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THE STONEFLY GENUS *LEDNIA* IN NORTH AMERICA (PLECOPTERA: NEMOURIDAE)

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ABSTRACT

The nemourid genus *Lednia* is characterized in the male, female and larval stages. Two new species are described, *L. borealis* and *L. sierra.* Illustrations are provided as line drawings and scanning electron microscope images for the adult stages. Three *Lednia* species are presently known from western North America: *L. borealis,* Cascade Range, Washington; *L. tumana,* northern Rocky Mountains and *L. sierra,* Sierra Nevada, California.

Keywords: Plecoptera, Nemouridae, *Lednia,* stoneflies, western North America

INTRODUCTION

Ricker (1952) in his "Systematic studies in Plecoptera" reviewed the North American species of Nemouridae and proposed eleven new subgenera, including *Lednia.* Ricker (1992) indicated that the name was derived from the Russian word "led" meaning "ice" ("collected by a cold stream in Glacier National Park") and tumana from the Russian "tumán," meaning "mist" ("It was a foggy day").

This subgenus was based on the species *Nemoura (Lednia) tumana* Ricker from a single locality in Glacier National Park, Montana. Illies (1966) in his world catalogue of the Plecoptera, recognized all of Ricker's subgenera as valid genera. A second Glacier National Park locality for this species was listed by Gaufin et al. (1972) as Logan Creek, Flathead Co. In Baumann et al. (1977) review of the stoneflies of the Rocky Mountains, this species was listed as "known only from" Flathead Co. and Glacier Co. in Glacier National Park. *Lednia tumana* was placed in the subfamily Nemourinae by Baumann (1975) in a revision of the world Nemouridae, and illustrations were provided of the male and female terminalia. *Lednia* was considered a monotypic genus known only from Montana. Later, Donald and Anderson (1977) recorded *L. tumana* from the Waterton River drainage in Waterton Lakes National Park, Alberta. Even though this was a new Alberta and Canadian record, Waterton Lakes National Park is adjacent to Glacier National Park, sharing very similar aquatic habitats. Baumann and Stewart (1980) described the larva from specimens collected at Logan Pass in Glacier National Park. Since *Lednia tumana* was only known from a small geographical area and apparently rare, it was listed in the United States Federal Register (1991) as a category 2 species, meaning that it was a candidate for listing as threatened or endangered, pending the acquisition of further data to support such action. It was called the Meltwater Lednian Stonefly in this listing, but given

the common name Mist Forestfly (Stark et al. 1998). After an in depth study of the stoneflies of Mount Rainier National Park, Washington from 1994-2004, *L. tumana* was listed as occurring in the Park by Kondratieff and Lechleitner (2002) and Kondratieff et al. (2006). Recently, Newell et al. (2008) reported *L. tumana* as occurring in both the eastern and western portions of Glacier National Park. Stark et al. (2009) listed *L. tumana* from Montana, Washington and Alberta, based on the above papers. Interest in this species has increased and it has been treated even in the popular literature as an indicator of climate change (Bogo 2010). Over the last fifty years additional information has been gathered on the genus *Lednia* and is summarized in this publication.

MATERIAL AND METHODS

Material was studied using a Wild M-8 stereomicroscope and a Philips XL30 ESEM FEG electron microscope at Brigham Young University. Line drawings were made using a Mac computer at the Monte L. Bean Museum, Brigham Young University. Figure plates were prepared at Colorado State University. Specimens listed in this study are located at the following institutions: Brigham Young University, Provo, Utah (BYUC); Canadian National Collection, Ottawa, Ontario (CNCI); Colorado State University, Fort Collins, Colorado (CSUC); David B. Donald Collection, Regina, Saskatchewan (DBDC); Illinois Natural History Survey, Champaign, Illinois (INHS); University of Montana Biological Station, Flathead Lake, Montana (UMBS), University of North Texas, Denton, Texas (UNTC) and United States National Museum, Smithsonian Institution, Washington, D. C. (USNM).

RESULTS AND DISCUSSION

Lednia (Ricker) 1952

Lednia Ricker, 1952: 29. Type species: *Nemoura* (*Lednia) tumana* (Ricker), by monotypy. Illies, 1966: 190 (generic status). Baumann, 1975: 19, 50 (redescription and illustrations). Baumann et al. 1977: 34 (distribution).

DESCRIPTION

Adult. Size small, length 4.5-7.5 mm. Wings macropterous, venation typical for family, mostly hyaline, with dark veins near cord. Gills absent.

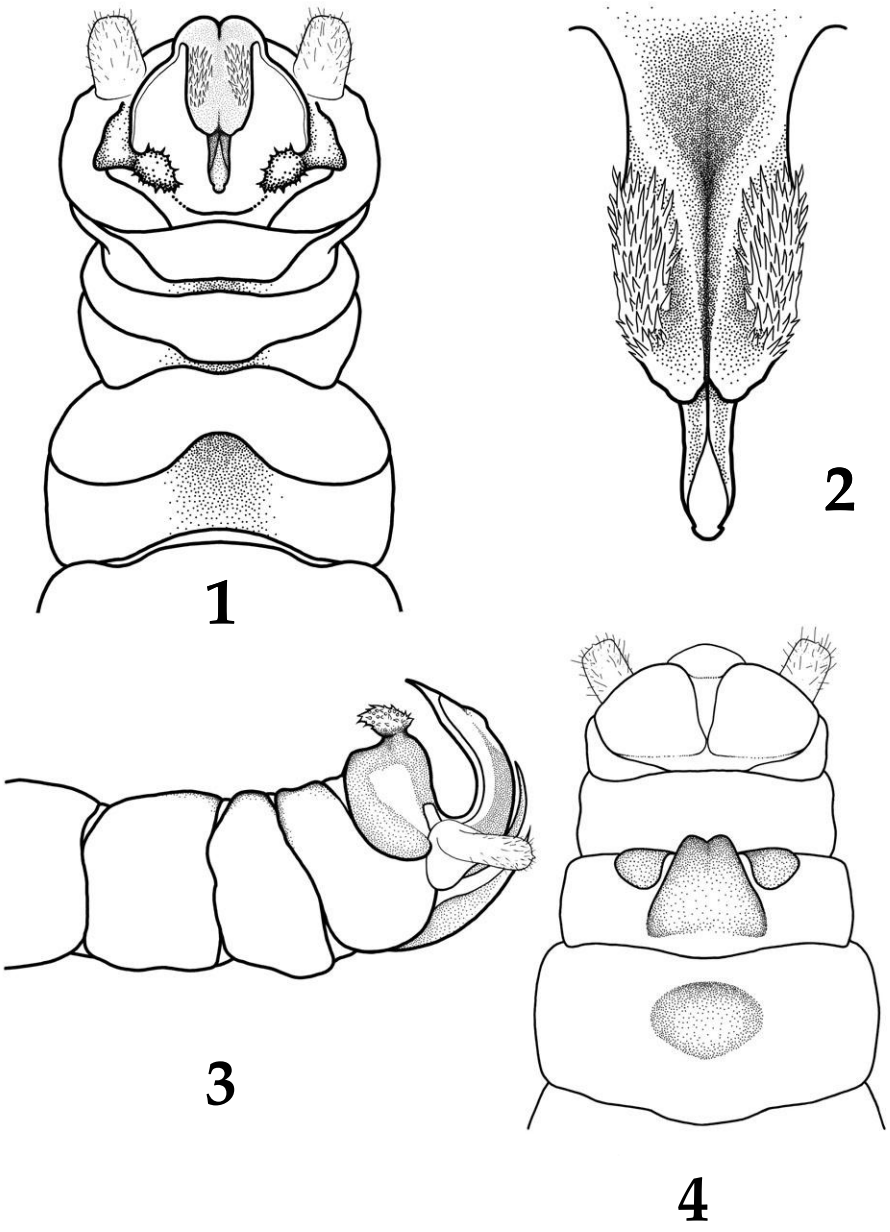
Male. Epiproct with ventral sclerite sclerotized, flat, broad and pointed at apex, extending beyond anterior margin of dorsal sclerite, bearing few small ventrolateral spines near apex, tip sharply pointed and grooved dorsally; dorsal sclerite grooved mesally and bilaterally symmetrical, bearing small to large posteriorly directed dorsolateral spines (Figs. 1-3, 5-6, 8-9, 13, 15-18, 23, 25-28). Paraprocts composed of two lobes, inner lobe long and thin and heavily sclerotized, with sharply pointed apex (Figs. 11, 19, 29); outer lobes, short broadly rounded and lightly sclerotized (Fig. 20). Hypoproct broad at base and becoming narrower towards apex, vesicle absent (Figs. 11, 19, 29). Cerci unmodified (Figs. 1, 3, 5, 8, 15, 25, 29). Tergum ten with median groove, bordered by paired mace-shaped prongs bordering tip of epiproct (Figs. 1, 3, 8, 10, 16, 21, 30).

Female. Sternum eight modified as subgenital plate, median area darkly sclerotized, broad basally and narrowing to apex, forming a generally triangular shape, apex narrowly rounded apically, but sometimes with a narrow slit at tip, lateral posterior margins with darkly sclerotized lobes that parallel the apex of subgenital plate (Figs. 4, 12, 14, 22, 24, 31, 32). Sternum seven with lightly sclerotized, round lobe near margin of sternum eight (Figs. 4, 12, 14, 24, 31).

Larva. Gills absent. Pronotum elongate, with narrow lateral discs. Body of nymph with relatively few spines present, most spines found dorsally at anterior margins of thoracic segments and anterior abdominal segments. Legs bearing few, mostly small spines, except for 3-5 larger spines that occur on dorsal margin of femur. Cerci with whorls of spines at distal margins of segments. Few small intercalary spinules present on all segments. Mature female larvae exhibiting a vesicle-like lobe on sternum eight. For a more complete description see Stewart and Stark (2002).

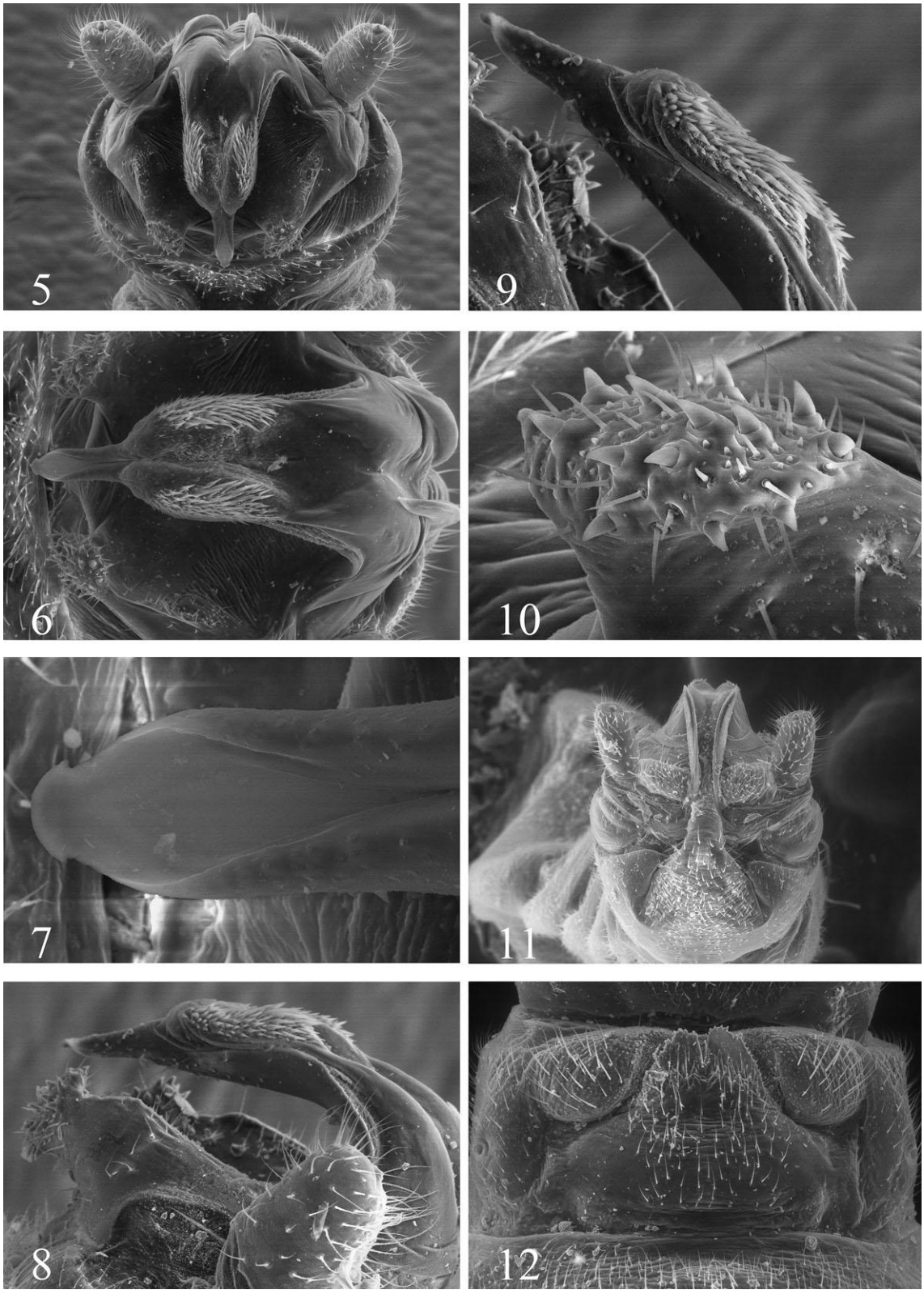
Lednia tumana (Ricker)
(Figs. 1-12)

Nemoura (Lednia) tumana Ricker 1952:29. Holotype ♂, Illinois Natural History Survey: Many Glaciers (sic), Glacier National Park, Montana.



Figs. 1-3. *Lednia tumana* male genitalia: 1. Dorsal. 2. epiproct, dorsal. 3. lateral. Fig. 4. *Lednia tumana* female terminalia, ventral.

Material examined. CANADA: Alberta: Waterton Lakes National Park, Bertha Brook, below Bertha Lake, 25 August 1976, D.B. Donald, 1♀ (DBDC). **USA: Montana:** Glacier National Park: Glacier Co., Base of Mount Clements, behind moraine, 16 Oct.1997, J. Giersch, 1♂, 11♀ (UMBS); Clements Drain, high, 6 Oct. 1998, J. Giersch, 4 larvae (UMBS); Clements Drain, low, 15 July 1998, J. Giersch, 3 larvae (UMBS); Small glacial stream, 5,500', Many Glacier, 24 August 1946, W.E. Ricker, 1♂ (Holotype), 1♀ (Allotype) (INHS); same locality, 24 August 1946, W.E. Ricker, 1♂ (Paratype) (CNCI); Reynolds Creek, headwaters, above



Figs.5-11. *Lednia tumana* male genitalia: 5. terminalia, dorsal. 6. epiproct, dorsal. 7. epiproct apex, dorsal. 8. terminalia, lateral. 9. epiproct, lateral. 10. prong on tergum 10. 11. terminalia, ventral. 12. female terminalia, ventral.

boardwalk bridge, Logan Pass, 6 Sept. 1997, J. Giersch, 1♂, 2♀ (UMBS); Reynolds, high, Logan Pass, 10 Sept. 1997, J. Giersch, 3♂, 9♀ (UMBS); Reynolds Spring, Logan Pass, 14 Sept. 1997, J. Giersch, 5♂, 7♀ (BYUC, UMBS); Reynolds, high, Logan Pass, 17 July 1998, J. Giersch, 4 larvae (UMBS); Below Reynolds Pass, 28 July 1998, J. Giersch, 47 larvae (UMBS); Reynolds Spring, Logan Pass, 29 July 1998, J. Giersch, 100 larvae (UMBS); South Face Reynolds, 4 August 1998, J. Giersch, (UMBS); Siyeh Bottom, 7 July 1998, J. Giersch, 2 larvae (UMBS). Flathead Co., Hidden Lake overlook pond, Logan Pass, 18 Sept. 1997 J. Giersch, 1♀ (UMBS); Logan Creek, Logan Pass, 6 August 1966, A.R. Gaufin, 1♂, 3♀ (BYUC); Logan Creek, Logan Pass, 5 Sept. 1972, R.A. Haick & D.S. Potter, 1♂, 1♀ (USNM); Logan Creek, Logan Pass, 22 July 1979, K.W. Stewart, R.W. Baumann & B.P. Stark, 8 larvae (BYUC); Logan Creek, Logan Pass, 11 August 1979, J. Fraley, 4♂, 1♀, 1 larva (UNTC); Logan Creek, springhead, 20 July 1998, J. Giersch, 117 larvae (UMBS); Logan Creek, springhead, 3 August 1998, J. Giersch, 29 larvae (UMBS); Logan Creek, springhead, 29 Sept. 1998, J. Giersch, 211 larvae (UMBS); Logan Creek, near water tank, Logan Pass, 20 July 1998, J. Giersch, 2 larvae (UMBS); Logan Creek, near water tank, Logan Pass, 3 August 1998, J. Giersch, 1♀ (UMBS); Logan Creek, near water tank, Logan Pass, 29 Sept. 1998, J. Giersch, 1 larva (UMBS); Mineral Creek, headwaters at East Fork, below Highline Trail, at stream reemergence, 28 August 1997, J. Giersch, 1♂, 5♀, 13 larvae (BYUC, UMBS).

Additional material (*L. tumana* ?): **Wyoming:** Teton Co. headwaters, South Fork Darby Creek, Wind Cave, southeast of Driggs, 14 August 2008, R.G. Call, 1♀ (BYUC); Same locality, 11 July 2009, R.G. Call, 1♀ (BYUC); Same locality, 26 July 2010, R.G. Call, 6 larvae (BYUC).

Male. Macropterous, wings hyaline with darker veins near cord. Length of body 4.5-5.5 mm, color dark brown, anterior abdominal segments lightly sclerotized. Epiproct bilaterally symmetrical, with dorsal groove that extends from tip to near base (Figs. 2, 6, 7); ventral sclerite flat, darkly sclerotized, bearing few stout ventral spines apically, apex narrowly pointed and extending beyond apex of dorsal sclerite, tip with dorsal groove terminating in an arrowhead-like point (Fig. 7); dorsal sclerite with broad, bare base, consisting of two large triangular lobes laterally, narrowing gradually toward apex, anterior portion bearing paired patches of large, equally sized, backward directed spines on dorsolateral margins (Figs. 1-2, 5-6, 8-9). Hypoproct sclerotized, broad at base, becoming gradually narrower towards apex, vesicle absent (Fig. 11). Paraprocts with two lobes, inner lobe long, thin and darkly sclerotized, tip sharply pointed; outer lobe short, broadly rounded, lightly sclertotized bearing numerous hairs (Fig. 11). Tergum ten with median anterior groove, bordered by paired mace-like prongs, which approach tip of epiproct (Figs. 1, 2, 8, 10).

Female. General color of body and wings similar to male. Length 5.5-7.0 mm. Sternum seven with broadly rounded, lightly sclerotized lobe posteriormedially. Subgenital plate covering most of sternum eight, darkly sclerotized, bearing sparse long hairs, base broad, tapering gradually to narrowly rounded apex that approaches junction of sternum nine, sometimes with small slit at tip, lateral posterior margins of sternum eight bearing nearly rounded, sclerotized lobes on either side of subgenital plate apex (Figs. 4, 12).

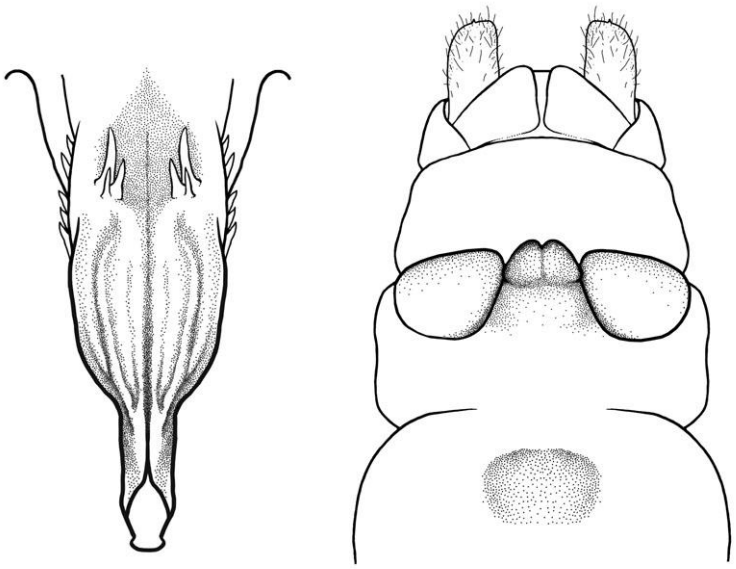
Larva. Gills absent. Length: mature male 4.5-5.5 mm, mature female 5.5-6.5 mm. Dorsal surface of body with few small spines, except at anterior margins of thoracic and anterior abdominal segments. Legs bearing numerous small spines, 3-5 larger spines present on dorsal margins of femora. Female larvae exhibiting large, truncate, plate-like lobe on dorsomedian margin of sternum eight. Cerci with whorls of spines on posterior margins of segments and sparse, small intercalary spinules present on all segments. For a more detailed description see Baumann and Stewart (1980).

Lednia borealis sp. n.

(Figs.13-22)

Material examined. Holotype ♂, **USA: Washington:** Whatcom County, Redoubt Lake, 1,615 m, North Cascades National Park, 48.97380 N, 121.31214 W, 29 August 1989, E. Deimling. Paratypes: **Washington:** Lewis Co., spring source Snow Lake, Snow Lake Basin, Mount Rainier National Park, 46.75631 N, 121.70052 W, 23 August 2010, J. Kubo, 4♀, 9 larvae (BYUC, CSUC); same but 25 August 2010, 2♂ 5♀

(CSUC), same but 8 Sept. 2010, 3♂ (BYUC, CSUC). Pierce Co., Fryingpan Creek, Sunrise Road Bridge, Mount Rainier National Park, 16 July 2000, B.C. Kondratieff, 1♂ (CSUC). Whatcom Co., Upper Bagley Lake, 4,400', Mount Baker National Forest, 30 July 1987, M.M. Ellsbury, 1♀ (BYUC); Nert Lake, 1,389 m, North Cascades National Park, 48.70487 N, 121.50160 W, 11 Sept. 1989, R. Hoffman, 1♀ (BYUC); No Name Lake, 1,171m, North Cascades National Park, 48.85027 N, 121.11291 W, 24 August 1989, R. Hoffman, 3♀ (BYUC); Price Lake, 1,192 m, North Cascades National Park, 48.85365 N, 121.60296 W, 6 Sept. 1989, E. Deimling, 1♂ (BYUC); Middle Tapto Lake, 1,747 m, Red Face Mountain Basin, North Cascades National Park, 48.88256 N, 121.36928 W, 8 Sept. 1989, G. Lomnicky, 1♂ (BYUC). The holotype is deposited at the USNM.



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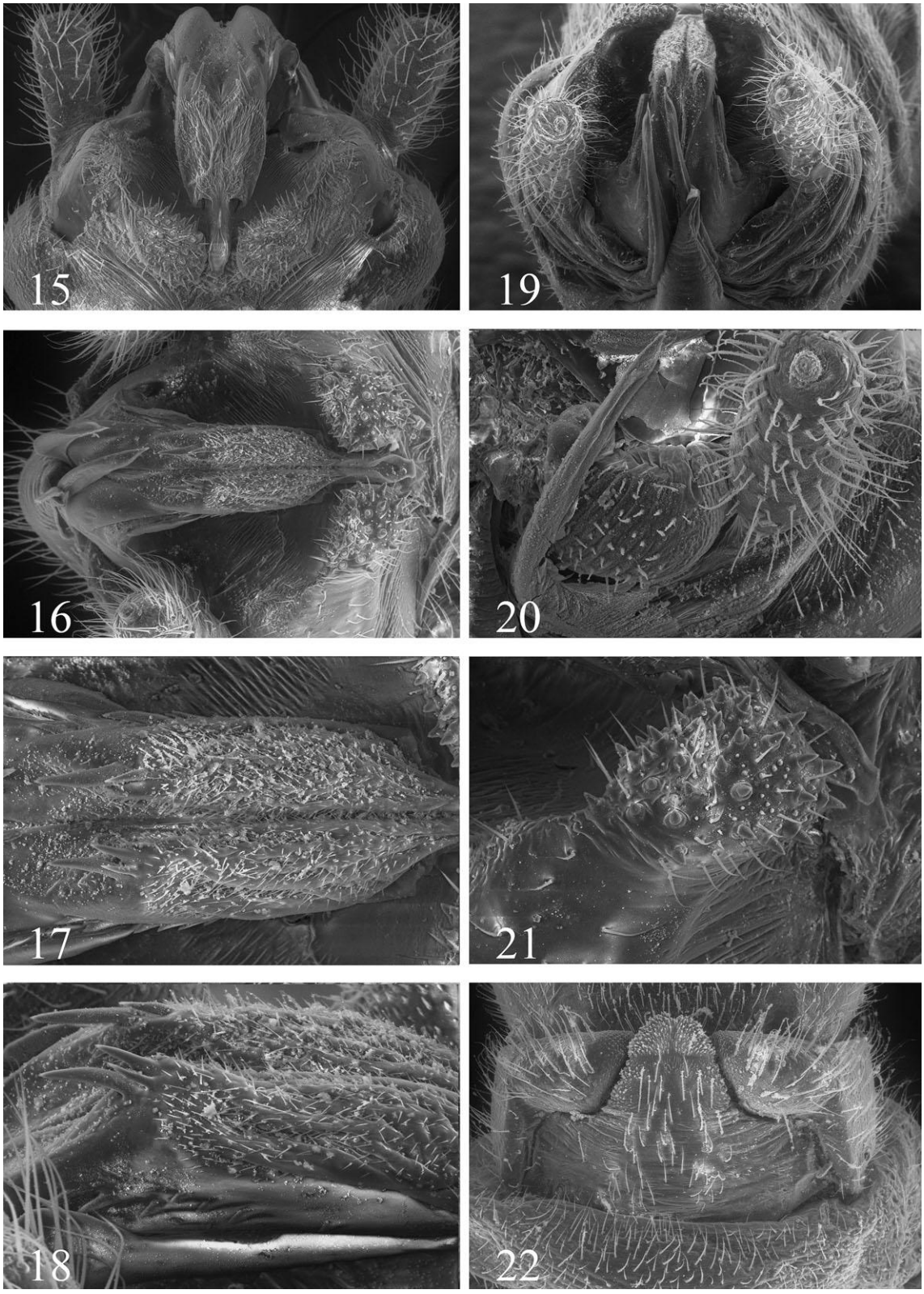
Figs. 13-14. *Lednia borealis*. 13. Male epiproct, dorsal. 14. female terminalia, ventral.

Male. Macropterous, wings hyaline, with darker veins near cord. Length of body 5.0-6.0 mm, color dark brown, anterior abdominal segments lightly sclerotized. Epiproct bilaterally symmetrical, with median dorsal groove; ventral sclerite flat, thin and darkly sclerotized, bearing few tiny spines ventrally near tip, apex of sclerite extending forward beyond anterior margin of dorsal sclerite, tip grooved dorsally, terminating in sharp arrowhead-like point; dorsal sclerite with broad, bare triangular-shaped lobes laterally at base, narrowing gradually towards apex, anterior dorsal surface bearing lateral patches of long hairs, located on heavily grooved lobes, 2-4 very large sclerotized spines located at base of lobes, several smaller spines on lateral margins near epiproct base (Figs. 13, 15-18). Hypoproct sclerotized, broad at base and becoming narrower towards apex, vesicle absent (Fig. 19). Paraprocts with two lobes, inner lobe long, thin and darkly sclerotized, tip sharply pointed, outer lobe short, broadly rounded, lightly sclerotized, bearing numerous hairs (Fig. 20). Tergum ten divided anteriorly with median groove, bordered by paired mace-like prongs that approach apex of epiproct (Figs. 16, 21).

Female. General color of body and wings similar to male. Length 6.0-7.5 mm. Sternum seven with



Figs. 15-21. *Lednia borealis* male genitalia: 15. terminalia, dorsal. 16. epiproct, dorsal. 17. epiproct, dorsal. 18. epiproct, lateral. 19. terminalia, ventral. 20. right paraproct. 21. prong on tergum 10. 22. female terminalia, ventral.

broadly rounded, lightly sclerotized lobe located posteromedially. Subgenital plate covering most of sternum eight, darkly sclerotized, bearing sparse long hairs, base broad, tapering gradually to narrowly rounded apex that approaches junction of sternum nine, sometimes with small indentation at tip, lateral posterior margins of sternum eight bearing small, nearly rounded sclerotized lobes on either side of subgenital plate apex (Figs. 14, 22).

Larva. Gills absent. Length of mature male 4.5-5.5 mm, mature female 5.5-6.5 mm. Pronotum elongate, with narrow lateral discs. Dorsal surface of larva with few small spines, except for sparse patches of short dark spines present on anterior margins of thoracic and anterior abdominal segments. Legs bearing numerous tiny light colored spines, 4-5 larger spines present on dorsal margin of femora. Male larva with large triangle-shaped process over developing hypoproct. Female larva bearing truncate plate-like lobe on sternum eight above developing subgenital plate. Cerci with sparse whorls of small spines at posterior margins of segments and tiny intercalary spinules present on all segments.

Etymology. Borealis = (north) and refers to the northern Cascade Range where it has been found in North Cascades National Park, Mount Rainier National Park and Mount Baker National Forest. It is used as a noun in apposition.

Diagnosis. The male of *L. borealis* can be distinguished from *L. tumana* and *L. sierra* by the details of the male epiproct. The epiproct of *L. borealis* bears patches of long hairs on the dorsal surface that cover numerous grooves and bears 2-4 large black spines on each side of the posterior margin of the dorsal sclerite and also has a few short spines along the basal margins of the epiproct (Figs. 13, 15-18). The dorsal sclerite of *L. tumana* bears oblong patches of small spines that are of equal size and is essentially bare of hairs and grooves (Figs. 1, 2, 5,6). In *L. sierra* the dorsal sclerite is deeply grooved but is essentially naked of hairs and bears several thin medium sized spines at the posterior margin of the dorsal sclerite and in addition has many large spines on the lateral basal margins of the epiproct (Figs. 23, 25-28). The female cannot be distinguished from the females of the other two species at this time. Larvae of the three species are very similar.

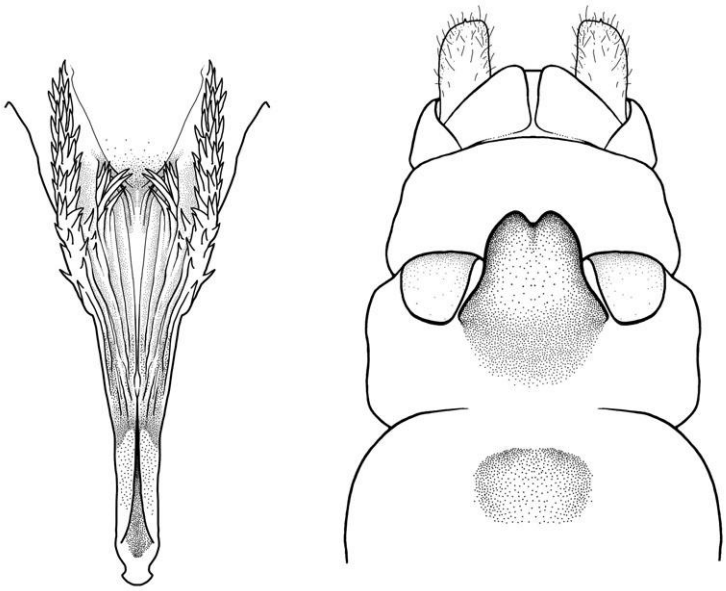
Lednia sierra sp. n.

(Figs. 23-32)

Material examined. Holotype ♂, **USA: California:** Inyo County, South Fork Big Pine Creek, 1.5 miles west of Willow Lake, 11,000′, Sierra Nevada, 27 August 1985, D. Giuliani. Paratypes: **California:** Inyo Co., same collection data as holotype, 1♂, 5♀ (BYUC); Ruby Creek, 11,319′, 37° 24′ 41″ N 118° 46′ 13″ W, Sierra Nevada, 20 August 2010, L.E. Serpa, 1♀ (BYUC). Mono Co., Cold Water Creek, 10,049′, 39° 34′ 27″ N 118° 59′ 17″ W, Sierra Nevada, 19 August 2010, L.E. Serpa, 1 larva (BYUC); stream above Coness Lakes, 11,200′ Sierra Nevada, 11 August 1986, D. Giuliani, 1♀, 6 larvae (BYUC). The holotype is deposited at the United States National Museum, Smithsonian Institution, Washington, D.C.

Male. Macropterous, wings hyaline, with darker veins near cord. Length of body 4.5-5.0 mm, color dark brown, anterior abdominal segments lightly sclerotized. Epiproct bilaterally symmetrical, with median dorsal groove; ventral sclerite flat, thin and darkly sclerotized, with few small spines near tip, apex of sclerite extending forward beyond anterior margin of dorsal sclerite, tip grooved dorsally ending in sharp arrowhead-like point, apex narrow and elongate; dorsal sclerite with broad bare triangular-shaped lobes laterally at base, narrowing gradually toward apex, possessing deep longitudinal grooves with few hairs, located on large, paired dorsolateral lobes, bearing patches of long thin spines medially at base of lobes, numerous large stout spines on lateral margins near base of epiproct (Figs. 23, 25-28). Hypoproct sclerotized, broad at base, narrow towards apex, vesicle absent (Fig. 29). Paraprocts bilobed, inner lobe long thin and darkly sclerotized, tip sharply pointed, outer lobe short broad, lightly sclerotized and bearing numerous hairs (Fig. 29). Tergum ten divided anteriorly by large median groove, bordered by paired mace-like spines that approach tip of epiproct (Figs. 28, 30).

Female. General color of body and wings similar to male. Length 5.0-6.5 mm. Sternum seven with broadly rounded, lightly sclerotized lobe near junction of sternum eight. Subgenital plate covering most of sternum eight, bearing sparse long hairs, triangle-shaped, broad at base and narrow at apex that reaches margin of sternum nine, apex pointed



23 **24**

Figs. 23-24. *Lednia sierra*. 23. male epiproct, dorsal. 24. female terminalia, ventral.

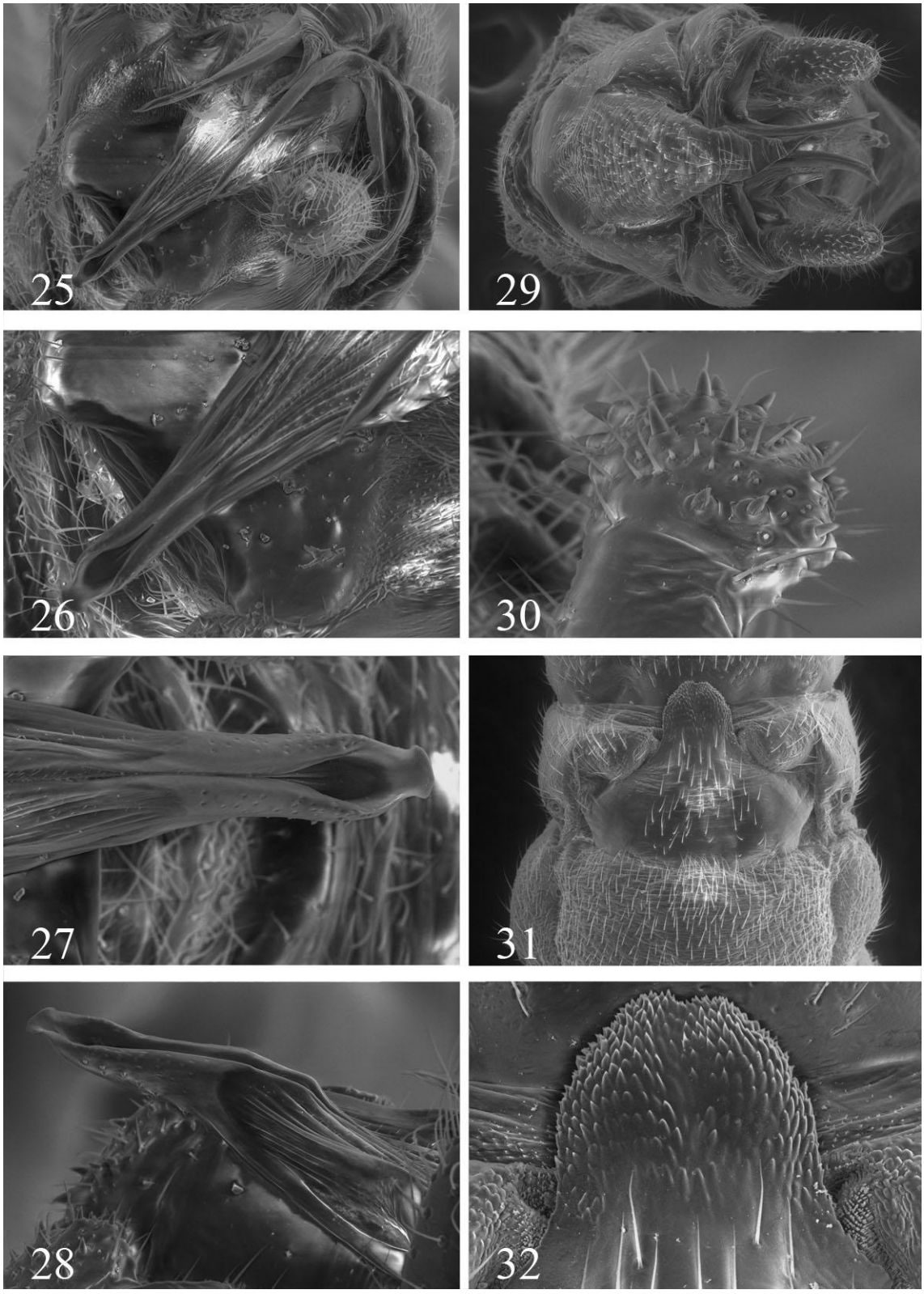
and sometimes with small median groove, lateral posterior margins of sternum eight with enlarged sclerotized lobes on both sides of apex of subgenital plate (Figs. 24, 31, 32).

Larva. Gills absent. Length: mature male 5.0-6.0 mm, mature female 6.5-7.5 mm. Dorsal surface of thorax and abdomen mostly naked of spines. Female with large truncate, plate-like lobe present on posteriormedian margin of sternum eight. Legs with few medium sized spines on dorsal margins of femora. Cerci with whorls of small spines on posterior margins of segments and intercalary spines tiny and scattered.

Etymology. This specific epithet refers to the California Sierra Nevada where all of the specimens have been collected to this time. The name is used as a noun in apposition.

Diagnosis. *Lednia sierra* differs from both *L. borealis* and *L. tumana* by the following characters. The epiproct of *L. sierra* has a dorsal sclerite that is deeply grooved with few hairs present and bears a fringe of long thin spines along its posterior margin (Figs. 23, 25, 28). In addition, the ventral sclerite is more elongate where it extends beyond the apex of the dorsal sclerite and there is a row of large stout spines on each basal lateral margin of the epiproct (Figs. 23, 26, 27). *Lednia tumana* has an epiproct where the dorsal sclerite has two oblong patches of spines of equal size, is not grooved, and bears few small hairs (Figs. 1, 5, 6, 9). The epiproct of *L. borealis* has a dorsal sclerite that is grooved, bears many long hairs and 2-4 large long black spines that are located at the posterior margin of the sclerite (Figs. 13, 15-18). Females of *L. sierra* cannot be identified without associated males. The larva has fewer distinct cuticular spines when compared to the larvae of *L. borealis* and *L. tumana*.

Discussion. Before the description of the two new species herein, *L. borealis* and *L. sierra*, the genus *Lednia* included a single species, *L. tumana*, restricted to the Glacier-Waterton Lakes International Peace Park region spanning the border of northern Montana and southern Alberta. This area has a pivotal position in the Western Cordillera of North



Figs. 25-30. *Lednia sierra* male genitalia: 25. terminalia, dorsal. 26. epiproct, dorsal. 27. epiproct apex, dorsal. 28. epiproct, lateral. 29. terminalia, ventral. 30. prong on tergum 10. 31. female terminalia, ventral. 32. female subgenital plate, ventral.

America (Chase et al. 1998). Maritime weather systems unimpeded by mountain ranges to the north and south allow floras and faunas characteristic of the Pacific Northwest to extend to and across the continental divide in the Park (Chase et al. 1998). This area is especially rich in alpine and glacial features. Ricker (1964) hypothesized that as Pleistocene ice margins receded northward, there were postglacial faunal invasions forming East-Cordilleran and West-Cordilleran stonefly distributions. The current distribution of the three species of *Lednia* seems to support the above hypothesis. The specimens collected in Wyoming near the Idaho border occur only a few kilometers west of Grand Teton National Park and not too far from Yellowstone National Park. Similar alpine habitats in northwestern Montana and northern Idaho may also have *Lednia* populations. *Lednia borealis* is known from the northern Cascade Range in Washington, but it could also occur in the southern Cascade Range in Oregon and northern California. *Lednia sierra* has been collected from only two counties in the California Sierra Nevada, but should occur in similar habitats nearby. Finally, the Canadian Rockies in both Alberta and British Columbia offer a vast area that should be searched for the presence of this interesting genus.

The moniker "Meltwater Stonefly" has been proposed for this genus (United States Federal Register 1991) because of its supposed occurrence near melting glaciers at high elevations. However, both *L. borealis* and *L. sierra* have been collected from 1st order rheocrenes draining into alpine lakes. As Fagre et al. (1997) and Hall and Fagre (2003) reported, under possible future climate scenarios, all glaciers are predicted to disappear by the year 2030 in the Glacier-Waterton Lakes International Peace Park region, resulting in increased water temperatures in streams draining this region, directly affecting the long-term survivability of stenothermic aquatic invertebrates, no doubt including *Lednia*. There are similar scenarios for high elevation watersheds in the Cascade Range (Nolin and Daly 2006) and the California Sierra Nevada (Maurer 2007). It is imperative that the life history and ecology of the species of *Lednia* be understood before they disappear.

ACKNOWLEDGEMENTS

Many individuals have helped over the years as we have attempted to gather as much data as possible on this rare stonefly genus and their help is much appreciated. Joe Giersch through his studies in Glacier National Park knows more about the biology and distribution of *L. tumana* than anyone and his help and specimen records were pivotal to this study. Bob Newell, Jack Stanford and Rick Hauer, University of Montana Biological Station provided specimens from Glacier National Park. David Donald found *L. tumana* in the Waterton River drainage, Waterton Lakes National Park, Alberta. Kenneth Stewart University of North Texas organized a special trip in 1979 with Bill Stark and the senior author to collect the larva of *L. tumana* at Logan Pass in Glacier National Park. He also obtained additional specimens from the park with the help of his student John Fraley. In 1985, the late Derham Giuliani collected the first *Lednia* specimens from the Sierra Nevada in California. Then in 1989, Bob Wisseman made several *Lednia* specimens available from North Cascades National Park and Mount Baker National Forest in Washington. Subsequently, Richard Lechleitner aided the junior author in collecting *Lednia* from Mount Rainier National Park, Washington. Larry Serpa made a second *Lednia* collection in 2010 from the California Sierra Nevada. Josh Kubo collected additional *Lednia* specimens in Mount Rainer National Park in the summer of 2010 and provided specimens upon which the larval description of *L. borealis* was based. Recently, Ron Call found a population of *Lednia* in Wyoming in the summers of 2008-2010. Ed DeWalt, Illinois Natural History Survey, Champaign, Illinois, provided information on the types of *L. tumana*. Owen Lonsdale, Canadian National Collection, Ottawa Ontario confirmed that the paratype male listed in Ricker (1952) is housed in their collection. Oliver Flint, Jr. of the Smithsonian Institution made their specimens available for study. Reed Glesne, North Cascades National Park and Robert Hoffman, Oregon State University provided more detailed collection data for specimens from North Cascades National Park. Michael Standing, Electron Optics Laboratory, Brigham Young University, aided in the production of the electron micrographs. Randal

Baker, Graphics Designer, Monte L. Bean Life Science Museum, Brigham Young University made the line drawings.

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