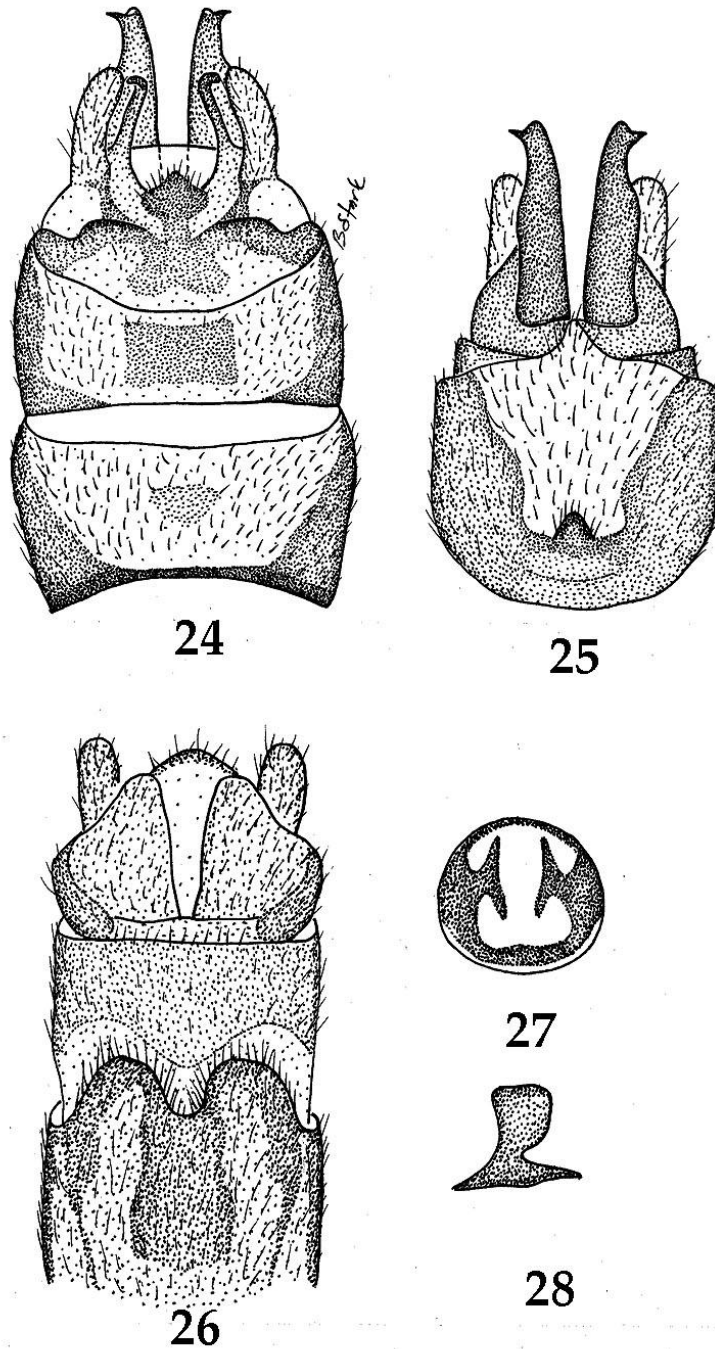
Larva. Unknown.

Diagnosis. This species is a member of the *Leuctra rickeri* subgroup of the *L. ferruginea* species complex which includes *L. alabama*, *L. paleo*, *L. rickeri* James and *L. szczytkoi*. Within this group only *L. hicksi* has broad inner paraproct lobes in caudal and anterior aspect which narrow abruptly in the apical third (Figs. 25, 32).

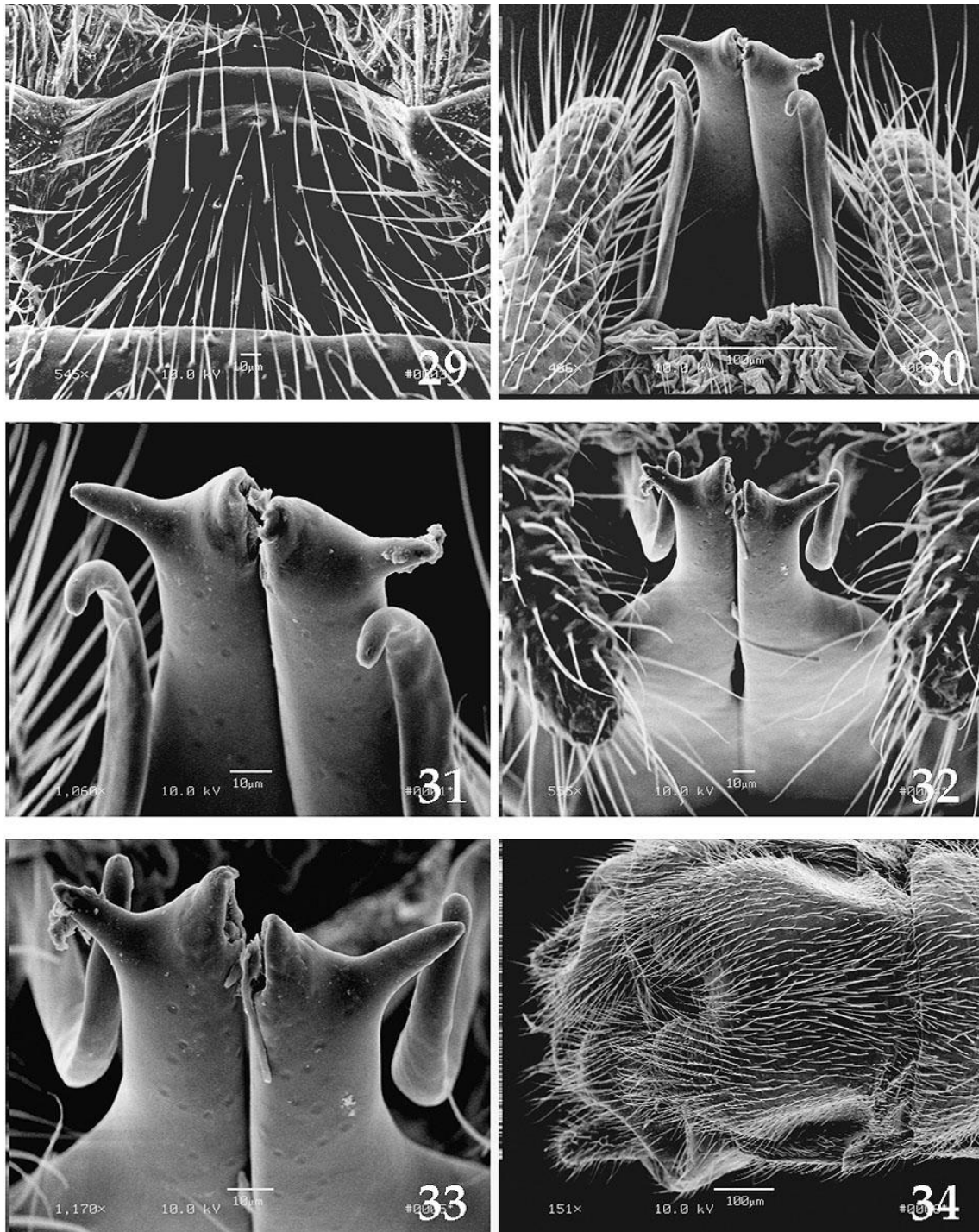
Comparative images of the paraprocts and tergal lobes of specimens presumed to be *L. alabama* (Cold Spring, Madison Co., Alabama) and *L. rickeri* (Burden Creek, Pope Co., Illinois) are presented in Figs. 35-40. The paraprocts of these are virtually identical suggesting only one of these species is valid. Additional images are also provided for specimens of *L. paleo* from a site near the type locality in Columbia Co., Arkansas (Figs. 45-50), and for *L. szczytkoi* specimens collected at the type locality of Schoolhouse Springs, Jackson Parish, Louisiana (Figs. 51-56). These images indicate the latter two species are also very similar, and probably synonymous, but they are clearly distinct from *L. hicksi* and other populations of the *L. rickeri* subgroup known from east of the Mississippi River. The spines on the inner lobes of the paraprocts of *L. szczytkoi* and *L. paleo* (range 48-55 µm) are ca. 2.5-3 times as long as those on paraprocts of *L. hicksi* and other eastern members

of the subgroup (range 18-22 μm). In addition, in lateral aspect the eastern species have the inner lobes much narrower basally and broader and more rounded near the tips, and in caudal aspect the

western species have an eroded appearance below the apical orifice (Figs. 47-48, 54), whereas the caudal surfaces of the eastern species are relatively smooth (Figs. 37, 40).



Figs. 24-28. *Leuctra hicksi*. 24. Male terminalia, dorsal. 25. Male terminalia, ventral. 26. Female terminalia, ventral. 27. Spermathecal sclerite, dorsal. 28. Spermathecal sclerite, lateral.



Figs. 29-34 . SEM images, *Leuctra hicksi*, Cypress Creek, Perry Co., Mississippi. 29. Male tergum 8. 30. Paraprocts, anterodorsal aspect. 31. Paraproct apex, anterodorsal aspect. 32. Paraproct apices, caudoventral aspect. 33. Paraproct apex, caudoventral aspect. 34. Female terminalia, ventral.

Etymology. The patronym honors our friend and colleague, Matthew B. Hicks, for his frequent assistance and continued interest in Mississippi's stoneflies. Matt first collected this species during our 2007 "winter stonefly blitz" and he generously made his specimens available for our study.

Comments. Cypress Creek at the type locality is a small blackwater stream about 1.5 m wide and 0.5 m deep. The stream is a tributary of Black Creek in the Pascagoula River Drainage Basin. Adults were collected using a beating sheet in riparian shrubbery. No larvae were found among the leaf packs examined.

Comparative Material

Leuctra alabama James (Figs. 35-37)

Leuctra alabama James, 1974:964. Holotype ♂ (INHS), Hwy. 65, 8.3 mi N Hwy 146 jct, Jackson Co., Alabama

Material examined. Alabama: Jackson Co., tributary Larkin Fork, Hwy 65, ~ 8 mi N Hwy 146 jct, 18 May 2009, B. Stark, 1♂ (BPS). Madison Co., Cold Spring, Fearn Street, Huntsville, 25 May 2006, B. Stark, I. Sivec, 21♂, 29♀ (BPS).

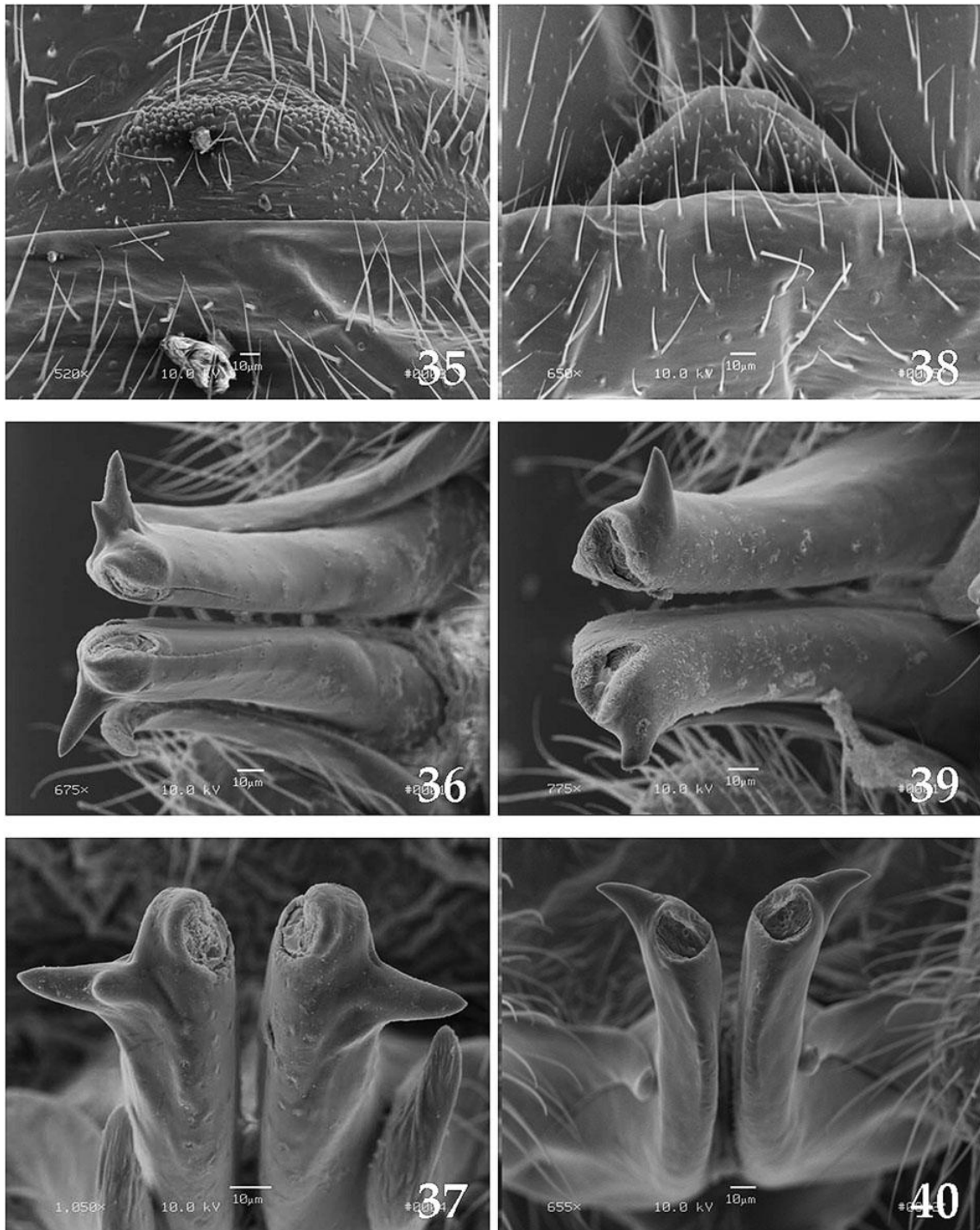
Comments. The Jackson County site listed above is near the type locality for this species, and the Cold Spring site is in an adjacent county. The similarity of the paraprocts of these specimens to those we determine to be *L. rickeri* suggests the need to examine the types and additional topotype specimens to determine if both species should be considered valid. Types of these species are on loan to a colleague and unavailable for our study (DeWalt pers. com.).

Leuctra ferruginea (Walker) (Figs. 15-23)

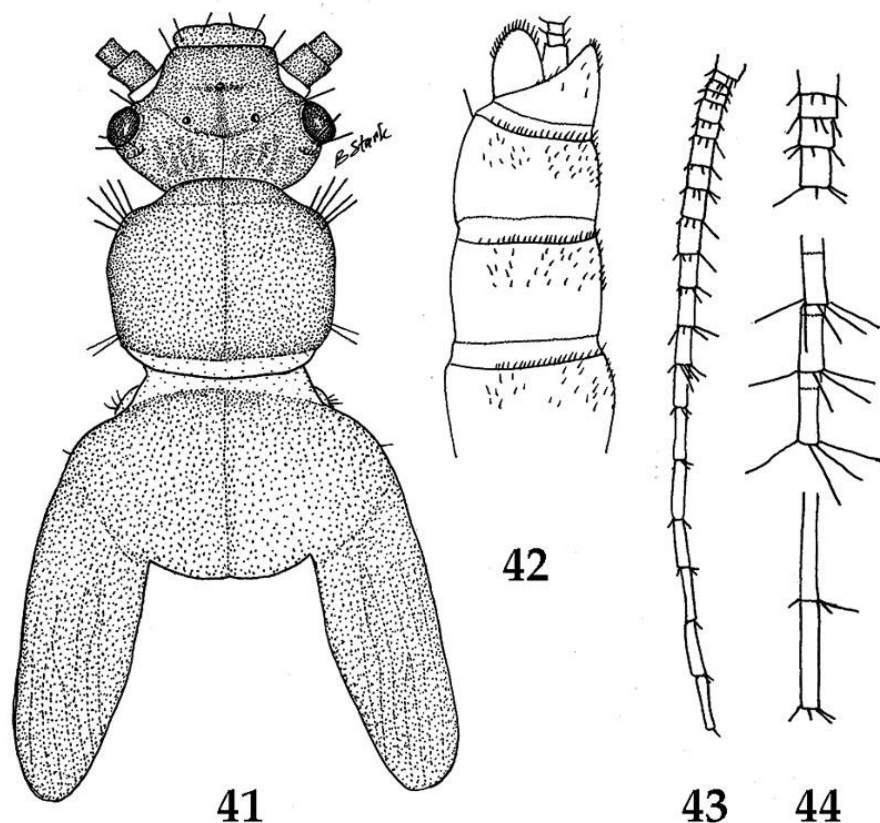
Nemoura ferruginea Walker, 1852:183. Lectotype ♀ (British Museum of Natural History), Nova Scotia, designated by Ricker (1938)

Leuctra decepta Claassen, 1923:260. Holotype ♂ (Cornell University), Ringwood Hollow, Ithaca, New York, synonymy by Illies (1966)

Material examined. Alabama: Mobile Co., Wilmer, 30.79° N, 88.39° W, Malaise trap, 25 February 2004, W.A. Pate, 1♂ (BPS). **Louisiana:** Washington Parish, Lee Memorial Forest, Bogue Lusa Creek, T2S, R12E, Sec 15/16, 18 November 1995, R.E. DeWalt, 7♂, 12♀ (INHS). Same site, 19 November 1996, R.E. DeWalt, 2♂, 5♀ (INHS). **Mississippi:** Amite Co., tributary Tom Way Branch, Homochitto National Forest, T4N, R3E, 2 February, 1997, M.H. Alford, 1♂, 4♀ (BPS). Amite Co., spring at Rocky Branch, T4N, R2E, Sec. 18, 26 December 1997, M.H. Alford, 4♂, 6♀ (INHS). Amite Co., spring at Lazy Creek, 18 December 1997, M.H. Alford, 5♂, 7♀ (INHS). Choctaw Co., Woods Spring, ~ 200 m N Woods Spring Baptist Church, 33.27359° N, 89.21984° W, 28 December 2009, B. Stark, 7♂, 6♀ (BPS). Franklin Co., Clear Springs Recreation Area, Homochitto National Forest, 1 January 2005, B. Stark, 3♂, 8♀ (BPS). Same site, 21 December 2009, B. Stark, 21♂, 14♀ (BPS). Simpson Co., Mill Creek, Hwy 472, 4-7 October 2004, B. Stark, 5♂ (BPS). Same site, 4 October 1997, B. Stark, 3♂, 1♀ (INHS). Tishomingo Co., tributary Sandy Creek, CR 355, 6 February 2010, A. Harrison, L. Little, 2♂, 2♀ (BPS). **Newfoundland:** Grandys Brook, Hwy 460 W Rose, 10 June 1998, B.C. Kondratieff, R.W. Baumann, 45♂, 55♀ (CSU). **New Jersey:** Burlington Co., Mt. Misery Brook, 6.5 km E Rt 70/172, J. Gelhaus, 2♂ (JIE). **New York:** Franklin Co., North Branch Saramac River, Goldsmith Road, 17 July 2006, L. Myers, 2♂ (CSU). Hamilton Co., Governor Brook, Limekiln Road nr. Red River, 29 June 2007, L. Myers, B.C. Kondratieff, 8♂ (CSU). Suffolk Co., Rattlesnake Brook, Blue Trail, 20 May 2008, B.C. Kondratieff, R.W. Baumann, L. Myers, 10♂, 5♀ (CSU). **Nova Scotia:** Inverness Co., Northeast Margaree River, N Margaree Valley, 21 June 1993, R.W. Baumann, B.C. Kondratieff, 3♂, 3♀ (BYU). Victoria Co., Cape Breton Highlands, 5 October 2005, J. Ogden, 3♂ (CSU). **Pennsylvania:** Schuylkill Co., Catawissa Creek, Hwy 339, 1 June 2004, J. Earle, 2♂ (JIE). Westmoreland Co., Camp Run, Hwy 381, 27 August 1997, J. Earle, 2♂ (JIE). **Tennessee:** Sevier Co., Stone Camp Branch at Lynn Camp Prong, Great Smoky Mountains National Park, 7 September 2001, B.A. Sikes, C.A. Walker, 3♂, 4♀ (CSU). Sevier Co., Doghobble Branch at Lynn Camp Prong, Great Smoky Mountains National Park, 7 September 2001, D. Etnier, 5♂, 4♀ (CSU).



Figs. 35-40. *Leuctra* spp. male terminalia, SEM images. 35-37. *L. alabama*, Cold Spring, Madison Co., Alabama, and 38-40. *L. rickeri*, Burden Creek, Pope Co., Illinois. 35. Tergum 8. 36. Paraprocts, anterodorsal aspect. 37. Paraprocts, caudoventral aspect. 38. Male tergum 8. 39. Paraprocts, anterodorsal aspect. 40. Paraprocts, caudoventral aspect.



Figs. 41-44. *Leuctra colemanorum* larva. 41. Head, pronotum and mesonotum. 42. Abdominal segments 7-10, lateral. 43. Dorsal aspect of cercus, outer margin to right. 44. Lateral aspect of basal, mid and apical cercal segments.

Comments. See "Diagnosis" section of *L. colemanorum* above. The Louisiana specimens loaned by R.E. DeWalt represent a new state record. The Bogue Lusa Creek site, located in Washington Parish, the northeastern most of the Florida Parishes is bordered on the north and east by three Mississippi counties, Pike, Walthall and Pearl River. No *Leuctra* records are reported for these counties but *L. ferruginea* is known from several sites in Amite County which borders Pike County.

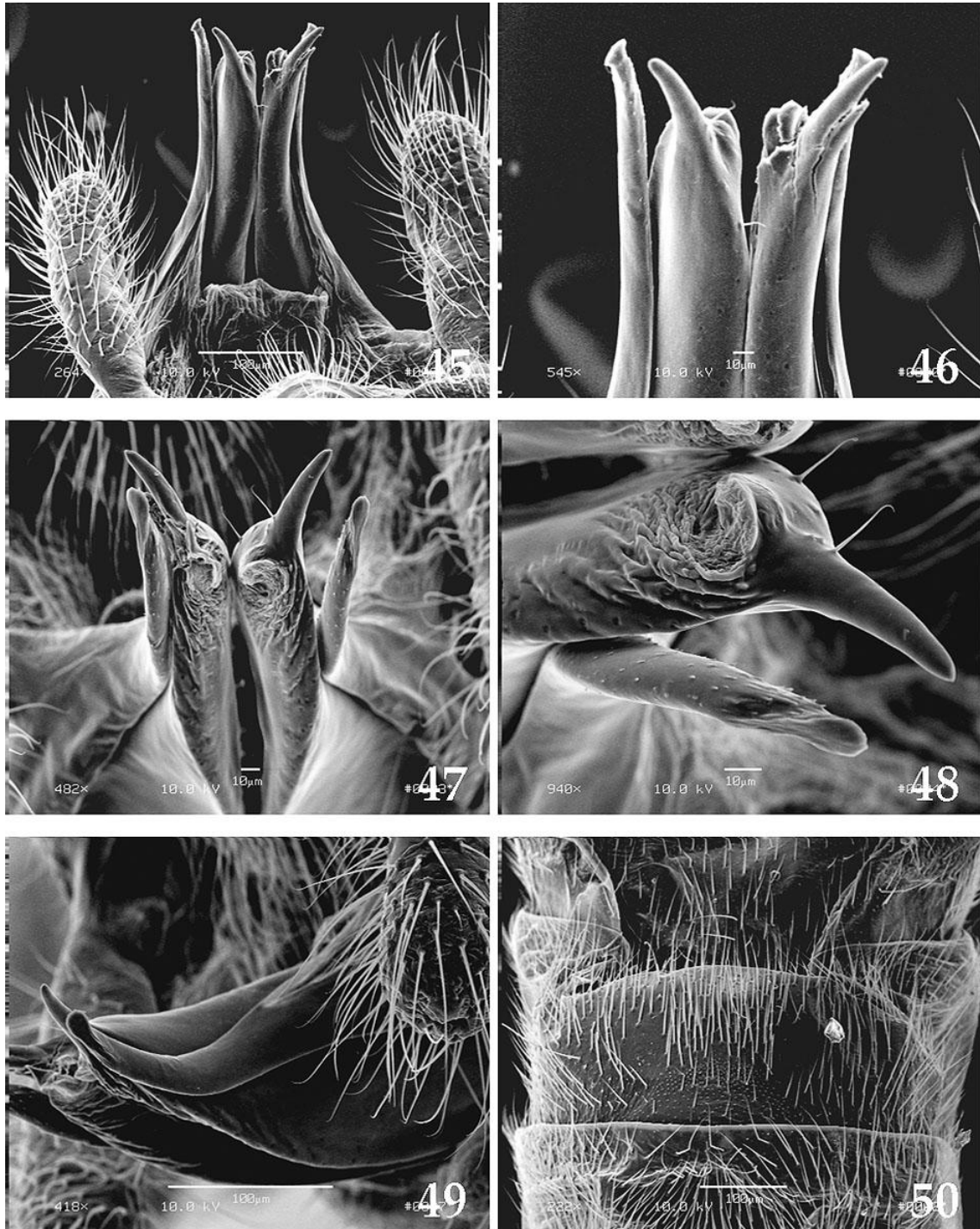
***Leuctra paleo* Poulton & Stewart**
(Figs. 45-50)

Leuctra paleo Poulton & Stewart, 1991:22. Holotype ♂ (USNM), tributary Smackover Creek, Hwy 98, 8.8 km E

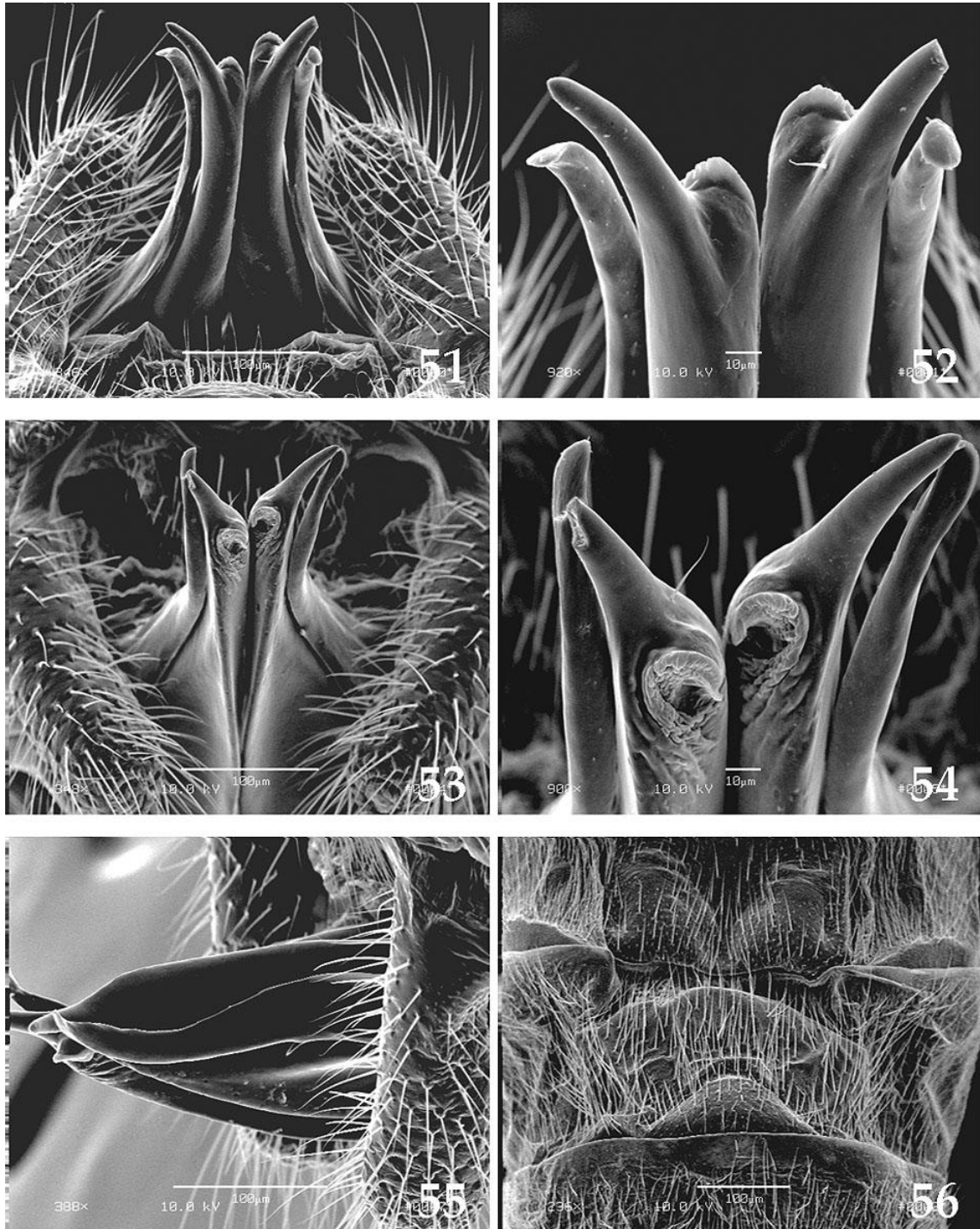
McNeil, Columbia Co., Arkansas

Material examined. **Arkansas:** Columbia Co., tributary Spring Branch, Hwy 98, 5.3 km NE McNeil, T16S, R20W, Sec 11, 12 October 1997, R.E. DeWalt, B. Stark, 24♂, 34♀ (INHS). Dallas Co., Campground Creek, Ben Few Campground, 2 km WSW Princeton, T8S, R15W, Sec 32, 12 October 1997, R.E. DeWalt, B. Stark, 5♂, 9♀ (INHS).

Comments. The specimens examined in this study are from a site near the type locality and an additional site in Dallas County near the site where paratypes were collected (Poulton & Stewart 1991). The major difference in males of this species and *L. szczytkoi* is in the tergal lobes of segment 8 (Figs. 50, 56).



Figs. 45-50. *Leuctra paleo* male terminalia, SEM images. 45. Paraprocts, anterodorsal aspect. 46. Paraproct apices, anterodorsal aspect. 47. Paraprocts, caudoventral aspect. 48. Paraproct apices, caudoventral aspect. 49. Paraprocts, lateral aspect. 50. Tergum 8.



Figs. 51-56. *Leuctra szczytkoi* male terminalia, SEM images. 51. Paraprocts, anterodorsal aspect. 52. Paraproct apices, anterodorsal aspect. 53. Paraprocts, caudoventral aspect. 54. Paraproct apices, caudoventral aspect. 55. Paraprocts, lateral aspect. 56. Tergum 8.

***Leuctra rickeri* James**

(Figs. 38-40)

Leuctra rickeri James, 1976:882. Holotype ♂ (INHS), 1.5 mi E Frenchburg, Hwy 460, Menifee Co., Kentucky

Material examined. **Illinois:** Pope Co., Burden Creek, FR 402, Burden Falls, 18 May 2006, B. Stark, I. Sivec, 34♂, 42♀ (BPS). **Kentucky:** Rowan Co., Logan Branch, Logan Hollow, 23 May 1999, B. Stark, R.F. Kirchner, 4♂, 10♀ (BPS). **Mississippi:** Webster Co., The Cove, 7 mi W Walthall, T 20 N, R 8 E, Sec. 12, Malaise trap, 22-28 April 1988, T.L. Schiefer, 1♂ (MEM).

Comments. Although the holotype is from Kentucky, most of the paratype series of this species are from sites in the Shawnee National Forest near the Burden Creek location of our specimens. The Logan Branch, Kentucky site is in a county adjacent to Menifee Co., where the holotype was collected. As discussed above for *L. alabama*, the holotype and topotype specimens need to be carefully studied to evaluate the status of this species. Additional material is needed to allow examination of Mississippi specimens with SEM.

***Leuctra szczytkoi* Stark & Stewart**

(Figs. 51-56)

Leuctra szczytkoi Stark & Stewart, 1981:91. Holotype ♂ (USNM), Schoolhouse Springs, Jackson Parish, Louisiana

Leuctra szczytkoi: DeWalt & Stark, 1996:61. Female and larval descriptions

Material examined. **Louisiana:** Jackson Parish, Schoolhouse Springs, 7.6 km NNW Eros, T17N, R1W, Sec 12, 11 October 1997, R.E. DeWalt, B. Stark, 14♂, 21♀ (INHS).

Comments. The specimens examined in this study are from the type locality. As indicated above the male paraprocts are very similar to those of *L. paleo*.

Updates to Alabama List of *Leuctra*

Ten *Leuctra* species are reported for Alabama (James 1972; Stark & Harris 1986; Stark et al. 2009; Grubbs & Sheldon 2009). To these we add *Leuctra*

triloba Claassen based on a male collected at Buttahatchie Bluffs in Lamar Co.; we also suggest deletion of the *L. moha* record for reasons stated below. New county records are given above for *L. alabama* and *L. ferruginea* and included below for *L. alta*. The current list includes:

L. alabama James: Described from Jackson Co by James (1974). A second record is given above for Madison Co.

L. alta James: Reported from Calhoun and Tuscaloosa counties in Alabama (James 1972; Stark & Harris 1986), and Grubbs (2005) compared Calhoun Co., paratypes to specimens of *L. alta* and *L. sibleyi* Claassen from Illinois, Indiana and Kentucky. We present an additional Alabama record from Monroe Co., Haines Island, seepage area above pond, 31° 43.23' N, 87° 28.10' W, 5 April 1995, T.L. Schiefer, 53♂, 18♀ (MEM, BPS).

L. biloba Claassen: Reported from Calhoun Co. (James 1972).

L. cottaquilla James: Reported from Calhoun Co. (James 1972; Stark & Harris 1986).

L. crossi James: Reported from Calhoun Co. (James 1976) and recorded by James (1972) as *L. alexanderi* Hanson.

L. ferruginea (Walker): Reported from Calhoun, Chilton, Clay, DeKalb and Talladega counties (James 1972). An additional record from Mobile Co. is given above.

L. moha Ricker: The Lawrence Co. record in James (1972) is based on three females identified by S.G. Jewett. We suggest this species be deleted from the Alabama list pending collection of male specimens.

L. pinhoti Grubbs & Sheldon: This recently described species is known from tributaries of South Fork Terrapin Creek in the Talladega National Forest, Cleburne Co. (Grubbs & Sheldon 2009).

L. rickeri James: Reported from Calhoun, Fayette, Madison and Tuscaloosa counties (James 1976; Stark & Harris 1986).

L. tenuis (Pictet): Reported from Calhoun, Cleburne and DeKalb counties (James 1972; Stark & Harris 1986).

L. triloba Claassen: The first Alabama record is from Lamar Co., Buttahatchie Bluffs, spring seep, off Hwy 35, 7 January 2004, B. Stark, M.B. Hicks, 1♂ (BPS).

Updates to Mississippi List of *Leuctra*

Five *Leuctra* species are included on the Mississippi stonefly list (Stark 1979; Stark et al. 2009). We are deleting three of these (*L. cottaquilla*, *L. tenella*, *L. tenuis*), and adding *L. carolinensis* Claassen and two new species described above.

L. carolinensis Claassen: Three male and 1 female of this species from Lafayette Co., 5 mi. E. Oxford in the University of Mississippi collection were previously determined as *L. tenella* Provancher (Stark 1979). Upon re-examination these specimens, and an additional series from Monroe Co., are identified as *L. carolinensis*. The new records are from a blacklight collection, 0.5 mi NE Hamilton, Monroe Co., 26 April 1991, D. Pollock, J. MacDonald, 2♂, 1♀ (MEM).

L. colemanorum sp.n.: Recorded above from Calhoun and Yalobusha counties.

L. cottaquilla James: The Mississippi record of this species was based on a single female from Oxford, Lafayette Co. whose vaginal sclerites were similar to those shown by Stark & Gaufin (1979) for this species. Unfortunately, the Mississippi specimen has been lost and, until male specimens are collected, this record should be deleted.

L. ferruginea (Walker): This species was not included on the Mississippi list by Stark (1979) but was added later without published records. The species is currently known from the records given above for Amite, Choctaw, Franklin, Simpson and Tishomingo counties.

L. hicksi sp.n.: Recorded above from two sites in Perry Co.

L. rickeri James: Stark (1979) listed this species based on 4 male and 3 female specimens from Claiborne Co., collected in April and a new record from Webster Co. is given above. Additional specimens are needed to examine with SEM in order to verify the status of this species in the state.

L. tenella Provancher: As discussed above for *L. carolinensis*, this species should be deleted from the Mississippi list.

L. tenuis (Pictet): The specimen records for this species were never published and the specimens have not been located during this study. Pending their discovery or the collection of new specimens from the state, we are removing this species from the Mississippi list.

Leuctra spp.: In addition to these records, undetermined female or larval specimens are known for the sites listed below. Additional collecting at these sites is needed to help resolve the Mississippi species list.

Lafayette Co.: Oxford, September, 1979, 1♀ (UM). 3 mi SE Oxford, Yellowleaf Creek, Hwy 334, 28 April 1995, G. Dick, 3♀ (UM). Bay Springs Branch, 9 mi NE Oxford, 23 October 1994, S. Stepp, 1♀ (UM). Pumpkin Creek, Hwy 334, T9S, R2W, Sec 19, 13 April 1997, R.E. DeWalt, 3♀ (INHS).

Lamar Co.: Black Creek, Surber sample, August 1976, P. Hartfield, 1 larva (BPS).

Tishomingo Co.: Tishomingo State Park, 28 October 1993, R. Weems, 1♀ (UM). Clear Creek, 4 mi E Iuka, Hwy 172, 18 May 2009, B. Stark, 4♀ (BPS).

Webster Co.: The Cove, 7 mi W Walthall, 18-19 May 1988, T.L. Schiefer, 1♀ (MEM). Same site, 4-11 March 1988, T.L. Schiefer, 1♀ (MEM).

Winston Co.: Nanih Wayah Creek, Hwy 14, 20 December 2006, M.B. Hicks, M. Howarter, 1♀ (BPS). Tombigbee National Forest, 33° 10.20' N, 89° 03.55' W, 3 May 1999, T.L. Schiefer, 1♀ (MEM).

ACKNOWLEDGMENTS

We thank R.W. Baumann, R.E. DeWalt, J.I. Earle, B.C. Kondratieff, P. Lago and T.L. Schiefer for the loan of material, and we thank M.H. Alford and M.B. Hicks for the gift of specimens and L. Little for assistance in collecting.

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Received 1 February 2010, Accepted 12 February 2010, Published 26 February 2010