



DESCRIPTION OF THE MALE TERMINALIA OF TWO WESTERN NEARCTIC PERLODINAE (*PICTETIELLA EXPANSA* (BANKS) AND *SALMOPERLA SYLVANICA* BAUMANN & LAUCK)

Chris J. Verdone¹ & Boris C. Kondratieff²

Department of Bioagricultural Sciences and Pest Management, Colorado State University,
Fort Collins, Colorado, 80523 U.S.A.

¹ E-mail: verdonec@gmail.com

² E-mail: Boris.kondratieff@colostate.edu

ABSTRACT

The male epiproct and aedeagus of *Pictetiella expansa* (Banks) and *Salmoperla sylvanica* Baumann & Lauck are described and supported by scanning electron micrographs and color images.

Keywords: Plecoptera, *Pictetiella*, *Salmoperla*, male genitalia

INTRODUCTION

Banks (1920) described *Perla expansa* from Grant, Park County, Colorado. The original description was based on a single adult female. Needham and Claassen (1925) putatively described the male, which was possibly incorrectly associated (Ricker 1952, Baumann 1973). Claassen (1931) putatively described, but did not illustrate, the nymph, but this was again apparently incorrectly associated (Ricker 1952, Baumann 1973). Ricker (1952) provided the first apparently valid description of “*Isogenus (Pictetia) expansus*” by dissecting the male genitalia from a pre-emergent nymph collected in Wyoming, but the illustration was “rather general” (Baumann 1973). Illies (1966) replaced the homonym *Pictetia* with the replacement name *Pictetiella*. Gaufin et al. (1966) provided illustrations of the dorsal and lateral view of male terminalia and ventral view of the female terminalia. Gaufin et al. (1972) used the

same illustrations originally from Gaufin et al. (1966) except the lateral view of the male terminalia. Baumann (1973) provided descriptions of the adult male and female, an illustration of the nymphal habitus, and scanning electron micrographs of the egg. Baumann et al. (1977) illustrated the wings and reproduced the Baumann (1973) illustrations of the dorsal view of the male terminalia and the ventral view of the female terminalia. Stark & Szczytko (1984) placed *P. expansa* in the tribe Diploperlini based on the presence of submental gills and the triangular shape of the eggs. Nymphs of *P. expansa* occur in small to medium-sized high elevation streams in the Rocky Mountains (Baumann et al. 1977, Kondratieff & Baumann 2002). Detailed images of the male epiproct and aedeagus are not currently available.

Baumann & Lauck (1987) described *Salmoperla sylvanica* from the Willow Creek drainage in

Humboldt County, California. In their original description, based on 33 nymphs and two adult male specimens, illustrations were provided for the male terminalia, nymphal habitus, and several other nymphal characters. Stark & Baumann (2006) described and illustrated the female terminalia and forewing and provided scanning electron micrographs of the egg. Stark & Baumann (2006) placed *S. sylvanica* in the tribe Arcynopterygini based on the presence of paired gill structures on the 2nd and 3rd thoracic segments. *Salmoperla sylvanica* is known from few locations and appears to be restricted to smaller streams in the mountainous regions of northern California and southern Oregon (Baumann & Lauck 1987, Nelson & Stark 1988, Stark & Baumann 2006, Stark et al. 2015). Detailed images of the male terminalia and aedeagus are not currently available. The purpose of this paper is to provide complementary descriptions further detailing the male epiproct and aedeagus of *P. expansa* and *S. sylvanica* using high quality color images and scanning electron micrographs (SEM).



Fig. 1. Head and pronotum dorsal, *Pictetiella expansa* ♂, Boulder Co., Colorado, North Fork Middle Boulder Creek, 29 Aug. 2015.

MATERIALS AND METHODS

A JEOL JSM-6500F Field Emission Scanning Electron Microscope (FESEM), Central Instrument Facility, Imaging Laboratory (<http://cif.colostate.edu/imaging-laboratory/>), Colorado State University was used for the SEM images. Samples were critical point dried and coated with 20 nm gold. Color images were captured using a Canon EOS 7D digital camera with a Nikon model K2 SE lens and CF3-CF10 lens adapters. Images resulted from batches of ≈ 60 photomicrographs taken at progressively deeper focal planes using Camlift and were edited together using Zerene Stacker version 1.04. Photographic adjustments were made using Adobe Photoshop CS6. Specimens listed in this study are deposited in the C.P. Gillette Museum of Arthropod Diversity, Colorado State University, Fort Collins, Colorado (CSUC).

RESULTS

Pictetiella expansa (Banks)

(Figs. 1-11)

Perla expansa Banks (1920:317.)

Perla expansa: Needham and Claassen, (1925:81., 313., 325.) [♂ possibly incorrectly associated? (Ricker, 1952:120., Baumann, 1973:97.)]

Perla expansa: Claassen, (1931:55.) [nymph incorrectly associated (Ricker, 1952:120., Baumann, 1973:98.)]

Isogenus (Pictetia) expansus: Ricker, (1952:120.)

Pictetiella expansella: Illies, (1966:375.)

Isogenus (Pictetia) expansus: Gaufin et al., (1966:62.)

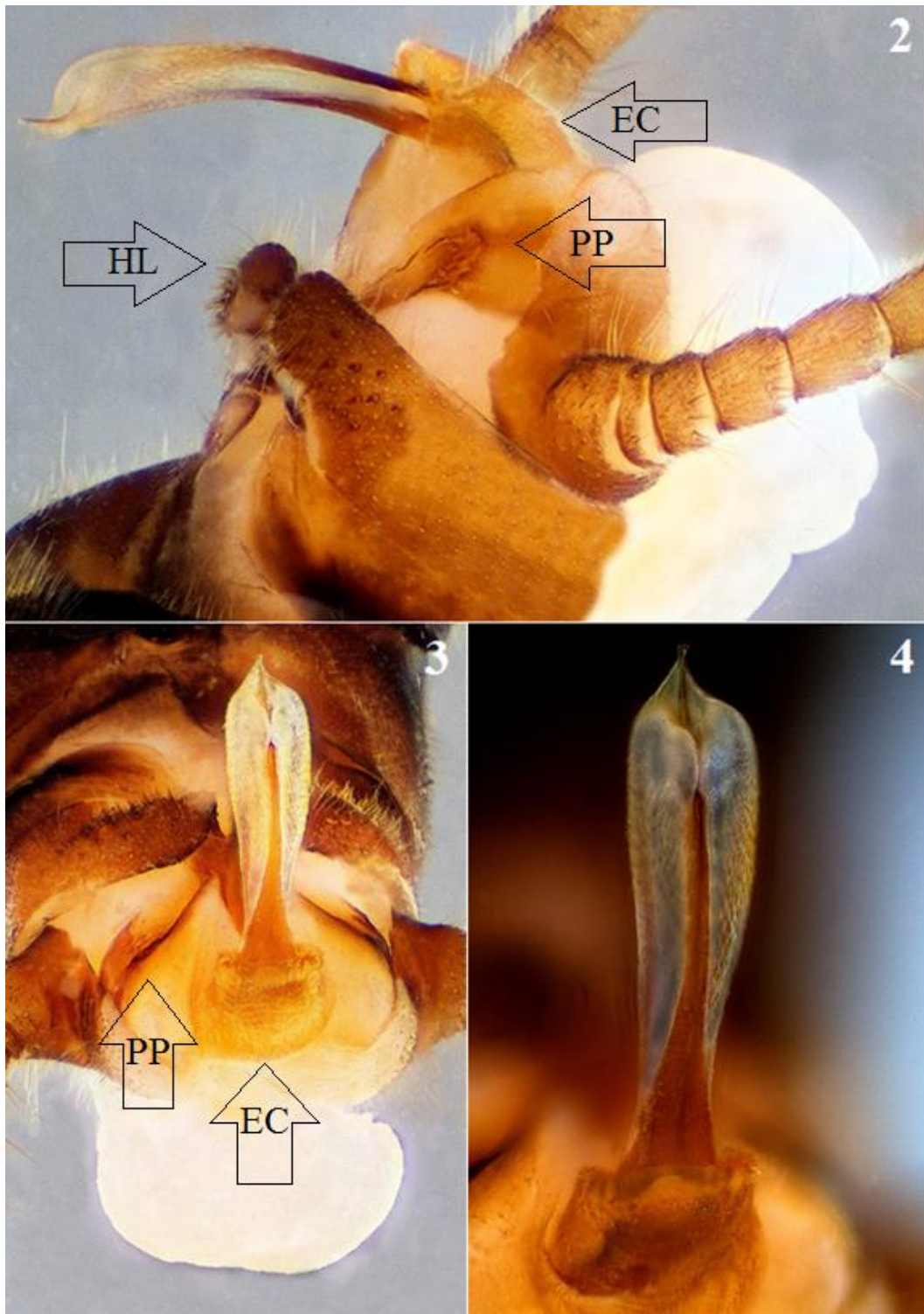
Isogenus (Pictetia) expansus [sic]: Gaufin et al., (1972:110.)

Pictetiella expansa: Baumann, (1973:98.)

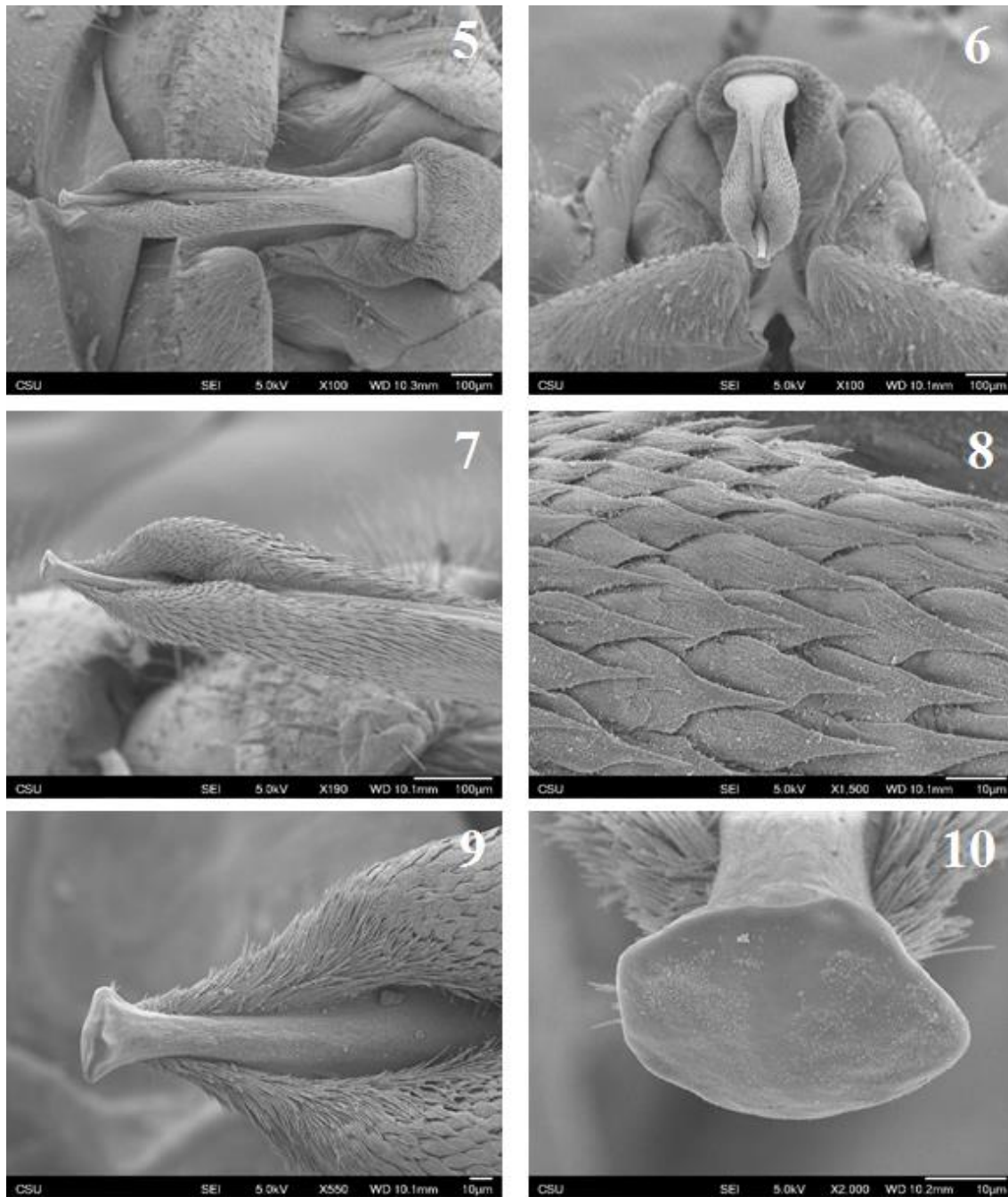
Pictetiella expansa: Baumann et al., (1977:22., 115.)

Material Examined. COLORADO: Boulder Co., North Fork Middle Boulder Creek, 4th of July Rd. below 4th of July Campground, 39.99194°N, 105.63226°W, 29 Aug. 2015, C. Verdone, D. Fuller & M. Diesenroth, 18♂, 7♀ (CSUC).

Description: Male. For a habitus description refer to Baumann (1973). Head and pronotum shown in (Fig. 1). Hemitergal lobes (HL) rounded produced inward, apices with long fine hairs, bearing sparse sensilla basiconica anteriorly (Figs. 2, 3). Epiproct



Figs. 2-4. *Pictetiella expansa* ♂, Boulder Co., Colorado, North Fork Middle Boulder Creek, 29 Aug. 2015. 2. Epiproct lateral, epiproct cowl (EC), hemitergal lobes (HL), paragenital plates (PP). 3. Epiproct dorsal, epiproct cowl (EC), paragenital plates (PP). 4. Epiproct dorsal.



Figs. 5-10. *Pictetiella expansa* ♂, Boulder Co., Colorado, North Fork Middle Boulder Creek, 29 Aug. 2015. 5. Epiproct dorsal. 6. Epiproct anterior. 7. Epiproct apex lateral. 8. Epiproct, scale-like setae. 9. Epiproct, bristle-like hairs. 10. Epiproct tip.

cowl densely clothed with short bristle-like setae (Figs. 2, 3) and flanked by inward pointed finger-like paragenital plates (PP) (Figs. 2, 3). Epiproct

sclerotized process bifurcate in lateral aspect (Fig. 2). Sclerotized process singular, widest at base from dorsal aspect (Figs. 3, 4). Fully everted

epiproct directed forward. Epiproct long, narrow and widest just before apex (Figs. 3-7). Anterior $\frac{2}{3}$ of epiproct covered in backward directed shingled scale-like setae, which appear translucent (Fig. 8). Scale-like setae transition into bristle-like setae near apex (Fig. 9). Apex of sclerotized process narrow with flared blunt tip (Figs. 9, 10). Lateral stylets absent. Aedeagus completely membranous, bearing only a few sparse hairs and two small posterolateral lobes (Fig. 11).

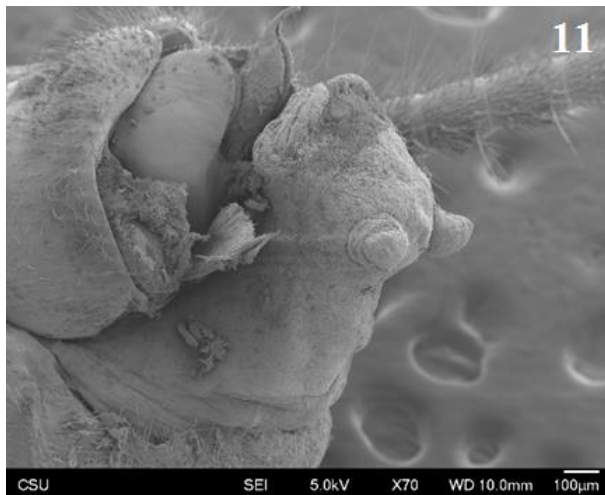


Fig. 11. Aedeagus lateral, *Pictetiella expansa* ♂, Boulder Co., Colorado, North Fork Middle Boulder Creek, 29 Aug. 2015.

***Salmoperla sylvanica* Baumann & Lauck**
(Figs. 12-17)

Salmoperla sylvanica Baumann & Lauck (1987:825.)
Salmoperla sylvanica: Stark & Baumann, (2006:24.)

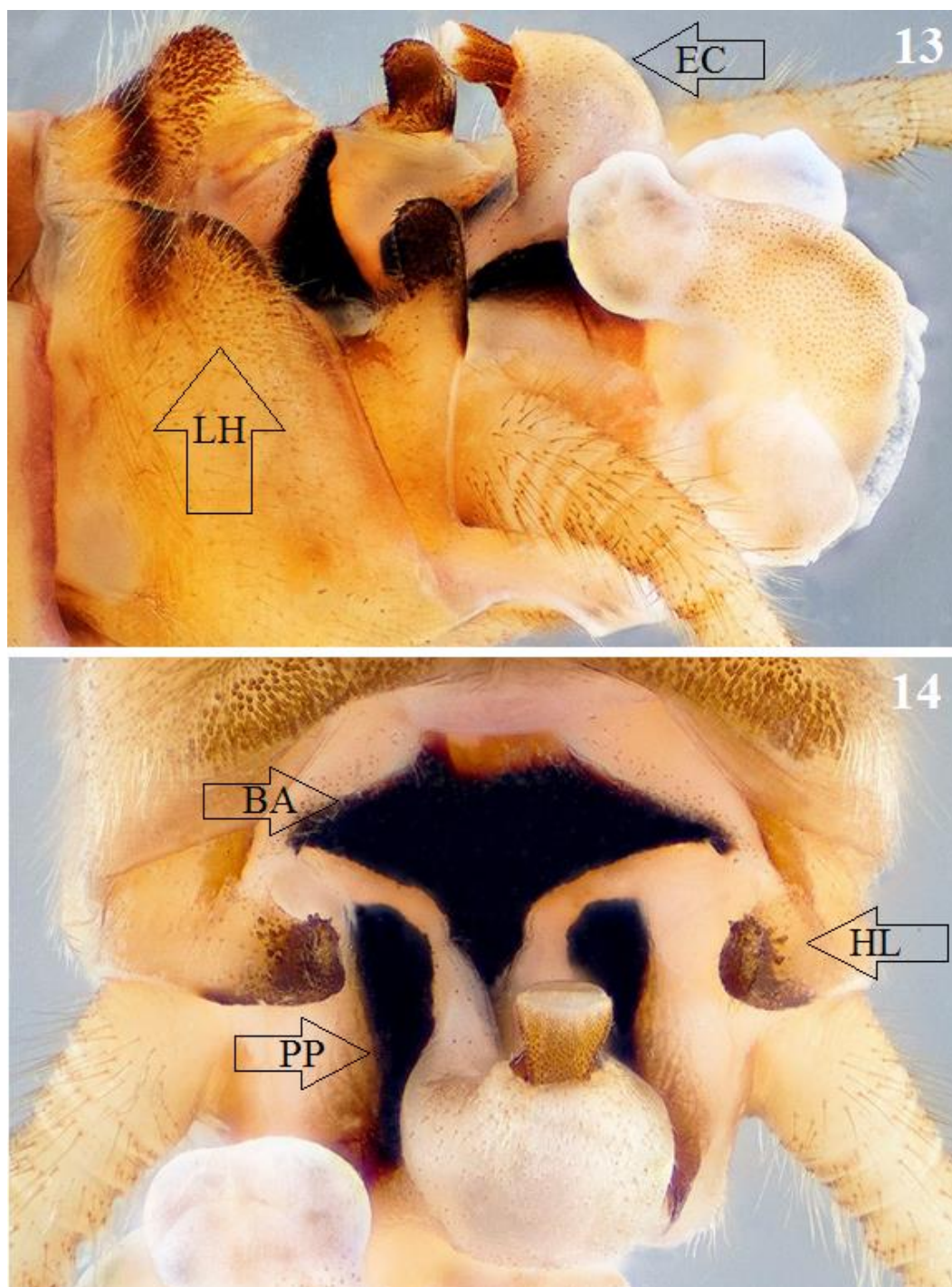
Material Examined. CALIFORNIA: Humboldt Co., Willow Creek, 40.931559°N, 123.681118°W, 17 June 2009, B. Kondratieff & J. Sandberg, 1♂ (CSUC); OREGON: Jackson Co., Split Rock Creek, Wagner Gap Road, 12 mi S Talent, 42.09480°N, 122.77397°W, 22 May 2014, B. Kondratieff, C. Verdone, J. Sandberg & B. Stark, 2♂, 1♀ (CSUC).

Description: Male. For a habitus description refer to Baumann and Lauck (1987). Head and pronotum shown in (Fig. 12). Ninth tergum with pair of lateral humps (LH), apices covered in sensilla basiconica,

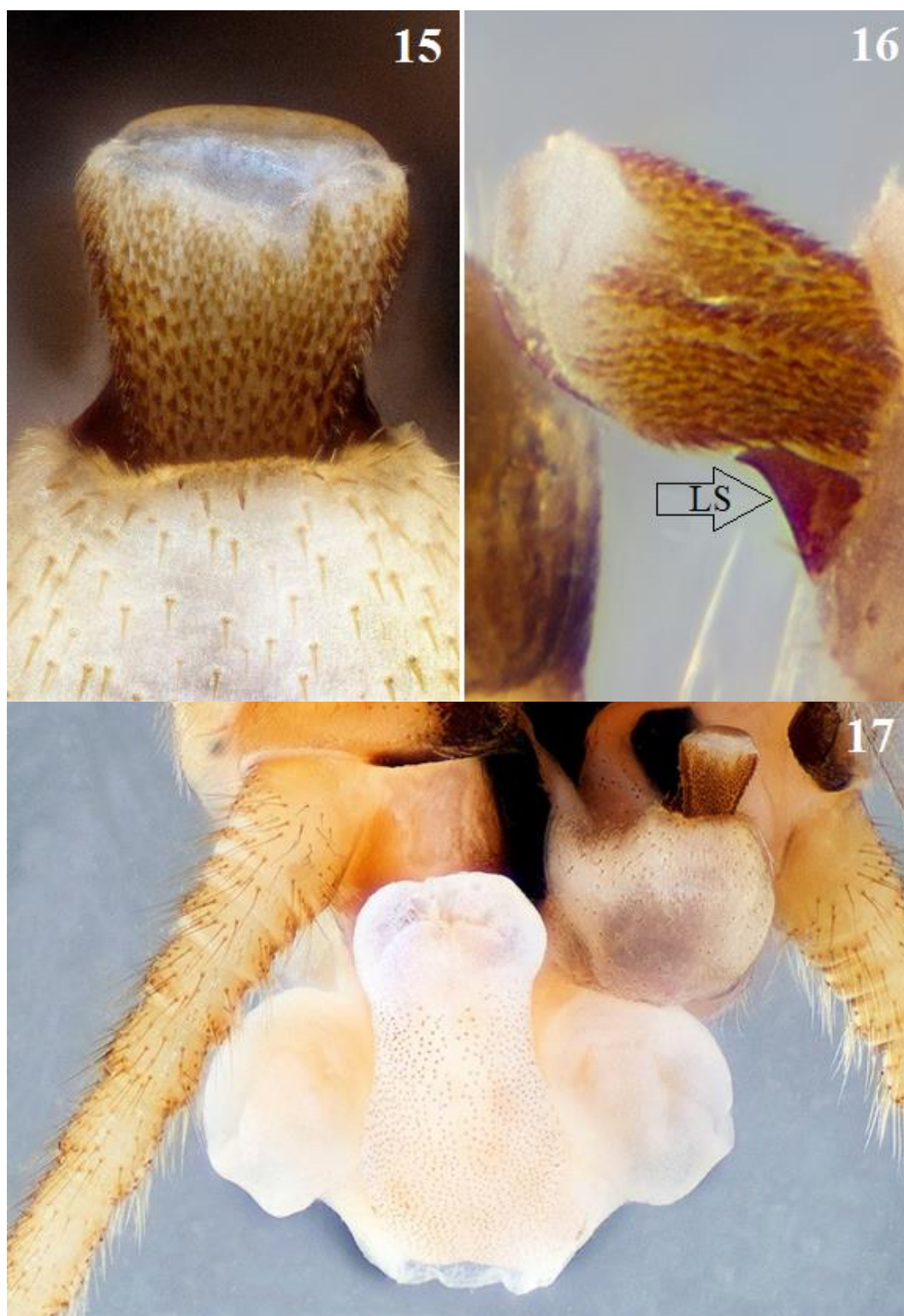


Fig. 12. Head and pronotum dorsal, *Salmoperla sylvanica* ♂, Siskiyou Co., Oregon, Split Rock Creek, 22 May 2014.

lateral margins covered in long fine hairs (Fig. 13). Tenth tergum deeply cleft, membranous with a large basal anchor (BA) which extends to base of the epiproct cowl (Fig. 14). Epiproct cowl (EC) membranous with sparse setae (Fig. 13) and flanked by two rectangular paragenital plates (PP) at base (Fig. 14). Hemitergal lobes (HL) rounded produced inward, sclerotized and flattened at apices bearing sensilla basiconica anteriorly and fine hairs posteriorly (Fig. 14). Epiproct short, box-like in dorsal aspect, basal portion slightly narrowed, covered in backward directed scale-like setae, setae absent on apex (Figs. 15, 16). Lateral stylets short, broad and darkly sclerotized terminating in outward directed hooks, present laterally at epiproct base (Fig. 16). Aedeagus with pair of large posterolateral lobes at base (Fig. 17).



Figs. 13-14. *Salmoperla sylvanica* ♂, Siskiyou Co., Oregon, Split Rock Creek, 22 May 2014. 13. Terminalia lateral, lateral humps (LH), epiproct cowl (EC). 14. Terminalia dorsal, basal anchor (BA), hemitergal lobes (HL), paragenital plates (PP).



Figs. 15-17. *Salmoperla sylvanica* ♂, Siskiyou Co., Oregon, Split Rock Creek, 22 May 2014. 15. Epiproct dorsal, scale-like setae. 16. Epiproct lateral, lateral stylet (LS). 17. Terminalia, aedeagus dorsal.

Basal portion of aedeagus covered with uniformly spaced spinulae (Fig. 17). Apex of aedeagus bulbous, glabrous (Fig. 17).

DISCUSSION

Pictetiella is currently represented by four species, *P. expansa* (Banks), *P. lechleitneri* Stark & Kondratieff (2004), *P. asiatica* Zwick & Levanidova (1971), and *P. zwicki* Zhiltzova (In Levanidova and Zhiltzova 1976) (DeWalt et al. 2016). The male terminalia of *P. expansa* is most similar to *P. lechleitneri*, which is the only other Nearctic species. The epiproct of these species are widest just before the apex and bear scale-like setae. However, the epiproct of *P. expansa* is longer and narrower near the apex than *P. lechleitneri*.

The function of the scale-like setae covering the epiproct of both *Pictetiella* and *Salmoperla* is unknown. Typical of all Perlodinae, *P. expansa* and *S. sylvanica* possess both an aedeagus and epiproct. The aedeagus is functionally equivalent to a penis and is ultimately the structure through which sperm is transferred (D. Murányi, personal communication). The epiproct in this case does not support sperm transfer as it does in the families Nemouridae and Capniidae (Zwick 1973). Several hypotheses are possible in regards to the purpose and complexity of the epiproct. The backwards directed scale-like setae may help to keep the epiproct inserted, or the setae may play a role in sexual stimulation (P. Zwick, personal communication). There does seem to be a general consensus among stonefly workers that the Perlodinae epiproct serves to open the female ducts to allow insertion of the aedeagus. Further insight into the epiproct question may be elucidated by examining specimens preserved in copula or by dissecting and examining internal female genitalia.

ACKNOWLEDGEMENTS

We thank Dr. John Sandberg, California State University, Chico, for his assistance in collecting specimens of *S. sylvanica* and providing locality information for *P. expansa*, which led to the large series collected for this study, Dr. Bill Stark, Mississippi College, Clinton, for his diagnostic

interpretation of the *Salmoperla* terminalia, Kim Vanderpool, Colorado State University, Department of Biomedical Sciences for the excellently prepared SEM images, Joseph Benz, Colorado State University, Department of Bioagricultural Sciences & Pest Management for photographing and preparing all the color images and finally, Dr. Peter Zwick, Schlitz, Germany and Dr. Dávid Murányi, Hungarian Natural History Museum, Budapest for their contributions to the discussion of the function of the epiproct.

REFERENCES

- Banks, N. 1920. Perlidae. Pp. 314- 328. In New neuropteroid insects. Bulletin of the Museum of Comparative Zoology at Harvard College, 64:299-362.
- Baumann, R.W. 1973. Studies on Utah stoneflies (Plecoptera). The Great Basin Naturalist, 33:91-108.
- Baumann, R.W. & D.R. Lauck. 1987. *Salmoperla*, a new stonefly genus from northern California (Plecoptera: Perlodidae). Proceedings of the Entomological Society of Washington, 89:825-830.
- Baumann, R.W., A.R. Gaufin, & R.F. Surdick. 1977. The stoneflies (Plecoptera) of the Rocky Mountains. Memoirs of the American Entomological Society, 31:1-208.
- Claassen, P.W. 1931. Plecoptera nymphs of America (north of Mexico). Thomas Say Foundation. Entomological Society of America, 3:1-199.
- DeWalt, R.E., M.D. Maehr, U. Neu-Becker, & G. Stueber. 2015. Plecoptera Species File Online. Version 5.0/5.0. Available from: <http://plecoptera.speciesfile.org/> (accessed 1 December 2015)
- Gaufin, A.R., A.V. Nebeker, & J. Sessions. 1966. The stoneflies (Plecoptera) of Utah. University of Utah Press, 14:1-93.
- Gaufin, A.R., W.E. Ricker, M. Miner, P. Milam, & R.A. Hays. 1972. The stoneflies (Plecoptera) of Montana. Transactions of the American Entomological Society, 98:1-161.
- Illies, J. 1966. Katalog der rezenten Plecoptera. Das Tierreich. Walter de Gruyter, Berlin, Germany.

82:I-XXX, 1-692.

Submitted 13 January 2016, Accepted 30 January 2016,
Published 11 February 2016

Hosted and published at the University of Illinois, Illinois
Natural History Survey, Champaign, Illinois, U.S.A.

- Kondratieff, B.C. & R.W. Baumann 2002. A review of the stoneflies of Colorado with a description of a new species of *Capnia* (Plecoptera: Capniidae). Transactions of the American Entomological Society, 128:385-401.
- Levanidova, I.M. & L.A. Zhiltzova (1976): [Stoneflies (Plecoptera) from Chukotka Peninsula]. pp.:1537. In: [The Freshwater Fauna of Chukotka Peninsula] ed. V.YA. Levanidov; Akademija Nauk SSSR, Vladivostok, 132 pp. (Russian, Eng. summary).
- Needham, J.G. & P.W. Claassen. 1925. A monograph of the Plecoptera or stoneflies of America north of Mexico. Thomas Say Foundation. Entomological Society of America, 2:1-397.
- Nelson, C.R. & B.P. Stark (1988). The *Salmoperla* safari: Hit and run stonefly collecting in Nevada and California. *Perla*, 8:7-11.
- Ricker, W.E. 1952. Systematic studies in Plecoptera. Indiana University Publications, Science Series, 18:1-200.
- Stark, B.P. & R.W. Baumann. 2006. The female and egg of *Salmoperla sylvanica* (Plecoptera: Perlodidae). *Illiesia*, 2:24-26.
- Stark, B.P. & B.C. Kondratieff. 2004. *Pictetiella lechleitneri* (Plecoptera: Perlodidae), a new species from Mount Rainier National Park, Washington, U.S.A. Proceedings of the Entomological Society of Washington, 106:747-750.
- Stark, B.P. & S.W. Szczytko. 1984. Egg morphology and classification of Perlodinae (Plecoptera: Perlodidae). *Annales de Limnologie*, 20:99-103.
- Stark, B.P., J.B. Sandberg, B.C. Kondratieff, C.J. Verdone, & A.B. Harrison. 2015. The 2014 *Sierraperla* (Plecoptera: Peltoperlidae) Pacific Northwest U.S.A. expedition. *Perla* 33:18-23
- Zwick, P. 1973. Insecta: Plecoptera. Phylogenetisches System und Katalog. Das Tierreich. Walter de Gruyter, Berlin, Germany. 94:I-XXXII, 1-465.
- Zwick, P., I.M. Levanidova, & L.A. Zhiltzova. 1971. On the fauna of Plecoptera from the Soviet Far East. *Entomologicheskoe Obozrenie*, 50:849-869.

ZOBODAT - www.zobodat.at

Zoologisch-Botanische Datenbank/Zoological-Botanical Database

Digitale Literatur/Digital Literature

Zeitschrift/Journal: [Illiesia](#)

Jahr/Year: 2016

Band/Volume: [12](#)

Autor(en)/Author(s): Verdone Chris J., Kondratieff Boris C.

Artikel/Article: [Description of the male terminalia of two western Nearctic Perlodinae \(*Pictetiella expansa* \(Banks\) and *Salmoperla sylvanica* Baumann & Lauck\). 1-9](#)