



## TWO NEW STONEFLY SPECIES IN THE *SWELTSA COLORADENSIS* (BANKS) COMPLEX (PLECOPTERA: CHLOROPERLIDAE)

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### ABSTRACT

Male reproductive structures were examined with scanning electron microscopy for populations of the *Sweltsa coloradensis* (Banks) complex from throughout the known range in western North America. Sufficient variation was observed in epiproct structure to recognize and describe two new species. *Sweltsa mogollonica*, n. sp. is recognized from eastern Arizona and western New Mexico and *S. lyrata*, n. sp. is recognized from Alberta, British Columbia, Idaho, Montana, Washington and Yukon Territory.

**Keywords:** Plecoptera, Chloroperlidae, *Sweltsa coloradensis* complex, western North America, new species

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### INTRODUCTION

*Sweltsa coloradensis* (Banks, 1898) was described as *Chloroperla coloradensis* by Banks (1898-1899) from a single female collected by C.F. Baker, and the type locality was identified only as "Colorado". The description, published in *Transactions of the American Entomological Society*, Volume 61 (4), was dated "1898-9, leading to some uncertainty for establishing priority. Banks (1898-1899) stated with regard to this and other species included in the study, "I have not as yet studied and figured the genitalia, but will leave such for a future revision which I hope abundant material may soon justify." At least in the case of *C. coloradensis*, Banks did not provide subsequent figures, but Needham &

Claassen (1925) provided a more detailed description of the female, and the first figures and description of the putative male as *Alloperla coloradensis*. Needham & Claassen (1925) list male specimens from several Colorado sites, and additional male specimens from Montana and the Canadian Rockies, but there is no indication from which of these specimens the figures were produced. Similar figures were also produced in Gaufin et al. (1966, 1972), Baumann et al. (1977), Surdick (1985), and the Needham & Claassen (1925) figures were also reproduced in Jewett (1959, 1960). In these, and other studies, there has been no indication that male specimens are variable in epiproct or aedeagal structure, despite

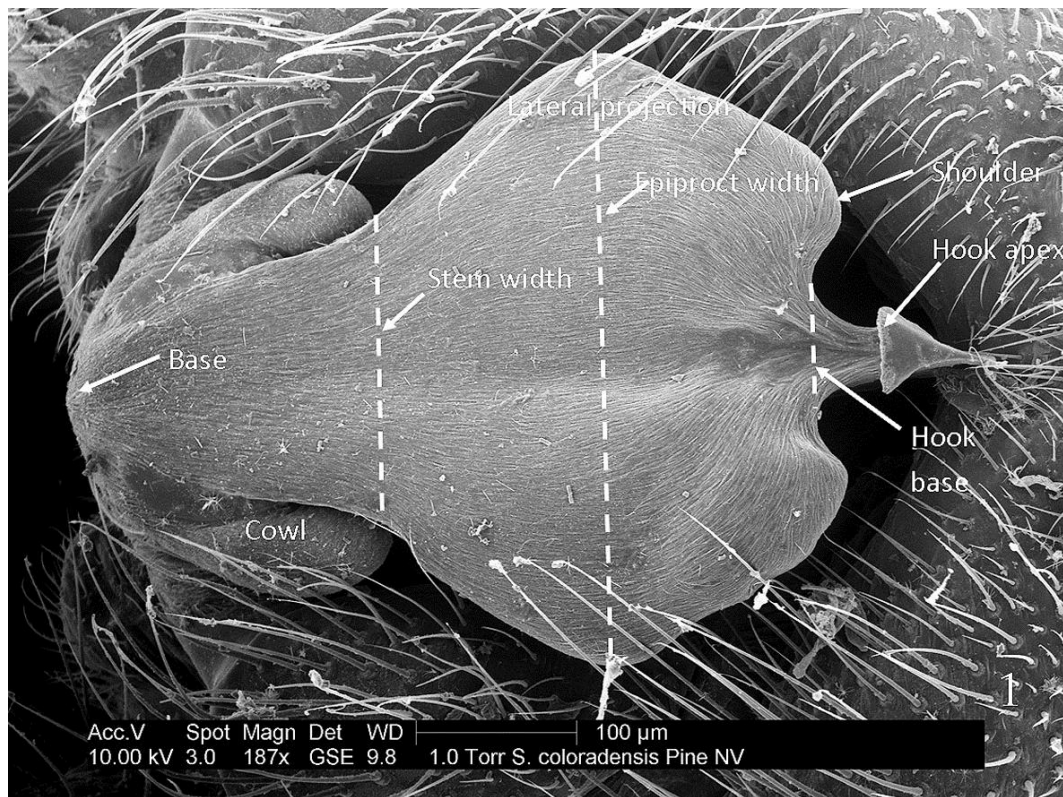


Fig. 1. *Sweltsa coloradensis* male epiproct with dorsal features labelled, Nevada, Nye Co., South Fork Pine Creek.

the distribution of the species complex over a rather large range that reportedly includes Alberta, British Columbia and Yukon Territory in Canada, and Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming in the United States (DeWalt et al. 2018, Surdick 1985).

In this study more than 300 scanning electron microscopy images of the epiprocts or aedeagi of male specimens of the *S. coloradensis* complex were produced. The images came from specimens collected at more than 50 sites located in 15 western Nearctic states and Canadian provinces. The epiprocts show significant variation (including asymmetry) in several features, and the degree of variation is considered sufficient to warrant recognition of two new species of western Nearctic *Sweltsa*. We

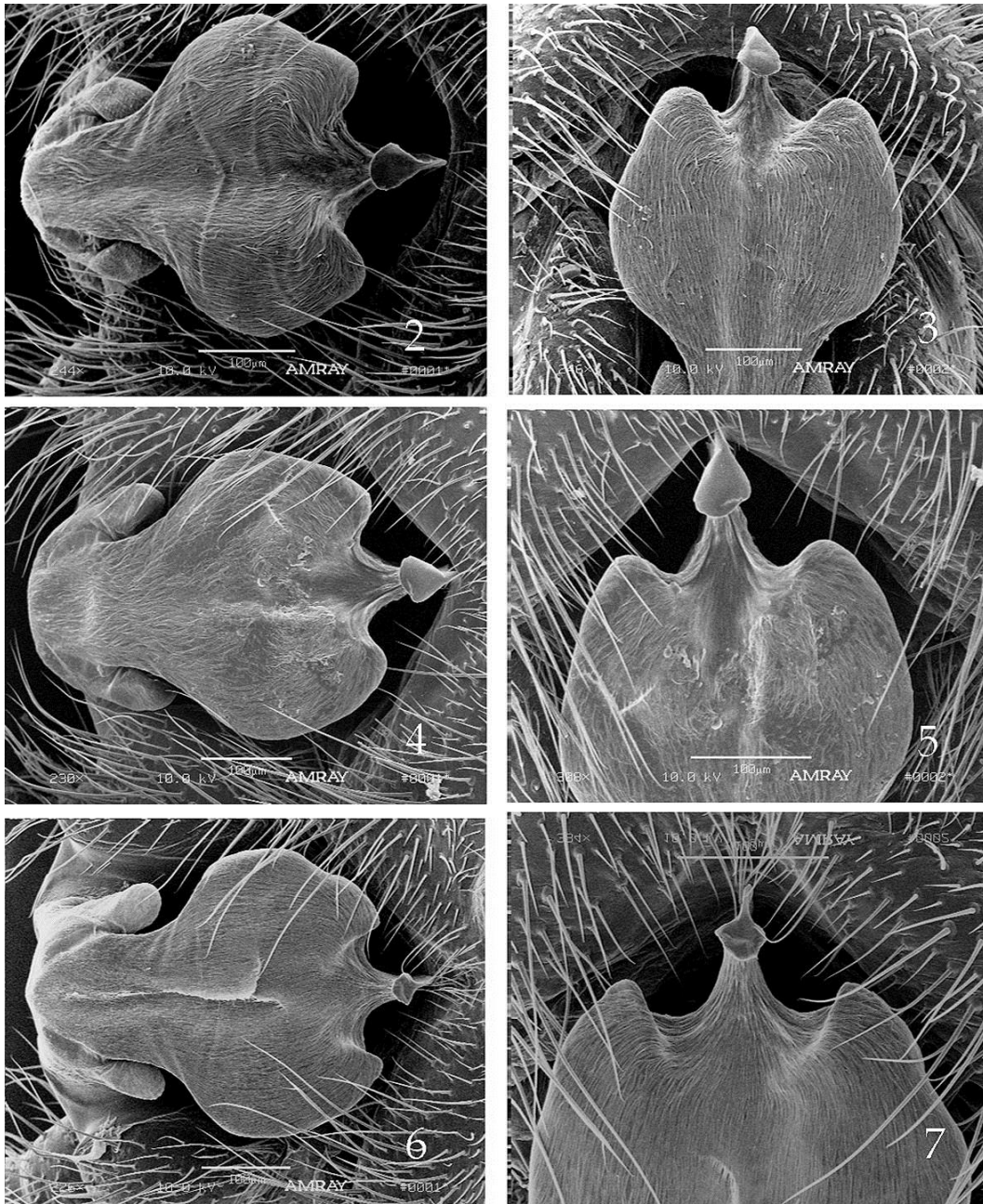
also examined the male aedeagus with SEM for a few specimens in which this structure had been properly everted in the field, but additional study is needed to determine if variation in the aedeagus is supportive of that observed in the epiproct.

## MATERIALS AND METHODS

Specimens were selected from material stored in 75-80% ethanol in the following collections.

BPSC- Bill P. Stark Collection, Mississippi College, Clinton, Mississippi  
 BYU- Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah  
 CAS- California Academy of Sciences, San Francisco, California  
 CSUIC- C.P. Gillette Museum of Arthropod Diversity, Colorado State University, Fort Collins, Colorado





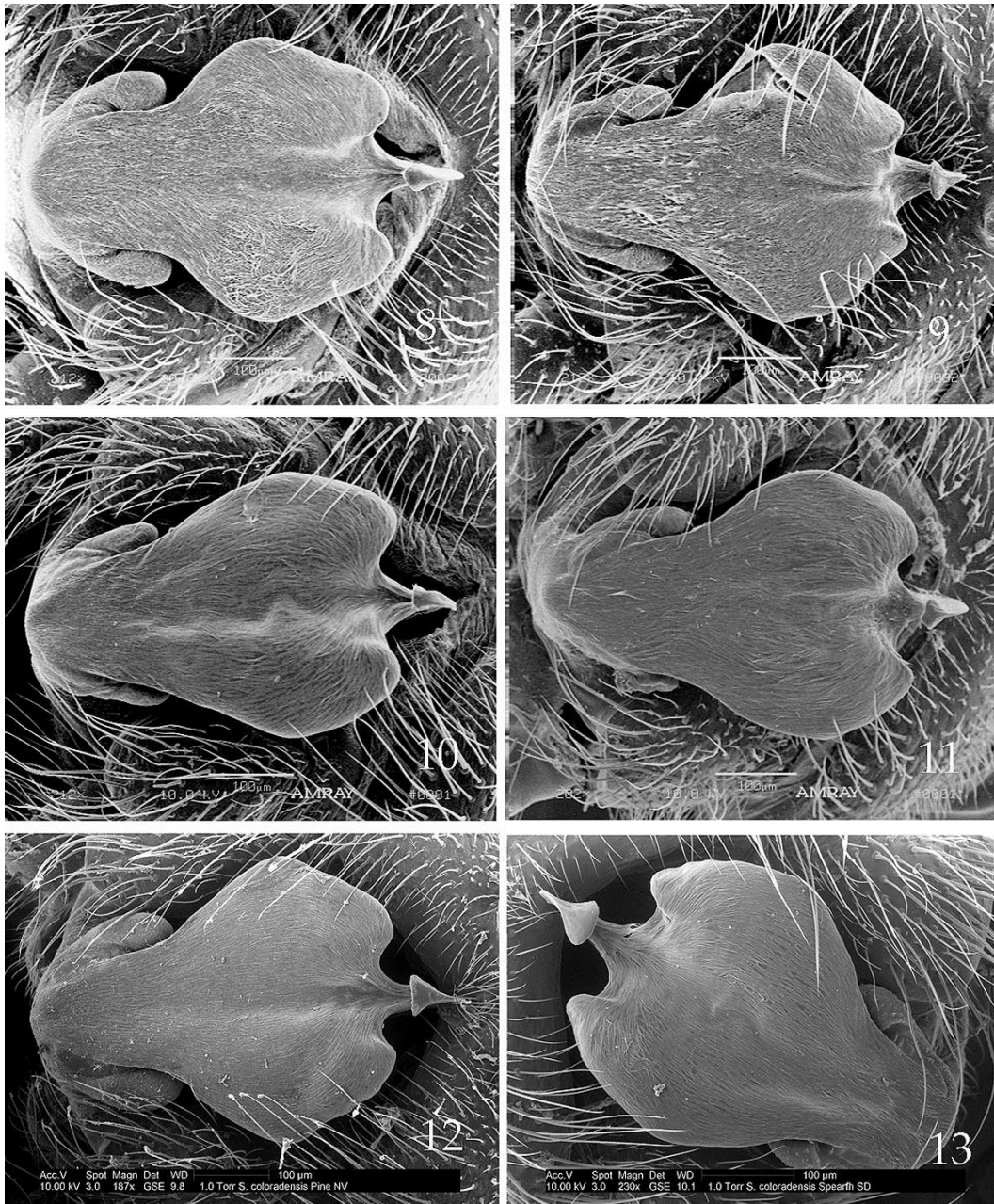
Figs. 2-7. *Sweltsa coloradensis* male epiproct, dorsal. 2-3. Colorado, Eagle Co., Deep Creek. 4-5. Colorado, Gilpin Co., South Boulder Creek. 6-7. Colorado, Gunnison Co., Quartz Creek.

Specimens were field collected primarily using beating sheets and sweep nets. Holotype specimens are deposited in the United States National Museum of Natural History, Washington, D.C. (USNM). Registered codens used for

institutional collections were obtained from the Global Registry of Repositories (<http://grbio.org>).

Abdominal tips were removed from selected specimens and placed in an ultrasonic cleaner for 10-15 seconds for cleaning. Cleaned specimens





Figs. 8-13. *Sweltsa coloradensis* male epiproct, dorsal. 8. Idaho, Bannock Co., Mill Creek. 9. Oregon, Umatilla Co., John Day River. 10. Utah, Wasatch Co., Cascade Springs. 11. Wyoming, Washakie Co., ESE Tensleep. 12. Nevada, Nye Co., South Fork Pine Creek. 13. South Dakota, Lawrence Co., Spearfish Creek.

were inspected under a SZH10 Olympus dissecting microscope, or a Wild M-8 stereomicroscope, and then serially dehydrated through ethanol solutions of 90, 95, and 100% for 10 minutes each. Specimens were then transferred to hexamethyldisilazane for 1

hour. Dehydrated specimens were mounted on aluminum stubs with double stick copper tape, coated with gold palladium with a Hummer coater and studied with an Amray 1810 SEM at Mississippi College. Alternatively, some specimens

were studied with a Philips XL30 ESEM FEG microscope at the Brigham Young University Electron Microscopy Laboratory. Terminology for epiproct structures is summarized on Fig. 1.

## RESULTS AND DISCUSSION

The epiproct for males in the *Sweltsa coloradensis* complex is covered with a dense mat of appressed hair and is a relatively wide, flattened structure, arising from a cowl surrounding the narrowed epiproct base (Fig. 1) and terminating in a slender, recurved hook. The greatest width extends between two lateral projections near midlength on the epiproct body; the epiproct narrows forward of the lateral projections and in many specimens a pair of projecting shoulders occurs on either side of the hook base (Fig. 1). The epiproct from specimens of different populations may vary conspicuously in shape and in the presence or absence of shoulder projections.

The male aedeagus is completely membranous but bears a sparse assemblage of long setae on a pair of small, dorsoapical, finger-shaped lobes (Figs. 14-17). A pair of subapical, median lobes is located proximally to the apical lobes; these lobes are glabrous but each has an obscure groove crossing the lobe on its distal side that gives an eye-like appearance. A smaller, less well-defined, nose-shaped lobe is located just proximally to the eye-shaped lobes. This arrangement of lobes and grooves gives an overall face-shaped appearance to the ventral aedeagal surface. A pair of prominent lobes occur laterally to the eye-shaped lobes.

### *Sweltsa coloradensis* (Banks)

(Figs. 1-15, 36-37, 42, 45)

<http://lsid.speciesfile.org/urn:lsid:Plecoptera.speciesfile.org:TaxonName:3555>

*Chloroperla coloradensis* Banks, 1898-1899:199.  
Holotype ♀ (Museum of Comparative Zoology),  
Colorado

*Alloperla coloradensis*: Needham & Claassen, 1925:113  
(In part)

*Alloperla (Sweltsa) coloradensis*: Ricker, 1943:135

*Sweltsa coloradensis*: Illies, 1966:451

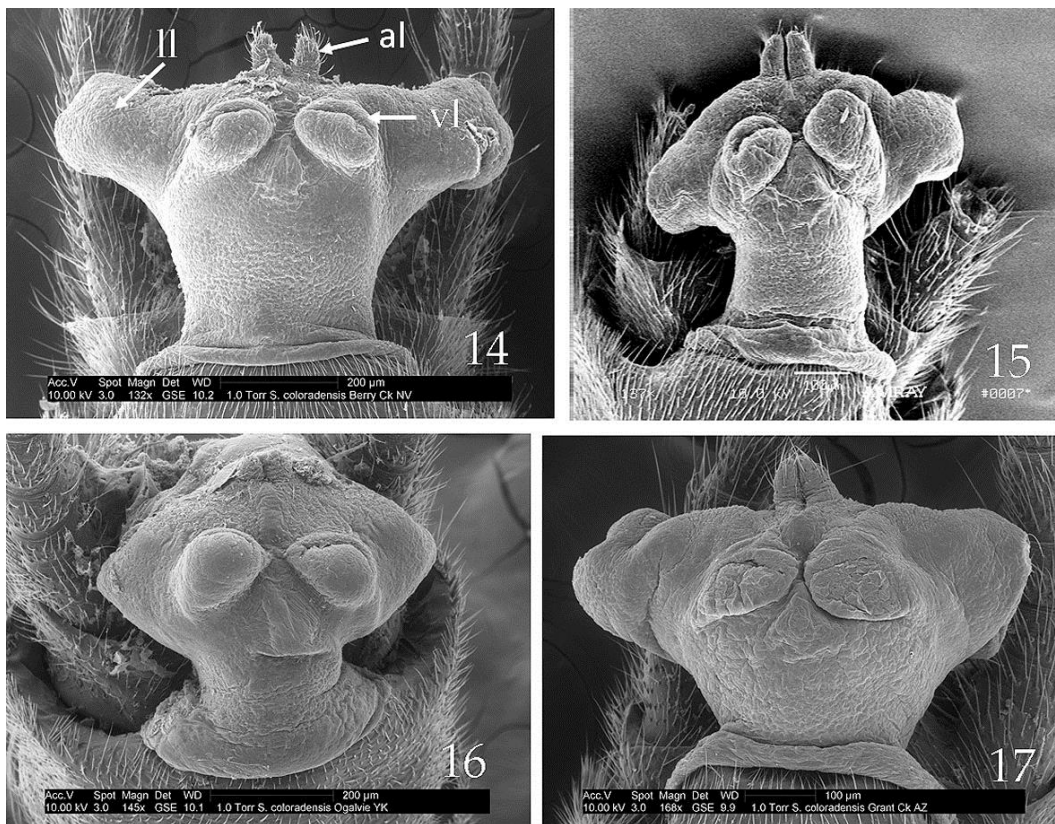
### Material examined. UNITED STATES: California:

*Modoc Co.*, Rush Creek, Hwy 299, Upper Rush Creek Campground, 24 May 2007, R.W. Baumann, B.C. Kondratieff, 1♂ (BYU). **Colorado**: *Eagle Co.*, Deep Creek, 17 Rd, 27 June 1997, B.C. Kondratieff, 11♂, 1♀ (CSUIC). *Gilpin Co.*, South Boulder Creek, 2 miles W Tolland, 7 July 1991, B.C. Kondratieff, R. Durfee, 16♂, 10♀ (CSUIC). *Grand Co.*, Colorado River, Kawuneeche Valley, Rocky Mountain National Park, 18 June 1980, B.C. Kondratieff, 3♂, 6♀ (CSUIC). *Gunnison Co.*, Quartz Creek, 76 Rd, N of Pitkin, 7 July 2008, K.W. Stewart, 25♂, 38♀ (BPSC). **Idaho**: *Bannock Co.*, Mill Creek, Summit Campground, 5 June 2010, B. Stark, R.W. Baumann, 2♂ (BPSC). **Nevada**: *Elko Co.*, Lamoille Creek, Thomas Canyon Campground, 40° 39' N, -115° 24.4' W. 23 June 2006, S.M. Clark, 7♂, 10♀ (BYU). *Humboldt Co.*, Indian Creek, Santa Rosa Range, 29 June 1999, A.L. Sheldon, 10♂, 19♀ (BYU). Mahogany Creek, Summit Lake Mountain, 1 July 1999, A.L. Sheldon, 16♂, 14♀ (BYU). *Nye Co.*, South Fork Pine Creek, Toquima Range, 7 July 1999, A.L. Sheldon, 14♂, 5♀ (BYU). *Washoe Co.*, Rock Creek, Granite Range, 5 June 1998, A.L. Sheldon, 1♂ (BYU). *White Pine Co.*, Berry Creek, Schell Creek Range, Berry Creek Campground, 24 June 2006, R.W. Baumann, B.C. Kondratieff, 15♂, 9♀ (BYU). Timber Creek, Timber Creek Campground, Schell Creek Range, 39° 24' N, -114° 38' W, R.W. Baumann, B.C. Kondratieff, 35♂, 14♀ (BYU). **New Mexico**: *Rio Arriba Co.*, Rio de las Vallecitos, 4 miles N Cañón Plaza, 11 June 1985, R.L. Hassage, 1♂ (BYU). *San Miguel Co.*, Terrero, Pecos River, 10 June 1974, B. Stark, T. Wolfe, 3♂, 6♀ (BPSC). **Oregon**: *Harney Co.*, McCoy Creek, 1 mile above Fish Lake, Steens Mountains, 20 July 1969, S.G. Jewett, Jr. 3♂, 10♀ (BYU). *Umatilla Co.*, Camas Creek, Hwy 395, Ukiah Dale State Park, 16 May 2001, B. Stark, K.W. Stewart, J.B. Sandberg, 3♂, 2♀ (BPSC). North Fork John Day River, Hwy 395, 12 miles S Ukiah, 16 May 2001, B. Stark, K.W. Stewart, J.B. Sandberg, 5♂, 1♀ (BPSC). *Union Co.*, Grande Ronde River, Bird Track Springs Campground, Hwy 244, 45° 18.027' N, -118° 18.427' W, 15 May 2014, B. Stark, A. Harrison, 1♂ (BPSC). **South Dakota**: *Lawrence Co.*, Spearfish Creek, Hwy 85, Cheyenne Crossing, 7 June 1995, R.W. Baumann, B. Huntsman, 10♂, 14♀ (BYU). **Utah**: *Box Elder Co.*, Clear Creek, Raft River



Mountains, 18 June 1979, R.W. Baumann, G.M. Webb, 23♂, 20♀ (BYU). *Juab Co.*, Granite Creek, Deep Creek Mountains, 14 April 1984, R.W. Baumann, 18♂, 5♀ (BYU). *Salt Lake Co.*, Big Cottonwood Creek, 22 June 1974, B. Stark, 10♂, 5♀ (BPSC). *Sanpete Co.*, Willow Creek, Ephraim Canyon, 39.29707 N, -111.52377 W, 28 June 2005, Johnson, Anderson, 14♂, 16♀ (BYU). *Tooele Co.*, Harker Creek, Harker Canyon, Sheep Rock Mountains, 39° 59' N, -112° 39' W, 30 May 2012, R.W. Baumann, G.M. Webb, 8♂, 5♀ (BYU). South Willow Creek, Boy Scout Campground, Stansbury

Mountains, 11 June 2007, R.W. Baumann, K. Anderson, 20♂, 21♀ (BYU). *Wasatch Co.*, Cascade Springs, Uintah National Forest, 27 May 2000, B. Stark, 8♂, 4♀ (BPSC). Daniels Canyon, Whiskey Springs Picnic Area, 40° 24.677' N, -111° 19.278' W, 13 June 2015, B. Stark. 7♂, 12♀ (BPSC). **Wyoming:** *Big Horn Co.*, West Tensleep Creek, N of West Tensleep Lake, 19 July 2005, D.E. Martin, 2♂ (BYU). *Fremont Co.*, Jakeys Creek, Hwy 26, 5 miles E of Dubois, 20 July 1967, R.W. Baumann, 2♂, 2♀ (BYU). *Washakie Co.*, 12.5 km ESE Tensleep, 25 June 1996, K.B. Miller, 9♂, 10♀ (CSUIC).



Figs. 14-17. *Sweltsa* sp. aedeagus, ventral. 14. *S. coloradensis*, Nevada, White Pine Co., Berry Creek. 15. *S. coloradensis*, Colorado, Gilpin Co., South Boulder Creek. 16. *S. lyrata*, Yukon, Ogilvie River. 17. *S. mogollonica*, Arizona, Graham Co., Grant Creek. (al = apical lobe; ll = lateral lobe; vl = ventral lobe).

**Adult habitus.** Described by Needham & Claassen (1925). Male forewing length 7.0-7.5 mm, female 8.5-9.0 mm. Head and pronotum pale yellow with dark markings; ocelli connected by a V-shaped dark brown mark, M-line and anteromedian area

of head forward of M-line dark brown. Pronotum pale yellow with almost complete dark brown margins and rugosities (Fig. 42). Abdomen brown with subtle, slightly darker median brown stripe. Cerci pale, antennae pale basally but brown in

apical two thirds. Wing membrane pale, veins pale brown.

**Male epiproct** (n=12). Maximum width 320-370 µm, length 360-450 µm. Base relatively narrow, but gradually expanded beyond cowl, and reaching maximum width across lateral projections of epiproct body. Shoulders project conspicuously beyond hook base (Figs. 1-13, 45).

**Aedeagus** (n=3). Length 500-524 µm, width 590-760 µm. Entirely membranous; apex with a pair of small finger-shaped lobes in a parallel or V-pattern, apicolateral margins, each bearing a large, projecting, rounded lobe, and mesoventral area with a pair of eye-like lobes (Figs. 14-15); Finger-shaped lobes bear scattered setae of variable length, apicolateral lobes bare; mesoventral lobes bare, but each with a transverse groove. Median ventral field below mesoventral eye-shaped lobes with a low nose-like tubercle.

**Female subgenital plate.** Posterior margin of plate projecting over basal third to half of sternum 9; plate truncate, to slightly concave along posterior margin. Plate usually darkly pigmented over most of surface, contrasting with the pale sternum 9 and the pale basal and lateral areas of sternum 8 (Figs. 36-37).

**Diagnosis and distribution.** This species, in which the epiproct shoulders conspicuously project beyond the base of the epiproct hook (Fig. 45), is the common form in the central Rockies and Great Basin, and the probable “true” *S. coloradensis*. Published records exist for *S. coloradensis* from Alberta, British Columbia and Yukon Territory in Canada, and from Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington and Wyoming in the United States (DeWalt et al. 2017; Surdick 1985). Many of the published records will apply to one of the two newly described species below. The Montana, Washington, Alberta, British Columbia and Yukon specimens examined by us have all been determined as *S. lyrata* sp.n., and the Arizona and western New Mexico specimens are determined as *S. mogollonica* sp. n. Specimens from the Central Rocky Mountains of Colorado and Utah are identified as *S. coloradensis*. Some states (e.g. Idaho and New Mexico) have populations of

at least two members of the complex. We have recognized populations of *S. coloradensis* from the sites listed in the “Material examined” section above.

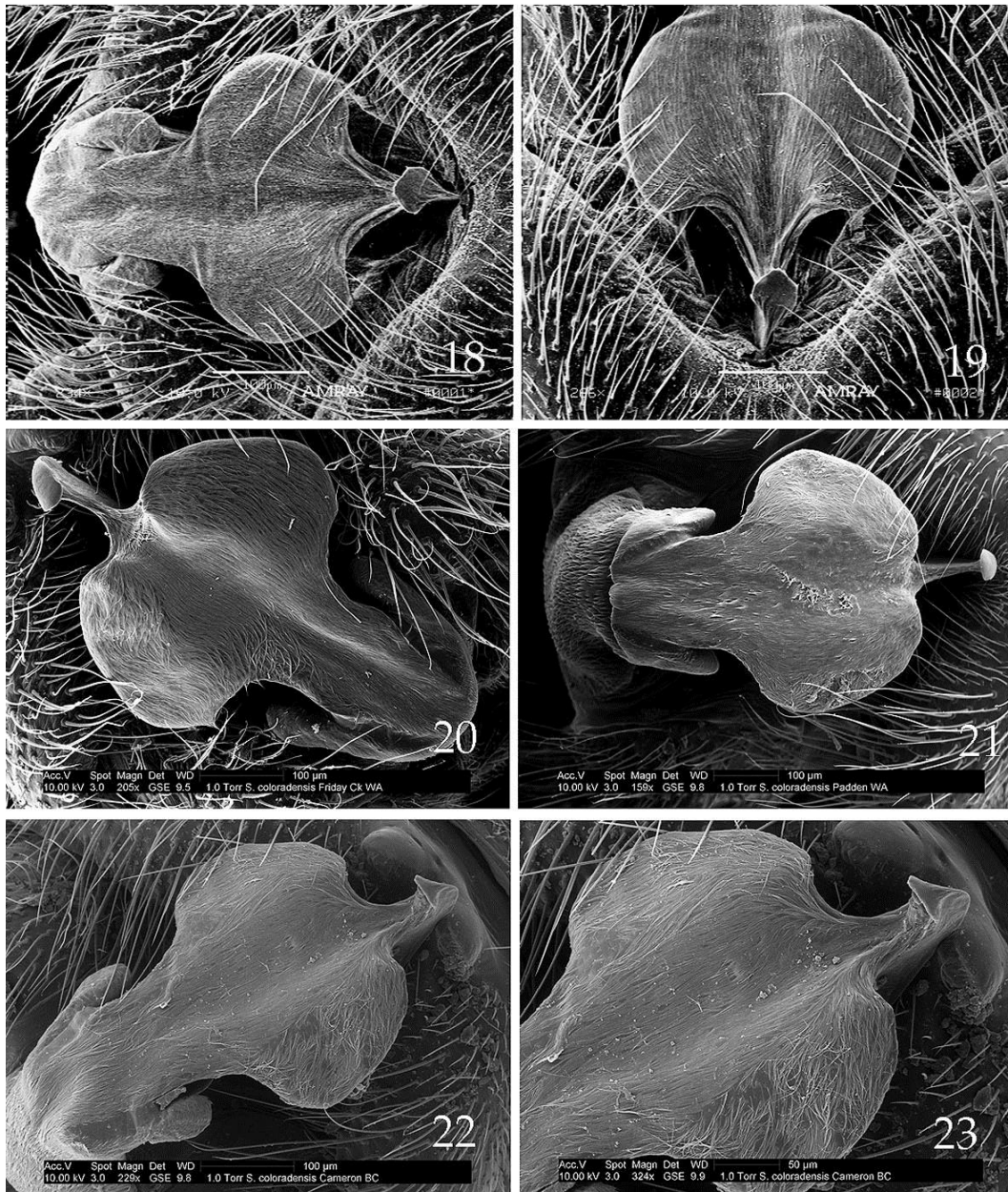
***Sweltsa lyrata*, sp. n.**

(Figs. 16, 18-29, 38-39, 43, 46)

<http://lsid.speciesfile.org/urn:lsid:Plecoptera.speciesfile.org:TaxonName:502536>

**Material examined.** Holotype ♂, 3♂, 1♀ paratypes, **Washington**, *Skagit Co.*, Friday Creek, Prairie Rd, 5 miles N of Burlington, 16 April 1967, K.E. Vander Mey (holotype, United States National Museum, paratypes BYU). Additional paratypes: **CANADA: Alberta:** Cameron Creek, Cameron Lake, Waterton Lakes National Park, 19 July 1965, A.R. Gaufin, 26♂, 30♀ (BYU). **British Columbia:** Duhamel Creek, Six Mile Rd, 30 May 2010, B. Stark, R.W. Baumann, 2♂, 1♀ (BPSC). **Yukon:** Klondike River, Dempster Hwy, 23 June 1996, J.C. Abbott, K.W. Stewart, 8♂, 7♀ (BPSC). Mayo River, Hwy 11, 63° 36' N, -135° 55' W, 24 June 1996, K.W. Stewart, J.C. Abbott, 5♂, 3♀ (BYU). McQuesten River, Hwy 2, 63°33'15.88" N, -137°24'37.88" W, 24 June 1996, K.W. Stewart, J.C. Abbott, 3♂, 6♀ (BYU). Ogilvie River, Dempster Hwy, 65°21'38.82" N, -138°18'20.73" W, 21 June 1996, K.W. Stewart, J.C. Abbott, 17♂, 5♀ (BYU). **UNITED STATES: Idaho:** *Bonner Co.*, Pack River, Pack River Rd, 26 May 2010, B. Stark, R.W. Baumann, 5♂, 8♀ (BPSC). **Montana:** *Gallatin Co.*, Duck Creek, 8 miles N West Yellowstone, 9 June 1987, B.C. Kondratieff, 1♂, 2♀ (CSUIC). *Gallatin Co.*, Squaw Creek Rd, 10 July 1999, B. Stark, L. Stark, 1♂, 1♀ (BPSC). *Mineral Co.*, St. Regis River, Little Joe Rd, St. Regis, 25 May 2010, B. Stark, R.W. Baumann, 28♂, 8♀ (BPSC). *St. Regis River*, Riverside, 11 June 1969, A.R. Gaufin, 4♂, 7♀ (BYU). *Trout Creek*, Trout Creek Campground, 4 June 2010, B. Stark, R.W. Baumann, 23♂, 6♀ (BPSC). **Washington:** *Okanogan Co.*, Buck Creek, 20 miles N of Winthrop, 9 June 1995, MacKenzie, 4♂, 1♀ (BYU). *Pend Oreille Co.* Sullivan Creek, below Sullivan Lake, 2 June 2010, B. Stark, R.W. Baumann, 35♂, 43♀ (BPSC). *Whatcom Co.*, Padden Creek, 33<sup>rd</sup> Street, Bellingham, 27 April 1994, Graham, MacKenzie, 6♂, 1♀ (BYU).



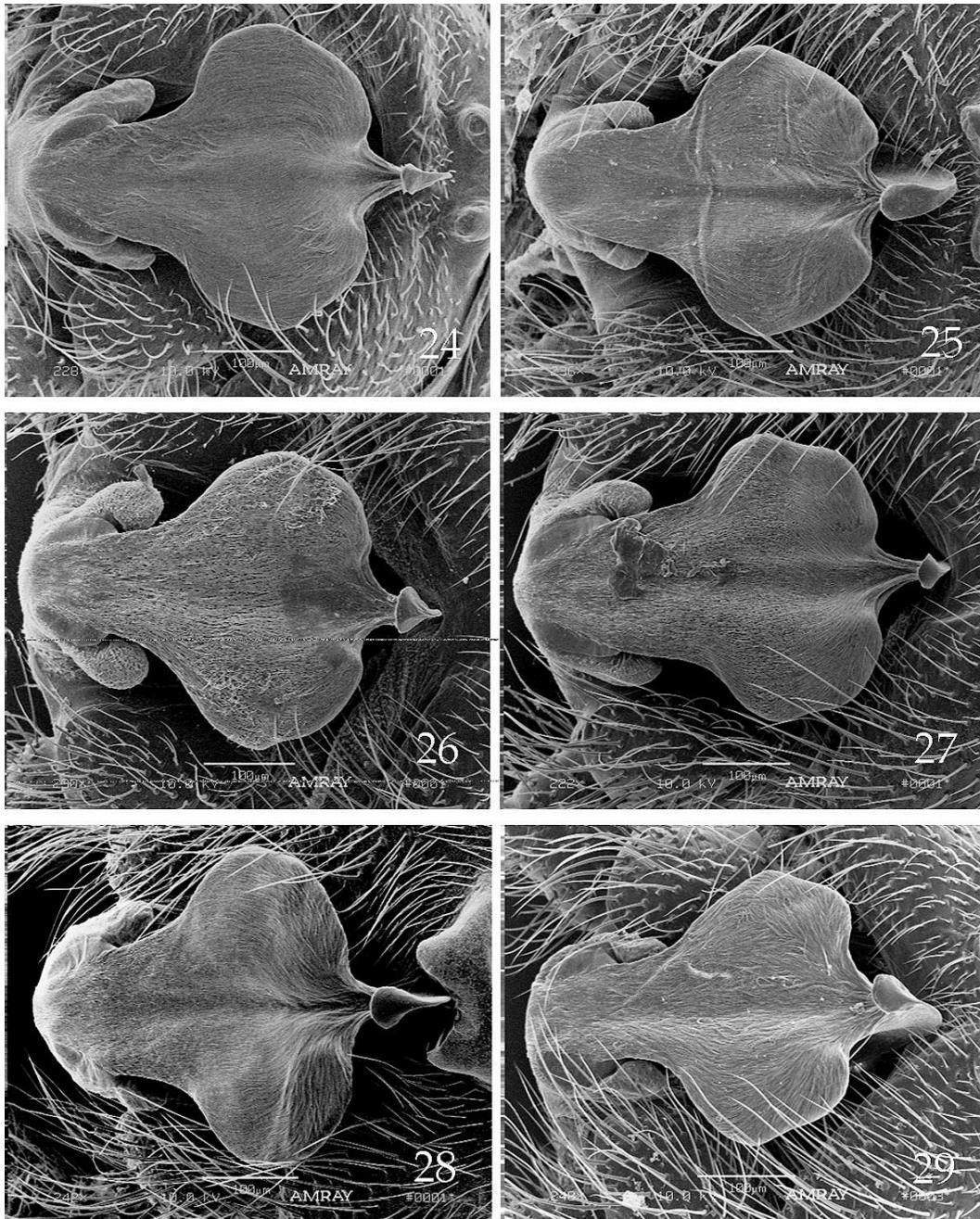


Figs. 18-23. *Sweltsa lyrata* male epiproct, dorsal. 18-19. Idaho, Bonner Co., Pack River. 20. Washington, Skagit Co., Friday Creek. 21. Washington, Whatcom Co., Padden Creek. 22-23. Alberta, Cameron Creek.

**Adult habitus.** Male forewing length 6.2-6.7 mm; female 7.0-7.5 mm. Similar to *S. coloradensis* with hieroglyphic-like markings on head and pronotum (Fig. 43). However considerable variation occurs in the pigmentation patterns of individuals within and between sites. Our impression is that the three species overlap in pigment pattern.

**Male epiproct** (n=14). Maximum width 310-410 µm, length 360-470 µm. Base conspicuously narrowed at stem and epiproct relatively wide across body at lateral projections giving a distinct stalked appearance (Figs.18-29). Shoulders scarcely, or not at all projecting beyond base of hook (Fig. 46).



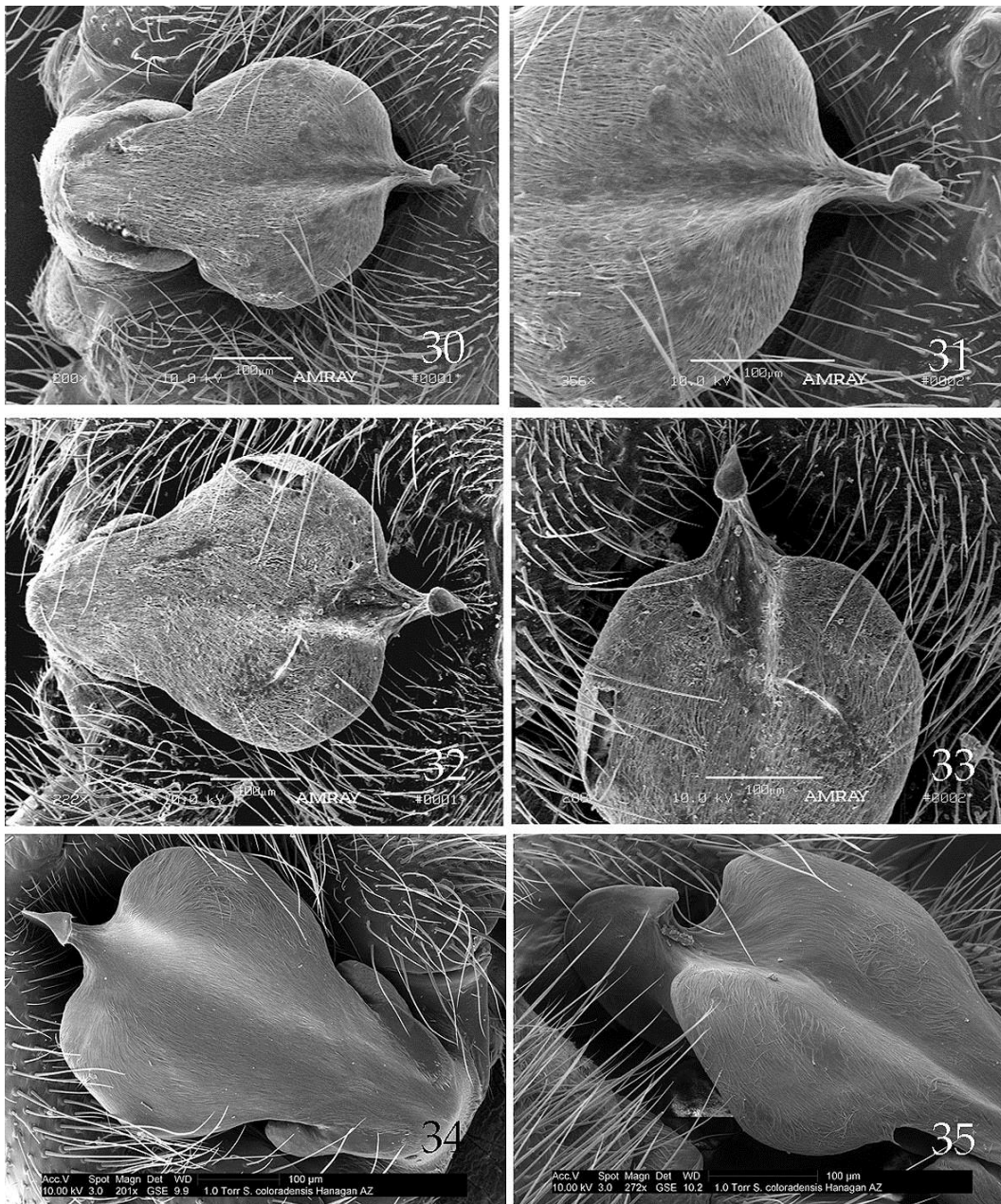


Figs. 24-29. *Sweltsa lyrata* male epiproct, dorsal. 24. Montana, Mineral Co., St. Regis River. 25. Montana, Gallatin Co., Duck Creek. 26. Montana, Mineral Co. Trout Creek. 27. Washington, Pend Oreille Co., Sullivan Creek. 28. British Columbia, Duhamel Creek. 29. Yukon, Klondike River.

**Aedeagus** (n=1). Length from base to base of apical finger-like lobes 466 µm, width across eye-like lobes to apices of lateral lobes 525 µm. Lateral lobes

broad basally near outer margins of eye-like lobes; margins of lateral lobes strongly convergent, forming an overall football-shape to the aedeagal





Figs. 30-35. *Sweltsa mogollonica* male epiproct. 30-31. Arizona, Apache Co., North Fork White River. 32-33. New Mexico, Catron Co., Willow Creek. 34-35. Arizona, Greenlee Co. Hannagan Creek.

body (Fig. 16).

**Female terminalia.** Posterior margin of subgenital plate truncate, overlapping that of *S. coloradensis* in shape (Figs. 38-39).

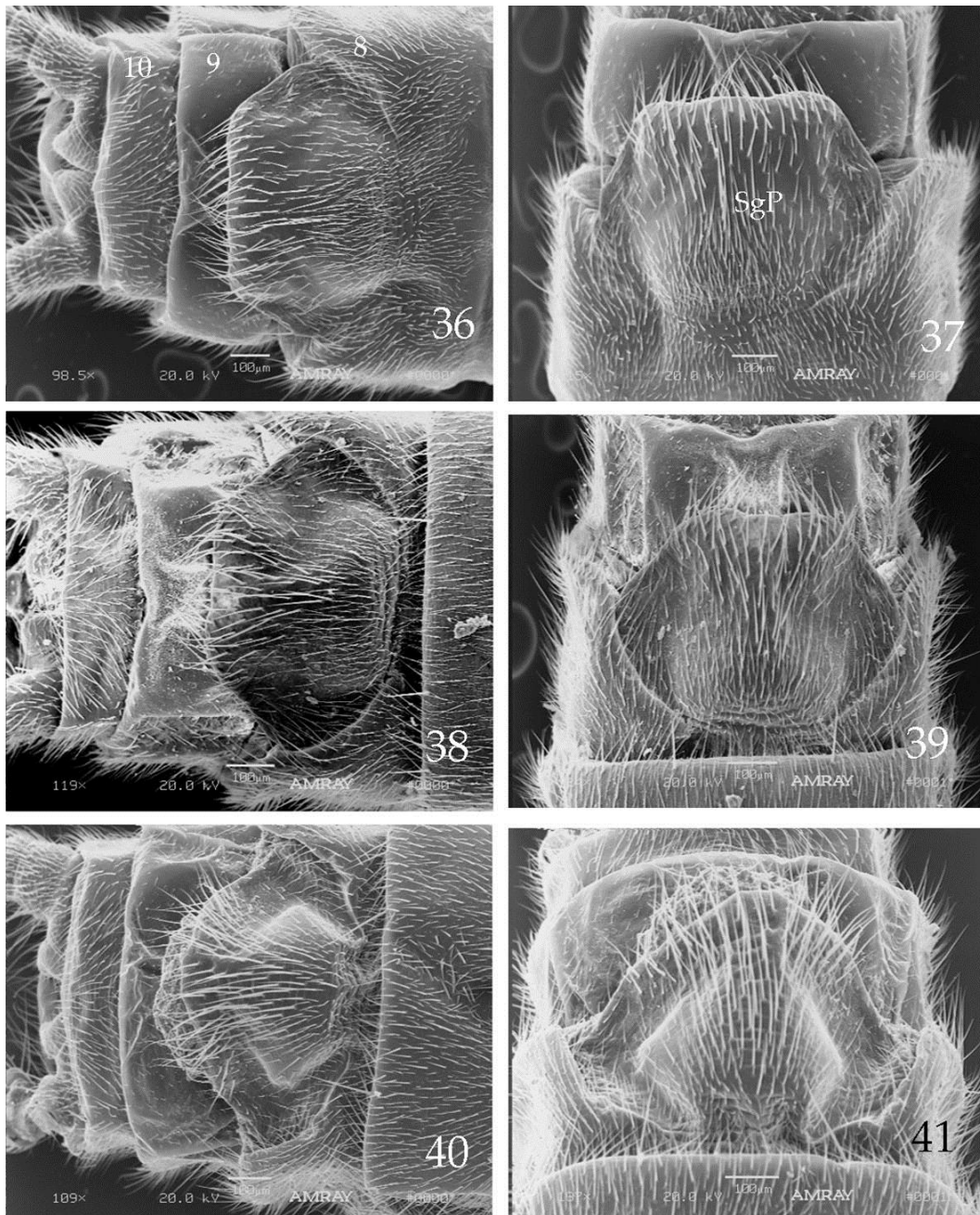
**Larva.** Unknown.

**Etymology.** The species name refers to the lyre-

shaped dorsal aspect of the epiproct of this species.

**Diagnosis and distribution.** *Sweltsa lyrata* is recognized by the prominent lateral projections, small apical projections and abruptly narrowed epiproct stem that give the epiproct a lyre-like shape. Males of this species are distinguished from





Figs. 36-41. *Sweltsa* sp. female terminalia, ventral. 36-37. *Sweltsa coloradensis*, Colorado, Gilpin Co., South Boulder Creek. 38-39. *Sweltsa lyrata*, Montana, Mineral Co., St. Regis River. 40-41. *Sweltsa mogollonica*, Arizona, Apache Co., North Fork White River (SgP = subgenital plate).

those of *S. mogollonica* by the enlarged lateral lobes of the epiproct (Figs.17-28), and from *S. coloradensis* by the prominent apical lobes of the epiproct in that species (Figs.2-13). The aedeagus of this

species (based on one specimen) is shorter than both additional species of the complex, and has the lateral lobes wider and more pointed at their apex. Populations exhibiting the *S. lyrata* epiproct type

are known from the Northern Rocky Mountains including sites in Alberta, British Columbia and Yukon Territory and adjacent areas in Washington, Montana and Idaho.

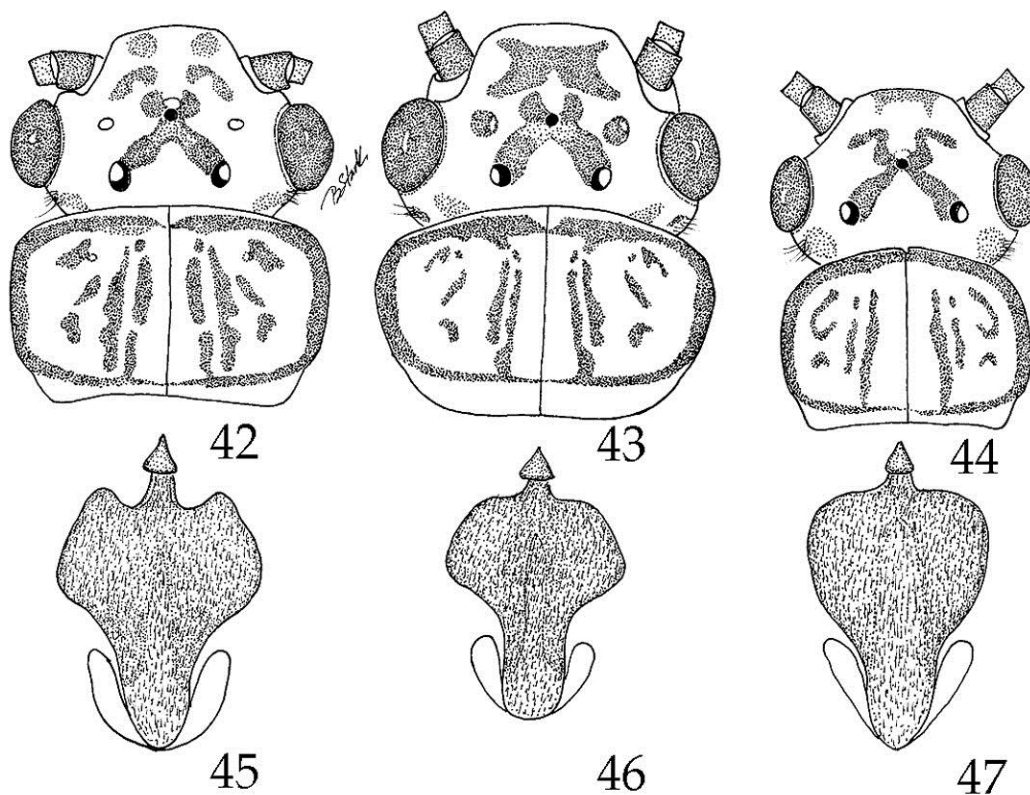
*Sweltsa mogollonica*, sp. n.

(Figs. 17, 30-35, 40-41, 44, 47)

<http://lsid.speciesfile.org/urn:lsid:Plecoptera.speciesfile.org:TaxonName:502537>

**Material examined.** Holotype ♂, 1♂, 10♀ paratypes, **Arizona**, Apache Co., North Fork White

River, Hwy 473, 12 June 1974, B. Stark, (holotype United States National Museum, paratypes BPSC). Additional paratypes, **Arizona**: Graham Co., Grant Creek, Hospital Flat Campground, Graham Mountains, 5 June 1982, R.W. Baumann, S.M. Clark, 12♂, 16♀ (BYU). **Greenlee Co.**, Hannagan Creek, Hannagan Meadow, Sitgreaves National Forest, 29 May 1993, C.R. Nelson, J.K. Gelhaus, 29♂, 14♀ (BYU). **New Mexico**: Catron Co., Willow Creek, Willow Creek Campground, 11 June 1974, B. Stark, 8♂, 7♀ (BPSC).



Figs. 42-47. *Sweltsa* sp. head and pronotal pigment and epiproct variation. 42. *Sweltsa coloradensis*, Colorado, Eagle Co., Deep Creek. 43. *Sweltsa lyrata*, Montana, Mineral Co., St. Regis River. 44. *Sweltsa mogollonica*, New Mexico, Catron Co., Willow Creek. Pigment patterns shown here are variable within and between populations of the three species. 45. *Sweltsa coloradensis* epiproct, Colorado, Gilpin Co., South Boulder Creek. 46. *Sweltsa lyrata* epiproct, Washington, Pend Oreille Co., Sullivan Creek. 47. *Sweltsa mogollonica* epiproct, New Mexico, Catron Co., Willow Creek.



**Adult habitus.** Pigment pattern not distinct from that of *S. coloradensis* or *S. lyrata* (Fig. 44). Male forewing length 6.8-7.5 mm, female forewing length 7.8-9.0 mm.

**Male epiproct.** Maximum width 320-340 µm, length 390-430 µm. Base and stem relatively wide and usually, more or less continuous with epiproct body (Figs. 30-35). Apical lobes not projecting from shoulders (Fig. 47).

**Aedeagus** (n=1). Length 357 µm, width 614 µm. Similar in shape and setation to *S. coloradensis* but conspicuously shorter in the only everted specimen available (Fig. 17).

**Female terminalia.** Subgenital plate not always distinct from that of *S. coloradensis* or *S. lyrata*. The specimen illustrated in Fig. 39-40 has a more rounded subgenital plate than is typical for the other species.

**Larva.** Unknown.

**Etymology.** This species name is based on the Mogollon Rim of Arizona and New Mexico.

**Diagnosis and distribution.** Epiprocts of specimens of this species have, at most, slightly projecting shoulders near the hook base and are relatively wide across the lateral lobes (Figs. 29, 32). The new species is similar to *S. lyrata* in the former character but the two are distinguished on the basis of the relatively greater width of the epiproct for males of *S. lyrata* (compare Figs. 19 and 29). The aedeagus may also be distinct (see Fig. 17), but verification is needed from additional material. Specimens are known from three Arizona sites, and an adjacent site in New Mexico.

## ACKNOWLEDGEMENTS

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complex.

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