



## **COSUMNOPERLA SEQUOIA, A NEW SPECIES OF STONEFLY FROM THE SIERRA NEVADA, CALIFORNIA (PLECOPTERA: PERLODIDAE: ISOPERLINAE)**

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### **ABSTRACT**

A new stonefly species, *Cosumnoperla sequoia*, is named from an intermittent stream in the southern Sierra Nevada, California. The adult male and female, mature larva, and egg are described, illustrated, and compared with *Cosumnoperla hypocrena* Szczytko and Bottorff. The adult males of *C. sequoia* most clearly differ from *C. hypocrena* by their unique 10<sup>th</sup> tergal process and swollen spinule patches on tergum 8 and 9. Adult females are distinguished by their elongated and shallowly notched subgenital plate, while larvae possess distinctive medial sclerites on ventral thoracic segments. Both species are apparently restricted to intermittent streams in the Sierra Nevada, California.

**Keywords:** Plecoptera, Isoperlinae, new species, southern Sierra Nevada, intermittent stream

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### **INTRODUCTION**

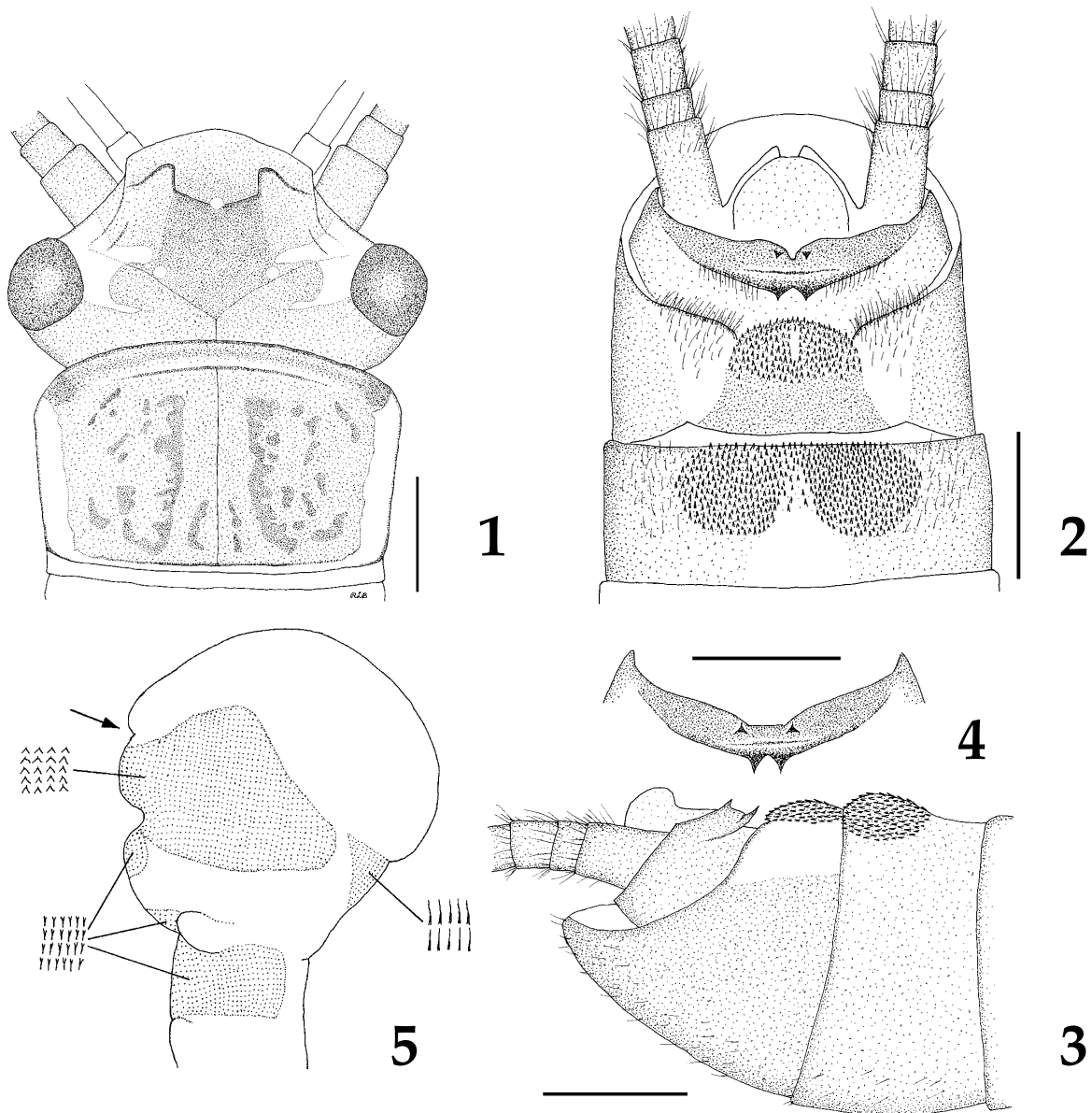
The Nearctic Isoperlinae presently include about 60 species in five genera, including the speciose *Isoperla* Banks and monotypic *Calliperla* Banks, *Cascadoperla* Szczytko and Stewart, *Clioperla* Needham and Claassen, and *Cosumnoperla* Szczytko and Bottorff (Stewart & Stark 2002). *Cosumnoperla* was first described in 1987 from specimens collected at mid-elevation streams in the central Sierra Nevada, with *C. hypocrena* being the type species (Szczytko & Bottorff 1987). *Cosumnoperla* adult males are distinguished within the Isoperlinae by having a reflexed pointed process on their 10<sup>th</sup> tergum, while the green collarless oblong egg of this genus is unique in being one of the largest known for stoneflies. The strict fidelity of *Cosumnoperla* larvae to intermittent streams is also uncommon in the order.

While examining unidentified stoneflies in the collection of the United States National Museum of Natural History, I recognized an undescribed species of *Cosumnoperla* originally collected by Charles P. Alexander in 1963 from the southern Sierra Nevada, California. Upon revisiting this collection site, I obtained male and female adults, mature larvae, and eggs of this new species. The following description is

based upon specimens deposited at the United States National Museum of Natural History, Washington, D.C. (USMN), and the Bottorff collection, South Lake Tahoe, California (RLB).

*Cosumnoperla sequoia*, sp. n.  
(Figs. 1-12)

**Material examined.** Holotype ♂, allotype ♀, and 4♂, 3♀, and 7 larval paratypes from the United States, California, Fresno County, unnamed intermittent creek (Latitude 36° 48.772' N, Longitude 118° 50.122' W, Elevation 1050 m), west of Redwood Creek, 10 mi [16 km] west of Cedar Grove, Sequoia National Forest, 5 June 1990, R. L. Bottorff (Holotype and allotype USNM, paratypes USNM, RLB). Additional paratypes: USA, California, Fresno County: Lockwood Creek at Hwy 180 (Elevation 1000 m), 8 mi [13 km] NE Wilsonia, Sequoia National Forest, 5 June 1990 (1♂), R. L. Bottorff (RLB); Kings Canyon Road, waterfall at 3,500' [1067 m], 31 May 1963 (1♂), C. P. Alexander (USNM); Kings Canyon, Rt. 180, waterfall above Horseshoe Bend, 3,500' [1067 m], 1 June 1963 (2♂, 2♀), C. P. Alexander (USNM).



Figs. 1-5. *Cosumnoperla sequoia* adult male. 1. Head-pronotum, dorsal; 2. Terminalia (segments 8-10, abdomen extended), dorsal; 3. Terminalia (segments 8-10, abdomen contracted), right lateral; 4. Variant of reflexed process, 10<sup>th</sup> tergum, dorsal; 5. Aedeagus, right lateral (arrow shows location of median indentation); Scale lines = 0.5 mm.

**Male.** Body uniform brown, length 8.1-9.0 mm. Head brown, width 1.9-2.0 mm (measured to outside margins of compound eyes), dark M-shaped mark anterior to median ocellus, intercellular area darker brown (Fig. 1). Pronotum uniform brown, anterior corners darker, lateral edges white, disks with

rugosities. Macropterous, forewing length 7.1-7.8 mm, most wing cells and veins dark brown, costa and subcosta veins white, cells between costa and radius white. Supra-anal process bulbous and membranous. Paraprocts reduced and lightly sclerotized, lying under supra-anal process. Tergum

9 and 8 with medial and bipartite elevated patches (respectively) of dense stout golden spinulae (Figs. 2, 3). Tergum 10 posterior margin with a shallow median notch (slightly wider in some specimens, Fig. 4); reflexed narrow process bearing two pairs of stout spines, the anterior pair pointing forward, the posterior pair pointing dorsally; fine stiff golden setae densely covering reflexed process (not shown in drawings). Aedeagus spherical with bulbous apex and lateral basal folds; small median cavity or indentation on posterior surface (this may be a narrow invaginated lobe that failed to extend when the aedeagus was extruded); posterior and lateral band of dense unpigmented stout spinulae, posterior and

lateral patches of medium golden spinulae at base of aedeagus, anterior medial patch of long golden spinulae (Fig. 5). Basal cercal segments (1-5) densely covered with stiff golden setae, these most abundant on the mesal and dorsal surfaces. Vesicle absent.

**Female.** Body coloration and general appearance similar to male, but of larger size (body length 8.5-12.6 mm, head width 2.2-2.6 mm). Macropterous, forewing length 8.6-10.4 mm. Subgenital plate elongated, nearly reaching posterior margin of 10<sup>th</sup> sternum, width narrowing from base to a shallowly notched apex, lateral sides irregularly indented, plate projecting ventrally from body axis (Figs. 6a,b, c).

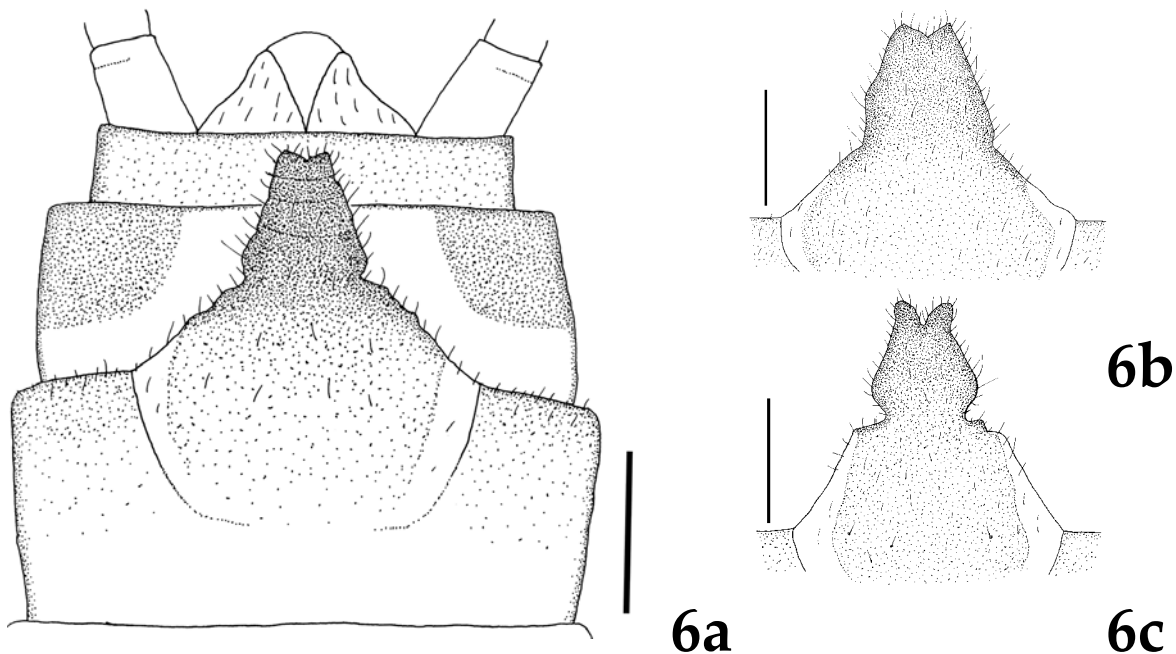
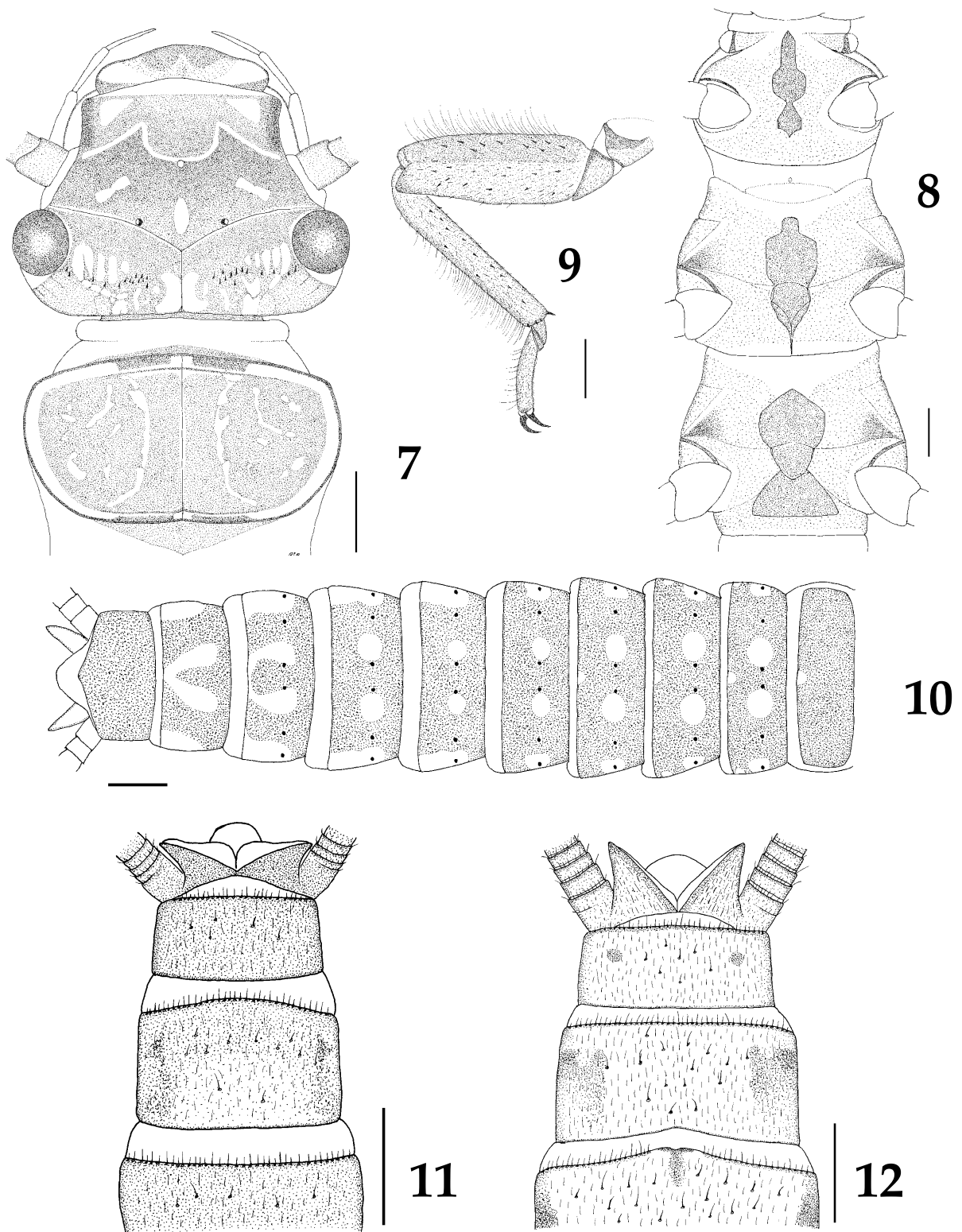


Fig. 6. *Cosumnoperla sequoia* adult female. 6a. Terminalia (segments 8-10), ventral; 6b-c. Variants of subgenital plate, ventral; Scale lines = 0.5 mm.

**Egg.** Oblong (circular cross-section). Length 700  $\mu$ m. Width 400  $\mu$ m. Color olive green. Collar and eclosion line absent. Chorion covered with irregular quadrangular or hexagonal follicle cell impressions (FCIs) bordered by raised walls, FCI floors flat. Each FCI typically surrounded by 6 other FCIs (range, 5-7). Micropyles not seen. Egg microstructure similar to that of *C. hypocrena* (see Figures 20-21 in Szczytko & Bottorff 1987).

**Larva.** General body color medium brown; pigment

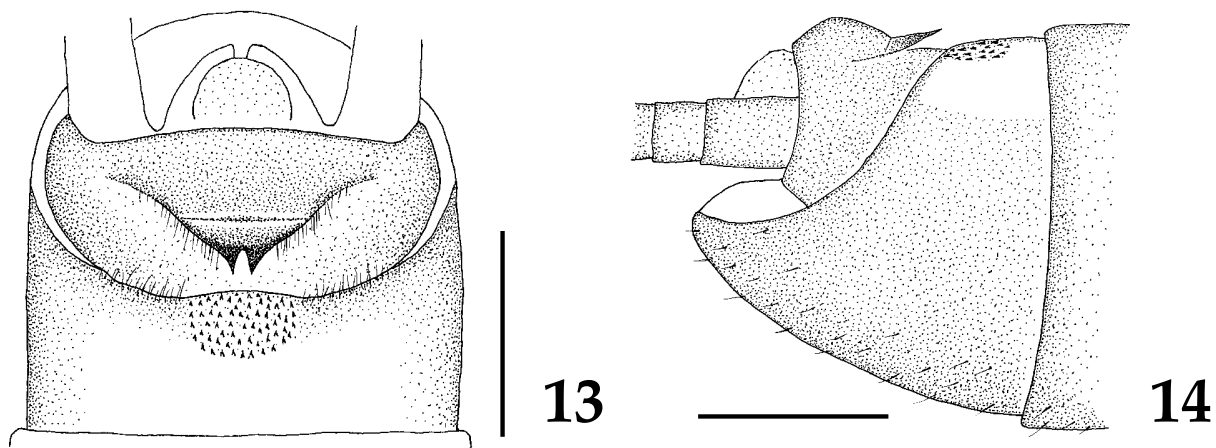
pattern similar to that of *C. hypocrena* (Szczytko & Bottorff 1987; Stewart & Stark 2002). Body length of mature larvae, 11.1 mm male and 11.3-13.8 mm female. Head width 1.8-2.4 mm. Head mostly brown, with light M-shaped mark anterior to median ocellus, ocellar triangle with a median oval white spot, rectangular white spots lateral to ocellar triangle, occiput with reticulate light patches and an irregular row of spinules (Fig. 7). Mandibles with 6 teeth, 5<sup>th</sup> tooth serrated; marginal brush of long stiff



Figs. 7-12. *Cosumnoperla sequoia* larva. 7. Head-pronotum, dorsal; 8. Thorax, ventral; 9. Right front leg, dorsal; 10. Abdomen (segments 1-10), dorsal; 11. Male terminalia (segments 8-10), ventral; 12. Female terminalia (segments 8-10), ventral; Scale lines = 0.5 mm.

setae; tuft of marginal bristles below 4<sup>th</sup> tooth (dense and expanded on left mandible, sparse on right mandible); ventral sparse setal patch extending from 1<sup>st</sup> tooth to mandible base (Figs. 15a, b). Lacinia with 2 large teeth; apical tooth about twice as long as the subapical tooth; 4-6 setae between apical and subapical teeth; lacinial margin below subapical tooth with 6-8 stout setae and then 10-12 thin setae, sub-marginal row of 4-6 stout setae (Fig. 16). Pronotum with brown disks and white rugosities, lateral margins white. All thoracic sterna with distinct medial sclerites covering and extending beyond furcal pits (Fig. 8). Prosternal sclerite extends forward from furcal pits to anterior margin of prosternum, sclerite swollen in mid-segment and then narrowed anteriorly. Mesosternal Y-arms meet posterior corners of furcal pits, transverse suture

connects anterior corners of furcal pits; sclerite extends laterally beyond Y-arms, lateral margin irregular or sinuous. Gills absent. Femora and tibia with dense short setae, scattered spinules, and fringed with light silky hairs (Fig. 9). Abdominal terga brown, most segments with a pair of large submedial and lateral light spots (overall, gives the appearance of longitudinal light and dark striping); each tergum with a transverse row of 6 dark dots, 2 mesally and 2 each laterally (Fig. 10). Posterior margin of male abdominal sterna 8 and 9 entire, with a continuous setal row (Fig. 11). Posterior margin of female abdominal sternum 8 sclerotized medially and slightly protruding, with a median setal gap (Fig. 12). Cercal segments with a posterior whorl of short setae, dorsal fringe of long hairs absent.



Figs. 13-14. *Cosumnoperla hypocrena* adult male. 13. Terminalia (segments 9-10), dorsal; 14. Terminalia (segments 9-10), right lateral; Scale lines = 0.5 mm.

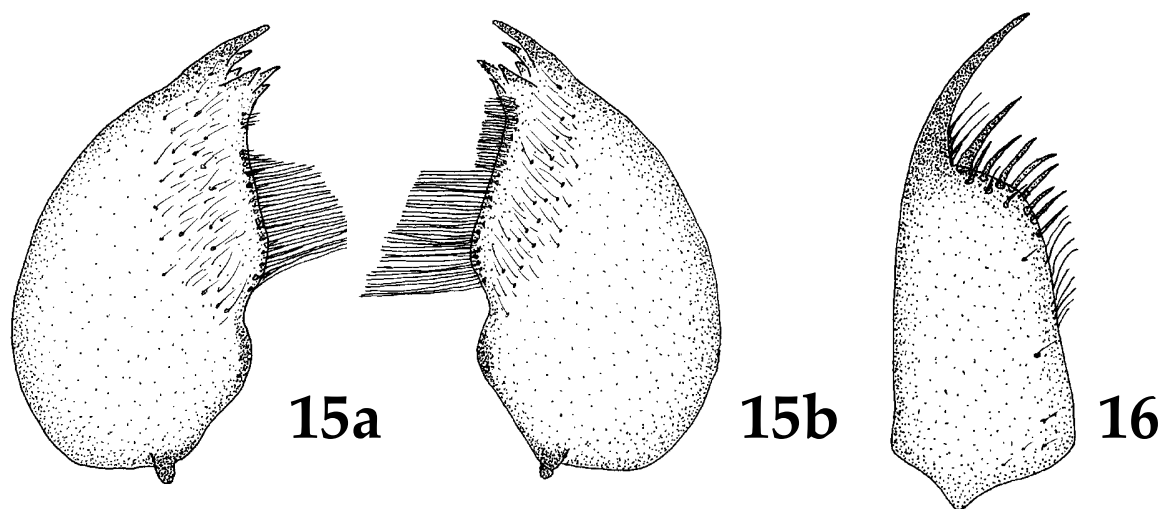
**Diagnosis.** *Cosumnoperla sequoia* shares several diagnostic features with *C. hypocrena*. Adult males of both species have (1) a reflexed process with an anterior pair of prominent spines on the 10<sup>th</sup> tergum, (2) a median patch of stout spinulae on the 9<sup>th</sup> tergum, (3) a membranous aedeagus, (4) a bulbous membranous supra-anal process, (5) weakly sclerotized flat paraprocts, and (6) vesicle absent. Adult females have an extended apically-notched subgenital plate. Larvae of both species have (1) abdominal longitudinal stripes and dark dots and (2) a sinuate mesosternal sclerite that extends laterally

beyond the Y-arms. Eggs have a punctate microstructure and are large, green, oblong, and collarless. Both species are restricted to intermittent streams in the Sierra Nevada, California.

*Cosumnoperla sequoia* adults and larvae differ from *C. hypocrena* by their smaller size and several morphological features: (1) adult pronotum – *C. sequoia* uniform brown, lateral margins white; *C. hypocrena* median light stripe, (2) wings – *C. sequoia* uniform dark brown except for white cells and veins between costa and radius; *C. hypocrena* cells and veins uniform dark brown, (3) 10<sup>th</sup> tergum of male

adults – *C. sequoia* narrow reflexed process with mesoposterior notch and two posterior spines; *C. hypocrena* broad reflexed triangular process with mesoposterior entire and posterior spines absent (Figs. 13, 14), (4) terga 8 and 9 of male adults – *C. sequoia* prominent swollen patches of golden stout spinulae; *C. hypocrena* small unswollen patch of spinulae on 9<sup>th</sup> tergum, few spinulae on 8<sup>th</sup> tergum (Figs. 13, 14), (5) basal cercal segments of male adults – *C. sequoia* dense long setae; *C. hypocrena* sparse long

setae, (6) subgenital plate of female adults – *C. sequoia* long and narrow with irregular sides and shallow apical notch; *C. hypocrena* short and broad with smooth sides and deep apical notch, (7) prosternal sclerite of larvae - *C. sequoia* swollen anterior to furcal pits; *C. hypocrena* uniformly narrow anterior to furcal pits. The oblong collarless green egg of *C. sequoia* is slightly smaller than that of *C. hypocrena*, but both eggs have similar microstructure and are some of the largest stonefly eggs reported.



Figs. 15-16. *Cosumnoperla sequoia* larva. 15. Right (a) and left (b) mandibles, ventral; 16. Right lacinia, ventral.

Several characters clearly place *Cosumnoperla sequoia* within the Isoperlinae – (1) smaller adult size than most Perlodinae, (2) reduced membranous supra-anal process, (3) simple unsclerotized paraprocts of male adults, (4) uncleft 10<sup>th</sup> tergum of male adults, (5) larvae with longitudinal abdominal stripes, and (6) larval submental and thoracic gills absent. Adult males of Isoperlinae often have various spinulae patches, dorsal swellings, or modifications of the 9<sup>th</sup> and 10<sup>th</sup> terga. Although not all characters clearly separate the Isoperlinae from Perlodinae, the preponderance of traits do distinguish these two subfamilies. *Cosumnoperla* and the monotypic Isoperlinae genera may be transitional forms between the Perlodinae and *Isoperla* since they share some characters with both taxonomic groups. In contrast with *Isoperla*, the adult males of *Cosumnoperla* and the monotypic Isoperlinae genera have various processes, lobes, ridges, or recurved

hooks on tergum 10 and lightly sclerotized paraprocts. Within the Nearctic Isoperlinae, only *Cosumnoperla sequoia*, *Clioperla clio*, and *Cascadoplerla trictura* have slightly to deeply notched 10<sup>th</sup> terga.

**Etymology.** This species is named after the type locality, which is near the impressive groves of Sequoia big trees (*Sequoiadendron giganteum*) and Sequoia National Park.

**Distribution.** This species is presently known from the type locality and a nearby creek in the southern Sierra Nevada, California.

**Biological Notes.** When the holotype and allotype of *C. sequoia* were collected in 1990, the type locality stream was dry, except at one location where a small trickle of water seeped down the vertical face of a granite bedrock cliff (10 m) and temporarily collected in a small shallow pool (1 m diameter) at the base, before sinking into the channel substrate. Mature larvae inhabited this one pool (water temperature,

16.3°C) and adults were collected on nearby vegetation. Obviously, these stoneflies were collected at the very end of the normal winter-spring flow period of this intermittent stream. *Cosumnoperla sequoia* was absent from a nearby perennial stream, Redwood Creek, which instead had a typical assemblage of Sierra stoneflies, including some semivoltine Perlidae. The distributions of *C. sequoia* and *C. hypocreana* are confined to intermittent streams at low to medium elevations (300-1500 m) of the Sierra Nevada. Based upon presently known distributions, these two species are separated by about 250 km along this mountain range.

#### NEW SIZE AND DISTRIBUTION RECORDS FOR *COSUMNOPERLA HYPOCRENA*

After *C. hypocreana* was first described from a small intermittent stream in the Cosumnes River drainage of California (Szczytko & Bottorff 1987), I collected this species from 11 other intermittent streams on the western slope of the central Sierra Nevada foothills. All collections were made from two adjacent major river basins, the American and Cosumnes. The new collection sites ranged over 60 km and elevations of 300-1500 m. Mature larvae from these new collection sites were somewhat larger (body length of male larvae, 12.3-13.5 mm; female larvae, 15.8-17.0 mm) than previously reported from the type habitat (body length, 10-13 mm).

USA. California. El Dorado County. All collections were made by R. L. Bottorff. Jackass Canyon Creek (637 m), 5 km E. of Somerset, 6 April 1988 (127 larvae); unnamed tributary to Knickerbocker Creek (424 m), 4 km NW of Pilot Hill, 6-7 February 1988 (20 larvae), 6 March 1988 (1 larva); unnamed tributary to Middle Fork American River, 3 km NW of Cool (313 m), 18 February 1989 (1 larva);

Blue Tent Creek and unnamed tributary (300 m), 1 km SE of Pilot Hill, 18 February 1989 (2 larvae), 26 February 1989 (5 larvae); unnamed tributary to Clear Creek (749 m), 1 km NW of Pleasant Valley, 14 January 1988 (11 larvae); Mills Creek (733 m), 6 km W of Pleasant Valley, 14 January 1988 (4 larvae); unnamed tributary to North Cosumnes River (385 m), 5 km N of El Dorado, 1 May 1987 (1 ♂, 4 ♀, 21 larvae), 12 May 1987 (3 ♂, 3 ♀, 2 larvae), 16 February 1989 (3 larvae); Ringold Creek (531 m), 2 km NE of Diamond Springs, 22 February 1988 (2 larvae), 17 March 1988 (1 larva); Cooper Canyon Creek (293 m), 3 km W of Pilot Hill, 2 April 1988 (4 larvae); unnamed tributary to North Fork American River (412 m), 4 km NW of Pilot Hill, 29 March 1998 (1 larva); Long Canyon Creek (1469 m), 5 km NE of Grizzly Flat, 12 June 1998 (7 larvae) (RLB).

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