EGGS OF WESTERN NEARCTIC ACRONEURIINAE
(PLECOPTERA: PERLIDAE)

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ABSTRACT
Eggs for western Nearctic acroneuriine species of Calineuria Ricker, Doroneuria Needham & Claassen and Hesperoperla Banks are examined and redescribed based on scanning electron microscopy images taken from specimens collected from a substantial portion of each species range. Within genera, species differences in egg morphology are small and not always useful for species recognition, however eggs from one population of Calineuria are significantly different from those found in other populations and this population is given informal recognition as a possible new species.

Keywords: Plecoptera, Calineuria, Doroneuria, Hesperoperla, Egg morphology, Western Nearctic

INTRODUCTION
Scanning electron microscopy (SEM) is often used to elucidate chorionic features for stoneflies (e.g. Baumann 1973; Grubbs 2005; Isobe 1988; Kondratieff 2004; Kondratieff & Kirchner 1996; Nelson 2000; Sivec & Stark 2002; 2008; Stark & Nelson 1994; Stark & Szczytko 1982; 1988; Szczytko & Stewart 1979) and Nearctic Perlidae were among the earliest stoneflies to be studied with this technique (Stark & Gaufin 1976). Unfortunately, the latter study is limited in sample size and in image quality. More recently, eggs of many eastern Nearctic Perlidae have been examined, or re-examined, greatly increasing the number of species studied and improving the image quality for species known from this region (e.g. Kondratieff & Kirchner 1996; Stark 2004; Stark & Lentz 1988), however eggs of the primary western Nearctic Acroneuriinae have not recently been re-examined.

The primary western North American acroneuriine stonefly fauna includes only three genera and five species of Perlidae, although a few representatives of primarily eastern (Perlesta, Acroneuria) or southern genera (Anacroneuria) also occur in the region (Baumann & Olson 1984; Kondratieff & Baumann 2002; Stark 1989; Stark & Gaufin 1976; Stark & Kondratieff 2004; Zuellig et al. 2006). SEM images for eggs of the primary western acroneuriine genera, Calineuria Ricker, Doroneuria Needham & Claassen and Hesperoperla Banks include single images for each of these genera in Stark & Gaufin (1976), three images of Hesperoperla hoguei Baumann & Stark (1980) and three images of H. pacifica (Banks) in Isobe (1997). In this study, we examine specimens from populations with available egg samples for each of the five western Nearctic acroneuriine species. Terminology follows Stark & Szczytko (1988) except in the designation of anterior and posterior poles, where Zwick (1982) is followed.

MATERIALS AND METHODS
Eggs were dissected from female specimens archived in 80% ethanol, cleaned manually with fine tipped forceps, fine dissecting needles and dental brushes and sonicated for 10-20 seconds to remove extra-chorionic membranes. Cleaned eggs were picked up with fine tip forceps, allowed to air dry and placed on specimen stubs covered with double
stick copper tape. Stubs were sputter coated with gold-palladium and examined with an Amray 1810 scanning electron microscope equipped with an Orion digital imaging system. Specimens used in the study are archived in the Stark collection, Mississippi College, Clinton, Mississippi (BPS), the Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah (BYU), or in the C.P. Gillette Museum, Colorado State University, Fort Collins, Colorado (CSU).


**RESULTS AND DISCUSSION**

*Calineuria californica* (Banks)  
(Figs 1-4)

*Perla californica* Banks, 1905:87. Holotype ♀ (Museum of Comparative Zoology), Claremont [Los Angeles Co.], California


**Egg.** Outline oval with short stalked collar, ends broadly rounded (Fig. 1). Length including collar ca.
430-460 μm, equatorial width ca. 360-390 μm, collar length ca. 35-40 μm, collar width at midlength ca. 60-68 μm. Egg body at base of collar encircled by slightly raised ridge. Sides of collar with irregular, prominent struts (Fig. 2); rim flanged and irregularly incised (Figs. 1-2). Anchor biscuit-shaped, surface with scattered mushroom bodies (Fig. 3). Chorionic surface relatively smooth but with obscure hexagonal follicle cell impressions visible at 500X (Figs. 2, 4). Micropylar row subequatorial.

**Calineuria sp. A**

(Figs. 5-8)


**Egg.** Outline oval, collar absent (Fig. 5). Length ca. 440 μm, equatorial width ca. 372 μm. Chorionic surface without punctations or obvious follicle cell impressions (Figs. 6, 8). Micropylar row subequatorial; micropylar orifices with raised rims (Fig. 7).

**Comments.** Eggs of *C. californica* (Figs. 1-4) and the three species of Japanese *Calineuria* (Isobe 1988; 1997) have similar short stalked collars encircled by a low to well developed basal ridge. The chorionic surface is punctate in the Japanese species but smooth or with obscure follicle cell impressions in *C. californica* and *C. sp. A* (Figs. 2, 6). The male and female of *C. sp. A* appear indistinguishable from *C. californica* in color pattern, subgenital plate shape and aedeagal armature, however, the egg has no collar. These specimens may represent an undescribed species, but a larger sample and a comprehensive study of other *Calineuria* specimens is needed in order to evaluate its status. Drumming and molecular data may also be desirable.

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**Doroneuria baumanni** Stark & Gaufin

(Figs. 9-12)

*Doroneuria baumanni* Stark & Gaufin, 1974:88. Holotype ♂ (United States National Museum), Burney Falls State Park, Shasta Co., California


**Washington:** Pierce Co., Carbon River, 16 August 1999, B.C. Kondratieff, 1♂, 3♀ (BPS).

**Egg.** Outline oval with short, narrow collar (Fig. 9). Egg length ca. 500 μm, equatorial width ca. 400 μm, collar length ca. 20 μm, width ca. 50 μm. Chorionic surface coarsely punctate with shallow pits over middle half of egg (Figs 10, 12); punctate zone ca. 260 μm wide; area around collar and a narrow opercular ring around lid lack pits; some pits on lid form obscure follicle cell impression walls. Micropylar row located on lid (Fig. 11); orifices raised, canals not clearly visible on surface.

*Doroneuria theodora* (Needham & Claassen)  
(Figs. 13-16)


**Egg.** Outline oval with short, narrow collar (Fig. 13). Egg length ca. 530 μm, equatorial width ca. 400 μm, collar length ca. 30 μm, width ca. 60 μm. Chorionic surface coarsely punctate in a band ca. 325 μm wide, extending from near collar (Figs. 14, 16) to smooth opercular band surrounding lid. Lid with obscure, irregularly shaped follicle cell impressions, but punctations absent (Fig. 15). Micropylar row located on lid; orifices raised, canals obscure (Fig. 15).

**Comments.** Eggs of *Doroneuria* are large, oval, and have small collars. The chorionic surface has a broad median zone of shallow pits, a narrow smooth opercular band and micropyles located on the lid near the anterior pole (Figs. 9, 13). The eggs of the two species are quite similar, but differ subtly among specimens examined in two respects. The punctate zone for *D. theodora* eggs extends nearer the collar and is, therefore, considerably broader in that species than in *D. baumanni* (Figs. 10, 14). In addition, the lid of *D. theodora* eggs lacks punctations, whereas in *D. baumanni* this area has obscure punctations which outline the irregular margins of follicle cell impressions (Fig. 12).

**Hesperoperla hoguei** Baumann & Stark  
(Figs. 17-20)

*Hesperoperla hoguei* Baumann & Stark, 1980:63. Holotype ♂ (Natural History Museum, Los Angeles County), Gibson Creek, Mendocino Co., California


**Egg.** Outline oval with short, wide collar (Fig. 17); collar base encircled by prominent raised ridge, sides of egg body adjacent to ridge with a series of vertical struts. Egg length ca. 400 μm, equatorial width ca. 360 μm, collar length ca. 50 μm, median width ca. 75 μm. Sides of collar with several prominent longitudinal ridges (Fig. 19); collar rim flanged and irregularly incised (Figs. 18, 20). Anchor biscuit shaped with moderately long pedicel; surface covered with mushroom bodies. Chorionic surface covered with shallow, hexagonal follicle cell impressions. Micropylar row subequatorial.

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**Hesperoperla pacifica** (Banks)  
(Figs. 21-30)

**Acnorneuria pacifica** Banks, 1900:242. Holotype ♀ (Museum of Comparative Zoology), Olympia [Thurston Co.], Washington
Material examined. Alberta: Battle Creek at Reservoir Lake, 23 June 1975, L. Dosdall, 1 ♀ (BPS).
New Mexico: San Miguel Co., Pecos River, 6 miles north Pecos, 12 July 1973, B. Stark, 2 ♂, 3 ♀ (BPS).

Egg. Outline oval with short, wide collar (Fig. 21); collar base encircled by a prominent basal ring, ca. 137-176 μm wide (Figs. 23, 25, 27, 29); sides of egg body along basal ring bearing a series of vertical ridges separated by wide depressions. Egg length ca. 428-484 μm, equatorial width ca. 312-324 μm, collar length ca. 34-55 μm, median collar width ca. 41-58 μm, rim width ca. 89-116 μm. Sides of collar with...
several prominent vertical ridges, rim flanged and irregularly incised. Chorionic surface appearing smooth (Figs. 21, 26, 28, 30) but with obscure hexagonal follicle cell impressions sometimes
apparent at higher magnifications. Micropyles located near equator; orifices raised slightly (Fig. 24).

**Comments.** Hesperoperla eggs are generally similar to those of *Calineuria californica* in shape, collar form and in having a basal ridge encircling the collar base (Baumann & Stark 1980; Isobe 1997). The most conspicuous feature distinguishing the eggs of the two genera is the row of vertical struts on the egg body which connect to the basal ridge in *Hesperoperla* (Fig. 25) which are absent in eggs of *Calineuria* (Fig. 2). No consistent morphological differences were found among eggs of different populations of *H. pacifica*, or between eggs of *H. hoguei* and *H. pacifica*. However, variations are evident in the images of *H. pacifica* eggs from different sites (Figs. 21-30), especially in shape of the anterior pole (e.g. Figs. 26, 28), shape of the collar (e.g. Figs. 25, 27) and in length of lines delimiting cells surrounding the basal ridge (= vertical struts). The specimen shown from the Gunnison River, Colorado, for example, has a few long lines of at least 57 μm (Fig. 25), whereas the longest vertical struts on the specimen shown from Trout Creek, Montana (Fig. 27) are only 30 μm.

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**REFERENCES**


