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Larval taxonomy of western Nearctic *Polycentropus* Curtis, 1835 sensu stricto (Trichoptera: Polycentropodidae), with comments on the identification of immature Nearctic *Polycentropus* sensu lato

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Abstract. Larval taxonomy of caddisflies (Trichoptera) lags behind that of adults. Taxonomic knowledge of Nearctic representatives of *Polycentropus* Curtis, 1835 (Polycentropodidae) is particularly poorly resolved with the larva of only one of 30 species described and with no western Nearctic larvae known. Herein, the late-instar larvae of four of seven western Nearctic *Polycentropus* species are described and figured for the first time. A diagnostic matrix to assist in their identification is provided, new state records are reported, and previous records clarified. Issues regarding existing keys for larval *Polycentropus* sensu lato (i.e., *Holocentropus* McLachlan, 1878, *Plectrocnemia* Stephens, 1836, and *Polycentropus*) are discussed in light of new findings.

Keywords. Caddisflies, description, discriminatory matrix, distribution, new records

Introduction

Trichoptera, or caddisflies, are a cosmopolitan order of holometabolous insects with immature stages found in a variety of aquatic habitats and alate adults in riparian habitats. With more than 16,250 described species, the order is more diverse than all other primarily aquatic orders of insects combined (Morse et al. 2019a). Alpha taxonomy is well-developed and primarily based on adult males, while larvae of less than half of Nearctic species are identifiable (Ruiter et al. 2013). This inability to identify immatures hinders studies of life histories, ecology, evolution, and pollution tolerance.

Within the suborder Annulipalpia, the family Polycentropodidae comprises fixed-retreat-making caddisflies that construct silken tubes or capture nets. One of the most diverse families, Polycentropodidae is represented globally by more than 800 extant nominal species in 14 genera (Chamorro & Holzenthal 2011, Johanson et al. 2012, Morse, 2022). Of these, 78 species in eight genera are recorded from the Nearctic (Rasmussen & Morse 2021). While historically well-studied in Europe (e.g., Lepneva 1964, Urbanič 2006, Waringer & Graf 2011, Karaouzas & Waringer 2017), immature stages of the North American polycentropodid fauna are largely unknown beyond genus level. Even identification to genus of Nearctic *Polycentropus* sensu lato (i.e., *Holocentropus* McLachlan, 1878, *Plectrocnemia* Stephens, 1836, and *Polycentropus* Curtis, 1835) is

based on only a few larval representatives from each genus and therefore should be reevaluated when describing additional larvae. To date, existing Nearctic keys to polycentropodid larvae (e.g., Wiggins 1996; Morse et al. 2017, 2019b) have relied on the same characters used to separate the European *Polycentropus* sensu lato genera without robust examination of the efficacy of the keys in North America.

Nearctic larvae of the genus *Polycentropus* (e.g., Fig. 1) are particularly poorly known, with the larva of only one of the 30 nominal *Polycentropus* species described. Ross (1944) provided a brief and somewhat vague description along with an illustration of the head for the larva of *Polycentropus centralis* Banks, 1914. In the Nearctic, the genus *Polycentropus* exhibits a generally East-West distributional divide (Hamilton 1986). Here, we consider the East as consisting of Ontario and the U.S. states adjacent to either side of the Mississippi River and eastward, and the West consisting of the complementary Nearctic region (following e.g., Lago & Harris 1987, Cooper & Morse 1998, Orfinger et al. 2022). This scheme roughly translates to eastern species being found east of 100 degrees West longitude and western species being found west of this meridian. The eastern diversity of the genus is much higher, with 23 named species, versus seven for the western fauna. The present paper is part of a series in an ongoing effort to better resolve the taxonomy of larvae of the Nearctic *Polycentropus* species.

Currently, no larvae of any of the seven western *Polycentropus* species are described. Using larvae associated using mtDNA from a previous study (Orfinger et al. 2022), the aims of this paper are to describe and figure the late-instar larvae of four western Nearctic *Polycentropus* species recently associated with identifiable adults and provide a discriminatory matrix for their identification. Finally, we conclude with a brief discussion on the efficacy of current keys to larval Nearctic polycentropodids in light of new findings.

Figure 1. Left lateral habitus of a late-instar larva of *Polycentropus variegatus*.

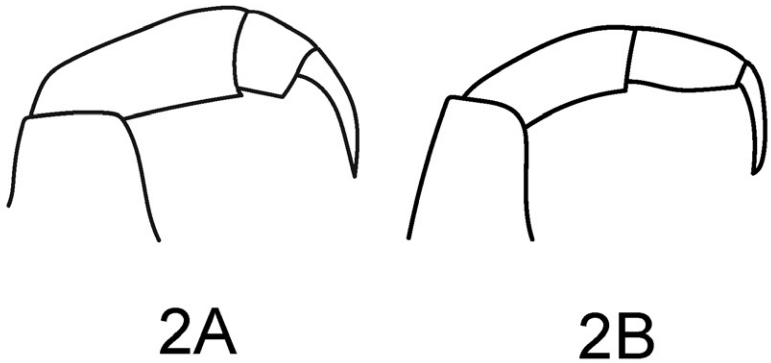
Methods and Materials

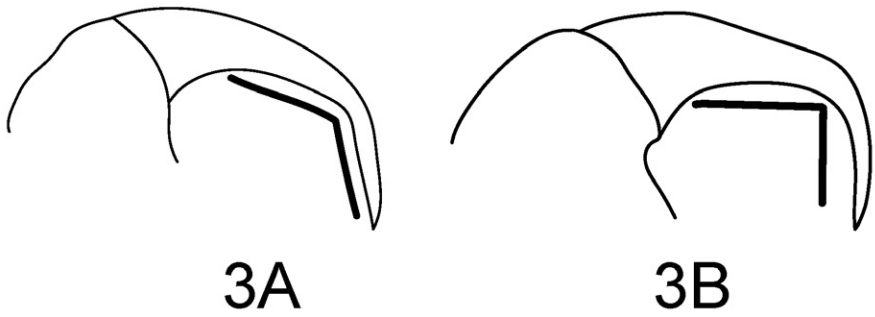
Life-stage association was accomplished using mtDNA barcoding as described by Orfinger et al. (2022). Specimens were observed under a Unitron Z10 stereomicroscope with up to 120× magnification. Measurements were obtained using a calibrated ocular micrometer. Length of each specimen refers to total length, i.e., anterior margin of head to posterior margin of anal claw. Because these larvae are frequently preserved in a curled position, careful straightening of specimens using two pairs of forceps was often necessary when performing length measurements. For morphometric measurements, head width refers to the width of the head measured dorsally at the widest point, while head length describes the length of the head measured dorsally at the longest point excluding the labrum. Terminology follows Waringer & Graf (2011) and Karaouzas & Waringer (2017).

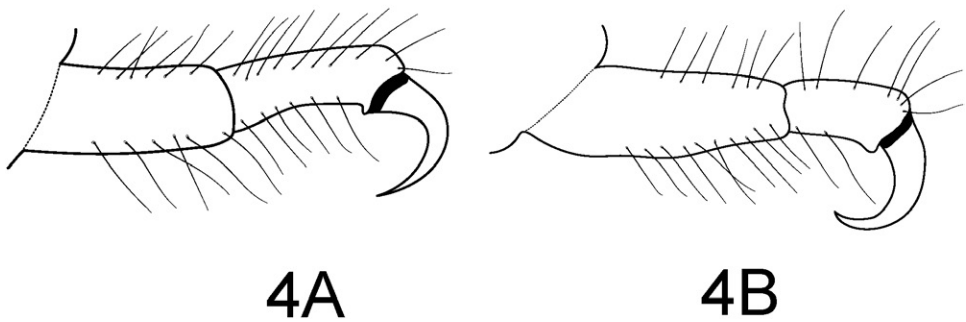
Among the numerous morphological characters examined were several that have been useful in separating larvae of polycentropodid genera and species (e.g., see Waringer & Graf 2011). The relative length and broadness of the foretarsi and foretibiae were among these characters. Character states include, on each side, a short, broad foretarsus that is no more than 1/2 the length of the broad foretibia (Fig. 2A), and a long, more-tubular foretarsus that is at least 2/3 the length of the narrow foretibia (Fig. 2B). Anal claw curvature was recorded as either obtuse (Fig. 3A) or right-angled (Fig. 3B). Anal proleg segments were examined to compare relative proportions of the basal and distal segments, being classified as either the distal segment subequal in length to the basal segment (Fig. 4A) or the basal segment being longer than the distal segment (Fig. 4B). The arrangement of posterior muscle scars (when present) of the frontoclypeal apotome form either a shallow arc (Fig. 5A) or a trapezoidal pattern (Fig. 5B). Finally, the distance of muscle scar 'm' (sensu Waringer & Graf 2011) relative to the frontoclypeal suture was classified as distant (Fig. 6A; previously termed "set back" by Waringer & Graf 2011) or close (Fig. 6B).

Unlike the abovementioned characters, setal arrangements were not illustrated because setal characters were not found to be informative in diagnosing species. In addition, it is common for specimens to have damaged or missing setae. For example, all available specimens of *Polycentropus halidus* Milne, 1936 had previously undergone full-body lysis for DNA extraction, rendering many setae broken or removing them altogether. Characters described above, such as anal claw curvature and muscle scar patterning, are consistency available regardless of deterioration due to, for example, poor preservation or lysis during DNA extraction, and were highlighted in diagnosing species. In addition, because neither metamorphotype specimens nor continuous size series were available for described larvae, instar determination could not be definitively made. Given that the specimens described are large sizes (i.e., 12.5–20.0 mm), it is likely that most or all represent final instar larvae. However, because this cannot be stated with certainty, the term "late-instar" is used instead.

For stacked photography of heads, heads were excised and placed in glycerin or hand sanitizer in a depression slide. Between six and 16 photographs of each larval head were taken at different depths of field using a Levenhuk M1400 Plus Digital Camera mounted to a Unitron Z10 dissecting microscope. Photographs were digitally stitched together using Helicon Focus version 7.7.4. Line drawings were produced using a 10 × 10 gridded ocular lens in conjunction with a gridded guide and pencil. Drawings were then scanned and used as templates for the final illustrations using Adobe Illustrator version 24.3.

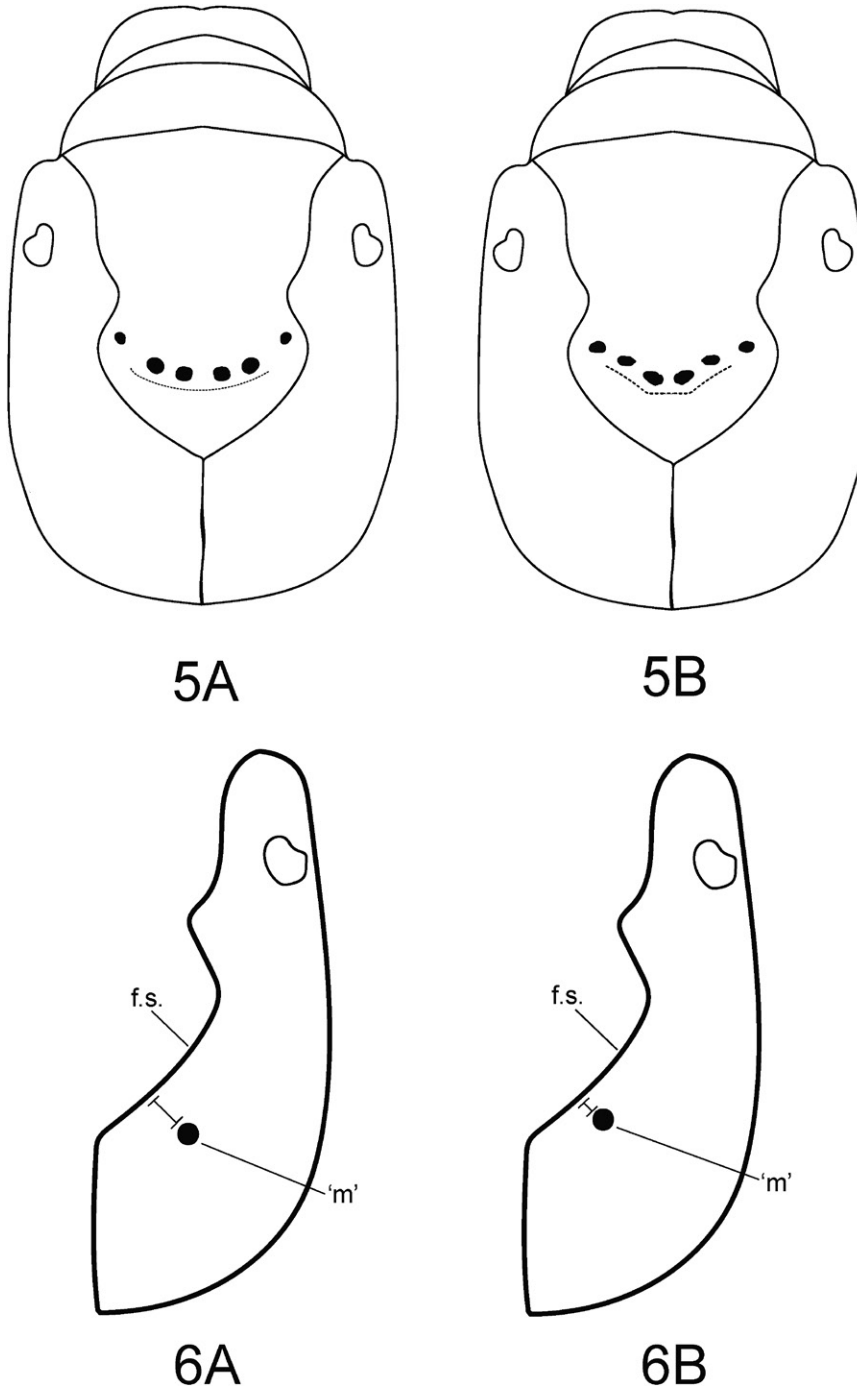






Figures 2–4. 2A, Foreleg exhibiting a short, broad tarsus that is less than half the length of its tibia; 2B, Foreleg exhibiting a longer, narrower, and more tubular tarsus that is at least 2/3 the length of its tibia; 3A, Obtuse-angled anal claw; 3B, Right-angled anal claw; 4A, Anal proleg segments roughly equal in length; 4B, Basal segment of anal proleg longer than distal segment.

Specimens are deposited at the Florida A&M University portion of the Florida State Collection of Arthropods (FAMU) in Tallahassee, Florida, U.S.A., the Centre for Biodiversity Genomics (BIOUG) in Guelph, Ontario, Canada, and the Monte L. Bean Life Science Museum at Brigham Young University, Provo, Utah, U.S.A. (BYU).



Figures 5, 6. 5, Types of muscle scar arrangements of posterior frontoclypeal apotome exhibited by known western Nearctic *Polycentropus* larvae, if present. 5A, shallow arc; 5B, trapezoid; 6, distances of muscle scar 'm' relative to frontoclypeal suture (f.s.). 6A, distant; 6B, close.

Only larval specimens examined are listed herein, except for the case of a new state record based on adults. The presence of an asterisk (*) following a state name signifies a new state record.

Point maps reflect adult and larval specimens of all seven western Nearctic *Polycentropus* species examined by the authors during this study.

Results

Polycentropus denningi Smith, 1962
(Figs. 7, 8, 15; Table 1)

Description of Late-instar Larva. Larval length 19 mm (n = 1).

Head. Length 1.8 mm, width 1.7 mm (n = 1). Dorsal area of head uniformly yellow with two symmetrically positioned, small, well-defined dark muscle scars on incurvate center of frontoclypeal sutures. Dorsal head surface without dark bands and with pale areas around eyes. Anterior margin of frontoclypeal apotome brown. Posteriorly, frontoclypeal apotome lacking muscle scars. Muscle scars 'm' faint and nearly invisible, small, and positioned close to frontoclypeal suture. Ventral area of head also uniformly yellow, lacking muscle scars. Anteroventral apotome long and narrow.

Prothorax. Pronotum same color as head, with no pigmentation or scarring. Prothoracic tarsi tubular, each about two-thirds tibial length and slightly narrower than its tibia (Fig. 2B). Faces of femora covered with numerous long setae. Distal section of each tarsus with well-developed pectinate setae.

Abdomen. Abdominal segments without gills. Basal segment of each anal proleg subequal in length of distal sclerotized section (Fig. 4A), and with numerous long setae. Anal claws obtuse-angled and lacking spines on the concave margins (Fig. 3A).

Distribution. Canada: British Columbia; U.S.A.: California*, Idaho, Montana, Oregon, Washington.

Specimens Examined. U.S.A.: California: Humboldt County, Upper Tectah Creek, J. Lee coll., 26/xi/2019, 1 larva. (FAMU). Sierra County, Highway 49, 2 miles east of Yuba Pass, Tahoe National Park, [N39°37′40.8″, W120°28′22.8″], D. Ruiter coll., 29/v/1991, 1 male. **New State Record**.

Polycentropus gertschi Denning, 1950
(Figs. 9, 10, 16; Table 1)

Description of Late-instar Larva. Mean larval length 15.7 mm (14–18, n = 10).

Head. Mean length 1.8 mm (1.5–2.0), width 1.4 mm (1.1–1.6, n = 10). Dorsal area of head yellow-tan with numerous positioned, variously sized, well-defined dark muscle scars; muscle scarring on head occasionally slightly asymmetrical. Dorsal head surface with subtle darker brown bands and with pale areas around eyes. Anterior margin of frontoclypeal apotome brown. Posteriorly, frontoclypeal apotome with muscle scar arrangement trapezoidal (Fig. 5B). Muscle scars 'm' small sized, faint, and positioned close to frontoclypeal suture (Fig. 6B). Ventral area of head also yellow-tan, with anterior half lacking muscle scars and posterior half with multiple dark muscle scars. Anterior ventral apotome long and narrow.

Pronotum. Same color as head, lacking pigment banding and with multiple small, dark muscle scars. Prothoracic tarsi tubular, each about two-thirds tibial length and

slightly narrower than tibiae (Fig. 2B). Faces of femora covered with numerous long setae. Distal section of each tarsus with well-developed pectinate setae.

Abdomen. Abdominal segments without gills. Basal segment of each anal proleg longer than distal sclerotized section (Fig. 4B), and with numerous long setae. Anal claws obtuse-angled and lacking spines on the concave margins (Fig. 3A).

Distribution. U.S.A.: Arizona, Colorado, New Mexico*, Texas; Mexico: Chihuahua.

Specimens Examined. U.S.A.: New Mexico: [Taos County], Taos Pueblo, Rio Pueblo, Aquatic Biology Associates, Inc. coll., 12/ix/2012, 28 larvae. (FAMU). Same data but Taos Pueblo Environmental Office, Rio Lucero Site 16, 4/x/2010, 30 larvae. (FAMU). **New State Record.**

Polycentropus halidus Milne, 1936
(Figs. 11, 12, 17; Table 1)

Description of Late-instar Larva. Mean larval length 12.9 mm (12.5–14, n = 10).

Head. Mean length 1.6 mm (1.5–1.8), width 1.4 mm (1.2–1.6, n = 10). Dorsal area of head tan with numerous symmetrically positioned, variously sized, well-defined dark muscle scars. Dorsal head surface with distinct darker brown bands and with pale areas around eyes. Anterior margin of frontoclypeal apotome brown. Posteriorly, frontoclypeal apotome with muscle scar arrangement forming shallow arc (Fig. 5A). Muscle scars 'm' large, distinct, and distant from frontoclypeal suture (Fig. 6A). Ventral area of head also tan, with anterior half lacking muscle scars and posterior half with multiple dark muscle scars. Anterior ventral apotome long and narrow.

Pronotum. Same color as head, lacking pigment banding and with multiple dark muscle scars. Prothoracic tarsi tubular, each about two-thirds tibial length and slightly narrower than its tibia. Faces of femora covered with numerous long setae. Distal section of each tarsus with well-developed pectinate setae.

Abdomen. Abdominal segments without gills. Basal segment of each anal proleg longer than distal sclerotized section (Fig. 4B), and with numerous long setae. Anal claws right-angled and lacking spines on the concave margins (Fig. 3B).

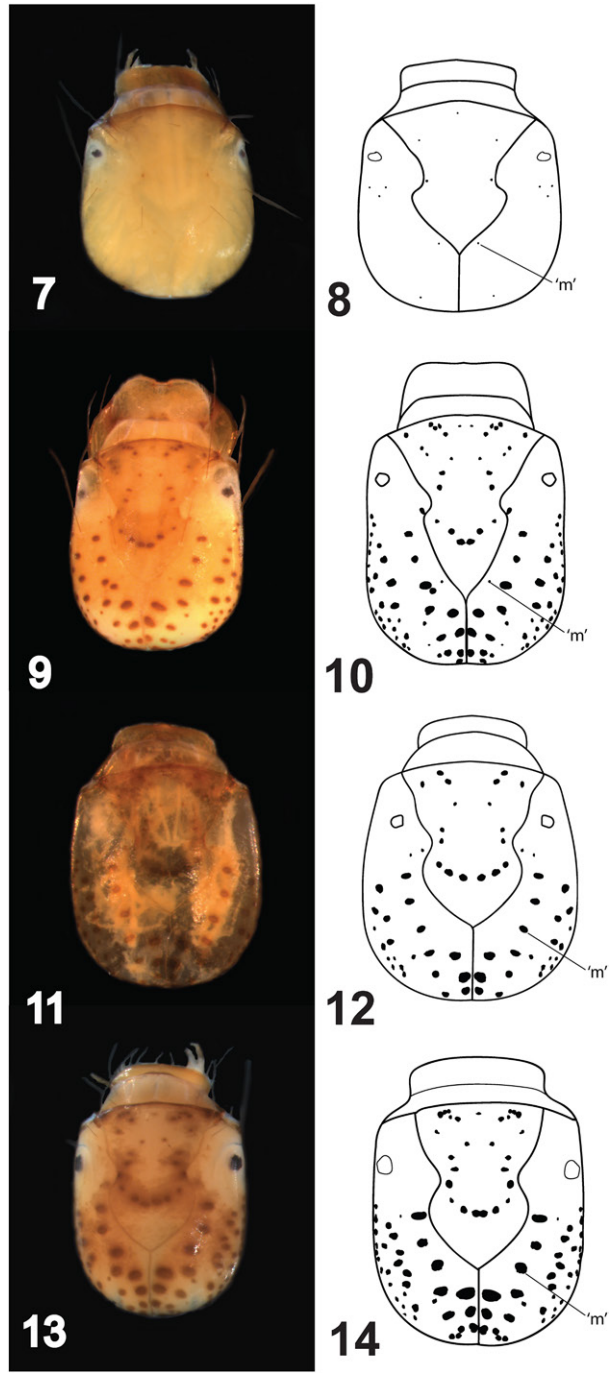
Distribution. Canada: British Columbia; U.S.A.: Alaska, Arizona, California, Colorado, Montana, New Mexico, Oregon*, Texas, Utah, Washington, Wyoming; Mexico: Chihuahua, Durango, Sinaloa.

Notes. Figures of *P. halidus* and *P. variegatus* were inadvertently interchanged by Denning (1956; p. 249, Figs. 10:17a, b), leading to subsequent misidentification of these two species in many instances.

Specimens Examined. U.S.A.: California: Los Angeles County, 334 m a.s.l., [N34°10′15.6″, W117°53′16.8″], B. Isham coll., 18/xi/2018, 24 larvae. (SGABR2639-12 - SGABR2663-12 (BIOUG)). Oregon: Josephine County, Whiskey Creek, at confluence with West Fork Illinois, at Forest Service Road 4402, At Light, [N42°06′08.2″, W123°46′23.7″], C.D. Kerst coll., 15/viii/2015, 5 females (BYU). [Josephine County], Whiskey Creek at Lone Mountain Road, 1738 m a.s.l., [N42°01′19.9″, W123°46′27.8″], 5/viii/2020, 2 males, 22 females (BYU) **New State Record.**

Polycentropus variegatus Banks, 1900
(Figs. 1, 13, 14, 18; Table 1)

Description of Late-instar Larva. Mean larval length 17.5 mm (14.9–20.0 mm (n = 10).



Figures 7–14. Head photographs (odd numbers, dorsal view) and muscle scar maps (even numbers, dorsal view) of late-instar larvae of associated western Nearctic *Polycentropus* species. 7, 8, *P. denningi*; 9, 10, *Polycentropus gertschi*; 11, 12, *P. halidus*; 13, 14, *P. variegatus*. Note that the *P. halidus* specimen underwent whole body lysis during DNA extraction and therefore the sclerotized head capsule remains (Fig. 11) but the internal soft tissue of the head is absent.

Figure 15. Point map of *Polycentropus denningi* specimens examined during this study. Circles represent adults and the square represents the single larval specimen. Any one circle may represent multiple specimens collected from a single location.

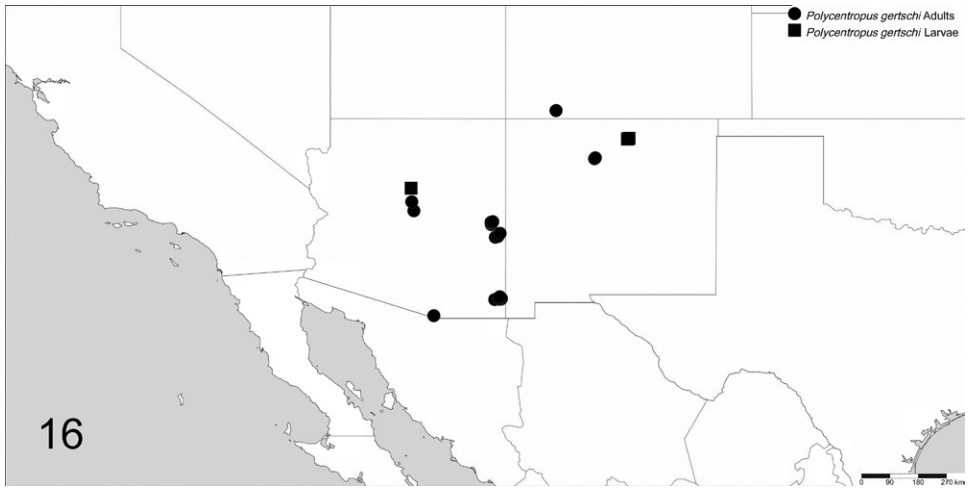


Figure 16. Point map of *Polycentropus gertschi* specimens examined during this study, reflecting adults and larvae. Circles represent adults and squares represent larvae. Any one symbol may represent multiple specimens collected from a single location.

Head. Mean length 1.8 mm (1.5–1.9, n = 10), width 1.4 (1.1–1.6, n = 10). Dorsal area of head tan with numerous symmetrically positioned, variously sized, well-defined dark muscle scars. Dorsal head surface with distinct darker brown bands and with pale areas around eyes. Anterior margin of frontoclypeal apotome brown. Posteriorly, frontoclypeal apotome with muscle scar arrangement forming shallow arc (Fig. 5A). Muscle scars 'm' large, distinct, and distant from frontoclypeal suture (Fig. 6A). Ventral area of head also tan, with anterior half lacking muscle scars and posterior half with multiple dark muscle scars. Anterior ventral apotome long and narrow.

Pronotum. Same color as head, lacking pigment banding and with multiple dark muscle scars. Prothoracic tarsi tubular, each about two-thirds tibial length and slightly narrower than tibiae (Fig. 2B). Faces of femora covered with numerous long setae. Distal section of each tarsus with well-developed pectinate setae.

Abdomen. Abdominal segments without gills. Basal segment of each anal proleg longer than distal sclerotized section, and with numerous long setae. Anal claws right-angled and lacking spines on the concave margin as (Fig. 3B).

Distribution. Canada: Alberta, British Columbia; U.S.A.: Alaska, Arizona, California, Colorado, Montana, Oregon, Utah, Washington, Wyoming.

Notes. This species was erroneously reported from Mexico by Wevers and Wisseman (1987). In addition, figures of *P. variegatus* and *P. halidus* were inadvertently interchanged by Denning (1956; p. 249, Figs. 10:17a, b), leading to subsequent misidentification of these two species and likely the inaccurate report of *P. variegatus* from Mexico.

Specimens Examined. U.S.A.: California: Placer County, Echo Creek, Tahoe Regional Planning Agency, 21/vii/2010, 7 larvae. (FAMU). [Placer County], Tahoe Regional Planning Agency, McKinney Creek, 18/vii/2013, 3 larvae. (FAMU). Oregon: Douglas County, Umpqua National Forest biomonitoring sites, Slide Creek, Aquatic Biology Associates, Inc. coll., 6/x/2012, 8 larvae. (FAMU). 4/x/2012, 4 larvae. (FAMU). 6/x/2012, 9 larvae. (FAMU). [Douglas County], Umpqua National Forest biomonitoring sites, Upper Cavitt Creek (margin), 8/x/2015, 5 larvae. (FAMU). Hood River County, Cabin Creek below falls and above bike path, 60 mm, [N45°41′13.9″, W121°41′49.2″], R. Wisseman coll., 9/v/2017, 1 larva. (FAMU). Lane County, McKenzie River side-channel restoration, Aquatic Biology Associates, Inc. coll., 7/x/2019, 57 larvae. (FAMU). [Lane County], South Fork Mckenzie River, [N44°09′27.7″, W122°16′58.8″], W.J. Gerth coll., 22/vii/2020, 1 larva. (FAMU). Multnomah County, Eagle Creek, Columbia River Gorge National Scenic Area, 76 m a.s.l., [N45°38′10.7″, W121°55′12.0″], R. Wisseman coll., 16/v/2015, 2 larvae. (FAMU). [Hood River County], Ruckel Creek, Columbia River Gorge National Scenic Area, 60 m a.s.l.,

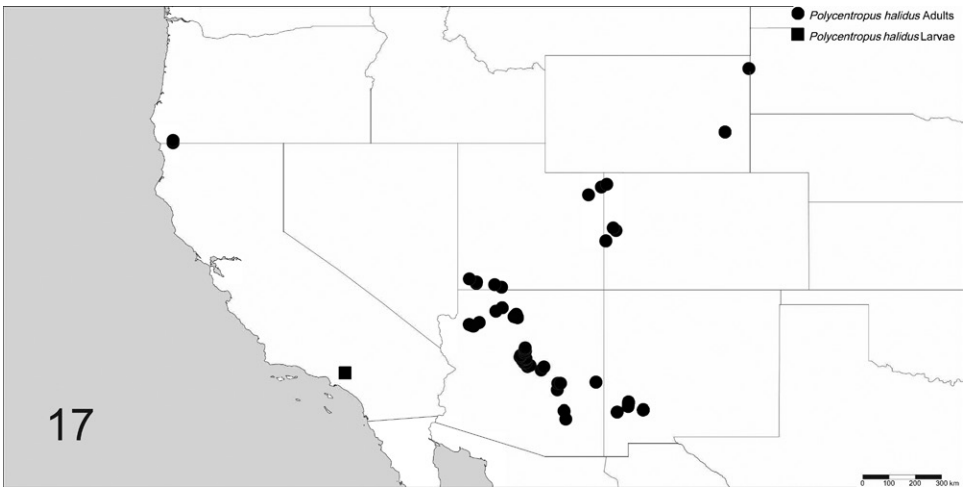


Figure 17. Point map of *Polycentropus halidus* specimens examined during this study, reflecting adults and larvae. Circles represent adults and squares represent larvae. Any one symbol may represent multiple specimens collected from a single location.

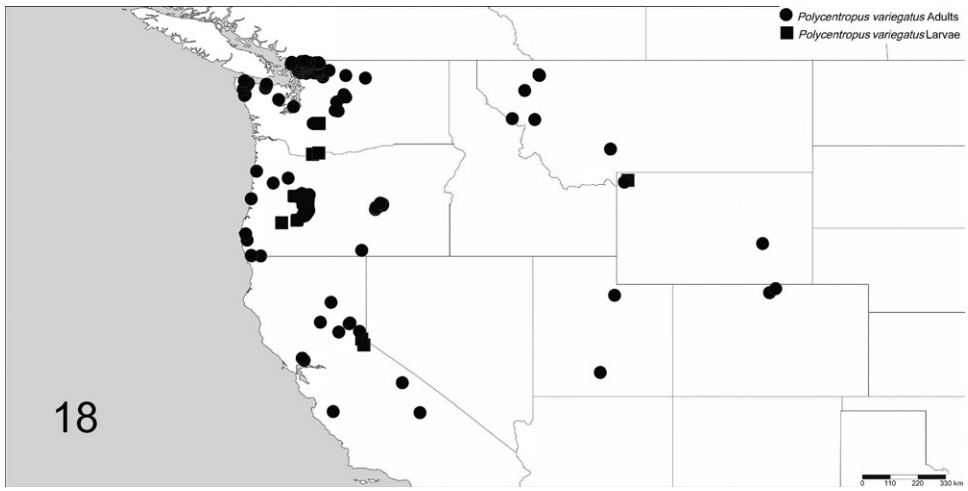


Figure 18. Point map of *Polycentropus variegatus* specimens examined during this study, reflecting adults and larvae. Circles represent adults and squares represent larvae. Any one symbol may represent multiple specimens collected from a single location.

[N45°38′42.0″, W121°55′04.8″], 15/v/2015, 1 larva. (FAMU). Washington: [Okanogan County], Mt. Rainier National Park, Blue Lake, 26/viii/2014, 17 larvae. (FAMU). Wyoming: [Park County], Yellowstone National Park, Gibbon River above Virginia Cascade, [N44°42′48.8″, W110°38′59.3″], R. Cantrell coll., 11/viii/2019, 4 larvae. (FAMU).

Unassociated *Polycentropus* Larvae

Western Nearctic *Polycentropus* larvae that remain unknown include *P. arizonensis* Banks, 1905 (recorded in the Nearctic from Arizona and New Mexico and the Mexican states of Chihuahua, Durango, and Michoacan), *P. aztecus* Flint, 1967 (recorded in the Nearctic from Arizona and from the Mexican states of Chiapas, Chihuahua, Durango, Hidalgo, Mexico, Michoacan, Morelos, and Oaxaca), and *P. picana* Ross, 1947 (recorded in the Nearctic from Texas and from the Mexican states of Durango, Jalisco, Neuvo Leon, San Luis Potosi, Tamaulipas, and Veracruz). Figs. 19–21 present distribution data for specimens of these species examined during this study.

In addition to the remaining unassociated Nearctic species, numerous *Polycentropus* species are reported from central and northern Mexico (Holzenthal & Calor 2017) and may eventually be recorded from the southern United States. Once larvae of these additional taxa are associated and described, the descriptions and diagnostic matrix generated here can serve as a framework to build upon for the identification of all western Nearctic *Polycentropus* species.

Discussion

This study provides descriptions and a diagnostic matrix (Table 1) for larvae of four of seven nominal western Nearctic *Polycentropus* species. Characters shared by the four species include the absence of abdominal gills, prothoracic tarsi being

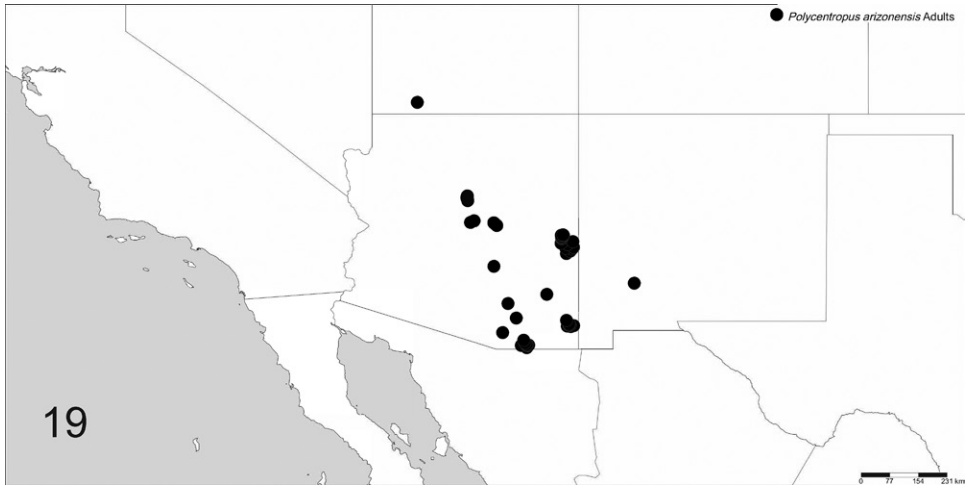


Figure 19. Point map of *Polycentropus arizonensis* specimens examined during this study, reflecting only adults. Any one symbol may represent multiple specimens collected from a single location.

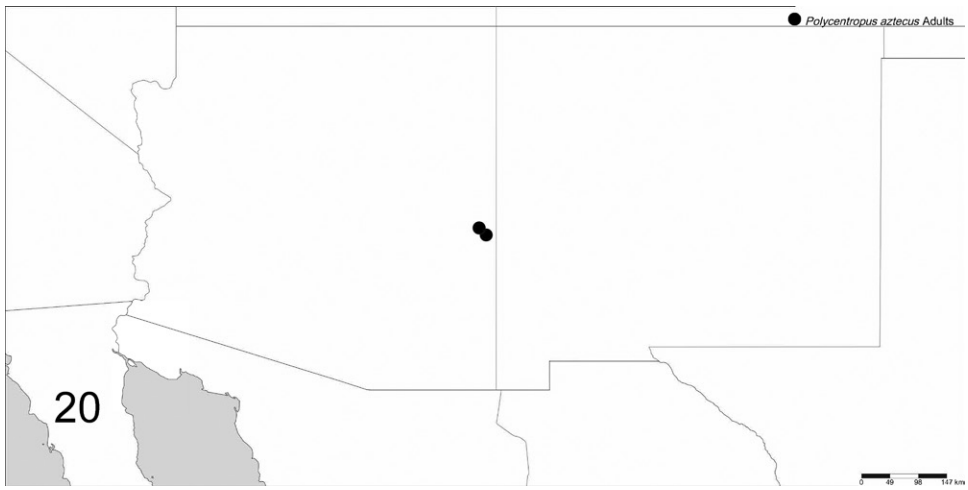


Figure 20. Point map of *Polycentropus aztecus* specimens examined during this study, reflecting only adults. Any one symbol may represent multiple specimens collected from a single location.

tubular and about two-thirds tibial length and slightly narrower than tibiae, and a lack of spines on the concave margin of the anal claw. Characters useful for separation of species are head color, head pigmentation banding and muscle scar patterns, head width to head length ration, head width to body length ratio, ratios of basal and distal segments of anal prolegs, and anal claw curvature. Each of the character states are easily viewable and consistent within each species based on the material available. Since the description of *P. denningi* is based on a single available specimen, future examination of additional specimens, once collected and identified, will provide additional information on intraspecific variation of this species.

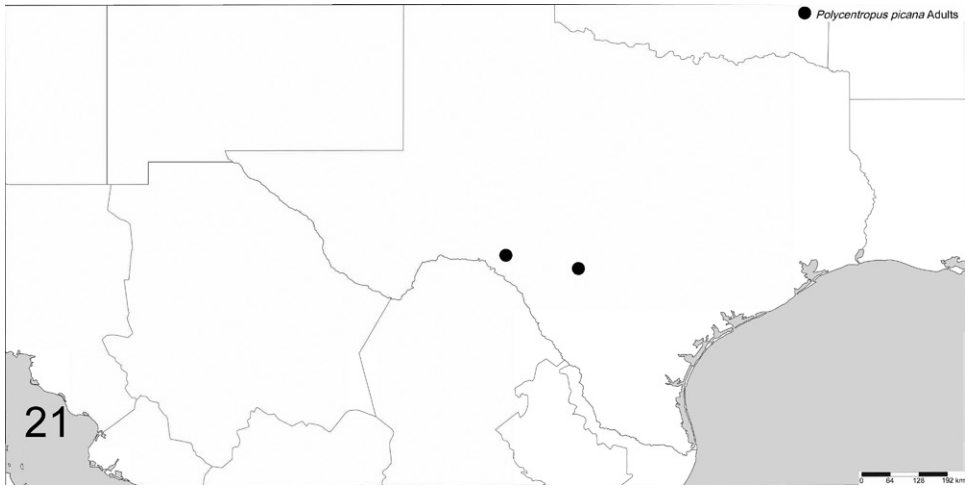


Figure 21. Point map of *Polycentropus picana* specimens examined during this study, reflecting only adults. Any one symbol may represent multiple specimens collected from a single location.

Using these available descriptions and the provided diagnostic matrix, species-level identification of these four western Nearctic *Polycentropus* species is now possible, with caution concerning the yet-unknown larvae. Workers in caddisfly taxonomy and systematics, aquatic ecology, aquatic entomology, and water resource monitoring can now begin to study the immature stages of these organisms at the species-level. In addition, new state records and corrections to previously published erroneous records provided here help to better resolve the distributions of these four species. Future work should focus on collecting additional specimens of various size classes for use in morphometric studies to delineate larval instars and association of the remaining, yet unknown western Nearctic *Polycentropus* larvae.

Issues Related to Separating Nearctic Polycentropodid Genera

During the course of this study, it became apparent that the existing keys (e.g., Wiggins 1996; Morse et al. 2017, 2019b) to the Nearctic genera comprising *Polycentropus* sensu lato (i.e., *Holocentropus*, *Plectrocnemia*, and *Polycentropus*) are inadequate in separating these genera. This possibility was also suggested by Wiggins (1996), who urged caution in separating these genera given that the larvae of so few Nearctic species are known.

Currently, the character for separating *Polycentropus* from *Cernotina* Ross, 1938, *Holocentropus*, and *Plectrocnemia* is: *Polycentropus* larvae have prothoracic tarsi that are broad and only one-half as long as the prothoracic tibiae (Fig. 2A), versus prothoracic tarsi narrow and at least two-thirds as long as the prothoracic tibiae (Fig. 2B) in the remaining genera. Based on the newly described material, all of the now-known Nearctic *Polycentropus* larvae exhibit narrower and more tubular prothoracic tarsi that are at least two-thirds as long as the prothoracic tibiae (Fig. 2B). Ross (1944) neither mentioned nor illustrated the forelegs of the single *P. centralis* larva he described, but examination of the specimen by the first author uncovered the same character state

Table 1. Discriminatory matrix to the known late-instar larvae of western Nearctic *Polycentropus* species.

Character/Species	*P. denningi*	*P. gertschi*	*P. halidus*	*P. variegatus*
Presence of Muscle Scars on Head	Yes	Yes	Yes	Yes
Muscle Scars on Head Distinct	No	Yes	Yes	Yes
Pigment Banding on Head	Absent	Subtle	Distinct	Distinct
Anal Claw Curvature	Obtuse-angled	Obtuse-angled	Right-angled	Right-angled
Frontoclypeus Concolorate	Yes	No	No	No
Position of Muscle Scar "m" Relative to Frontoclypeal Suture	Close	Close	Distant	Distant
Head Width : Head Length Ratio	0.944	0.733-0.800	0.800-0.899	0.733-0.842
Head Width : Body Length Ratio	0.089	0.078-0.089	0.096-0.114	0.074-0.084
Head Color	Yellow	Yellow-Tan	Tan	Tan
Arrangement of Posterior Scars on Frontoclypeal Apotome	Absent	Trapezoidal	Shallow Arc	Shallow Arc
Foretarsus Length Relative to Foretibia Length	≥2/3	≥2/3	≥2/3	≥2/3
Basal Segment Length Relative to Distal Segment Length of Anal Proleg	Subequal	Longer	Longer	Longer
Geographic Range	CA: British Columbia; USA: California, Idaho, Montana, Oregon, Washington	USA: Arizona, Colorado, New Mexico, Texas; MX: Chihuahua	CA: British Columbia; USA: Alaska, Arizona, California, Colorado, Montana, New Mexico, Oregon, Texas, Utah, Washington, Wyoming; MX: Chihuahua, Durango, Sinaloa	CA: Alberta, British Columbia; USA.: Alaska, Arizona, California, Colorado, Montana, Oregon, Utah, Washington, Wyoming

seen in the known western larvae. So, while foreleg segment ratios work in separating the European representatives of *Polycentropus* from other *Polycentropus* sensu lato genera (e.g., Waringer & Graf 2011), these characters are not useful in distinguishing *Polycentropus* from allied genera for the Nearctic fauna.

Similarly, the basal and distal segments of the anal prolegs of the single larval specimen of *P. denningi* being roughly equal in length (Fig. 4A) violates the existing keys (Wiggins 1996; Morse et al. 2017, 2019b). In these keys, the genus *Neureclipsis* McLachlan, 1864 is separated from *Cyrnellus* Banks, 1913, *Cernotina* Ross, 1938, and *Polycentropus* sensu lato by possessing basal and distal segments of the anal prolegs of approximately equal length (Fig. 4A), versus basal segments distinctly longer than the distal segments in the remaining genera (Fig. 4B). While three of the four larvae described here conform to the character state previously accepted for these anal proleg segment ratios in *Polycentropus* (Fig. 4B), *P. denningi* possesses segments of roughly equal length, akin to known *Neureclipsis* larvae (Fig. 4A). Larvae of *Neureclipsis* are still readily separated from *Cernotina*, *Cyrnellus*, and *Polycentropus* sensu lato by the presence of tiny spines on the concave margin of the anal claw observable in *Neureclipsis* versus the absence of these spines in the remaining genera. Likewise, despite the shared character state of the relative length of the anal proleg segments, *Neureclipsis* larvae have only two to three apicoventral setae versus numerous setae on the dorsal and ventral surfaces of the basal segments, enabling separation. Still, the abovementioned violation highlights the fluidity of the keys for the larvae of *Polycentropus* sensu lato in light of additional descriptions.

Characters useful for separating the Nearctic *Polycentropus* sensu lato genera could not be identified despite extensive examination of available material by the first author. While efforts will continue to attempt to identify and describe diagnostic characters, an alternative and potentially necessary solution is the generation of a species-level key or matrix inclusive of all known Nearctic *Polycentropus* sensu lato larvae. Currently, this includes 30 *Polycentropus* species with five described larvae (Ross 1944, current study), 14 *Plectrocnemia* species with three described larvae (Ross 1944, Moulton & Stewart 1996), and eight *Holocentropus* species with two described larvae (Ross 1944, Lepneva 1964, Hickin 1967). The new data provided here constitute a necessary step in that direction.

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