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A REVIEW OF THE GENUS SOLIPERLA (PLECOPTERA: PELTOPERLIDAE)

Bill P. Stark

ABSTRACT.—The western Nearctic stonefly genus Soliperla is reviewed and six species are recognized. Soliperla sierra (Calif.) and S. tillamook (Ore.) are described as new to science and illustrations of diagnostic features are presented for all species. Males and nymphs are keyed and a phylogeny for the group is proposed.

Soliperla was proposed by Ricker (1952) as a monotypic subgenus of Peltoperla to contain P. thyra Needham & Smith. At that time the species was known only from the male holotype but Jewett (1954) described the female along with males and females of two additional species, P. campanula and P. quadrispinula; the nymph of P. campanula was also described at this time. Jewett (1955) described the fourth member of the group, P. fenderi, from a single male. These species have remained poorly known since their discovery, with only synoptic notes and regional keys (Jewett 1959, 1960) appearing until Stark and Stewart (1981) gave additional characters that supported Illies’s (1966) elevation of the group to generic status.

During recent field work with colleagues in Washington, Oregon, and California, Soliperla nymphs were common in splash zones of small streams and springs. Through this work, nymphs were associated for the four known species, and the additional material collected along with specimens obtained from museums permits the first comprehensive treatment of Soliperla. Methods were given by Stark and Stewart (1981).

Soliperla Ricker


Adults and nymphs of Soliperla are unusual among Nearctic Peltoperlidae in displaying distinctive pigmentation patterns. Adults are typified by a dark mesal pronotal stripe that contrasts sharply with the light yellow background (Figs. 23, 31), and nymphs have conspicuous white areas on the abdominal terga that contrast with the dark background (Figs. 4, 15). Monophyly for the group is asserted on the basis of the distinctive epiproct, with recurved crenulate apex and the membranous pair of lobes associated with the epiproct (Figs. 5, 13). The genus is currently known from the western Nearctic region from central California to Washington (Fig. 1).

Keys to Soliperla males

1. Mesoventral area of aedeagus with two irregular longitudinal rows of short, thick setae (Figs. 3, 30) .......................................................... 2

   — Mesoventral area of aedeagus with short, thick setae, if present, not in longitudinal rows .......................................................... 3

2(1). Lateral aedeagal lobes terminating in sclerotized spine with 2–4 small subapical setae (Fig. 29) .......................................................... sierra

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Fig. 1. Distribution of Soliperla species. S. campanula = open circles, S. fenderi = closed circles, S. quadrispinula = open squares, S. sierra = triangles; S. thyra = closed squares, S. tillamook = x.
- Lateral aedeagal lobes membranous apically with 2–4 small subapical setae (Fig. 2) .................................................. *campanula*

3(1). Ventral aedeagal lobes with large sclerotized spine or a single long, thick seta (Figs. 19, 35) ................................. 4
- Ventral aedeagal lobes membranous with numerous scattered setae (Figs. 12, 45) .................................................. 5

4(3). Ventral aedeagal lobes with sclerotized bilobed process (Fig. 35) .............. *thyra*
- Ventral aedeagal lobes with a terminal long, thick seta (Fig. 19) ............ *quadrirspinula*

5(3). Ventral aedeagal lobes with irregular row of long, slender setae along apical margin (Fig. 12) .................................................. *fenderi*
- Ventral aedeagal lobes with scattered short setae along apical margins (Fig. 45) .................................................. *tillamook*

Preliminary key to nymphs

(sierra and tillamook unknown)

1. Some long setae in abdominal tergum 9 posterior fringe bent (Fig. 39); abdominal tergum 5 typically with lateral pale spots (Fig. 22) ......................... 2
- Long setae in abdominal tergum 9 posterior fringe straight (Fig. 6); abdominal tergum 5 typically without pale spots (Fig. 4) ........................................ 3

2(1). Mesal area of abdominal tergum 8 posterior fringe with ca 20 clavate setae between long setae (Fig. 40); mesal pale spots on abdominal terga 5 and 6 rounded (Fig. 38) .................................................. *thyra*
- Mesal area of abdominal tergum 8 posterior fringe with ca 5–7 clavate setae between long setae; mesal pale spots on abdominal terga 5 and 6 irregularly linear to triangular (Fig. 22) ........................................... *quadrirspinula*

3(1). Lateral pale spots on abdominal tergum 4 conspicuously larger than mesal spot (Fig. 15); known from Mt. Rainier, Washington ................................. *fenderi*
- Lateral pale spots on abdominal tergum 4 subequal to mesal spot in size (Fig. 4); widely distributed in northern Oregon ............................................. *campanula*

**Soliperla campanula** (Jewett)


Females cannot be distinguished with certainty from several related species, and the eggs (Figs. 7, 8) also seem to lack features that would distinguish them from other members of the genus. The species is currently known only from northern Oregon (Fig. 1).

Figs. 2-6. *S. campanula*. Fig. 2. Aedeagus, lateral. Fig. 3. Aedeagus, A = dorsal, B = ventral. Fig. 4 Nymphal abdomen, dorsal. Fig. 5. Epiproct, anterodorsal. Fig. 6. Nymphal abdominal tergum 8, posterior fringe.
Figs. 7-10. Soliperla eggs. Fig. 7. S. campanula, 280X. Fig. 8. S. campanula, 1000X. Fig. 9. S. fenderi, 300X. Fig. 10. S. fenderi, 1000X.

2 ♂ (OSU); 14 mi NE Blue Riv, H. J. Andrews Expt. For., 6-VII-78, B. Frost 1 ♂ (OSU). Multnomah Co., Wahkeena Falls, 3-V-47, S. G. Jewett, 2 ♂, 2 ♀ (ROM) (OSU); same location, 4-V-82, R. W. Baumann & S. G. Jewett, 1 ♂ (MLB).

**Soliperla fenderi** (Jewett)

Figs. 11–17. *S. fenderi*. Fig. 11. Aedeagus, lateral. Fig. 12. Aedeagus, A = dorsal, B = ventral. Fig. 13. Epiproct, anterodorsal. Fig. 14. Epiproct; lateral. Fig. 15. Nymphal abdomen, dorsal. Fig. 16. Female sterna 8 and 9. Fig. 17. Nymphal abdominal tergum 8, posterior fringe.
Jewett's (1955) description of this species from a single male included diagnostic features of the epiproct and aedeagus. The anterodorsal face of the epiproct is about the same width as the shaft and is armed by about 5–6 teeth along the anteroventral surface (Fig. 13). The apical aedeagal section has two large membranous ventral lobes that have long slender setae in an irregular row along the distal margins (Fig. 12).

Females are distinguished on the basis of the shallow V-shaped notch on the subgenital plate (Fig. 16) and the eggs (Figs. 9, 10) are typical of the genus. This species is presently known only from Mt. Rainier National Park, but a single nymph collected by R. W. Baumann near Snoqualmie Pass could be this species (Fig. 1).


*Peltoperla quadrispinula* (Jewett)

Holotype ♀ (CAS), Wrangle Gap Camp, Jackson Co., Oregon

Jewett's (1954) description suggested that the aedeagus of this species, as the name implies, has four prominent spines. I have found considerable variation in this character even within individuals taken from the same locality. However, all males examined had a single long, thick seta on each ventral lobe (Fig. 19); the variation occurs in the number of these setae on the dorsal lobes. The range of variation seen in this character extends from no setae (found on one male from Oak Crk, Benton Co., Oregon) to 4 setae (found on several individuals from Jackson Co., Oregon). The epiproct, as Jewett (1954) indicated, is similar to that of *S. campanula*, but the dorsal carina on the anterodorsal face is not developed mesally and the lateral margins near the anterovelar surface curve outward (Fig. 20).

The female and egg (Figs. 25, 26) are indistinguishable from several others in the genus. The species has the largest known range for any member of the genus. Records are presently from northern Oregon (Clatsop Co.) to northern California (Humboldt and Trinity Cos.). Adults reared from Fieldbrook, California, mated readily in captivity but did not mate with *S. thyra* specimens from Napa Co., California.


*Soliperla sierra*, n. sp.

Male.—Body length, 10 mm; forewing length, 12 mm. General color yellow patterned with light brown. Head without brown markings; pronotum with long light spot in mesal dark stripe (Fig. 31). Anterodorsal face of epiproct about 2× wide as stalk, lateral margins curved to anterovelar margin; mesal teeth widely separated (Fig. 32). Ventral lobe of aedeagus with 2 irregular mesal rows of about 5–8 short, thick setae; lateral lobes with a large conical terminal spine and about 2–4 subapical short, thick setae (Fig. 30).

Female.—Body length, 12 mm; forewing length, 14 mm. General color similar to male. Subgenital plate large, parabolic, reaching posterior margin of sternum 9.

Egg.—Typical of the genus (Figs. 27, 28) but micropylar orifices are irregular rather than smooth.


Etymology.—The specific name *sierra* refers to the mountain range in which it was collected.
Figs. 18-24. *S. quadrispinula*. Fig. 18. Aedeagus, lateral. Fig. 19. Aedeagus, A = dorsal, B = ventral. Fig. 20. Epiproct, anterodorsal. Fig. 21. Epiproct, lateral. Fig. 22. Nymphal abdomen, dorsal. Fig. 23. Female head and pronotum. Fig. 24. Nymphal abdominal tergum 8, posterior fringe.
Soliperla thyra (Needham & Smith)

Peltoperla (Soliperla) thyra: Jewett 1954: 167.

Jewett (1954) described the salient features of male and female genitalia and discussed the holotype specimen. After examining the holotype, I concur with Jewett in his usage of thyra. The anterodorsal face of the epiproct
is slightly wider than the stalk and about 10 irregular teeth are located along the antero-ventral surface (Fig. 36). The ventral aedeagal lobes bear a partially sclerotized spinelike bilobed process; the ventral portion of the process is less heavily sclerotized and bears about 6–8 short, thick setae, including an apical cluster (Fig. 35). The dorsal membranous lobes bear several scattered short, thick setae (Fig. 35).
The female and egg appear indistinguishable from several other members of the genus. The species is known from scattered localities around the San Francisco area, but no specimens have been taken in Nevada or eastern California except the holotype (Fig. 1).


**Soliperla tillamook**, n. sp.

**Male.**—Body length, 11 mm; forewing length, 13 mm. General color yellow patterned with brown. Anterodorsal face of epiproct slightly wider than stalk; anteroventral surface with about 7–9 teeth (Fig. 46). Ventral and lateral lobes of aedeagus membranous with scattered apical short, thin setae (Fig. 45).

**Female.**—Body length, 13 mm; forewing length, 15 mm. Subgenital plate large, parabolic, reaching to posterior margin of sternum 9.

**Types.**—Holotype (♂) and 1 ♂ paratype from Clatsop Co., Oregon, Osweg Crk, 2 mi E Elsie, 13-VI-64, S. G. Jewett. Holotype deposited in the Oregon State University museum. Allotype (♀) and 1 ♂ paratype from Clatsop Co., Oregon, trib. Big Crk, Salmon Hatchery, 28-V-49, S. G. Jewett (OSU).

**Etymology.**—The specific name honors the Tillamook Indians, who inhabited the area near the type locality.

**Discussion**

In this study several characters suitable for making phylogenetic inferences were observed. Most of these have been selected from male genitalic structures since the egg, nymph, and female show little apparent variation. A taxonomic out group (TOG) consisting of Yoraperla and Sierraperla was formed to assist in inferring polarity of selected characters (Watrous and Wheeler 1981).

1. **Aedeagal setae.** Two variations of setae occurring on the ventral lobes were noted in the TOG and TIG (taxonomic in group). In Yoraperla and Sierraperla these setae are not appreciably thickened. Fine setae also occur in *Soliperla fenderi* and *S. tillamook* (Figs. 12, 45), but in other *Soliperla* species these setae are distinctly thickened (Figs. 3, 19). This is most conspicuous in *S. quadrispinula*, in which the setae are also longer than usual. Hence, thickened setae are regarded as apomorphic.

2. **Epiproct tip.** Within *Soliperla* several species have the epiproct tip expanded into a process that is much wider than the epiproct base (Figs. 5, 20), but in other species the epiproct tip is about as wide as the base (Fig. 13). Since Yoraperla and Sierraperla lack a developed epiproct, the TOG was expanded to include other Nearctic peltoperlid genera (*Tallaperla, Peltopera, and Viehopera*). In this group, both Peltopera and Viehopera have narrow epiproct tips, and in *Tallaperla* the epiproct is poorly developed (Stark and Stewart 1981). Hence, the expanded epiproct
tip of S. campanula, S. quadrispinula, S. sierra, and S. thyra is regarded as apomorphic.

3. Subgenital plate margin. The apex of the female subgenital plate is emarginate (Sierraperla) or notched (Yoraperla) in the TOG, but most Soliperla have a large parabolic plate that is entire along the margin. Only S. fenderi has a notched plate, but this notching is considered nonhomologous to that in the TOG and the notched plate is regarded as apomorphic.

4. Outline of ventral aedeagal lobe. In Yoraperla, Sierraperla, and several Soliperla species, the ventral aedeagal lobe is divided longitudinally by a cleft into lateral lobes (Figs. 12, 35). In two Soliperla species (S. campanula and S. sierra) the apical margin of this lobe is entire; hence, this is considered to be the apomorphic feature.

5. Arrangement of aedeagal setae. Typically in Yoraperla, Sierraperla, and Soliperla species the setae on the ventral aedeagal lobe are scattered, but in two species (S. campanula and S. sierra) these setae form two irregular mesal rows (Figs. 3, 30). This latter variation is considered apomorphic.

6. Sclerotization of ventral aedeagal lobe. The TOG and most Soliperla species have entirely membranous ventral aedeagal lobes, but in S. thyra and S. quadrispinula these lobes are sclerotized (Figs. 19, 35). This latter modification is considered apomorphic.

These six characters were used to derive the cladogram shown in Fig. 47. This analysis must be regarded as tentative due to the limited number of characters utilized. The position of S. tillamook could not be determined since it exhibits the plesiomorphic condition for each of the six characters.

It seems probable, given the apparent high degree of endemicity in the genus, that additional species await discovery from the Olympic Peninsula, Mt. Baker, and other isolated areas of the Pacific Northwest. It is hoped material from these areas and a larger sample of S. tillamook will permit rigorous testing of this cladogram.
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LITERATURE CITED


