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SYSTEMATICS OF NEARCTIC *PARALEUCTRA* WITH DESCRIPTION OF A NEW GENUS (PLECOPTERA: LEUCTRIDAE)

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Nearctic *Paraleuctra* are reviewed and seven species placed in three species groups are recognized. The *P. sara* group includes *P. forcipata* (Frison), *P. sara* (Claassen), *P. vershina* Gaufin & Ricker and several Asian species. The *P. occidentalis* group includes *P. jewetti* Nebeker & Gaufin, *P. occidentalis* (Banks), *P. projecta* (Frison) and several Asian species and the *P. divisa* group includes only *P. divisa* (Hitchcock). *Paraleuctra rickeri* Nebeker & Gaufin is placed as a synonym of *P. projecta*, *P. dusha* Ricker is placed as a synonym of *P. occidentalis* and the first description is given for female *P. divisa*. Two additional species formerly included in *Paraleuctra*, *P. andersoni* Harper & Wildman and *P. purcellana* (Neave), are placed in *Pomoleuctra*, gen. n. Keys are given for the Nearctic leuctrid genera, the species of *Pomoleuctra* and the Nearctic species of *Paraleuctra*.

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Key words: *Paraleuctra; Pomoleuctra;* systematics; Nearctic

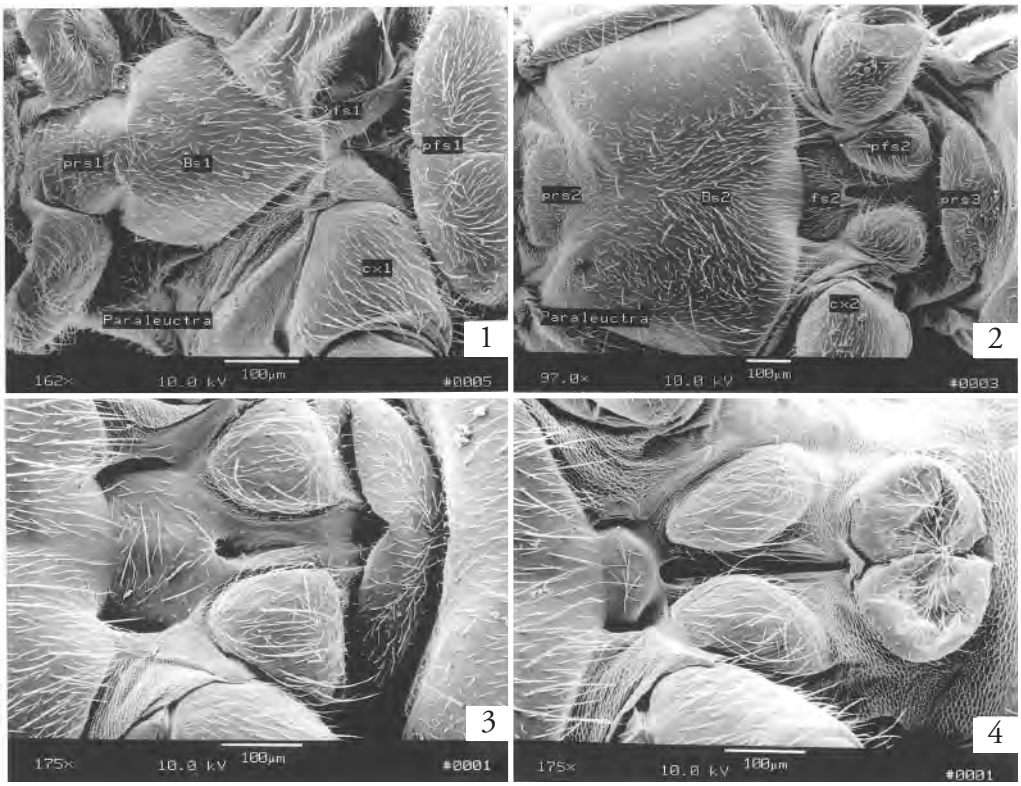
Hanson (1941) proposed *Paraleuctra* as a Nearctic genus embracing seven species. Subsequently, the number of accepted Nearctic species has fluctuated between four and nine with descriptions of new species, generic transfers and synonymies. Most of these systematic changes are summarized by Frison (1942), Ricker (1954), Nebeker and Gaufin (1966), Nelson (1977) and Harper and Wildman (1984).

Kawai (1967) recognized the presence of *Paraleuctra* in Japan and other species are now known from the Russian Far East (Zhiltzova 1974), Thailand (Harper 1977) and China (Yang & Yang 1995). After the work of Shimizu (unpublished) is presented, the total Asian *Paraleuctra* fauna will include eleven species until the status of several species similar to *P. cercia* (Okamoto) can be evaluated. Presently the genus includes fifteen Nearctic and Asian species united by these shared features extracted primarily from Hanson (1941) and Nelson (1977): (1) basisternum and presternum of prothorax partially fused, (2) basisternum and furcasternum of prothorax fused, (3) medio-cubital crossvein located beyond the fork of Cu1 in the hindwing, (4) median and radial sector veins with separate origins in the forewing, (5) outer paraproct lobes form slender suspensory bars, (6) inner paraproct lobes united into a subanal probe (titillator), (7) epiproct reduced to a small curved hook, (8) male cerci modified, and (9) female subgenital plate usually bilobed. We undertook this study to evaluate the status of the Nearctic species with scanning electron microscopy. The results support recognition of nine Nearctic species, but suggest two of these should be placed in a new genus.

METHODS AND MATERIALS

Legs and wings were removed from specimens stored in 80% ethanol and the bodies were agitated in an ultrasonic cleaner for 30 seconds. Cleaned specimens were dehydrated in 90%, 95% and 100% ethanol solutions for 10 minutes each, then transferred through two, 30 minute washes in hexamethyldisilizane (HMDS). Dehydrated specimens were blotted dry, attached to SEM stubs with double stick copper tape, and sputter coated with gold-palladium before study with SEM.

Specimens used in this study were provided by the following individuals and institutions: A.L. Sheldon Collection, Missoula, Montana (ALS); B.P. Stark Collection, Clinton, Mississippi (BPS); R.W. Baumann, Monte L. Bean Museum, Brigham Young University (BYU); C.R. Nelson Collection, Provo, Utah (CRN); B.C. Kondratieff, C.P. Gillette Museum, Colorado



Figs. 1-4. Thoracic sternal features of *Paraleuctra* and *Pomoleuctra.* – 1, *Paraleuctra vershina* prosternum; 2, *P. vershina* meso and metasterna; 3, *Paraleuctra projecta* meso and metasterna; 4, *Pomoleuctra purcellana* meso and metasterna. (Bs1,2 = pro and mesobasisternum; Cx1,2 = pro and mesocoxa; fs1,2 = pro and mesofurcasterna; pfs1,2 = pro and mesopostfurcasterna; prs 1,2,3 = pro, meso and metaprefurcasterna).

State University (CSU); E. DeWalt, Illinois Natural History Survey (INHS); I. Sivec, Prirodoslovni muzej Slovenije- (PMS); R. Bottorff Collection, South Lake Tahoe, California (RB); R.F. Kirchner Collection, Huntington, West Virginia (RFK); K.W. Stewart, University of North Texas (UNT); O.S. Flint, United States National Museum (USNM).

Pomoleuctra gen. n.

Type species. – *Paraleuctra andersoni* Harper and Wildman 1984: 982, by present designation.

Adult habitus. – Typical leuctrine including small size, dark wings and body and wings rolled around sides of abdomen.

Thoracic features. – Prothoracic basisternum and presternum partially fused forming a 'spade' shaped structure (fig. 1). Mesosternal furcasternum reduced in size and not divided by median longitudinal dark line; mesosternal spinasternum long, slender and open to base of metasternal presternum (fig. 4); metasternal presternum narrowly divided into small, almost circular sclerites (fig. 4).

Wings. – Typical paraleuctrine; forewing radial sector and media veins with separate origins; hindwing medio-cubital crossvein located beyond fork of Cu1 (fig. 5).

Male genitalia. – Vesicle present at base of sternum nine (figs. 6, 16, 21); sternum nine projecting caudally and dorsally (figs. 6-7, 16); titillator apex lacking scale-like armature (figs. 9, 19). Cerci with prominent basoventral thumb shaped lobe (fig. 17) and three apical spines (fig. 8).

Female genitalia. – Subgenital plate narrow, strongly sclerotized and deeply and narrowly cleft (figs. 12, 14); margins of plate scalloped (fig. 13). Posterior margin of sternum eight bearing prominent patches of coarse microtrichia adjacent to subgenital plate base (fig. 15). Sternum nine almost completely sclerotized.

Nymph. – Unknown.

Etymology. – The prefix 'Pomo' is used to honour the Native Americans of the Coast Range of the Pacific Northwest.

Included species. – *Pomoleuctra andersoni* (Harper and Wildman), *P. purcellana* (Neave), and an undescribed Japanese species (Shimizu unpublished).

Diagnosis. – *Pomoleuctra* species were previously included in *Paraleuctra*, consequently they are identified to that genus in Stewart and Harper (1996) and also in the revised version of Harper and Stewart (1984) given by Shepard and Baumann (1995). *Pomoleuctra* is distinguished from *Paraleuctra* by: (1) the absence of a dark line which divides the mesosternal furcasternum in *Paraleuctra*, (2) the divided metathoracic presternum, (3) the basoventral thumb shaped male cercal lobe and tridentate cercal apex, (4) the prolonged male ninth sternum, (5) the narrow, deeply cleft, marginally scalloped female subgenital plate, and (6) the patches of microtrichia on the hind margin of the female eighth sternum. We regard characters 3, 5 and 6 as apomorphies for *Pomoleuctra* and presence of a dark mesosternal line and fused metathoracic presternal plates as apomorphies for *Paraleuctra*. Although leuctrid cerci are often elaborated with lobes and spines, presence of a basoventral, bluntly rounded lobe and presence of three horn shaped apical spines is unique to *Pomoleuctra*. Similarly, the female characters (5 and 6) we regard as apomorphies for *Pomoleuctra* are apparently restricted to this genus.

Because *Calileuctra* Shepard and Baumann (1995) was not included in the Stewart and Harper (1996) key to Nearctic leuctrid genera, we offer the following key modified from Stewart and Harper (1996) and Shepard and Baumann (1995).

Key to the Nearctic genera of Leuctridae

1. Hind wing with six anal veins, forewing usually with an apical stigma .....*Megaleuctra*
– Hind wing with three or four anal veins, forewing without stigma.....2
2. Rs and M veins of forewing arise from a common origin on R .....*Perlomyia*
– Rs and M veins of forewing arise from separate origins on R (fig. 5) 3
3. Cu1 vein not forked in hind wing .....*Calileuctra*
– Cu1 vein of hind wing forked (fig. 5) 4
4. M-Cu crossvein located distal to Cu fork in hind wing (fig. 5) 5
– M-Cu crossvein located proximal to Cu fork in hind wing 7
5. Basisternum and presternum of prothorax completely separated; male tergum nine with a deep V or U-shaped mesal cleft; female terga 1-8 without mesal sclerite .....*Zealeuctra*

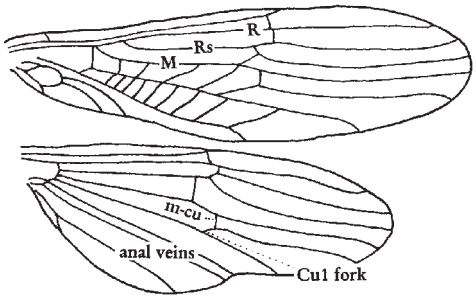


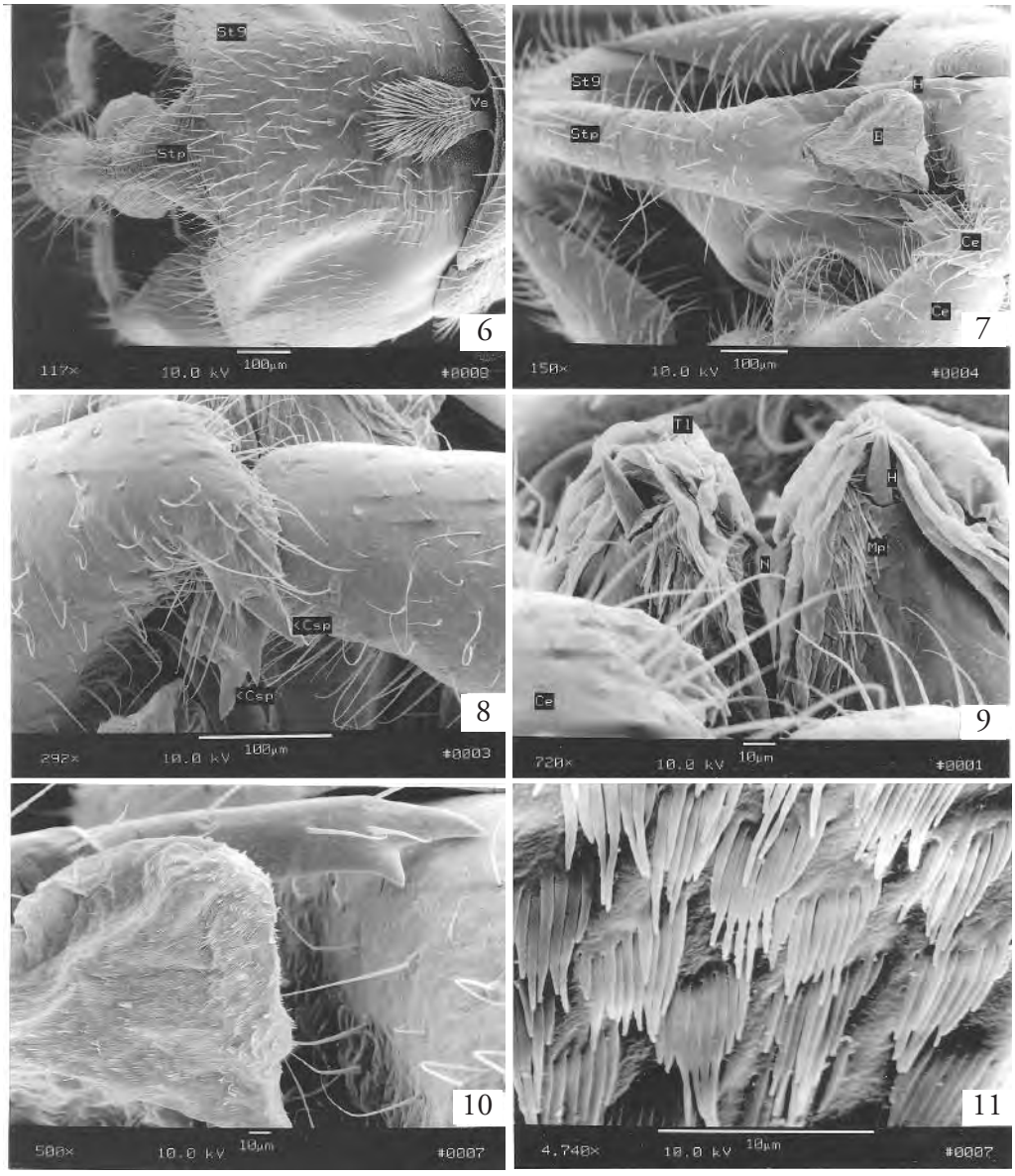
Fig. 5. *Pomoleuctra purcellana* wings. (R = radius; Rs = radial sector; M = media; Cu1 = 1st cubital; m-cu = medio-cubital crossvein).

– Basisternum and presternum of prothorax partially fused (fig. 1); male tergum nine without mesal cleft; female terga 1-8 with mesal sclerite.6
6. Metathoracic presternum divided, mesothoracic furcasternum without dark mesal line; male cerci with basoventral thumb shaped lobe and three apical spines (figs. 8, 17); female subgenital plate with narrow, deep cleft (figs. 12, 14).....
.....*Pomoleuctra*
– Metathoracic presternum fused (fig. 3), mesothoracic furcasternum with dark mesal line; male cerci without basoventral lobe, apex bifurcate or unmodified (figs. 24-25); female subgenital plate entire, or with shallow, broad notch (fig. 30) .....
.....*Paraleuctra*
7. Male without vesicle on sternum nine; female subgenital plate not projecting over base of sternum nine .....*Despaxia*
– Male with vesicle on sternum nine; female subgenital plate projecting over base of sternum nine
.....8
8. Wings with white humeral spot; male vesicle wider than long, cerci about four times long as wide; female abdominal terga 1-8 with median sclerite; western North America.....*Moselia*
– Wings without white humeral spot; male vesicle longer than wide, cerci about two times long as wide; female abdominal terga 1-8 without median sclerite; in North America only in the east.....
.....*Leuctra*

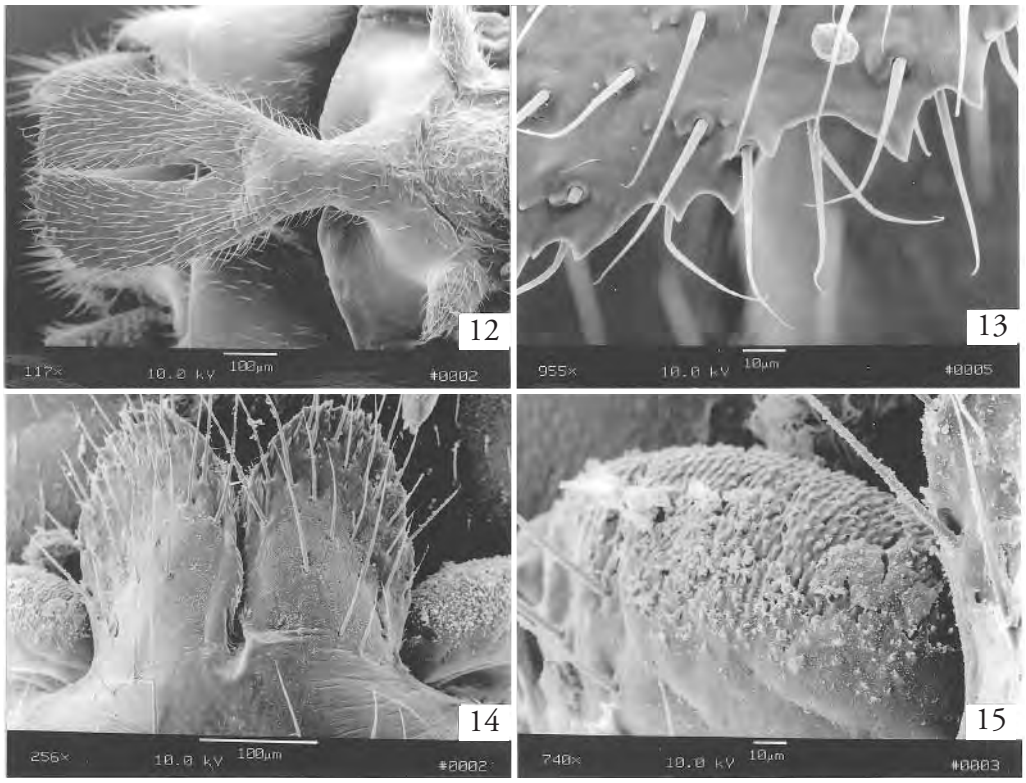
Pomoleuctra andersoni (Harper & Wildman) **comb. n.**

Paraleuctra andersoni Harper & Wildman 1984:982. Holotype ♂, Mack Creek, Lane Co., Oregon (USNM).

Material. – California: Humboldt Co., tributary Willow Creek, Hwy 299, 2.3 mi E Berry Summit, 2 May 1999,



Figs. 6-11. *Pomoleuctra andersoni* male terminalia. – 6, sternum nine; 7, caudal aspect of sternum nine and cerci; 8, cercal apices; 9, caudal aspect of titillator (subanal probe); 10, apex of sternal plate; 11, surface macrotrichia of sternal plate bulb. (B = bulb; Ce = cercus; Csp = cercal spines; H = horn; Mp = mesal setal patch; N = notch; Stp = sternal plate; Tl = titillator or subanal probe; Vs = vesicle).



Figs. 12-15. *Pomoleuctra* female terminalia. – 12, *P. andersoni* sternum eight; 13, *P. andersoni* subgenital plate margin; 14, *P. purcellana* subgenital plate; 15, *P. purcellana* microtrichia patch adjacent to subgenital plate base.

K.W. Stewart, 2♂ (UNT). Humboldt Co., same location, 19 May 1998, B.P. Stark, C.R. Nelson, S.W. Szczytko, I. Sivec, 1♀ (BPS). Humboldt Co., tributary Willow Creek, Hwy 299, 6.5 mi W Willow Creek (city), 19 May 1998, B.P. Stark, C.R. Nelson, S.W. Szczytko, I. Sivec, 1♀ (BPS). Humboldt Co., unnamed creek N of Fish Lake, 24 April 1987, R.W. Baumann, B.P. Stark, C.R. Nelson, 2♂, 1♀ (BYU). Oregon: Lane Co., H.J. Andrews Experimental Forest, 11 mi NE Blue River, 11 May 1979, G. Cooper, 1♀ (BPS). Lane Co., Alder Springs Camp Ground, Hwy 242, 3 June 2000, B.P. Stark, I. Sivec, M. Zúñiga, 5♂, 2♀ (BPS, PMS).

Diagnosis. – Harper & Wildman's (1984) figures and description identify the features essential for recognition of this species. The outstanding feature of the male is the prolonged ninth sternal plate which terminates in a membranous bulb and a pair of stout, bidentate horns (figs. 7, 10); the bulb surface is covered with peculiar digitate macrotrichia (fig. 11). The subanal probe, partially concealed by this process, is apically notched and bears a pair of short terminally projecting horns (fig. 9) and a lateral pair of smaller, caudally projecting horns; on either side of the notch in caudal and apicolateral aspects are sparse patches of fine setal-like spines. The cercal apex projects downward and bears a large, usually tridentate spine (fig. 8); a thumb shaped basoventral cercal lobe projects inwardly in most specimens.

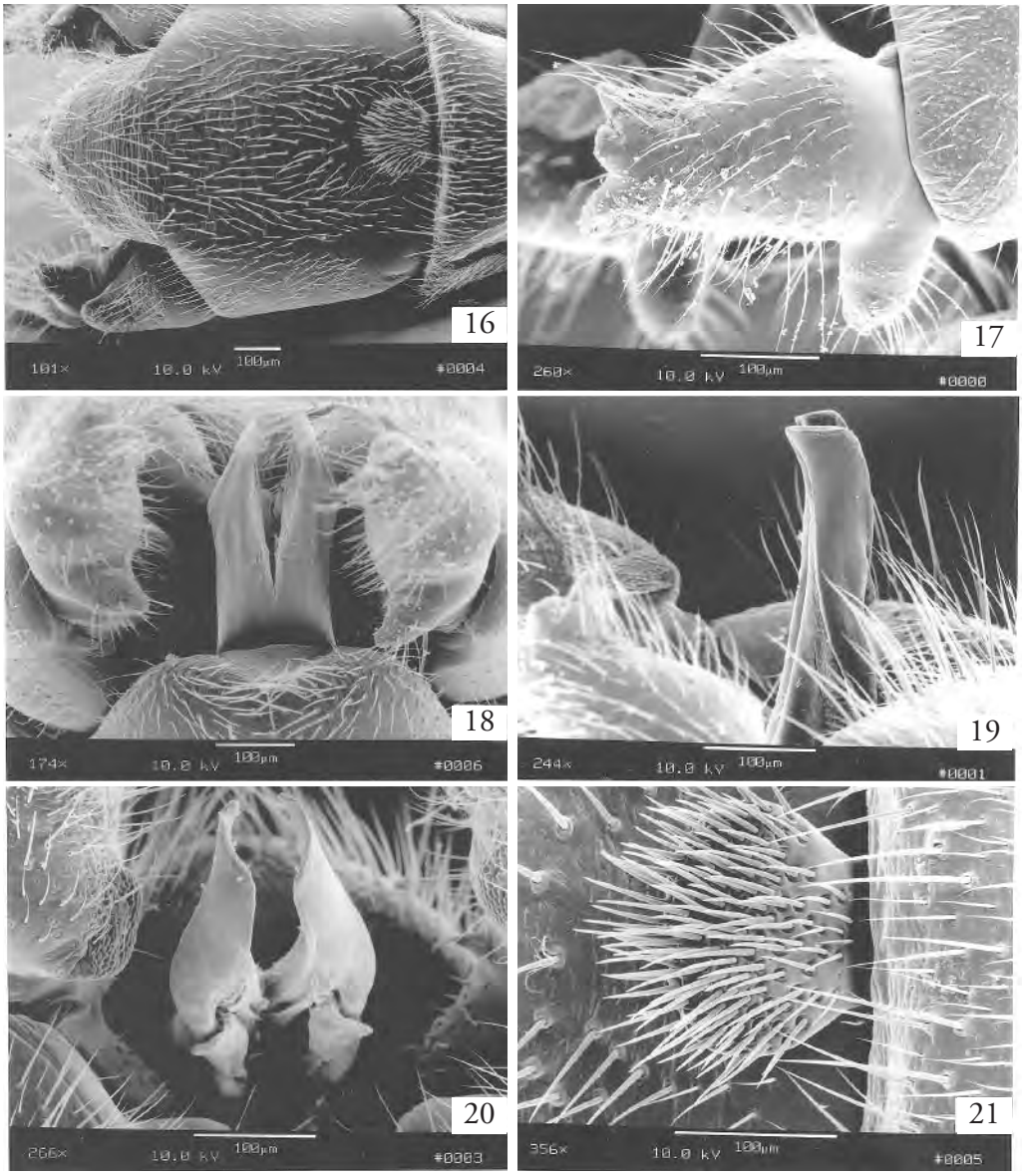
The female subgenital plate is a stalked, bilobed structure arising from the sclerotized margin of sternum eight; basolateral to the plate are a pair of projecting horns (fig. 12); the hind margin of sternum eight beneath the plate bears a patch of microtrichia. Margins of the plate near the apex are coarsely scalloped (fig. 13).

Distribution. – Cascade and Coast Range Mountains from northern California to central Oregon.

Pomoleuctra purcellana (Neave) **comb. n.**

Leuctra purcellana Neave 1934:2. Holotype ♂, Campbell Creek, Purcell Range, British Columbia (CNC)
Leuctra bilobata Claassen 1937:45. Syn. Ricker 1952:172.

Material. – Idaho: Bonneville Co., Palisades Creek, Hwy 26, 2 mi W Palisades, 28 June 1964, J.W. Richardson, S.L. Jensen, 1♀ (BPS). Montana: Glacier Co., 1 mi E Logan Pass,



Figs. 16-21. *Pomoleuctra purcellana* male terminalia. – 16, sternum nine; 17, cerci with basoventral lobe; 18, caudal aspect of titillator; 19, lateral aspect of titillator; 20, titillator apex; 21, vesicle.

Glacier National Park, 22 July 1963, A.R. Gaufin, 2♂, 2♀ (BYU). Glacier Co., Iceberg Lake Trail below Ptarmigan Creek, 8 June 1996, C.R. Nelson, R.S. Hansen, B.Ward, 9♂, 5♀ (CRN). Ravalli Co., Gash Creek, 18 May 1995, A.L. Sheldon, 3♂, 2♀ (ALS). Ravalli Co., Gash Creek, below lake, 16 June 1995, A.L. Sheldon, 3♂ (ALS).

Diagnosis.- Baumann et al. (1977) presented the most recent figures for this species. These clearly show the three apical spines and thumb shaped basoventral cercal lobe of the male, and the narrow, deeply cleft female subgenital plate. The male cercus is shown in fig. 17 and the female subgenital plate and detail of the microtrichial patches of sternum eight in figs. 14-15. The male ninth sternum is prolonged, but not so much as in *P. andersoni* (fig. 16) and a small hairy vesicle occurs at the base of the sternum (fig. 21). The subanal probe is slender, sclerotized to the tip, and deeply notched (figs. 18-20). Basolaterally the probe bears a strip of scale-like armature and the caudal margins of the notch are lined with fine setal-like spines; below the notch in anterior aspect are a pair of triangular flaps (fig. 20).

Distribution. – Northern Rocky Mountains from Alberta and British Columbia to Wyoming and eastern Oregon.

Key to Nearctic *Pomoleuctra* species

1. Apex of male sternum nine greatly prolonged into a slender probe which covers the subanal probe (fig. 7); projecting portion of female subgenital plate about three times long as wide, and with laterally projecting horns at base of plate (fig. 12) ..... *andersoni*
– Apex of male sternum nine moderately prolonged, not covering subanal probe (fig. 16); projecting portion of female subgenital plate slightly longer than wide and lacking basal horns (fig. 14) ..... *purcellana*

Paraleuctra Hanson

Type Species. – *Leuctra occidentalis* Banks 1907:329, by original designation, Hanson 1941:57.

The seven remaining Nearctic species currently placed in *Paraleuctra* represent three distinct species groups. Baumann et al. (1977) proposed the *P. sara* (Claassen) group for those species '...characterized by a simple elongate titillator' and the *P. occidentalis* (Banks) group for species having '...a titillator with an enlarged variable apex.' Nelson (1977) independently recognized the *P. sara* species complex, although without a formal name, and included three Asian species and *P. divisa* (Hitchcock) in the group. We regard *P. divisa* as sufficiently different from other *Paraleuctra* to be placed in a separate group. The following key will permit separation of Nearctic *Paraleuctra* species.

Key to males of Nearctic *Paraleuctra* species

1. Caudal and lateral aspects of subanal probe swollen (figs. 22, 40); posterior margin of sternum nine bilobed (fig. 23) 2
– Caudal and lateral aspects of subanal probe apex not swollen (figs. 24-25); posterior margin of sternum nine truncate to slightly emarginate 4
2. Lateral aspect of subanal probe apex without posteriorly projecting lobe (fig. 42); dorsal aspect of subanal probe not conspicuously narrowed at apex (fig. 43) ..... *projecta*
– Lateral aspect of subanal probe apex with posteriorly projecting lobe (fig. 44); dorsal aspect of subanal probe narrowed at apex (fig. 45) 3
3. Dorsal aspect of subanal probe abruptly constricted subapically (fig. 41); lateral aspect of subanal probe apex with little development of anterior lobe (fig. 40) ..... *jewetti*
– Dorsal aspect of subanal probe gradually narrowed to apex (fig. 45); lateral aspect of subanal probe apex with large anterior lobe (fig. 45) ..... *occidentalis*
4. Cerci simple, apex undivided (fig. 24) ..... *divisa*
– Cerci deeply bifurcate (fig. 25) 5
5. Vesicle at base of sternum nine well developed and densely hirsute (fig. 38); lower prong of cerci without secondary projection (fig. 26) .... *vershina*
– Vesicle at base of sternum nine obsolete, usually with few setae (fig. 37); lower prong of cerci typically with a secondary projection (fig. 25) 6
6. Cercal prongs subequal in size, tips somewhat convergent (fig. 27); western North America ..... *forcipata*
– Lower cercal prong larger than upper, tips strongly divergent (fig. 25); eastern North America ..... *sara*

Key to females of Nearctic *Paraleuctra* species

1. Subgenital plate produced into a narrow, tongue shaped structure, rounded or slightly emarginate at apex (fig. 46) ..... *divisa*
– Subgenital plate broad, with shallow apical notch (fig. 30) 2
2. Subgenital plate base at least partially fused to sternum seven (fig. 32); basolateral membranous lobes usually present on sternum eight (fig. 32) .. *jewetti, occidentalis, projecta*
– Subgenital plate base not fused to sternum seven (fig. 30); basolateral membranous lobes absent from sternum eight 3
3. Eastern North America ..... *sara*
– Western North America 4
4. Shelf along margins of subgenital plate notch irregularly toothed (fig. 30); lateral membranous areas on sternum eight unpigmented..... *forcipata*
– Shelf along margins of subgenital plate notch rel-

atively smooth (fig. 31); lateral membranous areas on sternum eight with light pigmentation ....*vershina*

The P. divisa Group

Members of this group are characterized by (1) simple unmodified male cerci, (2) a short, thick male subanal probe, and (3) a narrow, tongue shaped female subgenital plate. Only one species *P. divisa* (Hitchcock) is currently included in the group.

Paraleuctra divisa (Hitchcock)

Leuctra divisa Hitchcock 1958:77. Holotype ♂, Woodacre, Marin Co., California (CAS).

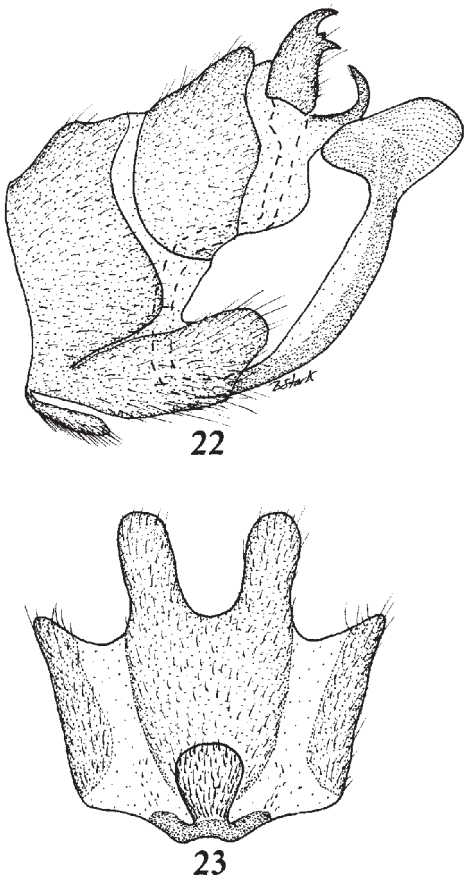
Material. – California: Glenn Co., Salt Creek, near Alder Springs, 27 April 1987, B.P. Stark, R.W. Baumann, C.R. Nelson, 1♀ (BPS). Humboldt Co., tributary Willow Creek, 2.5 mi E Berry Summit, Hwy 299, 19 May 1998, B.P. Stark, C.R. Nelson, S.W. Szczytko, I. Sivec, 2♀ (BPS). Humboldt Co., tributary Willow Creek, 1.7 mi E. Berry Summit, Hwy 299, 19 May 1998, B.P. Stark, C.R. Nelson, S.W. Szczytko, I. Sivec, 1♀ (BPS). Mendocino Co., North Caspar Creek, near jct South Fork, Jackson State Forest, 9 May 1991, R. Bottorff, 1♀ (RB). Mendocino Co., North Caspar Creek, near Caspar, 17 April 1985, R. Bottorff, 1♂ (RB). Mendocino Co., Caspar Creek, Jackson State Forest Experimental Area, 18 May 1998, B.P. Stark, C.R. Nelson, S.W. Szczytko, I. Sivec 10♀ (BPS, CRN, SWS). Sonoma Co., Copeland Creek, Fairfield Osborn Preserve, 12 April 1981, L.E. Serpa, 1♂, 1♀ (BYU).

Diagnosis. – Males, redescribed by Nelson (1977), are recognized by virtue of the simple cerci (fig. 24). The previously undescribed females have forewing lengths of 6-8 mm and differ from other *Paraleuctra* in the subgenital plate structure and in the shape of the ninth abdominal sclerite (fig. 46). The subgenital plate as suggested by Hitchcock (1958) is a narrow, tongue shaped structure with a truncate, rounded, or slightly emarginate apex. Sternum nine bears a strap-like sclerite that is not conspicuously excavated across the sternum as in other members of the genus.

Distribution. – Currently known from the Coast Range of northern California.

The P. occidentalis Group

Members of this group are characterized by (1) an apically swollen subanal probe, (2) bifurcation of male cerci at about the apical 4th of cercal length, (3) apex of male sternum nine bilobed, and (4) female sternum eight partially fused to sternum seven. This group includes three Nearctic and several Asian species (Shimizu unpublished).



Figs. 22-23. *Paraleuctra occidentalis* male terminalia. – 22, lateral aspect; 23, sternum nine.

Paraleuctra jewetti Nebeker & Gaufin

Paraleuctra jewetti Nebeker & Gaufin 1966: 255. Holotype ♂, Big Cottonwood Creek, Salt Lake Co., Utah (USNM).

Material. – Colorado: Grand Co., Frazier River, Hwy 40, Midland Campground, 27 June 1962, 1♂ (BPS). Utah: Salt Lake Co., Mill Creek, top of canyon, 23 May 1966, R.W. Baumann, 4♂, 1♀ (BYU). Utah Co., Stewart Creek, above Sundance, 30 April 1981, S.W. Szczytko, 1♂ (SWS).

Diagnosis. – The distinctive features of the male of this species are well illustrated by Nebeker & Gaufin (1966) and Baumann et al. (1977). The male is most easily recognized from the dorsal aspect of the titillator (fig. 41); in this aspect the swollen apex is abruptly narrowed and in lateral aspect (fig. 40), the caudal projection is greater than the anterior projection. The stem of the probe is sparsely armed with spines (fig.

51) and the cercal arms are usually small and convergent (fig. 52). Females are indistinguishable from those of *P. occidentalis* and *P. projecta* (Frison). The holotype, originally at the University of Utah, is now at the USNM (Baumann & Gaufin 1974).

Distribution. – Currently known from Colorado, Montana and Utah.

Paraleuctra occidentalis (Banks)

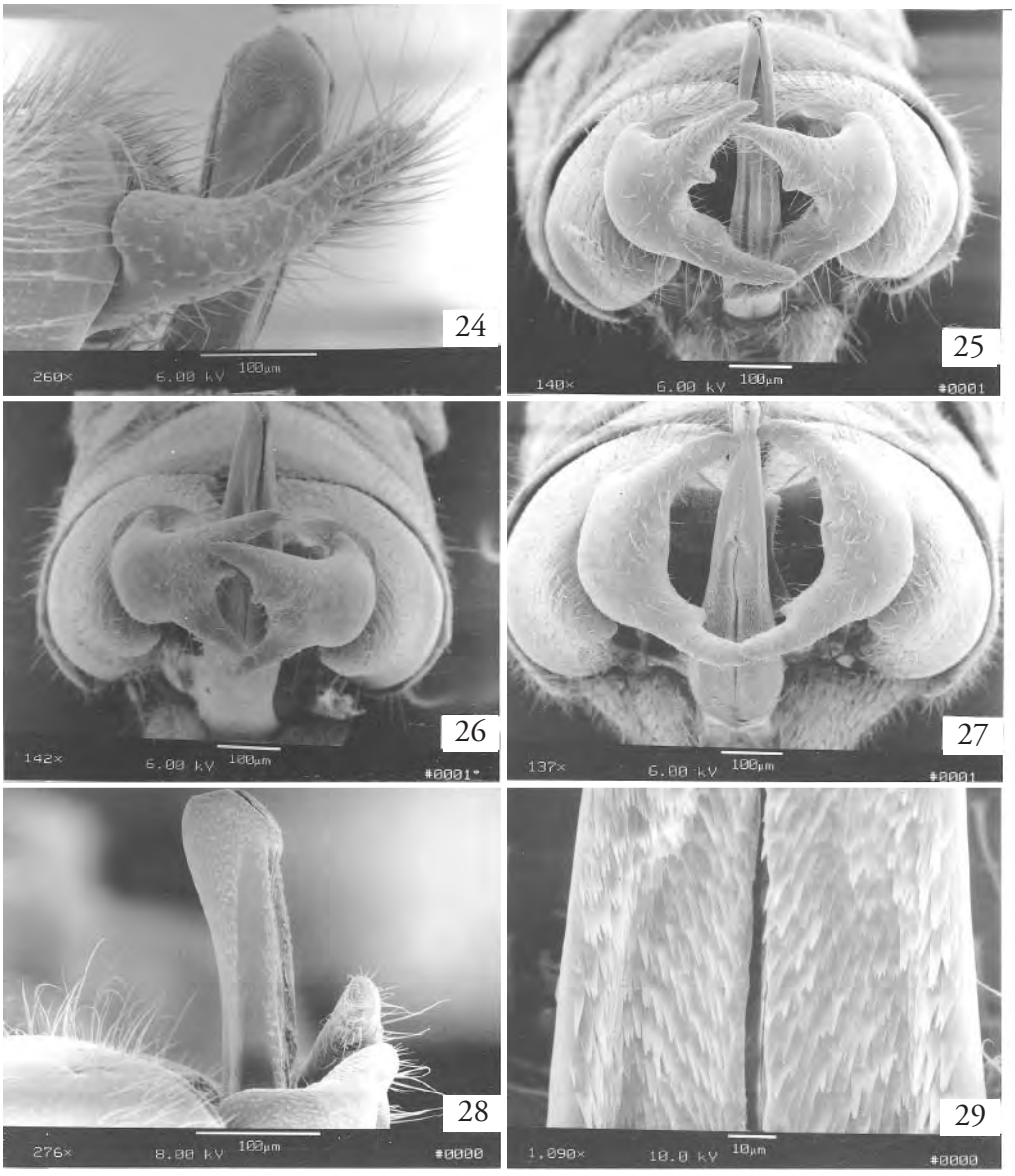
Leuctra occidentalis Banks 1907:329 Lectotype ♀, Laggan, Alberta (MCZ), designation by Ricker 1952:172.
Leuctra bradleyi Claassen 1923:257. Syn. Ricker 1954:38.
Paraleuctra dusha Ricker 1965:495. Syn. n. suggested by Ricker 1992:8.

Material.- California: Alpine Co., West Carson River, Hwy 89, Snow Shoe Campground, 9 May 1986, R.W. Baumann, 1♂ (BYU). Butte Co., Bear Creek at Feather River, 0.5 mi S Arch Rock Tunnel, 28 February 1975, T. D. Eichlin, Tikono, 3♂, 5♀ (BYU). Contra Costa Co., San Leandrew Creek Canyon, 19 February 1985, R.W. Baumann, C.R. Nelson, 4♂ (BYU). El Dorado Co., Bridal Veil Falls, Hwy 50 abv Pollack Pines, 21 March 1985, R.W. Baumann, C.R. Nelson, 1♂ (BYU). Fresno Co., Mill Creek, Hwy 245, 16 March 1985, R.W. Baumann, C.R. Nelson, 6♂ (BYU). Humboldt Co., creek N of Fish Lake, 24 April 1987, R.W. Baumann, B.P. Stark, C.R. Nelson, S. Wells, 9♂, 12♀ (BYU). Humboldt Co., tributary Willow Creek, 1.7 mi E Berry Summit, Hwy 299, 19 May 1998, B.P. Stark, C.R. Nelson, S.W. Szczytko, I. Sivec, 1♂ (BPS). Inyo Co., Lone Pine Creek, Whitney Portal Campground, 7 May 1986, R.W. Baumann, R. Guiliani, 5♂, 4♀ (BYU). Marin Co., Picher Canyon Creek, 19 February 1985, R.W. Baumann, C.R. Nelson, 1♂ (BYU). Mariposa Co., creek at Yosemite National Park South Entrance, 18 March 1985, R.W.Baumann, C.R. Nelson, 1♂, 3♀ (BYU). Mendocino Co., Caspar Creek, Jackson State Forest Experimental Area, 18 May 1998, B.P. Stark, C.R. Nelson, S.W. Szczytko, I. Sivec, 1♂ (BPS). Mendocino Co., Elder Creek, jct. South Fork Eel River, 18 February 1985, R.W. Baumann, C.R. Nelson, 1♂, 3♀ (BYU). Modoc Co., South Fork Davis Creek, 3 mi E Hwy 395, 21 May 1998, B.P. Stark, C.R. Nelson, S.W. Szczytko, I. Sivec, 2♂, 5♀ (BPS). Mono Co., Brownie Creek, Hwy 108, Leavitt Meadows Campground, 9 May 1986, R.W. Baumann, 1♂, 2♀ (BYU). Mono Co., Lee Vining Creek, Hwy 120, 15 May 1998, B.P. Stark, C.R. Nelson, I. Sivec, 1♂ (BPS). Placer Co., Bear Creek, below Alpine Meadows, 21 May 1987, R.W. Baumann, C.R. Nelson, S.Wells, 3♂, 2♀ (BYU). Plumas Co., Waller Creek, jct North Fork Feather River, Caribou Road, 14 February 1985, R.W. Baumann, C.R. Nelson, 9♂, 2♀ (BYU). Shasta Co., Hat Creek, Big Pine Campground, 26 April 1987, R.W. Baumann, B.P.Stark, C.R. Nelson, S.Wells, 5♂, 4♀ (BYU). Shasta Co., Lost Creek, Hwy 89 below Lassen National Park, 26 April 1987, R.W. Baumann, B.P. Stark, C.R. Nelson, S.Wells, 1♂, 1♀ (BYU). Shasta Co., Sacramento River, Sims Flat Campground, 16 February 1985, R.W. Baumann, C.R. Nelson, 10♂, 10♀ (BYU). Sierra Co., Little Truckee River, Hwy 89 near Truckee Pass, 10 May 1983, R.W. Baumann, Mower, 14♂, 17♀ (BYU). Siskiyou Co., Etna Creek, 1 March 1955, S.G. Jewett, 3♂, 4♀ (BYU). Sonoma Co., Copeland Creek, Fairfield Osborn Preserve, 28 January 1982, L.E. Serpa, 2♂ (BYU). Tehama Co., Big Chico Creek, Hwy 32, 15 February 1985, R.W. Baumann, C.R. Nelson, 9♂, 8♀ (BYU). Tulare Co., Bear Creek near Cove Flat, 16 March 1985, R.W. Baumann, C.R. Nelson, 7♂, 14♀ (BYU). Colorado: El Paso Co., South Cheyenne Creek, Seven Falls Park, 24 April 1986, B. Kondratieff, 1♂, 1♀ (CSU). Larimer Co., Fall Creek, Blue Lake Trail, Raviah Wilderness, 20 June 1998, S. Fitzgerald, A. Foley, 1♂, 1♀ (CSU). Nevada: Washoe Co., 1 mi below Mt. Rose Summit, Hwy 431, 17 April 1985, B.P. Stark, 2♂, 1♀ (BPS). Oregon: Benton Co., Rock Creek, Hwy 34, 28 February 1984, R.W. Baumann, C.R. Nelson, S.G. Jewett, 3♂, 2♀ (BYU). Clackamas Co., Salmon River near Hwy 26/35 jct, 26 April 1987, G.R. Fiala, 5♂ (BYU). Clatsop Co., Necanicum River, 12 February 1953, S.G. Jewett, 3♂, 3♀ (BYU). Marion Co., tributary Santiam River, Hwy 22, 4 April 1986, G.R. Fiala, 1♂, 3♀ (BYU). Utah: Summit Co., Yellow Pine Creek, 8 mi E Kamas, 16 May 1974, B.P. Stark, 34♂, 19♀ (BPS). Washington: Columbia Co., Tucannon River, 10 mi S Hwy 12, 24 February 1998, R.L. Newell, 3♂, 4♀ (BYU). Grays Harbor Co., Newberry Creek, Newberry Creek Road, 19 March 1989, G.R. Fiala, 1♂ (BYU). Lewis Co., Berwick Creek, E Mary McKranks, 16 February 1987, G.R. Fiala, 3♂, 2♀ (BYU). Lewis Co., Ohanapecosh River at campground, Mt. Rainier National Park, 28 May 1997, B. Kondratieff, 2♂ (CSU). Kickitat Co., Rock Creek, Box Canyon, 18 April 1998, R.L. Newell, 2♂, 1♀ (BYU). Pierce Co., Eagle Peak Creek, Glacier Bridge, Longmire, Mt. Rainier National Park, 1 January 1997, B. Kondratieff, 4♀ (CSU). Pierce Co., O.S.M.N. Ranger Station, White River Road, Mt. Rainier National Park, 21 April 1996, E.A. Lisowiski, 1♂ (CSU).

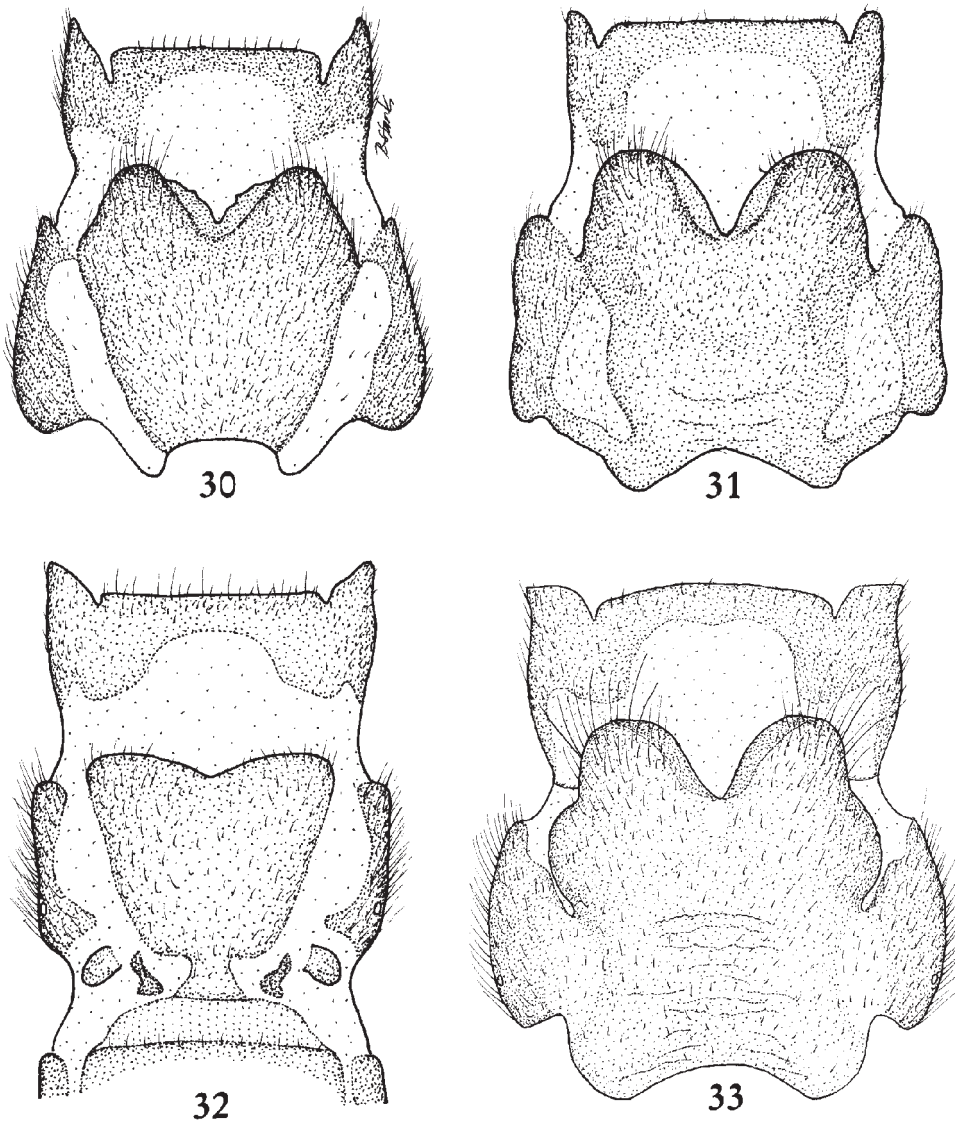
Diagnosis. – Males of this species are distinguished from those of *P. jewetti* and *P. projecta* by comparing the subanal probe apex in dorsal and lateral aspect (Nebeker & Gaufin 1966; Baumann et al. 1977). In dorsal aspect the swollen apex is gradually constricted to a rounded tip (fig. 45), and in lateral aspect the apex projects in both anterior and caudal directions from the stem; the anterior projections are often recurved as flaps (fig. 44). The subanal probe stem is armed with long, slender spines (fig. 49) and the cercal arms are usually divergent and often bear a projection on the ventral arm (fig. 50). Females are indistinguishable from those of *P. jewetti* and *P. projecta*.

Comments. – Ricker (1965) suggested the *P. dusha* holotype might be a 'gynandromorphic specimen of *P. occidentalis*' and later (Ricker 1992) stated in reference to this specimen, 'it is actually a gynandromorph, probably of *occidentalis* or *vershina*.' The figures given by Ricker (1965) certainly support the intrepretation of the holotype as a gynandromorph, and the strongly bilobed ninth sternum shown in those figures suggests the correct synonym is *P. occidentalis*.

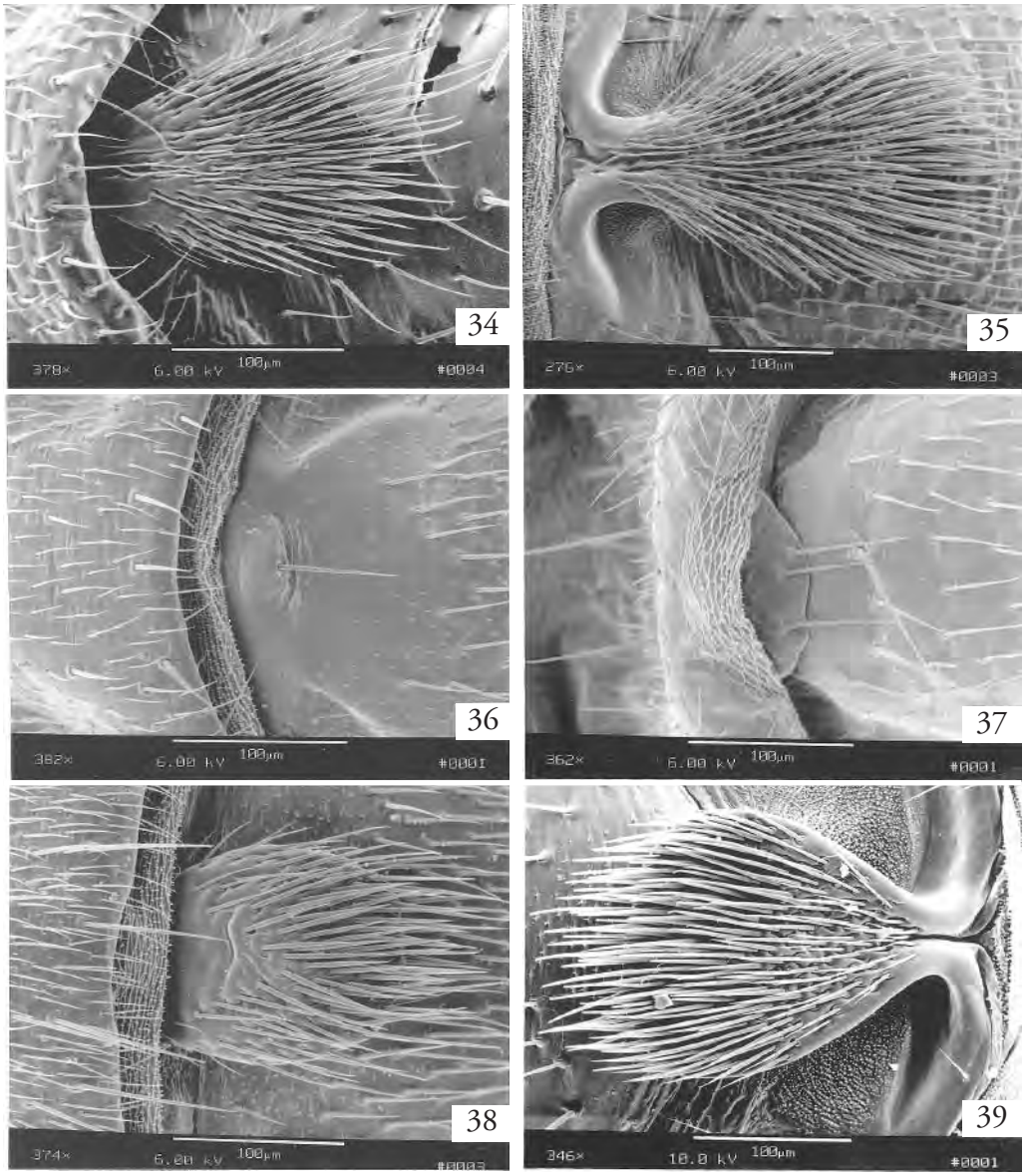
Distribution. – Western mountains from Alaska to southern California and New Mexico.



Figs. 24-29. *Paraleuctra* male terminalia. – 24, *P. divisa* lateral aspect of cerci and titillator; 25, *P. sara* caudal aspect of cerci and titillator; 26, *P. vershina* caudal aspect of cerci and titillator; 27, *P. forcipata* caudal aspect of cerci and titillator; 28, *P. forcipata* lateral aspect of titillator; 29, *P. forcipata* surface armature of titillator.



Figs. 30-33. *Paraleuctra* female terminalia. – 30, *P. forcipata*; 31, *P. vershina*; 32, *P. occidentalis*; 33, *P. sara*.



Figs. 34-39. *Paraleuctra* male vesicles. – 34, *P. divisa;* 35, *P. occidentalis;* 36, *P. forcipata*; 37, *P. sara;* 38, *P. vershina*; 39, *P. projecta.*

Paraleuctra projecta (Frison), sp. rev.

Leuctra projecta Frison 1942: 260. Holotype ♂, Wild Basin, Rocky Mountain National Park, Colorado (INHS), examined.
Paraleuctra rickeri Nebeker & Gaufin 1966:258. **Syn. n.**

Material. – Colorado: Boulder Co., Wild Basin, Rocky Mountain National Park, 13 June 1937, holotype ♂ (INHS). Garfield Co., South Fork White River, FR 600, Coffer, 26 June 1997, B. Kondratieff, 3♂, 1♀ (CSU). Garfield Co., Coffee Pot Springs, FR 600, 28 May 1998, B.C. Kondratieff, 13♂ (CSU). Montana: Glacier Co., Iceberg Lake Trail, below Ptarmigan Creek, Glacier National Park, 8 June 1996, C.R. Nelson, R.S. Hansen, B. Ward, 4♂, 1♀ (CRN). Lake Co., Crane Creek, Flathead Lake, 25 June 1970, D.S. Potter, 2♂, 2♀ (BYU). New Mexico: Taos Co., West Fork Red River, Wheeler Wilderness, 9 June 1974, B.P. Stark, T. Wolff, 6♂, 14♀ (BPS). Oregon: Lane Co., H.J. Andrews Experimental Forest, 11 mi NE Blue River, 25 April 1979, G.M. Cooper, 1♂, 1♀ (BPS). Utah: Salt Lake Co., Big Cottonwood Creek, Brighton, 15 June 1985, B.P. Stark, 4♂ (BPS). Washington: Lewis Co., Falls Creek, Hwy 706, near Ohanapecosh River, 15 June 1969, R.W. Baumann, 1♂, 2♀ (BYU).

Diagnosis. – The male subanal probe distinguishes this species from closely related congeners (Nebeker & Gaufin 1966, Baumann et al. 1977). In dorsal aspect (fig. 43) the swollen apex is little constricted and in lateral aspect there is only a slight caudal projection at the apex (fig. 42). Stem armature consists of relatively dense clusters of long thin spines (fig. 47); the ventral cercal arm is typically truncate or bifid (fig. 48). Females are indistinguishable from those of *P. jewetti* and *P. occidentalis*.

Comments. – *Paraleuctra projecta* has languished in the synonymy of *P. occidentalis* since Ricker (1954) dealt with the tangled nomenclature surrounding that species. Subsequently the holotype of *P. projecta* seems not to have been examined even though Frison's (1942) cercal figure strongly suggests that either *P. jewetti* or *P. rickeri* might be a synonym. Our study of the male holotype indicates it is of the *P. rickeri* type with only slight apical constriction of the subanal probe, consequently *P. rickeri* becomes a junior synonym of *P. projecta*.

Distribution. – Western mountains from Washington and Montana to New Mexico.

The *P. sara* Group

Members of this group are characterized by (1) a slender subanal probe, (2) deeply bifurcate male cerci, (3) apex of male sternum nine truncate or slightly emarginate, and (4) female sternum eight not fused to sternum seven. The *P. sara* Group includes three Nearctic and at least four Asian species (Kawai 1967; Zhiltzova 1974; Harper 1977; Yang & Yang 1995).

Paraleuctra forcipata (Frison)

Leuctra forcipata Frison 1937:85 Holotype ♂, Corvallis, Benton Co., Oregon (INHS), examined.

Material. – California: Humboldt Co., tributary Willow Creek, 0.8 mi E Berry Summit, Hwy 299, 19 May 1998, B.P. Stark, C.R. Nelson, S.W.Szczytko, I. Sivec, 1♂, 1♀ (BPS). Humboldt Co., creek near Fish Lake, 24 May 1987, B.P. Stark, R.W. Baumann, C.R. Nelson, 1♂, 1♀ (BPS). Montana: Gallatin Co., Hyalite Creek, Twin Falls Trail, 20 June 1979, J. Fraley, 2♂ (UNT). Glacier Co., Wilber Creek, Many Glacier, Glacier National Park, 29 June 1966, M.L. Miner, 4♂, 4♀ (BYU). Glacier Co., tributary Grimmell Creek, Glacier National Park, 19 July 1966, A.R. Gaufin, 4♂, 2♀ (BPS). Oregon: Benton Co., Corvallis, T.H. Frison, holotype ♂ (INHS). Clackamas Co., Still Creek Campground, 2 June 2000, B.P. Stark, I. Sivec, M. Zúñiga, 2♂, 2♀ (BPS). Washington: Lewis Co., White Pass, Hwy 12, 28 May 1985, B.P. Stark, 1♂, 3♀ (BPS).

Diagnosis. – Males of this species are recognized by the approximately equal upper and lower cercal prongs (fig. 27) and by the extreme reduction of the vesicle (fig. 36). Females have the subgenital plate notch margin irregularly dentate and the lateral membranous areas of sternum eight are unpigmented (fig. 30).

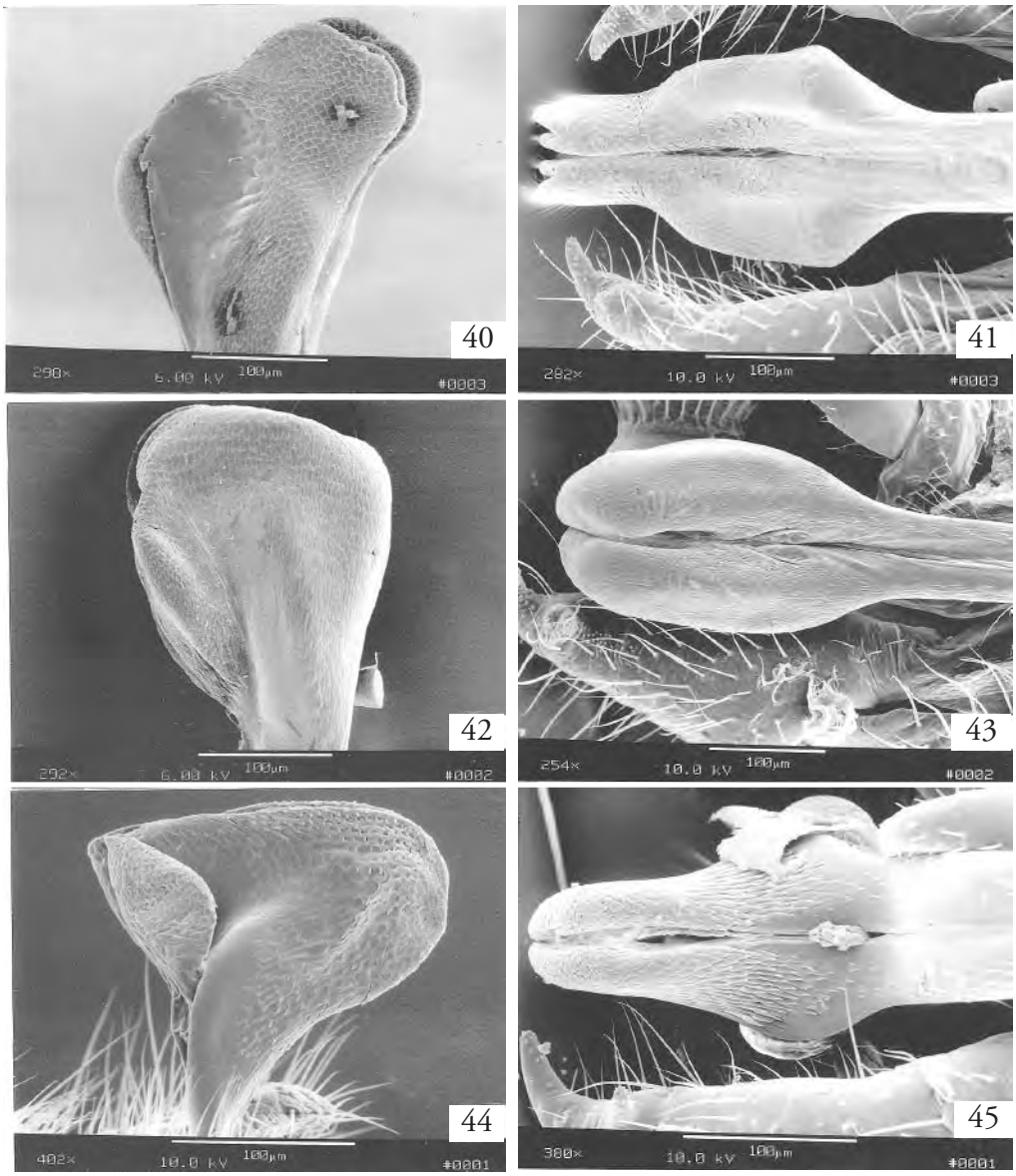
Distribution. – Western North America from Alaska to Montana and northern California

Paraleuctra sara (Claassen)

Leuctra sara Claassen 1937:44 Holotype ♂, Ringwood Lloyd Preserve, Tompkins Co., New York (CU).

Material. – Newfoundland: Labrador, stream below Tawta Lake, Labrador City, 11 June 1997, B. Kondratieff, R.W. Baumann, 1♂ (CUS). New Hampshire: Coos Co., Ellis River, Hwy 16, Pinkham Notch, 30 May 1987, R.W. Baumann, G.Z. Jacobi, 2♂ (BYU). New York: Essex Co., tributary Au Sable River, Hwy 73, St. Hubert's, 8 June 1997, B.P. Stark, 1♂ (BPS). Hamilton Co., seep below Wilnut Lake, 4 June 1997, R.W. Baumann, B. Kondratieff, 2♂ (BYU). South Carolina: Oconee Co., Walhalla Federal Fish Hatchery, 7 mi N Walhalla, 30 March 1969, J. Morse, 2♂ (BPS). Oconee Co., Limber Pole Creek, Hwy 37-171, 10 March 1977, T.R. White, 2♂ (BPS). Tennessee: Sevier Co., Little Pigeon River, near Newfound Gap, 15 April 1979, S.W.Szczytko, K.W. Stewart, B.P. Stark, 8♂, 2♀ (SWS). Sevier Co., Elkmont, Great Smoky Mountain National Park, 1 May 1982, B. Adams, M. Britton, 1♂ (BPS). Virginia: Wise Co., Phillips Creek Recreation Area, 29 April 1982, B. Kondratieff, 7♂, 5♀ (CSU). Wythe Co., East Fork of Stony Fork Reed Creek, Jefferson National Forest, 2 April 1978, R.F. Kirchner, 1♂ (RFK). West Virginia: Greenbrier Co., springs near summit, Lave Recreation Area, 26 April 1987, B. Kondratieff, R.F. Kirchner, 19♂, 10♀ (CSU). Mingo Co., Laurel Fork Pigeon Creek, CR 3/7 0.8 mi S. Dingess, 16 March 1975, R.F. Kirchner, Mayberry, 4♂ (RFK)..

Diagnosis. – *Paraleuctra sara*, the only member of the genus in eastern North America, is most similar to *P. vershina* Gaufin & Ricker in male cercal structure



Figs. 40-45. Apices of *Paraleuctra* titillators. – 40, *P. jewetti* lateral; 41, *P. jewetti* dorsal; 42, *P. projecta* lateral; 43, *P. projecta* dorsal; 44, *P. occidentalis* lateral; 45, *P. occidentalis* dorsal.

but the lower prong typically bears a basal knob (fig. 25) and the vesicle is poorly developed (fig. 37). Females cannot be reliably distinguished from *P. vershina* females except on a geographical basis.

Distribution. – Eastern North America from the Maritime Provinces and Ontario to South Carolina and Tennessee.

Paraleuctra vershina Gaufin & Ricker

Paraleuctra vershina Gaufin & Ricker 1974:285. Holotype ♂, City Creek, Salt Lake Co., Utah (USNM).

Material. – California: Eagle Co., Deep Creek, Hwy 17, 17 May 1997, B. Kondratieff, 3♂, 1♀ (CSU). El Dorado Co., Long Canyon Creek, E Grizzly Flat, 16 May 1998, B.P. Stark, C.R. Nelson, S.W. Szczytko, R. Bottorff, I. Sivec, 7♂ (BPS). El Dorado Co., Mutton Creek, U.C. Blodgett Forest, 5 July 1989, P. Kleintjes, 1♂, 1♀ (BYU). El Dorado Co., Tony Gulch, 11 May 1995, R. Bottorff, 2♂ (RB). Humboldt Co., tributary Willow Creek, 0.8 mi E Berry Summit, Hwy 299, 19 May 1998, B.P. Stark, C.R. Nelson, S.W. Szczytko, I.Sivec, 4♂ (BPS). Mendocino Co., Leggett, Drive Through Tree, 18 May 1998, B.P. Stark, C.R. Nelson, S.W. Szczytko, I.Sivec, 1♂ (BPS). Modoc Co., Upper Rush Creek, 0.7 mi NE Adin, 11 June 1997, P. Kleintjes, 6♂, 3♀ (BYU). Modoc Co., Willow Creek, 21 May 1998, B.P. Stark, C.R. Nelson, S.W. Szczytko, I. Sivec, 1♂ (BPS). Nevada Co., Sagehen Creek, Biological Station, 19 June 1985, B.P. Stark, 4♂, 4♀ (BPS). Nevada Co., Donner Lake Vista, Hwy 80, 20 June 1986, K.W. Stewart, 5♂, 1♀ (UNT). Shasta Co., small seep near Sulfur Works, Lassen National Park, 5 July 1979, B.P. Stark, K.W. Stewart, 20♂, 20♀ (BPS). Shasta Co., Hat Creek, Lassen National Park, 6 July 1979, B.P. Stark, K.W. Stewart, 2♂, 1♀ (BPS). Trinity Co., Hennessy Creek, Burnt Ranch, 25 April 1987, B.P. Stark, R.W. Baumann, C.R. Nelson, 4♂, 4♀ (BPS). Colorado: Boulder Co., Middle St. Vrain Creek, Forest Road 114, 17 July 1993, B. Kondratieff, Painter, 2♂, 8♀ (CSU). Montana: Carbon Co., Rock Creek, Ratine Campground, 15 July 1989, B.P. Stark, 1♂ (BPS). Flathead Co., McGregor Creek, Thompson River Road, 20 July 1969, A.R. Gaufin, 23♂, 5♀ (BYU). Gallatin Co., Grayling Creek, N West Yellowstone, 9 June 1987, B. Kondratieff, 17♂, 17♀ (CSU). New Mexico: Taos Co., Rio Trampas, above El Valle, 9 June 1974, B.P. Stark , T. Wolff, 6♂ (BPS). Oregon: Lane Co., H.J. Andrews Experimental Forest, 11 mi NE Blue River, 11 April 1979, G.M. Cooper, 4♂, 2♀ (BPS). Union Co., Burnt Corral Creek, Forest Road 2444, 29 May 2000, B.P. Stark, I. Sivec, M. Zúñiga, 2♂ (BPS). South Dakota: Pennington Co., Sunday Gulch, Hwy 87 S Hill City, 9 July 1997, R.W. Baumann, B. Kondratieff, 1♂, 4♀ (BYU). Utah: Wasatch Co., Round Valley Creek, 5 mi SE Wallsburg, 13 June 1986, S.M. Clark, 4♂, 2♀ (BYU). Washington: Lewis Co., Ohanapecosh River, Grove of the Patriarchs, Mt. Rainier National Park, 28 May 1997, B. Kondratieff, 20♂, 7♀ (CSU). Pierce Co., Forest Loop Trail, Carbon River Entrance, Mt. Rainier National Park, 27 May 1997, B. Kondratieff, 5♂, 3♀ (CSU). Pierce Co., Rainforest Loop Trail, Carbon River Entrance, 9.8 mi E Wilkeson, 8 May 1995, E.A. Lsowsky, 7♂, 1♀ (CSU). Pierce Co., White River, Rt. 40, Mt. Rainier National Park, 29 May 1997, B. Kondratieff, 1♂, 4♀ (CSU).

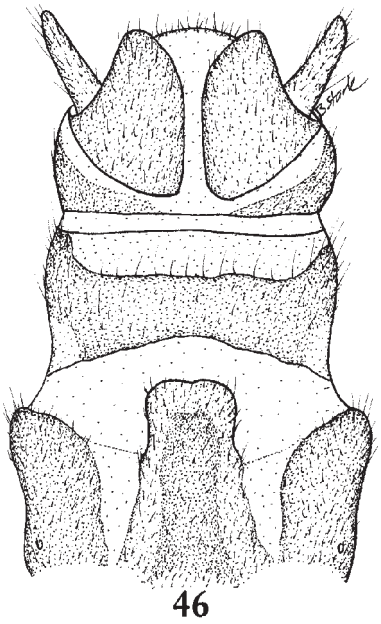


Fig. 46. *Paraleuctra divisa* female terminalia.

Diagnosis. – Adults of *P. vershina* are similar to the eastern species, *P. sara*, as noted above, and these can be separated on a geographical basis. In the northern Rocky Mountains, Cascades and Coast Ranges, *P. vershina* may be taken with *P. forcipata.* Males of these species are separated by shape of the cercal prongs (fig. 26) and by the much reduced vesicle of *P. forcipata* (fig. 36). Females of these species are separated by the irregular teeth found along the notch margin in *P. forcipata* (figs. 30-31).

Distribution. – Western mountains from Alaska and South Dakota to southern California and New Mexico.

Acknowledgements

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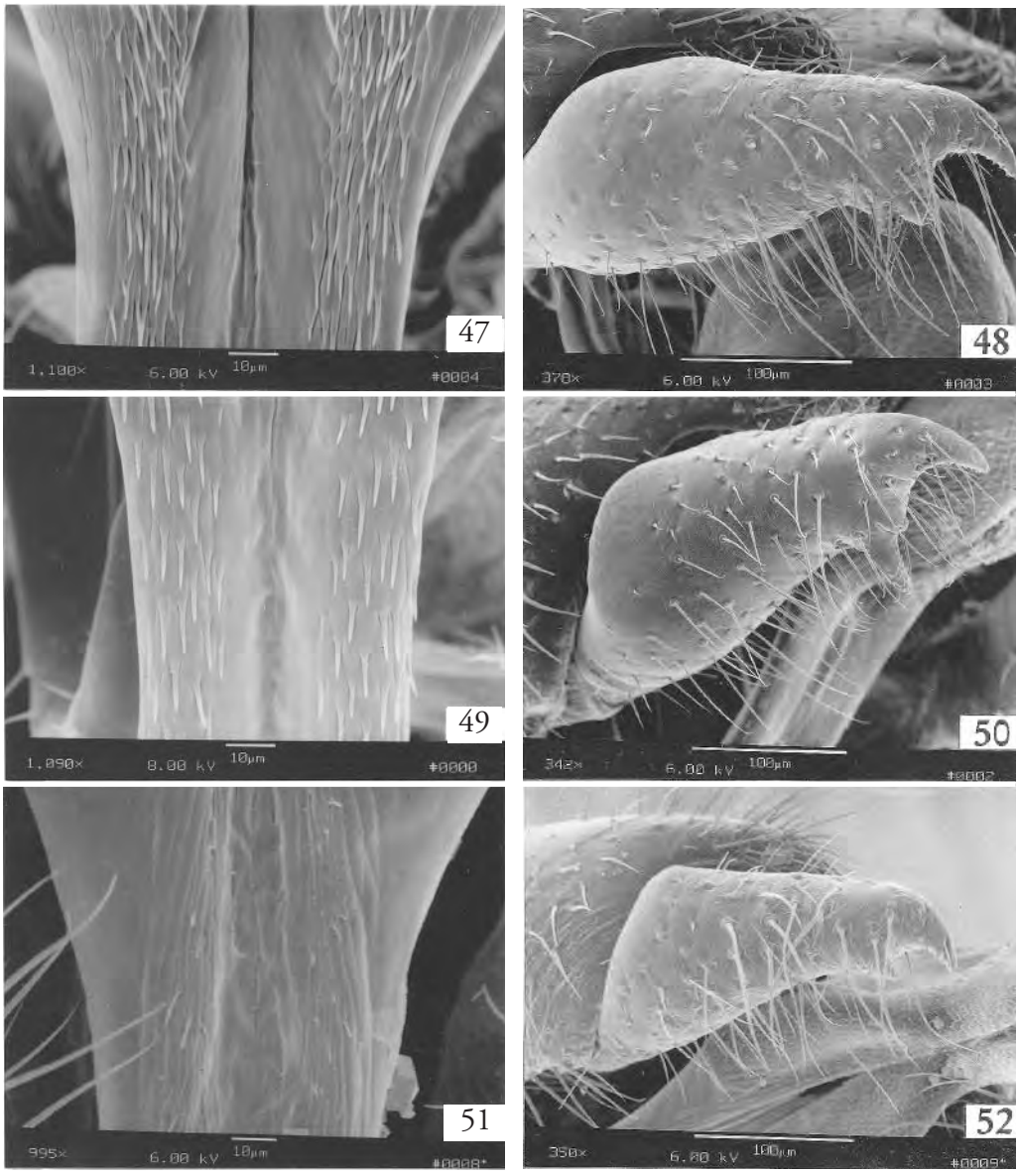

Figs. 47-52. *Paraleuctra* titillator armature and cerci. – 47, *P. projecta* armature; 48, *P. projecta* cercus; 49, *P. occidentalis* armature; 50, *P. occidentalis* cercus; 51, *P. jewetti* armature; 52, *P. jewetti* cercus.

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