



NEARCTIC *NEMOURA TRISPINOSA* CLAASSEN, 1923 AND *N. RICKERI* JEWETT, 1971 ARE JUNIOR SYNONYMS OF HOLARCTIC *NEMOURA* SPECIES (PLECOPTERA: NEMOURIDAE)

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ABSTRACT

Only five species of the diverse Holarctic stonefly genus *Nemoura* Latreille, 1796 are known to occur in North America. We used scanning electron microscopy to show that (a) *N. trispinosa* Claassen, 1923 is a junior synonym of *N. arctica* Esben-Petersen, 1910, and (b) *N. rickeri* Jewett, 1971 is a junior synonym of *N. sahlbergi* Morton, 1896. Four species of *Nemoura*: *N. arctica*, *N. normani* Ricker, 1952, *N. sahlbergi*, and *N. spiniloba* Jewett, 1954, and are now recognized from the Nearctic realm.

Keywords: Plecoptera, Nemouridae, *Nemoura*, *N. arctica* Esben-Petersen, 1910, *N. sahlbergi* Morton, 1896, Nearctic, Holarctic

INTRODUCTION

Holarctic *Nemoura* Latreille, 1796 (Insecta, Nemouridae) is among the speciose stonefly genera, with ca. 190 species distributed mainly across Asia and Europe (DeWalt et al. 2018). In contrast, only five species are recognized from North America: *N. arctica* Esben-Petersen, 1910, *N.*

normani Ricker, 1952, *N. rickeri* Jewett, 1971, *N. spiniloba* Jewett, 1954, and *N. trispinosa* Claassen, 1923. *Nemoura spiniloba* is a member of the *N. cercispinosa* Kawai, 1960 group (*sensu* Baumann 1975) and distinct from the other four Nearctic species.

The main intent of this paper was to access the

taxonomic status of two Nearctic species: *N. rickeri* and *N. trispinosa*. We provide evidence using scanning electron microscopy (SEM) that Nearctic *N. trispinosa* Claassen, 1923 and Nearctic *N. rickeri* Jewett, 1971 are junior synonyms of Holarctic *N. arctica* Esben-Petersen, 1910 and Palearctic *N. sahlbergi* Morton, 1896, respectively. Systematic notes are also provided for *N. normani*. Terminology follows that of Baumann (1975).

METHODS

Material of adult *Nemoura* were examined from the Monte L. Bean Museum, Brigham Young University, Provo, Utah (BYU), California Academy of Sciences, San Francisco (CASC), Canadian National Collection of Insects, Ottawa (CNCI), Cornell University Insect Collection, Ithaca, New York (CUIC), Illinois Natural History Survey, Champaign (INHS), Zoological Museum, University of Oslo, Norway (NMHO), United States National Museum, Washington, DC (USNM), University of Prince Edward Island, Charlottetown (UPEI), and Western Kentucky University, Bowling Green. Adult male and female terminalia were studied with SEM using a Philips XL30 ESEM FEG scanning electron microscope at Brigham Young University.

The following are locality data for specimens that were examined during this study. Records extend geographically across Europe, Asia, and North America:

Nemoura arctica

NORWAY

Buktved Garnvika, rock pools, 17-V-2010, T.E. Krem (NHMO)

Finnmark, Kautokeino, Caskijas, 30-VI-1972, A. Lillehammer (NHMO)

RUSSIA

Siberia, Magadan Oblask, Kontaktovy Creek, Kolyma Water Balance Station, 61°50' N, 147°40' E, 17-VI-1995, P.H. Adler (BYU)

MONGOLIA

Bayan Olgii Aimag, Tsengel Soum, Khoton Lake, 15 km NW Syrgal, 14-VII-2008, C.R. Nelson (BYU)
Hovsgol Aimag, Tsagaan Nuur Soum, stream

16 km NW Tsagaan Nuur Town, 3-VII-2006, C.R. Nelson (BYU)

CANADA

Manitoba

Warkworth Creek, Churchill, 18-VI-1948, F.P. Ide (CNCI)

New Brunswick

Madawaska Co., Coombs Brook, Hwy 17, E St. Leonard, 16-VI-1993, Baumann & Kondratieff (BYU)

Northwest Territories

Thelon River, 63°49'58" N, -104°06' 21" W, 1-VII-2002, Giberson & Purcell (UPEI)

Tuktoyaktuk, 12-VII-1971, D.R. Oliver (CNCI)

Prince Edward Island

Queens Co., Balsam Hollow Brook, Cavendish, 6-VI-1997, M.D. Dobrin (UPEI)

Saskatchewan

stream at Promontory Campground, 15 mi N of La Rouge, junction Hwy 102, 21-VI-1976, L. Dosedall (BYU)

UNITED STATES

Illinois

Kane Co., stream, Elgin Botanical Garden, Elgin, 20-VI-1946, Ross & Sanderson (INHS)

Iowa

Winneshiek Co., Twin Springs, Twin Springs State Park, Hwy 52, Decorah, 13-IV-1996, Baumann, Kondratieff & Huntsman (BYU)

Ohio

Greene Co., spring, John Bryan State Park, 7-VI-1989, Baumann & Clark (BYU)

South Dakota

Pennington Co., Burnt Fork, Rd 389, E Tigerville, 6-VI-1995, Baumann & Huntsman (BYU)

Wisconsin

Dunn Co., spring, Paradise Valley Road, 1 mi N Irvington, 23-V-1988, B.C. Poulton (BYU)

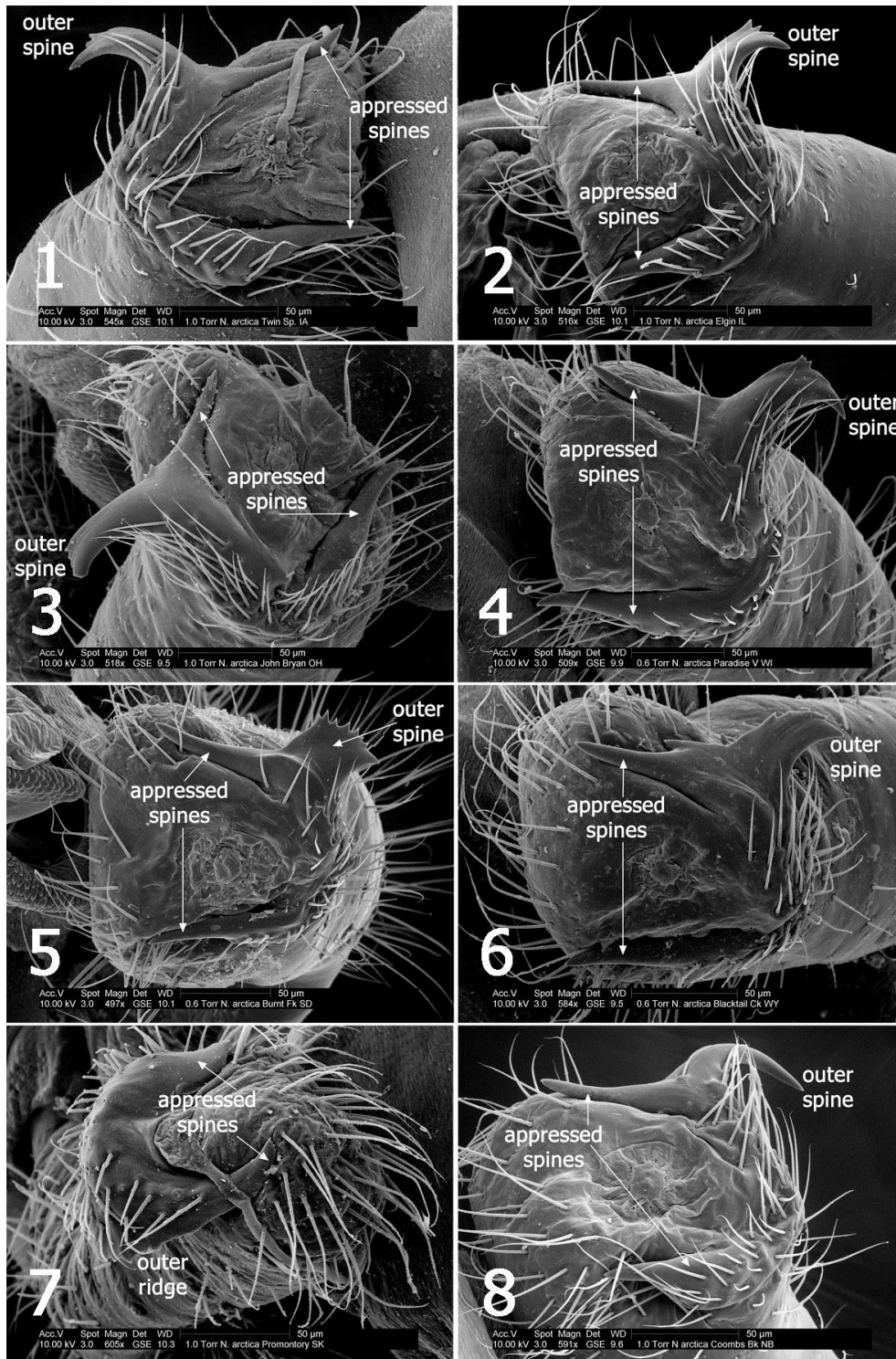
Wyoming

Crook Co., Blacktail Creek, Rd 849, SW Cook Lake, 44°32'32" N, -104°27'02" W, 16-VII-1997, Baumann & Kondratieff (BYU)

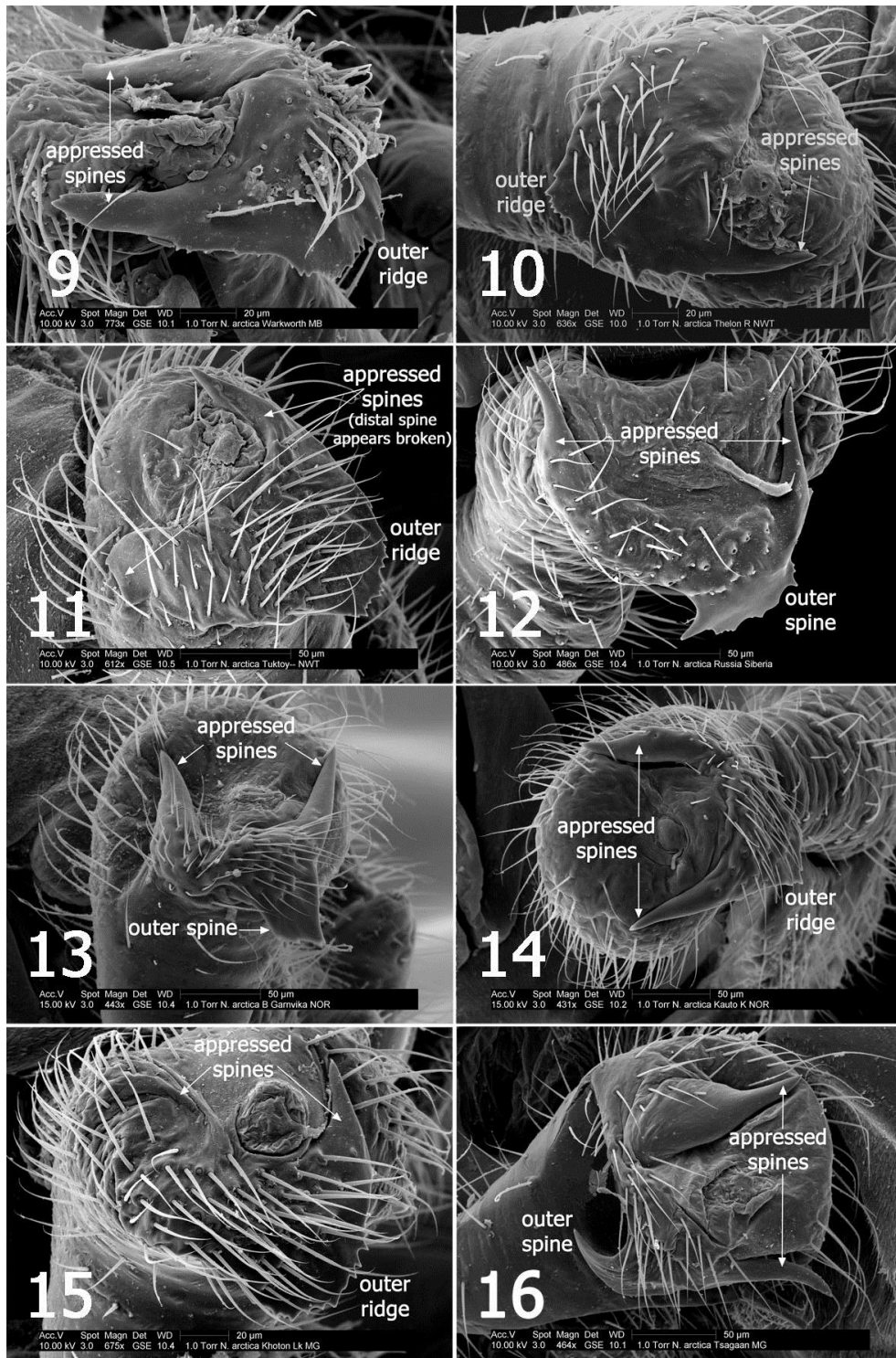
Nemoura sahlbergi

NORWAY

Gargiaelva, ved Storeng, 28-VI-2010, L. Boumans (NHMO)



Figs. 1–8. *Nemoura arctica*, cerci, distal view. 1, USA, Iowa, Twin Springs, 545X; 2, USA, Illinois, Elgin, 516X; 3, USA, Ohio, John Bryan State Park, 518X; 4, USA, Wisconsin, spring, 1 mile N Irvington, 509X; 5, USA, South Dakota, Burnt Fork, 497X; 6, USA, Wyoming, Blacktail Creek, 584X; 7, Canada, Saskatchewan, Promontory Campground, 605X; 8, Canada, New Brunswick, Coombs Brook, 591X.



Figs. 9–16. *Nemoura arctica*, cerci, distal view. 9, Canada, Manitoba, Warkworth Creek, 773X; 10, Canada, Northwest Territories, Thelon River, 636X; 11, Canada, Northwest Territories, Tuktoyaktuk, 612X; 12, Russia, Siberia, Magadan Oblask, 486X; 13, Norway, Buktved Garnvika, 443X; 14, Norway, Kautokeino, 431X; 15, Mongolia, Khoton Lake, 675X; 16, Mongolia, Tsagaan Lake, 646X.

Baukop, bekk fra Vuolit Gealbotjavri, 15-VI-2010, T.E. Krem (NHMO)

Finnmark, Porsaugen, Jagecolas, 2-VII-1968, A. Lillehammer (NHMO)

MONGOLIA

Khovsgol Aimag, stream above Bul Nai Hot Springs, 18-VIII-2005, C.R. Nelson (BYU)

CANADA

Manitoba

Goose Creek, tributary Churchill River, near Churchill, 7-VI-1976, T.D. Galloway (BYU)

Yukon

Glacier Creek, Dempster Hwy, 66°38'38"N, 136°19'27"W, 22-VI-1996, Abbott & Stewart (BYU)

UNITED STATES

Alaska

creek, 7 mi E Eureka, Glenn Hwy, 30-VI-1968, S.G. Jewett, Jr. (1♂ paratype) (BYU)

Ogotoruk Creek, 21-VI-1960, D.G. Wilson (BYU)

RESULTS AND DISCUSSION

Nemoura arctica Esben-Petersen, 1910

Arctic Forestfly
(Figs. 1–52)

<http://lsid.speciesfile.org/urn:lsid:Plecoptera.speciesfile.org:TaxonName:6232>

Nemoura arctica Esben-Petersen 1910:85. Holotype ♂, Type locality – Karasjok, Norway

Nemoura trispinosa Claassen 1923:289. Holotype ♂, Type locality – Mud Creek, Tompkins Co., New York. **New synonym** (Holotype ♂ examined)

Nemoura trispinosa: Needham & Claassen 1925:213.

Nemoura arctica: Claassen 1940:50.

Nemoura trispinosa: Claassen 1940:64.

Nemoura trispinosa: Frison 1942:261

Nemoura arctica: Koponen & Brinck 1949:7.

Nemoura trispinosa: Weber 1950:175.

Nemoura arctica: Brinck 1952:107.

Nemoura trispinosa: Harden & Mickel 1952:19.

Nemoura (Nemoura) arctica: Ricker 1952:36.

Nemoura arctica: Zhiltzova 1964:187.

Nemoura arctica: Illies 1966:194.

Nemoura trispinosa: Illies 1966:214.

Nemoura arctica: Lillehammer 1972a:163.

Nemoura trispinosa: Lillehammer 1972a:163.

Nemoura arctica: Zwick 1973a:332.

Nemoura trispinosa: Zwick 1973a:342.

Nemoura arctica: Lillehammer 1974a:82.

Nemoura arctica: Baumann 1975:21.

Nemoura trispinosa: Baumann 1975:21.

Nemoura arctica: Baumann et al. 1977:34.

Nemoura arctica: Lillehammer 1988:113.

Nemoura arctica: Zhiltzova 2003:266.

Nemoura arctica: Kondratieff & Baumann 2004:114.

Nemoura arctica: Stewart & Oswood 2006:78.

Nemoura arctica: Judson & Nelson 2012:33.

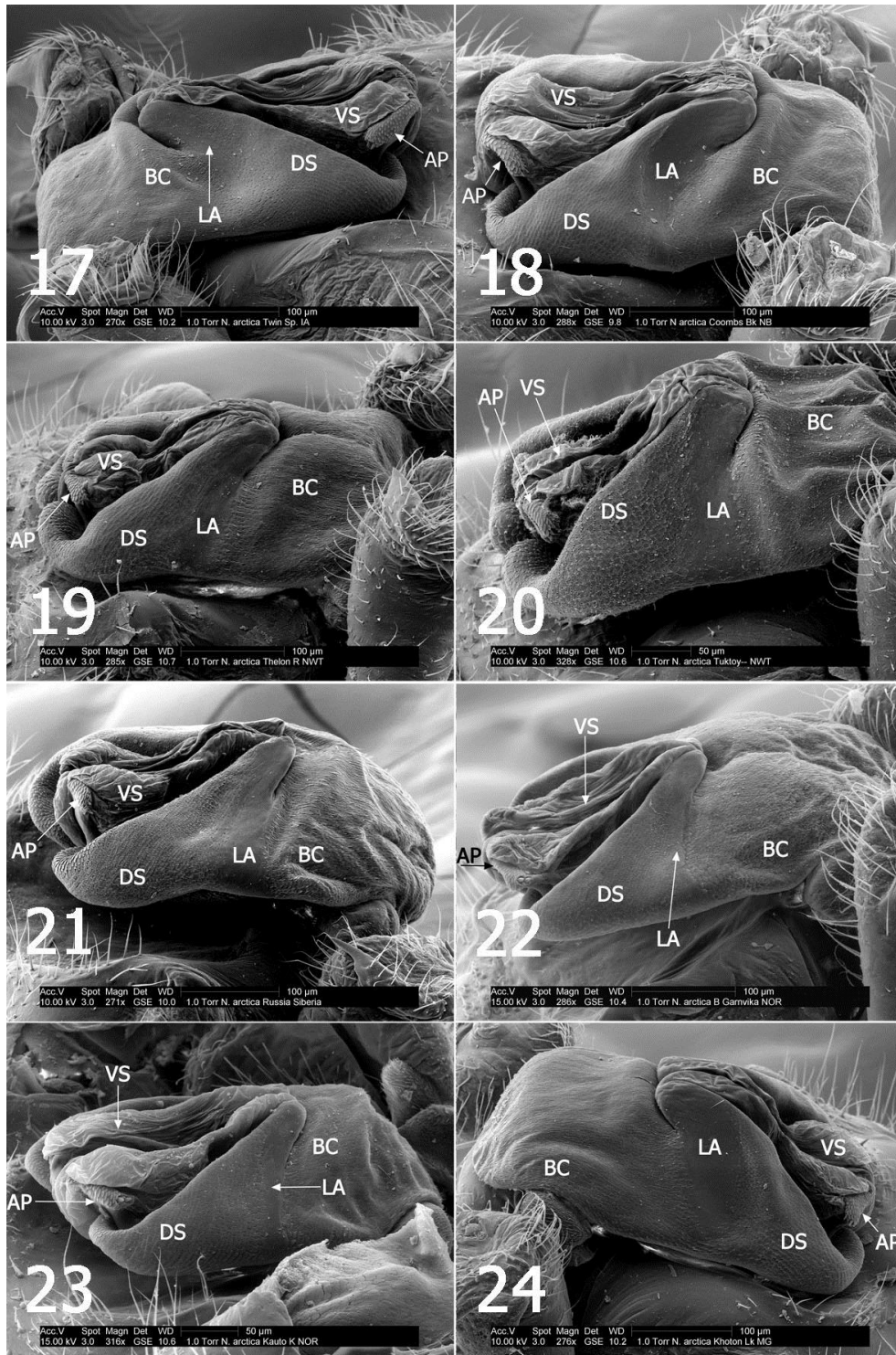
Distribution. Canada: AB, BC, LB, MB, NB, NS, NT, NU, ON, PE, PQ, YK. Europe: Baltic States, Finland, Norway, Sweden. Mongolia. Russia East, Russia North, West Siberia. USA: AK, IA, IL, ME, MI, NY, OH, PA, SD, WI, WY (DeWalt et al. 2018).

New Canadian province and USA state records.

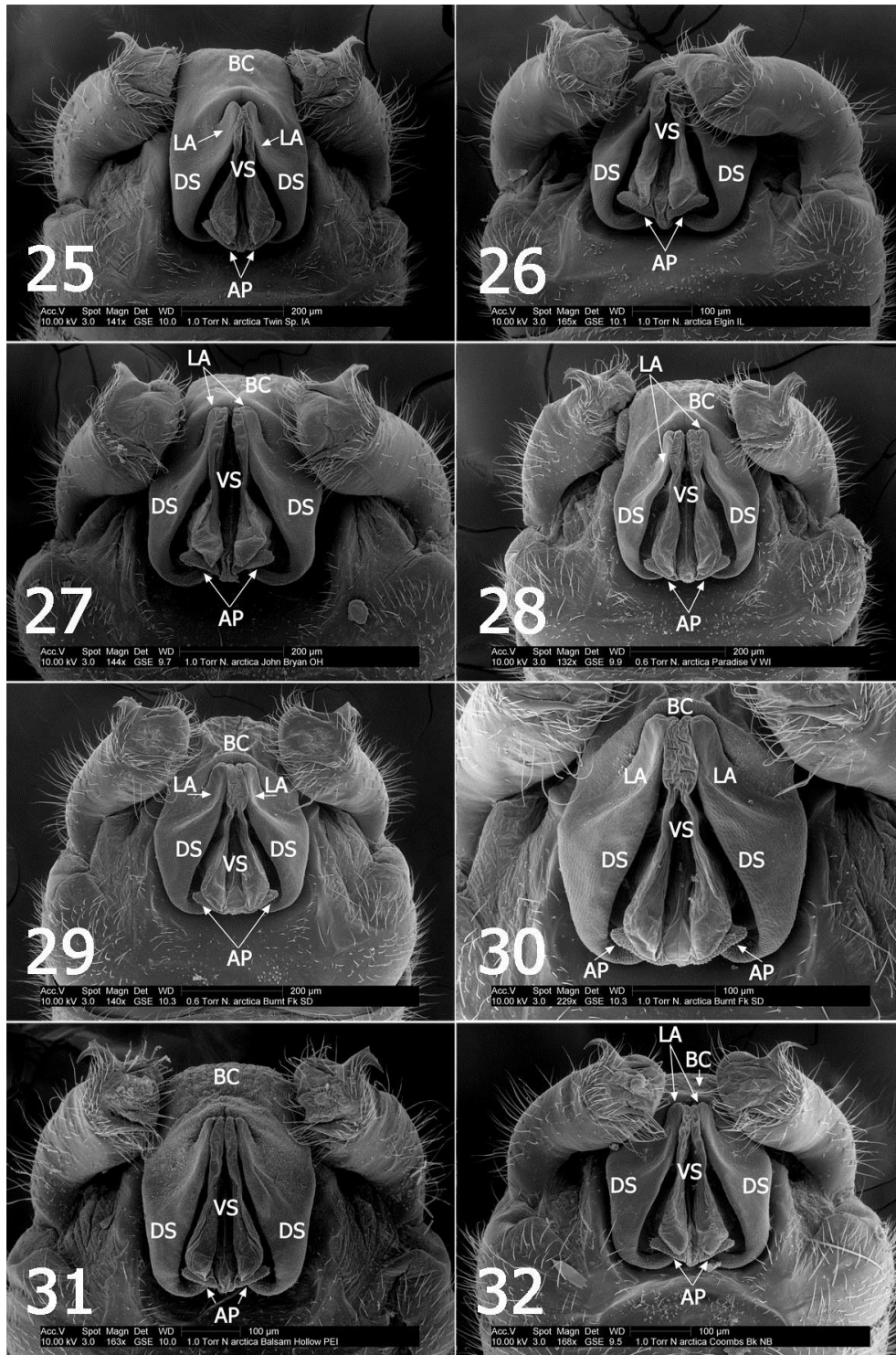
Canada, Saskatchewan, stream at Promontory Campground, 15 miles north of La Rouge, junction Hwy 102, 21-VI-1976, L.M. Dodsall, 4♂, 2♀; Puskwakau River, Hwy 106, 30-V-1976, L.M. Dodsall, 1♂. **USA, Minnesota** (Harden & Mickel 1952, their pp. 19–20). **New Hampshire**, Coös Co., Lakes of the Clouds, White Mountains, 20 June 1951, C.P. Alexander, 1♂ (USNM); Grafton Co., Franconia, A.T. Slosson, no date information, 1♂ (USNM; Ac #26226). **West Virginia**, Tucker Co., Abe Run, Canaan Valley State Park, 28 May 1993, S.M. Clark, 1♀ (BYU).

Diagnosis.

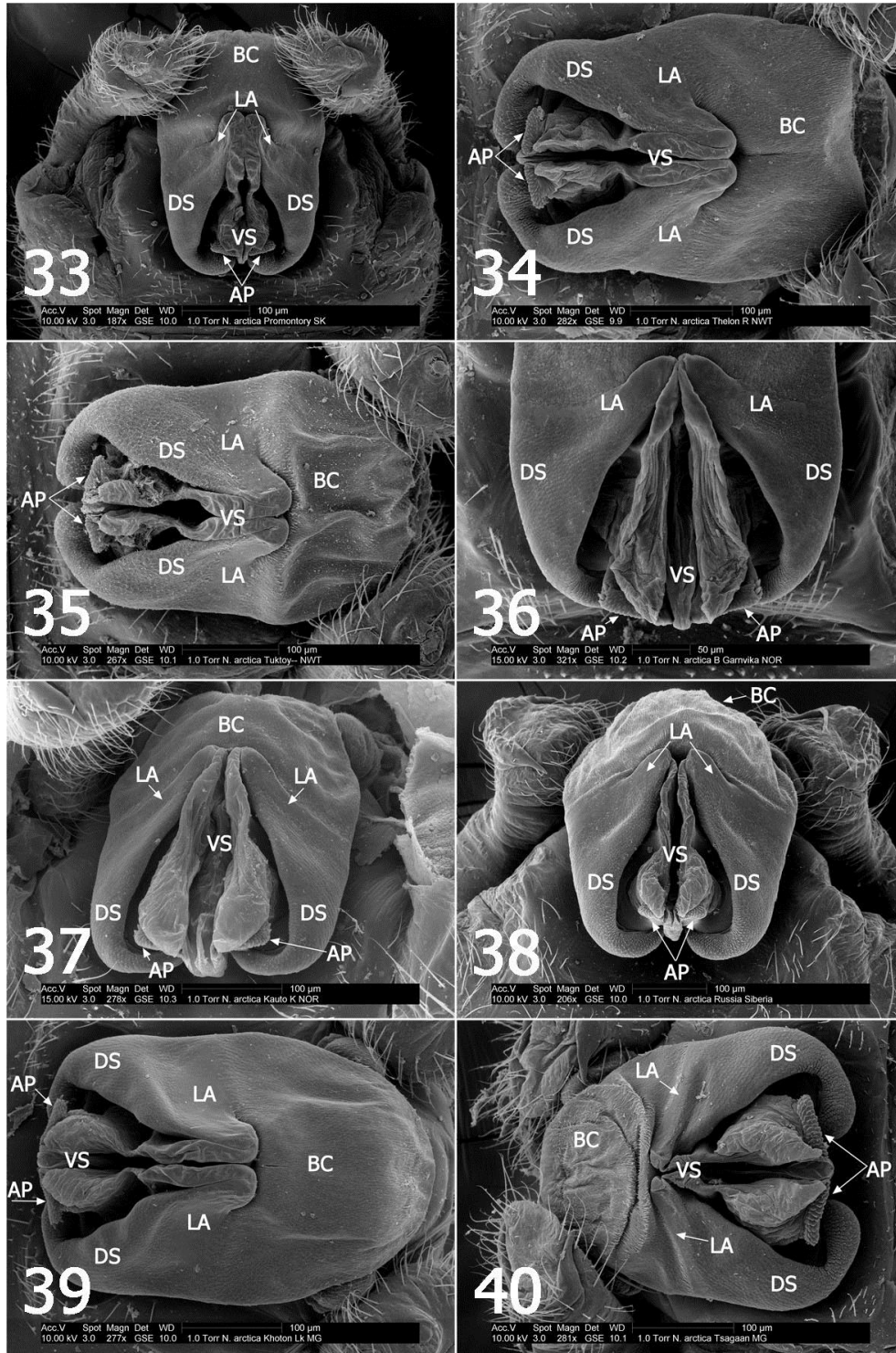
Cercus. Highly variable. Adults of *N. arctica* and *N. trispinosa* have been previously differentiated by a combination of cercal characteristics (males) and body size and distribution (females) (Ricker 1952). Male cerci are sclerotized laterally and terminate typically in a pair of appressed spines that vary in length and degree of tapering (Figs. 1–16), plus a third unit that is highly variable and has been used for the past ca. 65 years to separate males of *N. arctica* and *N. trispinosa* (Ricker 1952). Lillehammer (1972a) later illustrated cerci as either lacking (*N. arctica*, his Fig. 4b) or possessing a distinct (*N. trispinosa*, his Fig. 4a) spine. Ricker's (1952, p. 36) key to *N. trispinosa* males focused on "...the outer edge of the cercus produced into a slender acute spine... may be forked once or twice at the tip". This feature is common in North America and shown here clearly for populations from Iowa (Fig. 1),



Figs. 17–24. *Nemoura arctica*, epiproct, lateral view. 17, USA, Iowa, Twin Springs, 270X; 18, Canada, New Brunswick, Coombs Brook, 288X; 19, Canada, Northwest Territories, Thelon River, 285X; 20, Canada, Northwest Territories, Tuktoyaktuk, 328X; 21, Russia, Siberia, Magadan Oblask, 271X; 22, Norway, Buktved Garnvika, 286X; 23, Norway, Kautokeino, 316X; 24, Mongolia, Khoton Lake, 276X. AP = apical prong, BC = basal cushion, DS = dorsal sclerite, LA = lateral areas, VS = ventral sclerite.



Figs. 25–32. *Nemoura arctica*, epiproct, dorsal view. 25, USA, Iowa, Twin Springs, 141X; 26, USA, Illinois, Elgin, 165X; 27, USA, Ohio, spring, John Bryan State Park, 144X; 28, USA, Wisconsin, spring, 1 mile N Irvington, 132X; 29, USA, South Dakota, Burnt Fork, 140X; 30, USA, South Dakota, Burnt Fork, 229X; 31, Canada, Prince Edward Island, Balsam Hollow, 163X; 32, Canada, New Brunswick, Coombs Brook, 168X. AP = apical prong, BC = basal cushion, DS = dorsal sclerite, LA = lateral area, VS = ventral sclerite.



Figs. 33–40. *Nemoura arctica*, epiproct, dorsal view. 33, Canada, Saskatchewan, Promontory Campground, 187X; 34, Canada, Northwest Territories, Thelon River, 282X; 35, Canada, Northwest Territories, Tuktoyaktuk, 267X; 36, Norway, Buktved Garnvika, 321X; 37, Norway, Kautokeino, 278X; 38, Russia, Siberia, Magadan Oblask, 206X; 39, Mongolia, Khoton Lake, 277X; 40, Mongolia, Tsagaan Lake, 281X. AP = apical prong, BC = basal cushion, DS = dorsal sclerite, LA = lateral area, VS = ventral sclerite.

Illinois (Fig. 2), Ohio (Fig. 3), Wisconsin (Fig. 4), South Dakota (Fig. 5), Wyoming (Fig. 6), and New Brunswick (Fig. 8), and also from Siberia (Fig. 12), Norway (Fig. 13) and Mongolia (Fig. 16). The spine, however, varies in width and degree of tapering. For example, males from South Dakota have an outer spine that is rectangular, not “slender”, and crenulated distally (Fig. 5). *Nemoura arctica* was separated out by Ricker (1952) as the “...outer edge of the cercus bordered by a crenulate shelf or ridge”. No form of a spine is evident for populations studied from North America from Saskatchewan (Fig. 7), Manitoba (Fig. 9), and the Northwest Territories (Figs. 10–11) plus Norway (Fig. 14) and Mongolia (Fig. 15). Overall, there is sufficient variability (e.g. forked vs. crenulated; tapered or not) to strongly suggest that the male cercus does not provide objective, diagnostic information to support *N. trispinosa* as distinct from *N. arctica*.

Epiproct. Males exhibit consistency with epiproct shape and characteristics across the Holarctic with only minor differences between individuals. In lateral aspect, the basal cushion occupies the anterior ca. ½ and is separated from the dorsal sclerite by smooth lateral areas (Figs. 17–24). The lateral areas vary in thickness but are consistently recurved slightly over the distal medial portion of the basal cushion. The dorsal sclerite appears scaly at high magnifications, especially at the distal tips (Figs. 41–52). The dorsal sclerite is open apically, exposing parallel, broad, hatchet-like apical prongs of the ventral sclerite (Figs. 25–40) and prominent, scaly, apical prongs positioned ca. perpendicular to the ridges (Figs. 41–52). The prongs terminate laterally bearing two short, thick, grooved spines (e.g. Figs. 42, 45, 49, 52).

Comments. *Nemoura trispinosa* is placed in synonymy with *N. arctica* due to consistencies in epiproct characteristics across the Holarctic, particularly the paired apical prongs of the ventral sclerite (Figs. 41–52). In contrast, cercal spine characteristics are highly variable and do not provide objective, diagnostic information. Even males from the same geographic entity (e.g. Mongolia, Figs. 15–16) exhibit different cercal forms. Lillehammer (1972a, his Fig. 25.4)

previously illustrated several different cercal forms from Norway.

Geographic notes. Holarctic: Scandinavia east across Asia; east to Alaska, Yukon, Northwest Territories and Nunavut. South in Europe to Latvia and in far eastern Asia to Mongolia and Siberia. South in North America to Wyoming and South Dakota east across the Great Lakes region to Atlantic Canada, with relictual southern populations in Ohio, Pennsylvania, and West Virginia. Additional notable references include Ricker (1944, 1964), Brinck (1958), Ulfstrand (1969), Jewett (1971), Lillehammer (1974, 1985, 1986, 1988), Harper (1973), Flannagan & Flannagan (1982), Burton (1984), Stewart et al. (1990), Harper & Ricker (1994), Stewart & Ricker (1997), Huntsman et al. (1999), Teslenko & Bazova (2009), Walters et al. (2009), Zhou et al. (2010), Boumans (2011), Boumans & Brittain (2012), Surenkhorloo et al. (2012), Dossdall & Giberson (2014), Kendrick & Huryn (2014), and Potikha (2015).

Nemoura sahlbergi Morton, 1896
(Figs. 53–84)

<http://lsid.speciesfile.org/urn:lsid:Plecoptera.speciesfile.org:TaxonName:6326>

Nemoura sahlbergi Morton 1896:56. Holotype ♂, Type locality – Utsjoki, Lake Enara, Finland

Nemoura sahlbergi: Claassen 1940:63

Nemoura trispinosa: Ricker 1944:177. In part

Nemoura sahlbergi: Brinck 1952:104

Nemoura sahlbergi: Zhiltzova 1964:187

Nemoura sahlbergi: Meinander 1965:17

Nemoura sahlbergi: Illies 1966:212.

Nemoura rickeri Jewett, 1971:190. Type locality – Cache Creek, 19 mi E Eureka, Glenn Highway, Alaska. **New synonym** (Paratype ♂ examined)

Nemoura sahlbergi: Lillehammer 1972b:157

Nemoura sahlbergi: Benedetto 1973:20

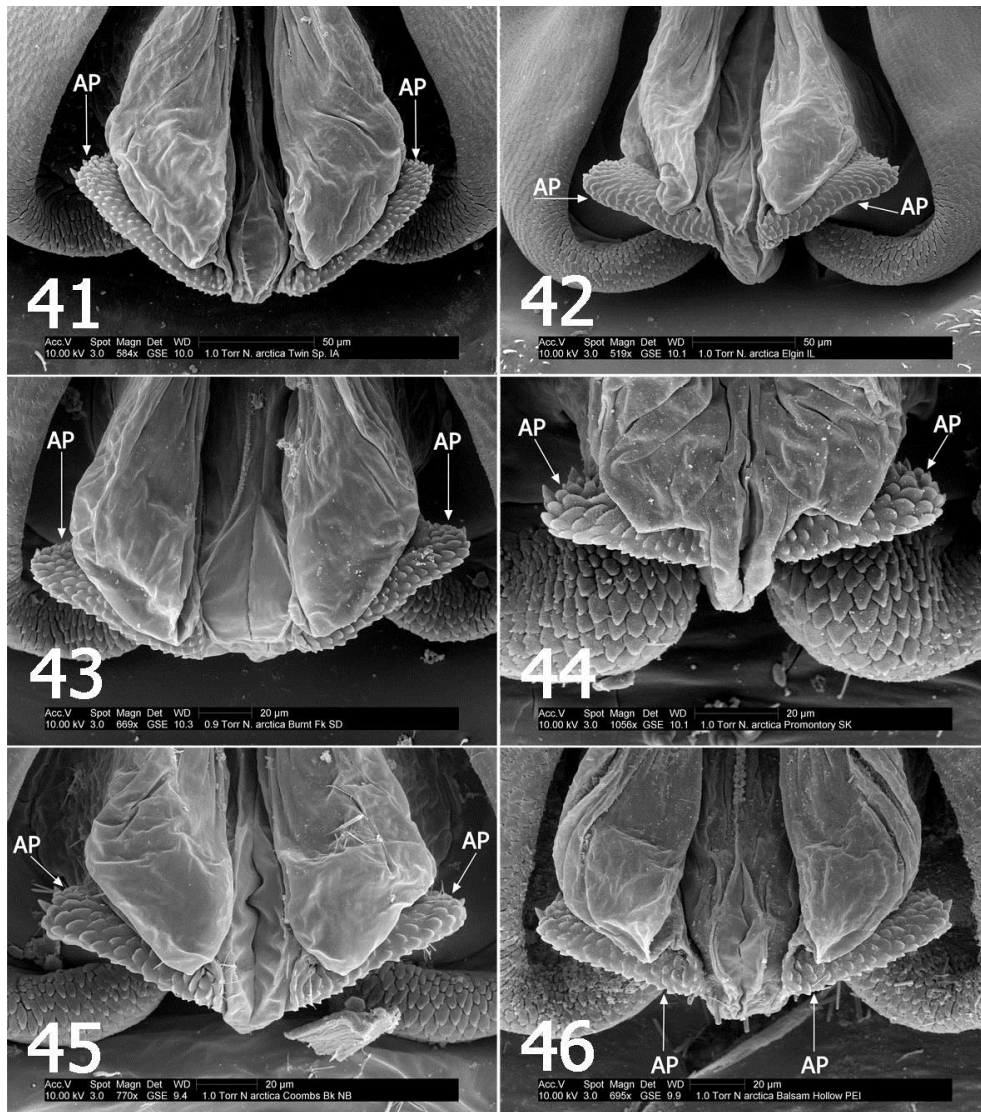
Nemoura sahlbergi: Zwick 1973a:340

Nemoura sahlbergi problematica: Zwick 1973b:162. Type locality – Diamond Range, Kangwon Province, People’s Republic of Korea. **Nomen dubium** Zwick 2010

Nemoura sahlbergi: Lillehammer 1974a:85

Nemoura rickeri: Dossdall & Lehmkuhl 1979:34

Nemoura rickeri: Stewart & Oswood 2006:78



Figs. 41–46. *Nemoura arctica*, epiproct, dorsal view. 41, USA, Iowa, Twin Springs, 584X; 42, USA, Illinois, Elgin, 519X; 43, USA, South Dakota, Burnt Fork, 669X; 44, Canada, Saskatchewan, Promontory Campground, 1056X; 45, Canada, New Brunswick, Coombs Brook, 770X; 46, Canada, Prince Edward Island, Balsam Hollow, 695X. AP = apical prong.

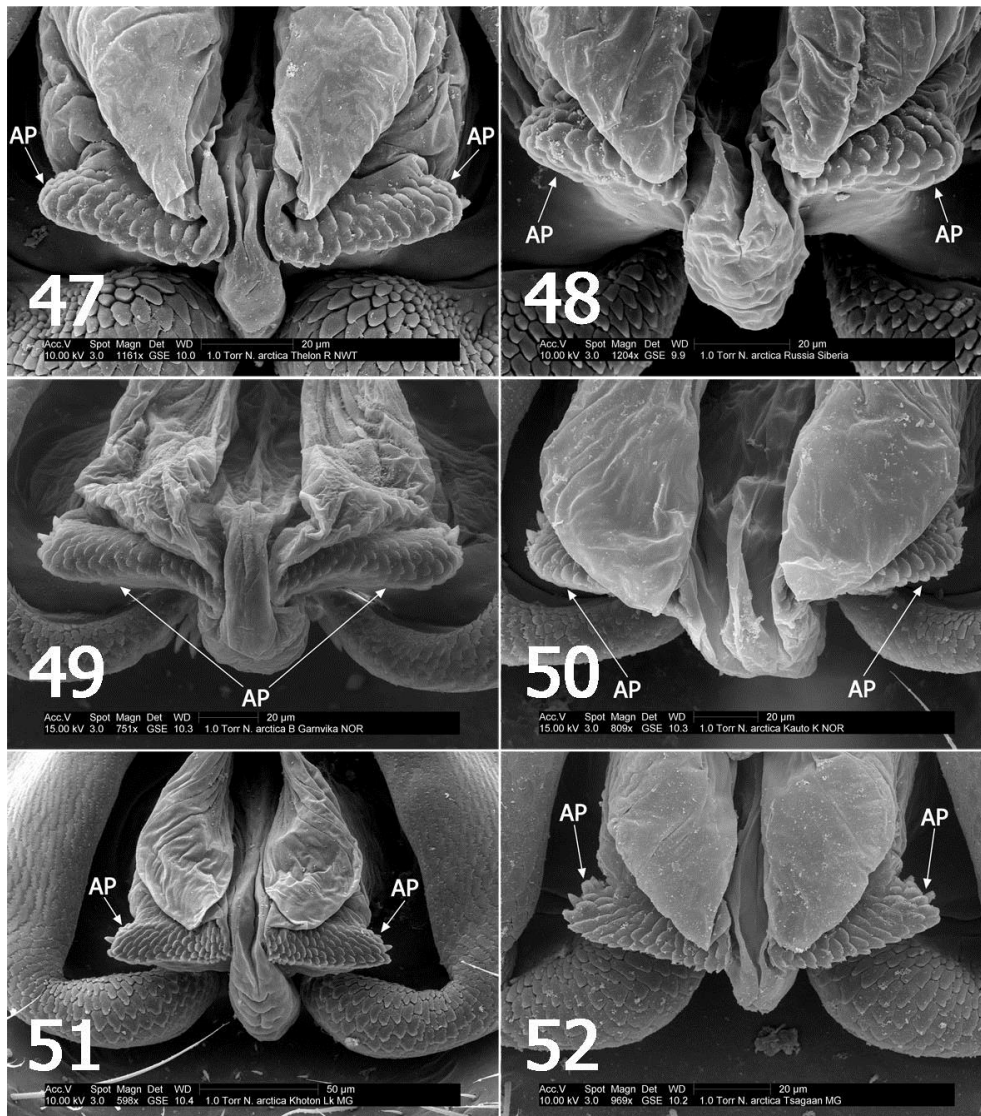
Distribution. Canada: MB, NT, NU, SK, YK. Europe: Baltic States, Finland, Norway, Sweden. Mongolia. Russia East, Russia North. USA: AK (DeWalt et al. 2018).

Diagnosis.

Cercus. Highly variable. Male cerci are sclerotized laterally and terminate in either one (Figs. 54–57, 59) or two (Figs. 53, 58, 60) produced, curved spines that vary in length, curvature, and degree of

tapering, plus a third unit (= outer spine) that tapers little and is typically crenulated distally.

Epiproct. Males exhibit consistency with epiproct shape and characteristics across the Holarctic with only minor differences between individuals. In lateral aspect, the basal cushion occupies the anterior ca. ½ and is separated from the dorsal sclerite by smooth lateral areas (Figs. 61–68). The lateral areas are consistently recurved slightly over

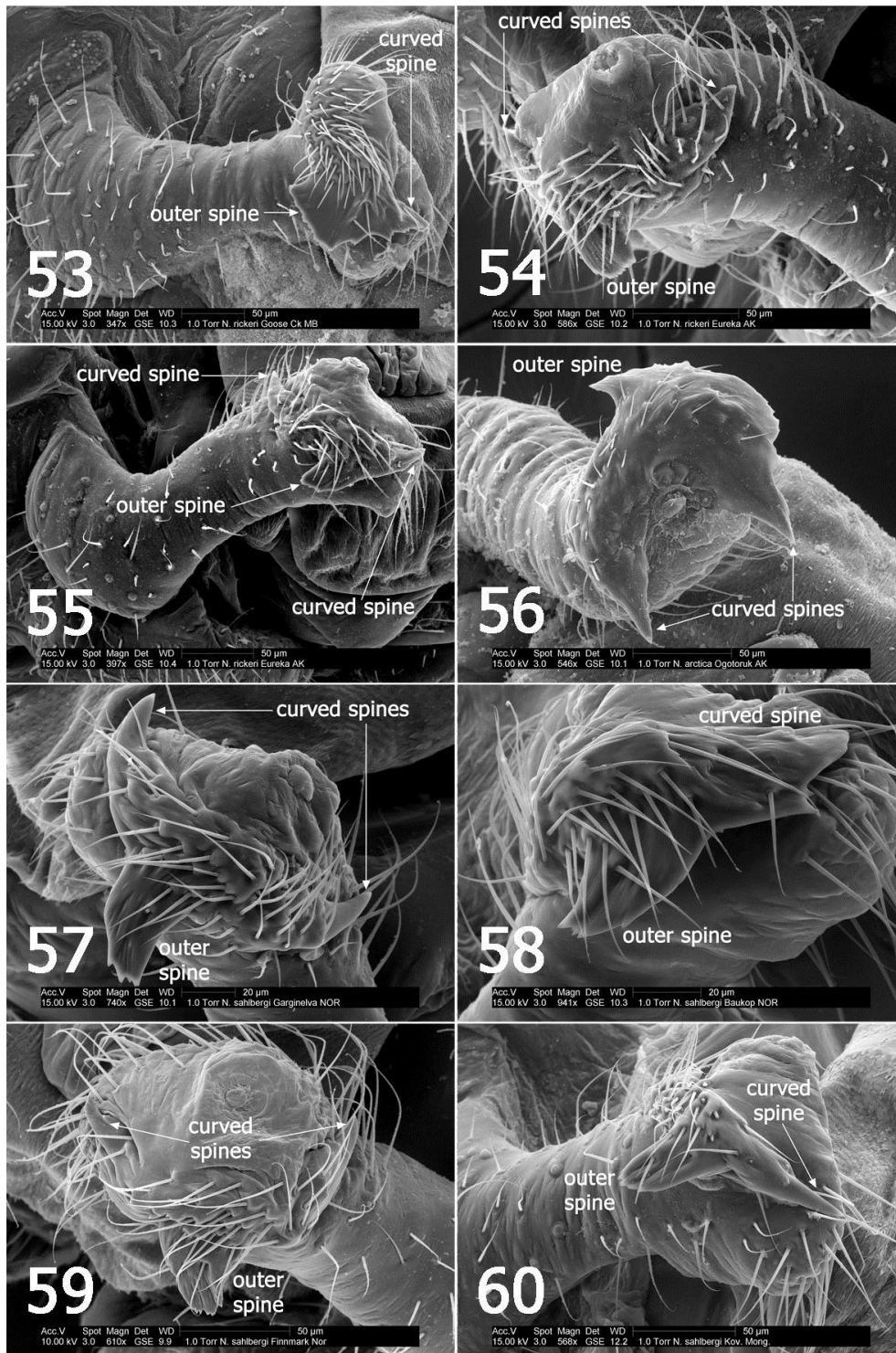


Figs. 47–52. *Nemoura arctica*, epiproct, dorsal view. 47, Canada, Northwest Territories, Thelon River, 1161X; 48, Russia, Siberia, Magadan Oblask, 1204X; 49, Norway, Buktved Garnvika, 751X; 50, Norway, Kautokeino, 809X; 51, Mongolia, Khoton Lake, 598X; 52, Mongolia, Tsagaan Lake, 969X. AP = apical prong.

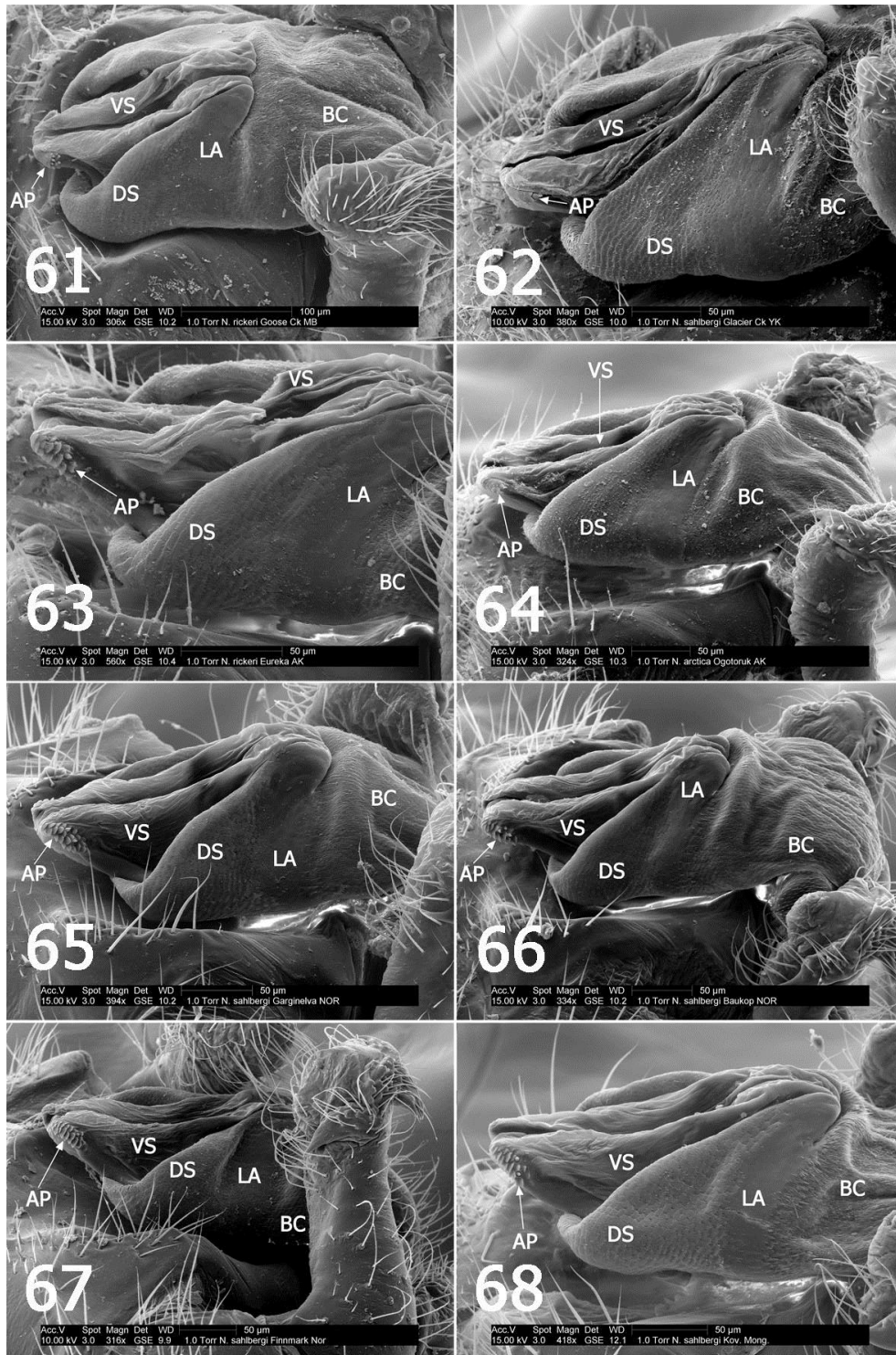
the distal medial portion of the basal cushion. The dorsal sclerite is open apically, exposing paired, rounded apical prongs bearing scale-like ridges, terminating laterally into one or two stout, grooved lateral spines (Figs. 69–76). The apical prongs are positioned either ca. parallel (Figs. 82, 84) or ca. diagonal to the ridges (Figs. 77–81, 83).

Comments. The synonymy of *N. rickeri* with *N.*

sahlbergi has been suggested previously (e.g. Lillehammer 1972b; Boumans & Brittain 2012). Jewett (1971) noted in his description of *N. rickeri* that this species "...is similar to the rare northern European *Nemoura sahlbergi*...". Lillehammer (1972a, his Fig. 29.4) illustrated several different cercal forms from Norway, showing variability in the curved and outer spines. The epiproct apical



Figs. 53–60. *Nemoura sahlbergi*, cerci, distal view. 53, Canada, Manitoba, Goose Creek, 347X; 54, USA, Alaska, 7 mi E Eureka, 586X; 55, USA, Alaska, 7 mi E Eureka, 397X; 56, USA, Alaska, Ogotoruk Creek, 546X; 57, Norway, Gargiaelva, 740X; 58, Norway, Baukop, 941X; 59, Norway, Finnmark, 610X; 60, Mongolia, Khovsgol Aimag, 568X.



Figs. 61–68. *Nemoura sahlbergi*, epiproct, lateral view. 61, Canada, Manitoba, Goose Creek, 306X; 62, Canada, Yukon, Glacier Creek, 380X; 63, USA, Alaska, 7 mi E Eureka, 560X; 64, USA, Alaska, Ogotoruk Creek, 324X; 65, Norway, Gargiaelva, 394X; 66, Norway, Baukop, 334X; 67, Norway, Finnmark, 316X; 68, Mongolia, Khovsgol Aimag, 418X. AP = apical prong, BC = basal cushion, DS = dorsal sclerite, LA = lateral area, VS = ventral sclerite.

prongs studied herein from the Northwest Territories (Fig. 78), Alaska (Fig. 80), Norway (Fig. 82), and Mongolia (Fig. 84) are consistent with illustrations or images in Lillehammer (1972a, his Fig. 31.3; Norway), Boumans (2011, his Fig. 2; Norway) and Judson & Nelson (2012, their Fig. 187; Mongolia).

Geographic notes. Holarctic: Scandinavia east across Asia; in North America from Alaska east to Nunavut and Manitoba. South in Europe to Latvia and in eastern Asia south to Mongolia and far eastern Siberia. South in North America to the treeline in the Saskatchewan River Basin in Manitoba and Saskatchewan. Additional notable references include Rauser (1968), Lillehammer (1972a, 1974, 1985, 1988), Burton (1984), Teslenko & Bazova (2009), Zhou et al. (2010), Zwick (2010), Boumans (2011), Boumans & Brittain (2012), and Judson & Nelson (2012).

Nemoura normani Ricker

Alaska Forestfly

<http://lsid.speciesfile.org/urn:lsid:Plecoptera.speciesfile.org:TaxonName:6350>

Nemoura species E: Ricker 1944:177.

Nemoura sp. A: Weber 1950:175.

Nemoura normani Ricker 1952:37. Type locality – Mackenzie River, Fort Norman, Northwest Territories (Holotype ♀ and Paratype ♀ examined)

Nemoura normani: Illies 1966:209.

Nemoura normani: Stewart & Oswood 2006:78.

Distribution. Canada: NT. USA: AK (DeWalt et al. 2018).

Diagnosis. *Nemoura normani* was described from the holotype female and one paratype female (Ricker 1952) and is still unknown from the male stage. The females were described as “noticeably larger” than both *N. arctica* and *N. trispinosa* and exhibit subtle differences in the shape of the subgenital plate (Ricker 1952). Stewart and Oswood (2006) examined the paratype female (Alaska, Anaktuvik Pass, 6 July 1949, preserved in alcohol) during their study of the stoneflies of Alaska and western Canada but were unable to collect additional material. We likewise studied the paratype female and determined that it was indeed

a *Nemoura* female with the correct wing venation, sclerotized cerci, and no cervical gills. The color of the wings are fumose in alcohol. This species is perhaps also absent from the Yukon (Stewart and Ricker 1997). Hence, the two females remain the only specimens of this species collected and none since 1949. Males or molecular data are needed to determine if this is a valid species, another *Nemoura* species (Ricker, 1964), or a junior synonym of either *N. arctica* or *N. sahlbergi*.

Conclusions

We present morphological evidence with SEM micrographs of the male epiprocts and cerci to propose that Nearctic *N. rickeri* and Nearctic *N. trispinosa* are junior synonyms of Holarctic *N. arctica* and Palearctic *N. sahlbergi*, respectively. Hence, both *N. arctica* and *N. sahlbergi* exhibit Holarctic distributions. On a similar note, Boumans & Baumann (2012) synonymized *Amphinemura linda* (Ricker, 1952), a species recognized for ca. 65 years, with *A. palmeni* (Koponen, 1917) using a combination of external reproductive morphology plus mitochondrial COI subunit and nuclear 28S gene sequence data. *Amphinemura palmeni* likewise is a Holarctic species (DeWalt et al. 2018).

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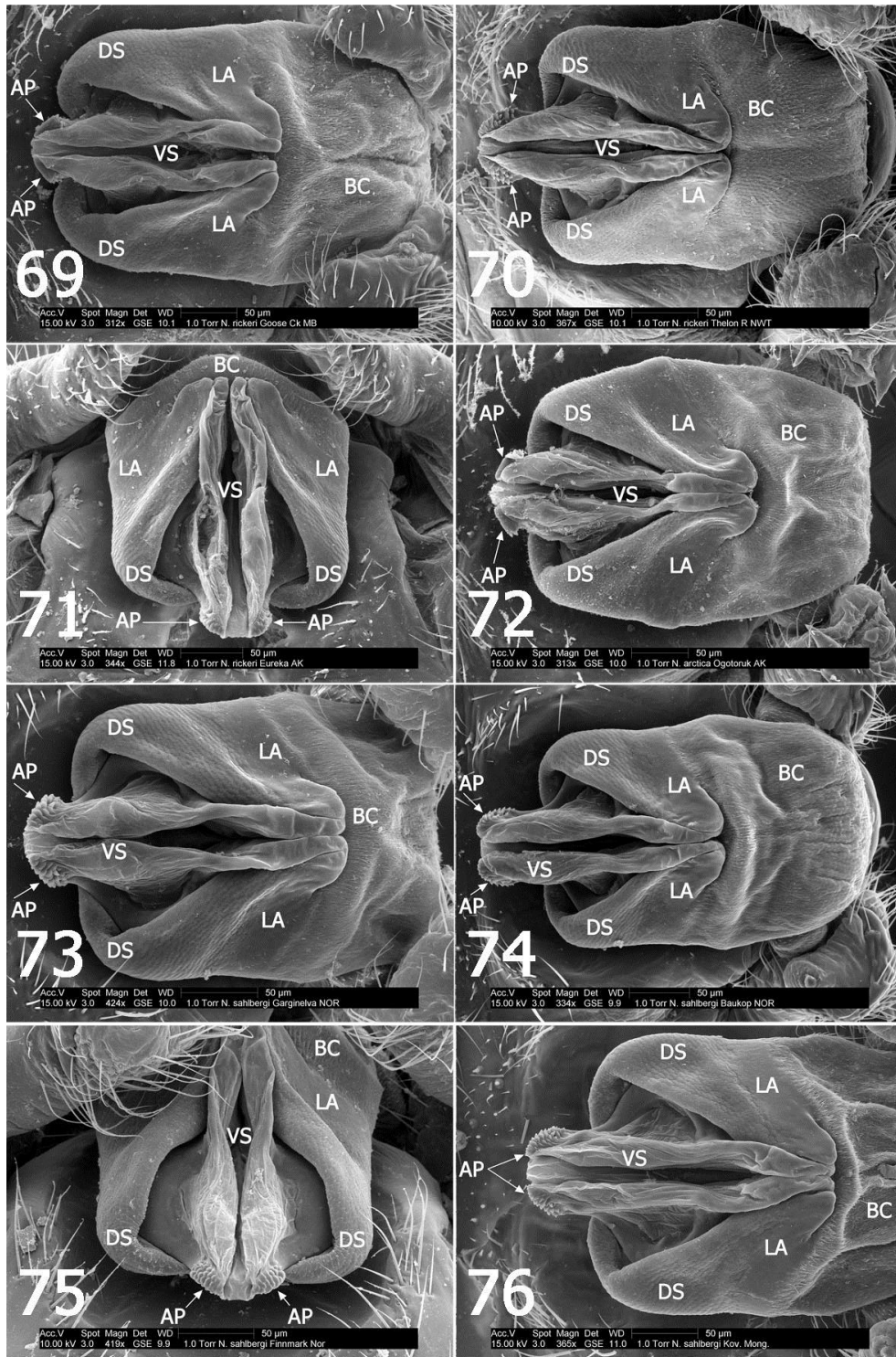
Thanks are extended to Boris Kondratieff (Colorado State University, Fort Collins, Colorado, USA) and Peter Zwick (Limnologische Flußstation Max-Planck_Institut für Limnologie, Schlitz, Germany) for thoughtful reviews and comments that improved the quality of this paper. Several individuals have provided assistance, shared ideas, and provided material across several years that has made this study possible:

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Louis Boumans, Insect Collection, Department of Zoology, Natural History Museum, University of Oslo, Oslo, Norway

Per Brink, Department of Animal Ecology, Zoological Institute, University of Lund, Sweden



Figs. 69–76. *Nemoura sahlbergi*, epiproct, dorsal view. 69, Canada, Manitoba, Goose Creek, 312X; 70, Canada, Northwest Territories, Thelon River, 367X; 71, USA, Alaska, Eureka, 344X; 72, USA, Alaska, Ogotoruk Creek, 313X; 73, Norway, Gargiaelva, 424X; 74, Norway, Baukop, 334X; 75, Norway, Finnmark, 419X; 76, Mongolia, Khovsgol Aimag, 365X. AP = apical prong, BC = basal cushion, DS = dorsal sclerite, LA = lateral area, VS = ventral sclerite.

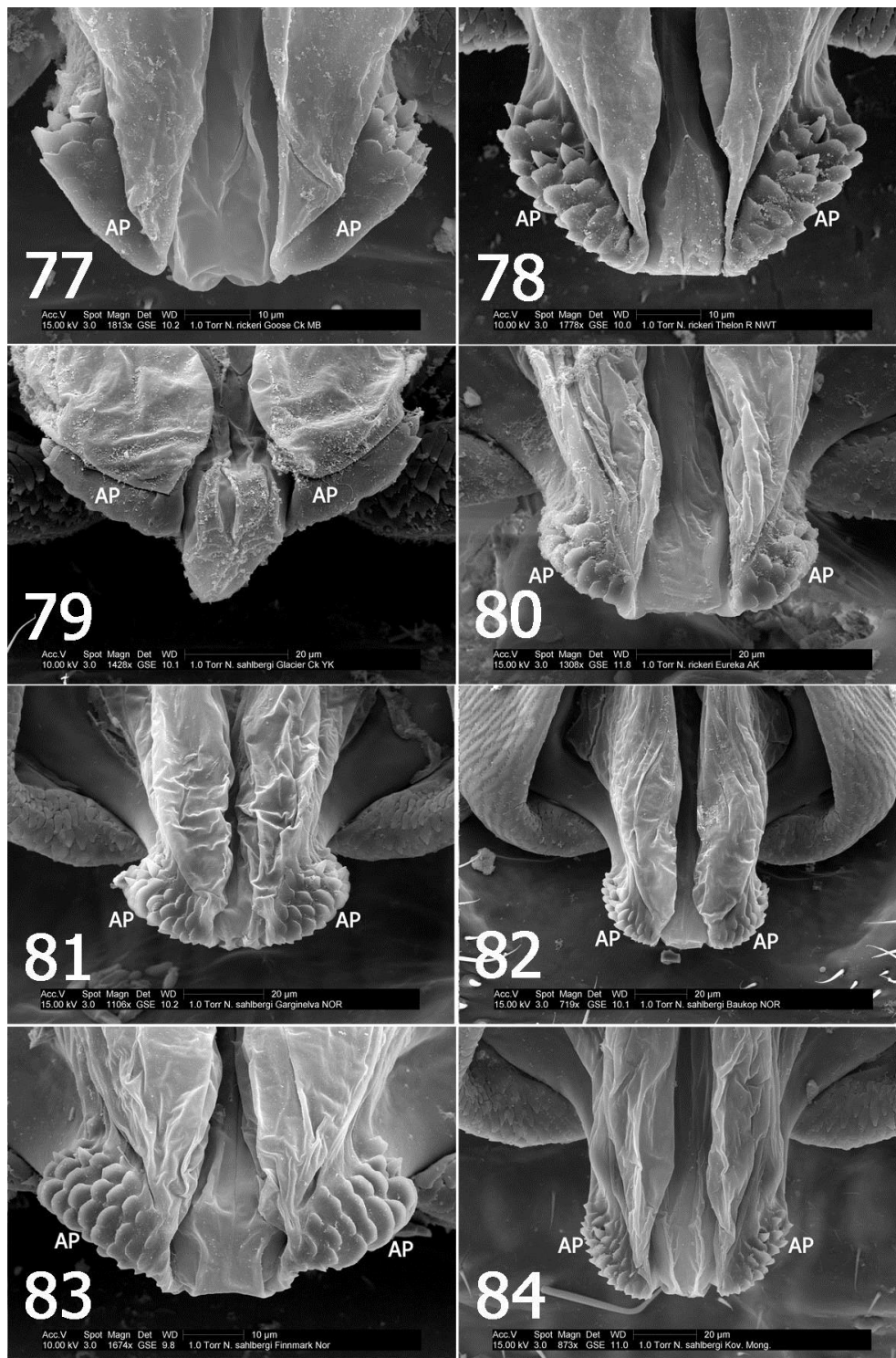


Fig. 77–84. *Nemoura sahlbergi*, epiproct, dorsal view. 77, Canada, Manitoba, Goose Creek, 1813X; 78, Canada, Northwest Territories, Thelon River, 1778X; 79, Canada, Yukon, Glacier Creek, 1428X; 80, USA, Alaska, 7 mi E Eureka, 1308X; 81, Norway, Gargiaelva, 1106X; 82, Norway, Baukop, 719X; 83, Norway, Finnmark, 1674X; 84, Mongolia, Khovsgol Aimag, 873X.

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