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DESCRIPTIONS OF THE ADULT MALE AND FEMALE GENITALIA OF THE GENUS *OSOBENUS* RICKER (PLECOPTERA: PERLODIDAE)

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ABSTRACT
The male and female terminalia of the perlodine *Osobenus yakimae* (Hoppe 1938) are described, supported by scanning electron micrographs and color images. The distinctive epiproct of the male is described in detail for the first time. The paired dorsal membranous processes of the epiproct terminating in 6-7 large external spinulae processes appear unique within the Diploperlini of the Perlodinae.

Keywords: Plecoptera, *Osobenus* adult male and female genitalia descriptions

INTRODUCTION

Hoppe (1938) described *Perla yakimae* from the Yakima River, at Cle Elum, Kittitas County, Washington. In her original description, based upon a single male, the epiproct was briefly described and a ventral view of the epiproct apex was illustrated. Ricker (1952) proposed the subgenus *Osobenus* for *P. yakimae*, inferring with the etymology of the name to the "unusual structure of the epiproct." Ricker (1952) mentioned that the epiproct "has a rather complex structure, almost impossible to illustrate satisfactorily."

Jewett (1955) provided the first description of the mature male nymph of *Isogenus* (*Osobenus*) *yakimae*, indicating the dorsal abdominal stripes "closely resemble species in the genus *Isoperla*." Jewett (1959, 1960) briefly treated *O. yakimae*, providing in the latter paper records for California. However, the southern California records need to be confirmed. Both of these publications used the original illustration of the male terminalia of Hoppe (1938).

Illies (1966) recognized *Osobenus* as a genus. Stark and Szczytko (1984) placed *Osobenus* into their new tribe Diploperlini based on the

synapomorphies of extreme reduction of setae on the nymphal lacinia, and ventral position of the collar of the eggs. Stewart and Stark (2002) described in detail and illustrated the nymph of *Osobenus* from the Yakima River, Washington. Finally, Stark et al. (1998) presented a photograph of an adult female of *O. yakimae* and mentioned that the epiproct "consists of an upturned dorsal sclerite surmounting a basal, bulbous structure."

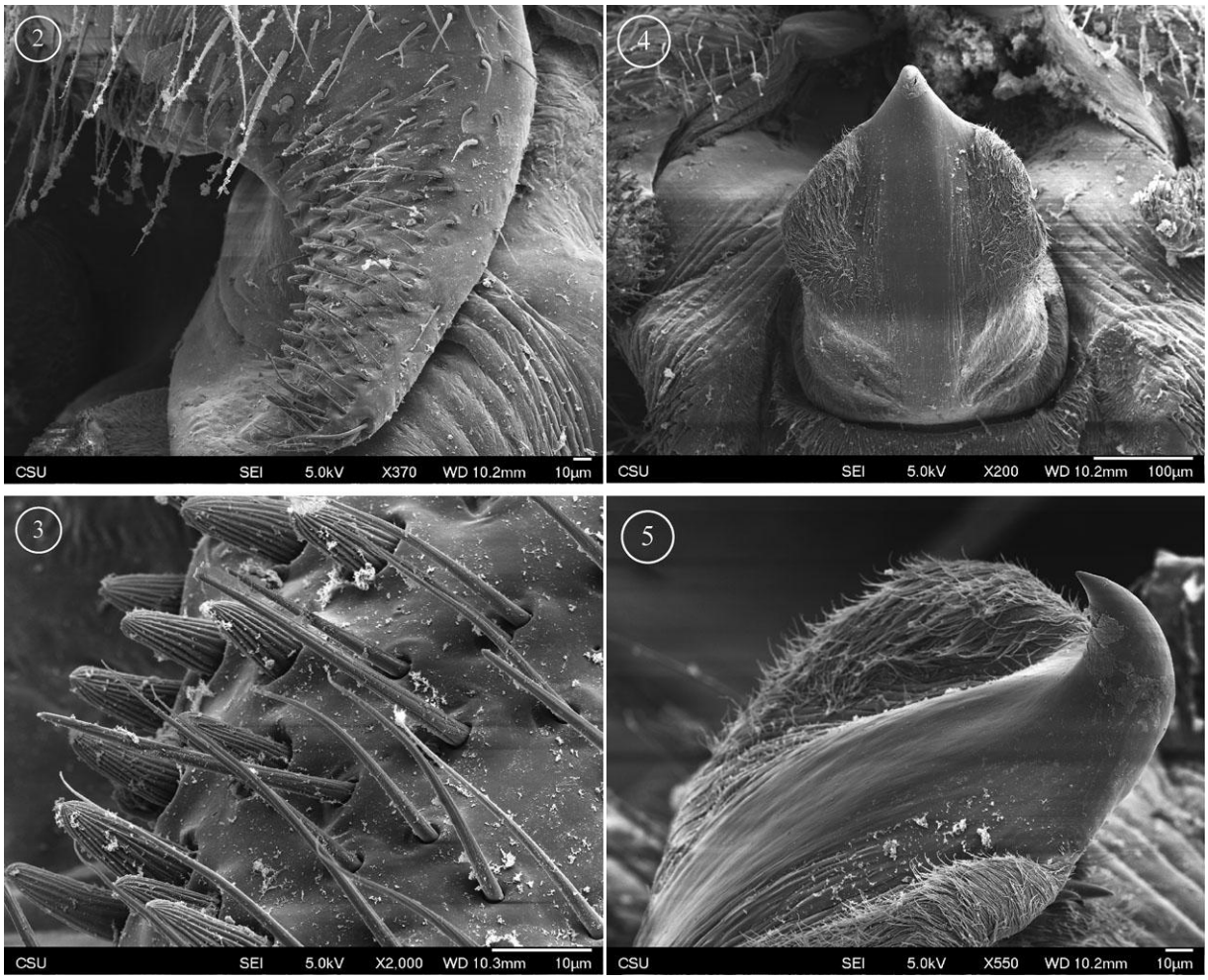
Nymphs of *O. yakimae* are often common in larger streams and rivers from British Columbia (Stark et al. 1998) to California (Stewart and Stark 2002). However, no detailed illustrations of the interesting male terminalia of *O. yakimae* are currently available. The purpose of this paper is to provide a description of the adult terminalia of both sexes, especially the male, using scanning electron micrographs and color images.

Fig. 1. *Osobenus yakimae* ♀, habitus, Amador Co., California, Cosumnes River, 14 May 2011.

MATERIALS AND METHODS

Material was studied using a JEOL JSM-6500F Field Emission Scanning Electron Microscope (FESEM), Central Instrument Facility, Imaging Laboratory (http://cif.colostate.edu/imaging-laboratory/), Colorado State University. Samples were critical point dried and coated with 20nm gold. Images were captured in Tiff file format. Color photomicrographs were taken using a Zeiss Stemi SV6 fitted with an intermediate phototube, 1.0x camera adapter, and a Lumenera Infinity 2-2C (1/1.8 inch CCD sensor) video camera and Infinity Analyze image capture software. The color figures resulted from batches of 4-23 photomicrographs taken at successively deeper focal planes that were combined and simultaneously focused using Helicon Focus version 5.3. Photographic adjustments were made using the Curves control in Adobe Photoshop CS3.

Specimens listed in this study are located at Colorado State University, Fort Collins, Colorado (CSUC), John B. Sandberg Collection, Paradise, California (JBSC), Monte L. Bean Life Science Museum, Brigham Young University Insect Collection, Provo, Utah (BYUC), and Illinois Natural History Survey, Champaign, Illinois (INHS).



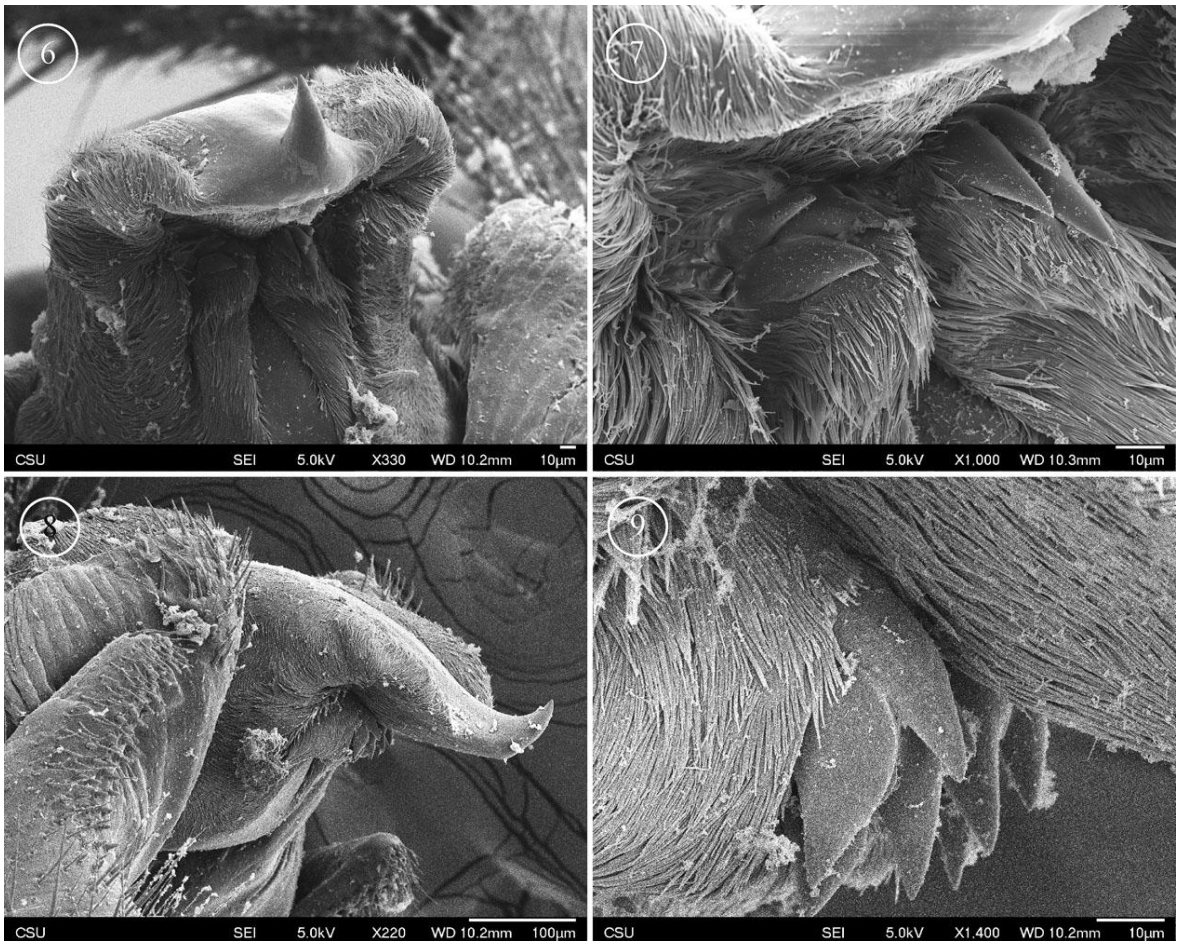
Figs. 2–5. *Osobenus yakimae* ♂, Siskiyou Co., California, McCloud River, 23 May 2014. 2. Hemitergal lobe, dorsolateral. 3. Sensilla basiconica and trichoid sensilla of hemitergal lobe. 4. Epiproct everted, ventral surface, dorsal. 5. Epiproct everted, ventral surface, dorsolateral.

RESULTS

Osobenus yakimae (Hoppe)
Figs. 1-17.

Perla yakimae Hoppe 1938:150.
Isogenus (*Osobenus*) *yakimae*: Ricker, 1952:118.
Isogenus (*Osobenus*) *yakimae*: Jewett, 1955:148.
Isogenus (*Osobenus*) *yakimae*: Jewett, 1959:68.
Isogenus (*Osobenus*) *yakimae*: Jewett, 1960:155.
Osobenus yakimae: Illies, 1966:373.
Osobenus yakimae: Zwick, 1973:235.

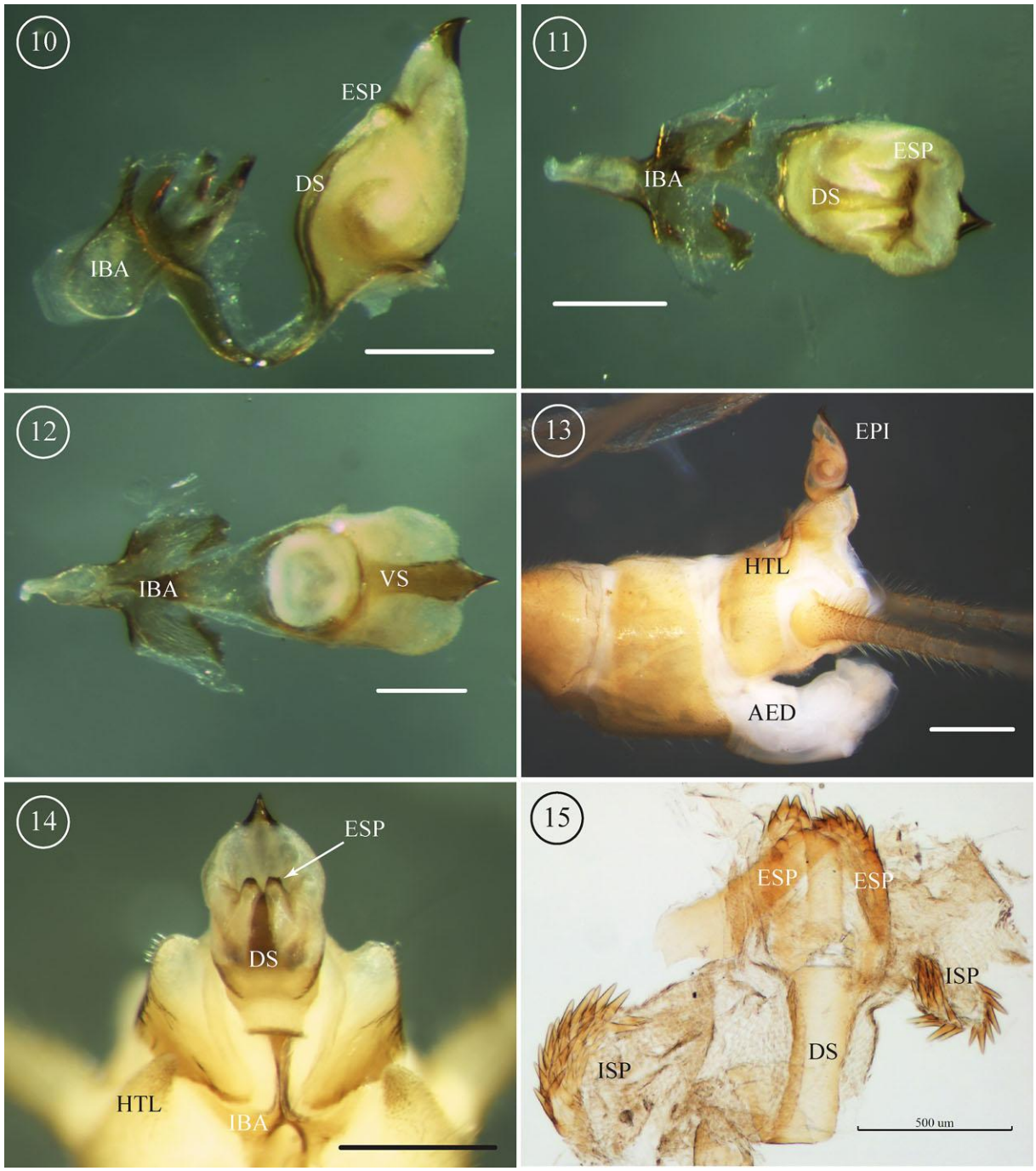
Material Examined. CALIFORNIA: Amador Co., Cosumnes River, Hwy 49 bridge below North & Middle Forks Cosumnes Rivers confluence, 14 May 2011, J. Sandberg, 1♀ (JBSC); Butte Co., Big Chico Creek, Big Chico Creek Ecological Reserve, 24 May 2009, J. Sandberg, B. Richards, 18♂, 21♀ (JBSC); Big Chico Creek, Big Chico Creek Ecological Reserve, 27 April 2010, B. Kondratieff, R. Baumann, & J. Sandberg, 1♂ (CSUC); Nevada Co., South Yuba River, I-80, Cisco Grove, 22 June 2009, B. Kondratieff & R. Baumann, 4♂, 2♀ (CSUC); Placer Co., Truckee River, Hwy 89, Silver Creek



Figs. 6–9. *Osobenus yakimae* ♂, Siskiyou Co., California, McCloud River, 23 May 2014. 6. Epiproct everted, posterior. 7. External spinule processes, lateral. 8. Epiproct everted, lateral. 9. External spinule processes, lateral.

Campground, 24 June 2009, B. Kondratieff & R. Baumann, 5♂, 3♀ (CSUC); Siskiyou Co., Butte Creek, USFS 44N15Y crossing off Deer Mountain & Tenant Rds., 7.9 km S Hwy 97, 23 June 2013, J. Sandberg, B. Kondratieff, 2♀ reared (JBSC); McCloud River, Falls of McCloud River, 25 May 2007, B. Kondratieff & R. Baumann, 2♀ (CSUC); McCloud River, Lower Falls Picnic Area, off Hwy 89, 23 May 2013, J. Sandberg, B. Kondratieff, 1♂, 1♀, 1 larva (JBSC); McCloud River, Lower Falls Picnic Area, off Hwy 89, 23 May 2014, B. Kondratieff, J. Sandberg, B. Stark, & C. Verdone, 8♂, 11♀ (CSUC), 5♂, 7♀ (JBSC); Yuba Co., Yuba River, Hammon Grove Park, Hwy 20, 25 April 2010, B. Kondratieff & R. Baumann, 5♂, 10♀ (CSUC).

Additional Material. CALIFORNIA: Del Norte Co., Klamath River, Hwy 169. Klamath Glen, 41° 30′N 123° 60′W, 8 June 2005, R. Baumann & B. Kondratieff, 1♂, 1♀ (BYUC); El Dorado Co., South Fork American River, Hwy 49, Coloma, 38° 49′N 120° 54′W, 29 April 2010, R. Baumann & B. Kondratieff, 1♀ (BYUC); Lake Co., Anderson Springs (light), 26 March 1955, R. Leuschner, 1♂ (BYUC); Placer Co., Truckee River, Hwy 89, 1 mi. S Truckee, 19 June 1985, R. Baumann, C. Nelson &



Figs. 10–15. *Osobenus yakimae* ♂, Butte Co., California, Butte Creek, 24 May 2009. 10-12. Epiproct dissected, lateral, dorsal, ventral, respectively (50x). 13. Epiproct and aedeagus everted, lateral (40x). 14. Epiproct everted, dorsal (50x). 15. Internal epiproct coiled sac dissected, external and internal spinule process (100x). Abbreviations: Aedeagus (AED), Dorsal Sclerite (DS), Epiproct (EPI), External Spinule Processes (ESP), Hemitergal Lobes (HTL), Internal Basal Anchor (IBA), Internal Spinule Processes (ISP), Ventral Sclerite (VS). White and black bars = 1 mm except Fig. 15.

M. Whiting, 6♂, 4♀ (BYUC); Truckee River, Hwy 89, Goose Meadow Campground, 24 June 2009, R. Baumann, B. Kondratieff & S. Szczytko, 1♂, 2♀ (BYUC); Truckee River, Hwy 89, Silver Creek Campground, 24 June 2009, R. Baumann, B. Kondratieff & S. Szczytko, 6♂, 6♀ (BYUC); Sacramento Co., Cosumnes River, Michigan Bar, 13 May 1984, R.L. Bottorff, 11♂, 9♀ (BYUC); Shasta Co., North Fork Battle Creek, Hwy A-6, S Shingletown, 31 May 1991, R. Baumann & B. Stark, 5♂, 1♀ (BYUC); Hat Creek, Lassen National Forest, 24 June 1961, S. Wood, J. Karren & D. Bright, 7♀ (BYUC); Tehama Co., Mill Creek, Big Bend, 10 July 1993, R.W. Rockwell, 1♂, 1♀ (BYUC); Yuba Co., Yuba River, Hwy 20, Hammon Grove Park, 28 April 2010, R. Baumann & B. Kondratieff, 2♂, 1♀ (BYUC). OREGON: Deschutes Co., Deschutes River, Dillon Falls, 8 mi S Bend, 18 June 1975, N. Anderson, 1♂, 1♀ (BYUC); Marion Co., North Fork Silver Creek, Upper North Falls, Silver Creek State Park, 13 June 2004, R. Baumann & B. Stark, 1♀ (BYUC); Tillamook Co., Wilson River, Hwy 6, 10 mi SE Tillamook, 12 June 2005, R. Baumann & B. Kondratieff, 3♂, 3♀ (BYUC). WASHINGTON: Chelan Co., Wenatchee River, Cashmere, 10 July 1936, H.H. Ross, 1♀ (INHS); King Co., Cedar River, Cedar Falls, 24 June 1972, J. Malick, 1♂; Lewis Co., Chehalis River, Hwy 6, Rainbow Falls State Park, 13 June 2005, R. Baumann & B. Kondratieff, 1♂, 4♀ (BYUC).

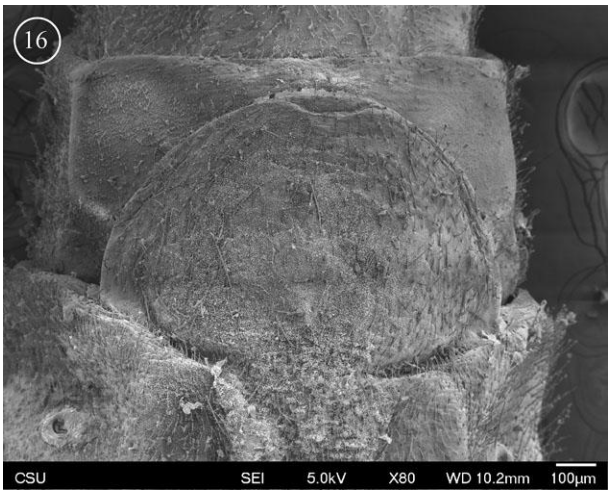


Fig. 16. *Osobenus yakimae* ♀, Subgenital plate, Siskiyou Co., California, McCloud River, 23 May 2014.

Fig. 17. *Osobenus yakimae*, egg, dorsal, El Dorado Co., California, 15 July 1982, R. Bottorff.

Descriptions: Male. Pale yellowish brown in color, head with obscure brownish marking, pronotum with a broad yellow stripe (Fig. 1). Tenth tergum deeply cleft, hemitergal lobes elongate, narrowly rounded at apex, bearing ribbed peg-like sensilla basiconica and trichoid sensilla (Figs. 2–3). Lateral stylets absent. Epiproct, large, bulbous, triangular in shape (Figs. 4, 5, 10–13). Ventral sclerite brown, strap-like, terminating in downturned spine in repose (Figs. 4, 6–8, 12); dorsal sclerite brown, terminating between two external patches of stout spinulae and continuing internally to form a coiled sac (Figs. 6, 10–12, 14); laterally covered by dense hairs (Figs. 4–7). Epiproct with a wide opening on dorsal surface located behind external paired

patches of 6-7 spines each (Figs. 6–9) arising from two longitudinal membranous swellings; opening internally connected to a coiled sac with two basolateral patches of internal spines (Fig. 15). Female. Subgenital plate parabolic (Fig. 16). Egg. Typical of the Diploperlini, oval shape, medially with raised ridge, cross section semicircular (Fig. 17). Chorion with visor-like extension covering collar (Fig. 17), chorion with dense punctations, visor coarsely punctate (Fig. 17).

DISCUSSION

The male terminalia of *Osobenus* shares several characters with *Kogotus* Ricker, especially the internal coiled spinose sac and lack of lateral stylets. However, the distinctive epiproct with the paired dorsal membranous processes terminating with 6-7 large flat spine-like teeth appear unique within the Diploperlini. Ricker (1952) indicated that the *Osobenus* lateral stylets are "Short, broad, and blunt, lying anterior (dorsal) to the process." He also commented that "Two cylindrical dorsal lobes, tipped by a few spines, may be homologous with the lateral stylets of other genera though their position is unusual." The lateral stylets as recognized in other groups of Perlodinae arise laterally from the epiproct base, whereas, the two spine tipped processes in *Osobenus* are attached to the membrane of the outer epiproct, and are not considered here as homologous with lateral stylets, as recognized in other genera of Perlodinae.

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REFERENCES

Hoppe, G.N. 1938. Plecoptera of Washington. University of Washington Publications in Biology, 4:139–174.

Jewett, S.G., Jr. 1955. Notes and descriptions concerning western North American stoneflies (Plecoptera). Wasmann Journal of Biology, 13:145–155.

Jewett, S.G., Jr. 1959. The stoneflies (Plecoptera) of the Pacific Northwest. Oregon State Monographs. Studies in Entomology, 3:1–95.

Jewett, S.G., Jr. 1960. The stoneflies (Plecoptera) of California. Bulletin of the California Insect Survey, 6:125–177.

Illies, J. 1966. Katalog der rezenten Plecoptera. Das Tierrech. 82. Walter de Gruyter, Berlin, Germany. 632 pp.

Ricker, W.E. 1952. Systematic studies in Plecoptera. Indiana University Publications, Science Series, Number 18:1–200.

Stark, B.P. and S.W. Szczytko. 1984. Egg morphology and classification of Perlodinae (Plecoptera: Perlodidae). Annales de Limnologie, 20:99–104.

Stark, B.P., S.W. Szczytko, and C.R. Nelson. 1998. American stoneflies: A photographic guide to the Plecoptera. Caddis Press, Columbus, Ohio. 126 pp.

Stewart, K.W. and B.P. Stark. 2002. Nymphs of North American stonefly genera (Plecoptera). 2nd edition. Caddis Press, Columbus, Ohio. 510 pp.

Zwick, P. 1973. Insecta: Plecoptera. Phylogenetisches system und katalog. Das Tierreich, 94. Walter de Gruyter, Berlin, Germany. 465 pp.

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