Bryelmis Barr (Coleoptera: Elmidae: Elminae), a New Genus of Riffle Beetle with Three New Species from the Pacific Northwest, U.S.A.

Author(s) : Cheryl B. Barr
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Bryelmis Barr (Coleoptera: Elmidae: Elminae), A New Genus of Riffle Beetle with Three New Species from the Pacific Northwest, U.S.A.

Cheryl B. Barr
Essig Museum of Entomology
1101 Valley Life Sciences Bldg., #4780
University of California
Berkeley, CA 94720-4780, U.S.A.

Abstract

Bryelmis Barr, a new genus of elmid, and three new species, Bryelmis idahoensis Barr, Bryelmis rivularis Barr, and Bryelmis siskiyou Barr, are described from streams and springs in Washington, Oregon, California, and Idaho. Drawings or photographs of the adult habitus and male genitalia of each species, and of the larval habitus of the genus, are included, as well as a key to the adults of the species and revised couplets for insertion into existing adult and larval keys to the Elmidae. The biogeography, habitat, and microhabitat of the species are discussed. Aquatic liverworts are the unusual primary microhabitat of all three species of Bryelmis.

Key Words: aquatic beetles, aquatic liverwort, Chiloscyphus, glacial refugium, Nearctic

The Elmidae of North America, excluding Mexico, were reviewed in depth by Sanderson (1953, 1954) and Brown (1972), who included keys to species. Recent keys by White and Roughley (2008) and Shepard (2002) are to the generic level only. There are nearly 100 described species in 27 genera currently known from North America. The last new genus described from the continent was Huleechius Brown (1981) from Arizona and Mexico.

In his multi-volume treatment of the beetles of the Pacific Northwest (British Columbia, Washington, Oregon, Idaho), Hatch (1965) listed and provided keys for 10 genera and 16 species of elms. Since then, Atractelmis wawona Chandler (1954), described from California, was reported from Oregon and Idaho (Shepard and Barr 1991), and a new species, Zaitzevia (Susevia) posthonia Brown (2001) was described from British Columbia, Washington, Oregon, Idaho, and northern California.

Until fairly recently, the new genus described herein was only rarely collected, perhaps because its specific microhabitat would likely be missed in typical stream substrate kick sampling. In addition, it superficially resembles the very common Cleptelmis Sanderson, which may contribute to it being overlooked in the field and in museum collections. After discovering that my 1985 collections of elms from Washington and Oregon contained an unknown genus and species of elmid, I focused subsequent collecting efforts on aquatic bryophytes, the suspected microhabitat. Identification of the inhabited bryophyte from several collection localities revealed it to be an aquatic liverwort rather than a moss. Examination of specimens I later collected in northern California revealed a second species. Subsequently, additional specimens were obtained from laboratories and collectors engaged in water quality monitoring who became aware of the existence of this new elmid and its particular microhabitat. More recently, specimens from northern Idaho, sent to me for examination, turned out to be a distinct third species.

Aquatic bryophytes are not a common microhabitat for elms, with only three species in North America frequently associated with aquatic mosses or liverworts: Promoresia tardella (Fall) in the East, and A. wawona and Cleptelmis addenda (Fall) in the West (Brown 1972; Shepard and Barr 1991). Unlike members of the new genus described here, the bodies of the first two species are spindle-shaped, i.e., narrowed anteriorly and posteriorly; Cleptelmis is quadrate, similar to the new genus in general shape.

Material and Methods

The following observations are based on the examination of 652 adult and over 200 larval specimens. Larvae are treated at the generic level only, and are excluded from the species treatments and range map. Photographs of the adult specimens were taken with a Visionary Digital BK Plus Lab System and line drawings were executed using a Zeiss Stemi SV6 dissecting microscope with camera lucida, and a Leica DM LS2 compound microscope with camera lucida. Specimens will be deposited in the following institutions and private collections as designated in Material Examined:

ABAC: Aquatic Biology Associates, Inc., Corvallis, OR, USA
Aquatic bryophytes associated with the new genus were identified by specialists William Buck of The New York Botanical Garden, Bronx, NY and Daniel Norris of the University and Jepson Herbaria, University of California, Berkeley, CA. These samples will be deposited as vouchers in the latter collection.

*Bryelmis* Barr, new genus
(Figs. 1–9)

**Type Species.** *Bryelmis rivularis* Barr, new species, here designated.

**Fig. 1.** Dorsal habitus of *Bryelmis rivularis*, type species.

**Adult Description.** Male. Body elongate-ovoid, approximately twice as long as wide, robust, convex dorsally and ventrally, well-sclerotized (Figs. 1, 3–4, 8–9). **Head:** Prognathus, punctate with moderately long, pale setae. Antenna filiform, with 11 antennomeres; basal antennomere 1/3X longer than antennomere 2; antennomeres 3–10 about the same length as antennomere 2 but narrower, about 1/2X width of first 2, size slightly increasing distally; ultimate antennomere fusiform, 2X as long as the penultimate, bearing a cluster of short, dense setae at tip. Eye ovoid, well-developed. Clypeus rectangular, extending basally beneath antennal insertions, anterior angles broadly rounded. Mandible dark basally, lighter apically, with 3 long, slender teeth, tips narrowly rounded; prostheca transparent with 4 fine apical teeth. Maxillary palpus 3-segmented; apical segment fusiform, slightly asymmetrical, longer than previous two segments; basal segment 1/2 the length of the second segment. Labrum rectangular, narrower than clypeus; apicolateral, and occasionally mediolateral, margins with dense fringe of pale, stout setae. Labial palpus 3-segmented, apical segment subovoid, as long as basal 2 segments and 2X as wide. Gena and gula with dense, yellow plastron.

**Pronotum:** Generally trapezoidal, convex, carinate, and sulcate. Wider than long, widest about 1/3 distance from base, narrowest at apex. Lateral margins entire, margined and faintly crenate,
basal 1/3 from near apical margin to base, often obscured at distinct subparallel, sublateral carinae extending from near apical margin to base, often obscured at basal 1/3 by a shelf-like area extending nearly to lateral margin, area margined by an obscure to distinct carina; carinae together having an “h”-shaped, forked appearance. A deep, granulate sulcus at lateral margin, widest anteriorly, abruptly narrowed at basal 1/3; a pair of broad, shallow foveae present near basal margin, mesal to bases of main sublateral carinae. Disc of pronotum with small, sparse to moderately dense punctures accompanied by long, fine setae; basolateral shelf-like area rugose with deep, closely-spaced punctures. Elytron: Elongate, convex, laterally margined; disk carinate and sulcate, depressed at base; together wider than base of pronotum. Lateral margin slightly arcuate to apical 1/4, then abruptly narrowed to rounded tip. Sublateral carinae at intervals 7 and 8, bordering striae 6 and 7, joined at the umbone; the more medial stria ends at about 1/5 the distance from the elytral apex, most distinct in apical 1/3; the more lateral stria is shorter. Longitudinal sulcus 3 intervals wide, extending from carina at interval 8 to lateral margin, deepest adjacent to metasternum. Nine punctate striae. Scutellum: Small, longer than wide. Metathoracic wings: Present or absent. Legs: Prothoracic legs shortest, metathoracic leg longest. Femur with basal patch of pale yellow setae on medial/inferior surface, at basal 2/3 of profemur and metafemur and basal 1/2 of metafemur. Protibia with dense cleaning fringe of long, pale yellow setae on distal 2/3–3/4 of medial/inferior surface; fringe of setae present but sparse on mesotibia and metatibia. Tarsus including claw nearly as long as tibia, with tarsomere 5 as long as tarsomeres 1–4 combined. Tarsal formula 5–5–5. Claws long and slender, without teeth. Venter: Glabrous medially, dense silver to golden plastron present laterally. Prosternal disc roughly triangular, emarginate; disc concave anteriorly, convex between procoxae, concave posteriorly near apex; anterior margin straight beneath head, apex bluntly rounded and inserted into a deep mesosternal fossa. Mesosternal disc concave between mesocoxae. Metasternal disc roughly cordate with a median, longitudinal sulcus, partly margined with a carina extending from between mesocoxae posteriorly nearly to metacoxae; each metacoxa with a small, posteriorly-projecting lobe. Abdomen with 5 sterna, most convex medially; sternum 1 with a pair of arcuate, divergent carinae extending from mesal margin of metacoxae to posterior margin of sternum, forming an approximate triangle; sternum 5 broadly triangular with a bluntly rounded apex. Plastron present on gena, gula, prosternal epimeron and hypomerion, metasternal episternum and lateral to carinae, elytral epipleura (hypomerion) except for base, laterally on all abdominal sterna, and on bases of all coxae. Genitalia (Figs. 5–7): Typical for an elmine and with no features unique to the genus.

Adult Diagnosis. Adults of *Bryelmis* superficially resemble those of *Cleptelmis*, and can be mistaken for this genus because of basally forked sublateral pronotal carinae and similar size, shape, and coloration. *Bryelmis* is distinguished by a median longitudinal pronotal carina and distinct elytral sublateral carinae, and the often-indistinct forks of the sublateral pronotal carinae and basal areas between are more or less “h”-shaped. *Cleptelmis* lacks a median pronotal carina and elytral sublateral carinae, and the basal forks of the distinct sublateral pronotal carinae form an upside-down “Y.” The genera *Rhitelmis* Chandler and *Ampumixis* Sanderson both have a median pronotal carina like *Bryelmis*, but lack elytral carinae. *Bryelmis* keys to *Cleptelmis* in White and Roughley (2008), couplet 11; Shepard (2002), couplet 11; and Brown (1972), couplet 46. To include *Bryelmis*, the following substitutions should be made:

# Pronotal carinae appearing forked at basal third...........................................................................................................A

A Pronotum with median longitudinal carina, at least anteriorly; elytra with sublateral carinae...

A’ Pronotum without median longitudinal carina; elytra without sublateral elytral carinae........

I find the character “pronotal carinae forked at base or not forked at base” to be problematic and subject to misinterpretation, and think that existing generic keys need revision.

Larval Description. Mature larva (Fig. 2) approximately 4.5 mm long, 0.7 mm wide at metathorax; elateriform, tapering posteriorly, striate in cross-section; red brown with pale middorsal suture, head darker; moderately to densely tuberculate, with flattened setae. Head: Highly sclerotized, darker dorsally than ventrally, normally partly concealed by pronotum. Antenna cylindrical, 3-segmented; basal segment stout, as wide as long, 1/3 length of segment 2; segment 2 longest, 3X as long as wide, bearing apical seta as long as apical segment; apical segment minute, 1/2 width and 1/4 length of segment 2. Stemmata well-developed, grouped in
an oval cluster. Frontal sutures together narrowly U-shaped and meeting near base of head, epicranial stem very short; frons dorsolaterally flattened. Clypeus fused to frons. Labrum transverse, 4X longer than wide, truncate with rounded apicolateral margins, margins setose. Mandible with 3 stout, blunt, apical teeth; the middle one largest. Maxilla with galea and lacinia distinct and apically setose; maxillary palpus transparent, 4-segmented, with a long seta laterally adjacent. Labium rectangular, 2X longer than wide; labial palpus transparent, 2-segmented.

Thorax: Prothorax nearly as long as meso- and metathorax together, with 2 irregularly-shaped mesolateral depressions on each side; prothorax with cervical sclerites configured like a “V,” postpleurite with a single, undivided sclerite, posterior sternum absent (procoxal cavities open posteriorly). Mesothorax and metathorax of similar size and shape, with 2 anterolateral depressions; meso- and metasternum each with 2 pairs of pleural sclerites. Notal margins rounded laterally. Legs 5-segmented, terminal segment a tarsungulus.

Abdomen: Nine-segmented; segments 1–7 with separate tergites, pleurites, and sternites; segments 8 and 9 each united into a ring. Pale middorsal suture on tergites 1–7; each tergite with a middorsal, hump-like protubercane on posterior tergal margin becoming more prominent on posterior segments, together appearing bluntly saw-toothed in lateral view (Fig. 2b). Dorsal, anterolateral spiracles near margins of segments 1–8. All segments except 9 with apical fringe of peg-like setae. Segment 9 narrow, elongate, with emarginate apex; dorsal longitudinal carina convex in lateral view except near apex; tip acuminate in lateral view; ventral operculum ovate, broadly rounded anteriorly and narrowly rounded posteriorly; opercular chamber with 2 retractile anal hooks.

Larval Diagnosis. Bryelmis larvae (Fig. 2) most resemble those of Ampumixis in general shape and sclerite characteristics. They differ in that Ampumixis has prominent dorsal clusters of pale, spatulate setae on the middorsal and mediolateral protuberances and lateral margins, whereas Bryelmis at most has small numbers of pale, flattened setae. In Ampumixis, all abdominal tergites have pronounced, rounded middorsal protuberances; in Bryelmis, they are less developed and usually most noticeable on the posterior segments. Although the larvae of Optioservus Sanderson and Heterlimninius Hinton are subtriangular in cross-section like Bryelmis, unlike Ampumixis (Fig. 2c) their prothoracic postpleurites are composed of two parts. In addition, the lateral margins of the thorax are explanate in the former genera, while those of Bryelmis are not. The larvae of Cleptelmis and Atractelmis are hemicylindrical and do not have dorsomedial hump-like protuberances.

Bryelmis larvae key to Ampumixis in White and Roughley (2008), couplet 18, and Brown (1972), couplet 26. To include Bryelmis, the following substitution should be made:

# Body robust and broad, subtriangular in cross section; with or without spatulate spines along lateral margins and middorsal line .......... A
A With prominent clusters of spatulate spines along lateral margins and middorsal line....Ampumixis
A’ Without prominent clusters of spatulate spines ....................................................Bryelmis

Etymology. The generic name combines bry-, from the Greek bryon, meaning moss, plus elmis, from the nominate genus of the family, Elmis. Gender: feminine.

Bryelmis idahoensis Barr, new species
(Figs. 3–5, 10, 11)

Description. Length 2.00–2.34 mm; width 1.04–1.18 mm. Body color dark brown to black; rugose and sculptured with prominent carinae, sulci, striae, and punctures. Antenna: Testaceous, often darker at tip. Head: Dark brown to black. Eyes strongly protuberant. Frons finely rugose with moderately coarse punctures and long, pale setae; epicranial sutures prominent. Clypeus with fine punctures, evenly spaced more than 2X their
diameters apart, integument between punctures smooth; setae moderately long, sparse except at lateral margins. Labrum with evenly spaced fine punctures bearing sparse, moderately long setae; apico-lateral margins with dense clusters of setae. **Pronotum**: Dark brown to black, shiny. Distinctly wider than long, widest about 1/3 distance from base or occasionally at base; length 0.60–0.70 mm, width at widest point 0.84–0.96 mm. Basalolateral angles right-angled to slightly obtuse, occasionally slightly acute. Disc smooth, with small, sparse punctures accompanied by fine setae distributed mostly along midline and near lateral margins; longitudinal, central elevation bearing a narrow, median, longitudinal carina extending from near apical margin to basal margin. Sublateral carinae prominent, narrow or broad but not sharply carinate; each bordered medially by a rounded basal and an elongate apical fossa, both moderately deep. **Elytron**: Convex; shiny with short, sparse setae; dark brown to black, occasionally red brown, often with a slight metallic sheen. Length 1.50–1.78 mm, width 0.50–0.58 mm. Disk usually flattened at basal 1/3 with broad, shallow depression present laterad of suture, distinctly humped at middle, angled downward at apical 1/2; sometimes not flattened at base and without depression, and more evenly rounded from base to apex. Two distinct sublateral carinae at intervals 7 and 8; the

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**Figs. 3-4.** Habitus of *Bryelmis idahoensis*. a) Dorsal, b) Lateral. Scale bars = 0.5 mm.
more medial stria ending abruptly at about 1/5 the distance from the elytral apex; the more lateral stria slightly shorter. Deep longitudinal sulcus bordering lateral margin, with deeper fovea adjacent to metasternum. Nine, often deeply-impressed striae with moderately deep punctures separated by 1X their diameters.

Leg: Shiny, red brown except for distal 1/4–1/3 of femur which is dark brown; visible portion of femur dark in dorsal habitus view. Femur with closely spaced, minute punctures and sparse setae.

Venter: Shiny, red brown to dark brown medially, prosternum darkest; dense silver to golden plastron present laterally. Apex of prosternum broadly rounded. Mesosternal disc deeply concave between mesocoxae. Metasternal disc convex.

Male genitalia: In dorsal view (Fig. 5), parameres with outer margins more or less parallel, tips narrowly rounded. Penis slightly longer than parameres, widest near middle then abruptly narrowed to a blunt tip which is about as wide as that of a paramere.

Variation. There is notable individual variation in this species, even within a single population. All specimens examined were strongly sculptured and striate, but varied in the degree of pronotal and elytral convexity, the presence or absence of basal elytral depressions, the presence or absence of metathoracic wings, and the width of the pronotum at the apical margin behind the head (Figs. 3, 4). Figure 4 illustrates an unusually stocky and sculptured specimen with deep elytral striae. Body size and color, ranging from occasionally red brown to more common dark brown and black, are other variables. Females (n = 5) were slightly longer than males (n = 5) in a comparison of the length measurements of the longest and shortest specimens, with the longest specimen a female and the shortest a male.

Comparative and Diagnostic Comments. *Bryelmis idahoensis* (Figs. 3, 4) is black or dark brown with a body that is generally rugose and sculptured with prominent carinae, sulci, striae, and punctures. The median pronotal carina is produced and ridge-like, the pronotal disc is relatively smooth with few punctures and setae, and the lateral elytral sulcus is deep and trench-like. Its overall appearance is broad, stocky, and “tank-like”. *Bryelmis rivularis* (Fig. 8) and *B. siskiyou* (Fig. 9) are much less rugose with elytra not as deeply striate, shallow lateral elytral sulci, less prominent median longitudinal pronotal carinae, and more punctuation and setation on the pronotal discs. The male genitalia of *B. idahoensis* (Fig. 5) is somewhat similar to that of *B. siskiyou* (Fig. 6), but differs from that of *B. rivularis* (Fig. 7) which has the paramere tips angled outward.

Material Examined. 458 specimens. HOLOTYPE ♂ in EMEC, labeled “IDAHO: Clearwater Co., Clearwater NF, Fern Creek at FS Rd. 700 N of Isabella Landing, 14-VII-2007, C. B. Barr // trib. Isabella Creek, 46°51.703′N, 115°37.379′W, elevation 1980 ft. // HOLOTYPE Bryelmis idahoensis Barr” [red label]. Two hundred two paratypes (P) [yellow labels] and 255 non-paratypes (NP) were examined from the following localities: Same data as holotype (4 P, BNHM; 4 P, CASC; 2 P, CNCI; 22 P, 3 NP, EMEC; 4 P, USNM).


**Distribution, Habitat, and Biology.** Based on collection records, the range of this species extends from the lower “panhandle region” of northern Idaho, in an area from the St. Joe River in Shoshone County, southeast to the Salmon River in Lemhi County (Fig. 10). This mountainous area includes the three main forks of the Clearwater
River in the counties of Clearwater and Idaho. In July 2007, I went to Idaho, along with Bill Shepard, to collect additional specimens and examine the habitat of *B. idahoensis*. We collected specimens at 13 localities, all of which are low-order, closed-canopy streams with cool to cold water, the largest at 1.5–3.0 m wide being Fern Creek, the type locality (Fig. 11). Most of the sites are cold, high-gradient, first-order rivulets that are completely concealed from the road by plant cover. Sampling was also done in larger streams which lacked aquatic bryophytes, but these were unproductive for *Bryelmis*. When found at a site, specimens of *B. idahoensis* were often present in large numbers.

The majority of specimens were collected in association with aquatic bryophytes attached to rocks, although in some cases the beetles were also found on waterlogged wood. Bryophyte samples from eight sites yielded one species of liverwort and four species of moss. The liverwort *Chiloscyphus polyanthos rivularis* (Schrad.) Nees (Geocalycaceae) was present in six of the eight samples, and was exclusive in three. The most common moss, *Platyhypnidium riparioides* (Hedwig) Dixon (Brachytheciaceae), was present in two samples, and the other three moss species were present in one sample each. *Bryelmis idahoensis* specimens were collected from waterlogged wood at four localities and were common at two; aquatic bryophytes also occurred at three of these sites. Two specimens borrowed for this study were collected in a “pitfall trap in moist old growth cedar forest” (Isabella Creek) (F. Merickel, *in litt.*).

I recorded the following elmid species co-occurring with *B. idahoensis* at one or more of the collecting localities: *C. addenda*, *Heterelimnius corpulentus* (LeConte), *Lara avara* LeConte, *Narpus concolor* LeConte, *Optioservus quadrimaculatus* (Horn), and *Z. posthonia*. In the smaller streams, *B. idahoensis* was usually the only elmine present, but was sometimes accompanied by *L. avara*, a laraine elmid that producing an obtuse angle. Penis slightly longer than metasternum. **Leg:** Shiny red-brown except for distal 1/4–1/3 of femur which is dark brown; visible portion of femur dark in dorsal habitus view. Femur with closely spaced, small punctures and sparse setae. **Venter:** Shiny, red-brown to dark brown medially, prosternum darkest; dense silver to golden plastron present laterally. Apex of prosternum broadly rounded. Mesosternal disc shallowly concave between mesocoxae. Metasternal disc flat to slightly convex. **Male genitalia** (Fig. 7): Parameres narrowed medially, then flared laterally at tips, each producing an obtuse angle. Penis slightly longer than parameres, more or less parallel-sided to apical third, then narrowed to acumenate tip.

**Variation.** The most conspicuous variable among individuals is the color of the elytra, which can range from orange to black, or be more or less vittate with orange or red-brown laterally and a black stripe at the suture. Less noticeable are differences in the size and depth of the elytral depression at the basal 1/3. Metathoracic wings may be present or absent. Measurements of the length of the longest and shortest specimens showed size overlap between males (*n* = 4) and females (*n* = 4), with both the longest and shortest being males.
Comparative and Diagnostic Comments.

*Bryelmis rivularis* is unique among the three species in having male genitalia with the paramere tips angled outward (Fig. 7). In addition, some individuals are bicolored, having broad, red-brown elytral vittae lateral to the midline (Fig. 8). Externally, this species most resembles *B. siskiyou* (Fig. 9), but differs in that the median pronotal carina is distinct, the sublateral pronotal carinae are often more pronounced, and the elytra are more deeply striate with larger punctures. In *B. siskiyou*, the median pronotal carina is reduced, the sublateral pronotal carinae are distinct but less prominent, and the elytra are not as deeply striate and punctate, giving the body a smoother appearance.

*Bryelmis idahoensis* (Figs. 3, 4) is more rugose and sculptured with prominent carinae, sulci, striae, and punctures. Unlike *B. rivularis* and *B. siskiyou*, the median pronotal carina is produced and ridge-like, the pronotal disc is smooth with few punctures and setae, the lateral elytral sulcus is deep and trench-like, and the male genitalia have the tips of the parameres unbent (Fig. 5).

North America: B. idahoensis (squares), and B. siskiyou (ary, Donkey Cr. at FS Rd. 22, ~WSUC). Grays Harbor Co.: Olympic NF bound-
Sec 20, 24 June 1992, R. S. Zack collector (1 P, Beaver Crk., ca 2 mi N of Sappho, R12W T30N (2 P, EMEC; 1 NP, ABAC); Mary
from moss on margin of stream with berlese funnel 9-VIII-1983, R.W. Wisseman coll. // extracted
tors (1 P, WSUC).
SE Salem, 26 Oct 1985, R S & V L Zack collec-
Co.: Silver Falls SP, S fork Silver Crk. ca 16 mi
3-VI-1992, C. B. Barr (8 P, 2 NP, EMEC). Marion
Creek along Hwy. 47, 2.7 mi. WSW Clatskanie,
R. D. Kenner (1 P, SMDV). Columbia Co.: Fall
Columbia Co.: Fall Creek along Hwy. 47, 2.7 mi. WSW Clatskanie, 3-VI-1992, C. B. Barr (8 P, 2 NP, EMEC). Marion
Beaver Crk., ca 2 mi N of Sappho, R12W T30N Sec 20, 24 June 1992, R. S. Zack collector (1 P, WSUC). Grays Harbor Co.: Olympic NF bound-
dary, Donkey Cr. at FS Rd. 22, ~10 air mi. NE Humptulips, 2-VI-1992, coll. C.B. Barr (3 P,
OREGON: Benton Co.: Siuslaw NF, trib. Crooked
17 NP, EMEC; 2 P, LSAM; 4 P, OSAC); type (4 P, BNHM; 4 P, CASC; 4P, CNCI; 25 P,
from the following localities: Same data as holo-
labels] and 42 non-paratypes (NP) were examined

**Family Elminidae**

Fig. 10. Known distribution of *Bryelmis* spp. in North America: *B. idahoensis* (circles), *B. rivularis* (squares), and *B. siskiyou* (triangles).

Barr" [red label]. Ninety-six paratypes (P) [yellow labels] and 42 non-paratypes (NP) were examined from the following localities: Same data as holo-
type (4 P, BNHM; 4 P, CASC; 4P, CNCI; 25 P, 17 NP, EMEC; 2 P, LSAM; 4 P, OSAC); **OREGON**: Benton Co.; Siuslaw NF, trib. Crooked
Cr. along Marys Peak Rd. 0.3 mi. W jct. Hwy. 34, 28-VI-1985, C. B. Barr (2 P, EMEC); Siuslaw
NF, Marys Peak Campgrd., Parker Cr., el. 3600', 9-VIII-1983, R.W. Wisseman coll. // extracted
from moss on margin of stream with berlese funnel (2 P, EMEC; 1 NP, ABAC); Mary's Peak, 85/6/28, H.P.B. [Harley P. Brown] (1 P, OMNH); Siuslaw
creek along Hwy. 47, 2.7 mi. WSW Clatskanie, 3-VI-1992, C. B. Barr (8 P, 2 NP, EMEC). Marion
dary, Donkey Cr. at FS Rd. 22, ~10 air mi. NE Humptulips, 2-VI-1992, coll. C.B. Barr (3 P,

**Distribution, Habitat, and Biology.** Based on collection records, *B. rivularis* inhabits the Coast Ranges from the Olympic Mountains of northwestern Washington, south to northwestern Oregon where it also occurs in the western Cascades (Fig. 10).

The type locality, Hell Roaring Creek (Fig. 13), is near the Hoh Rainforest area of Olympic National Park in Washington. This is the only known locality to yield more than a few specimens of the species. The water is tea-colored due to tannins in the allochthonous input from the surrounding coniferous forest, and much coarse, woody debris is present in the stream. In the areas where specimens were collected, the stream bed ranges from 3–6 m wide and the water depth is generally less than 0.3 m. The substrate is sandy gravel and cobbles less than 30 cm in diameter, and occasional larger boulders. A series of 54 specimens of *B. rivularis* collected in June 1992 had a sex ratio of 28 females to 26 males.

Microhabitat preference for bryophytes was examined during a second visit to Hell Roaring Creek, and was found to be the aquatic liverworts *C. polyanthos rivularis* and *Scapania undulata* (L.) Dumort (Scapaniaceae). A more in-depth look at microhabitat preference at this locality is con-
tained in the Discussion section.

The four other streams where I have collected *B. rivularis* ranged from small (1.5–3.0 m wide) with cobbles and sandy gravel, to large (>7.5 m) with swift water, bedrock ledges, and small waterfalls. Despite the dissimilarities in stream type, in all cases *B. rivularis* was found among aquatic bryophytes attached to rocks. Several species of Elminae inhabit three of the streams, including the type locality, but only *B. rivularis* occurs in the two smaller streams. I have recorded the following elmid species co-occurring with *B. rivularis* at one or more of the collecting localities: *C. addenda*, *Heterlimnius koebeli* (Martin), *L. avara*, *Narpus angustus* Casey, *N. concolor*, *O. quadrimaculatus*, *Zaitzevia parvula* (Horn), and *Z. posthonia*.

**Etymology.** The specific epithet, *rivularis*, from the Latin *rivulus* or *rivalis*, meaning "stream or brook", is taken from the name of the aquatic liverwort with which it has been most commonly associated, *C. polyanthos rivularis*.
Bryelmis siskiyou Barr, new species
(Figs. 6, 9, 10, 12)

Description. Length 1.8–2.3 mm, width 0.92–1.14 mm. Body color dark brown to black; appearing smooth, with elytral carinae, striae, and punctures not prominent. Antenna: Testaceous, often darker at tip. Head: Black. Eyes weakly protuberant. Frons with scattered small punctures bearing fine setae. Clypeus with fine, evenly spaced punctures more than 2X their diameters apart, integument between punctures smooth. Labrum faintly margined, smooth, with fine, evenly spaced punctures bearing setae; apico-lateral, and occasionally medio-lateral, margins with dense clusters of setae. Pronotum: Dark brown to black, shiny. Slightly wider than long, widest about 1/3 distance from base; length 0.58–0.70 mm, width at widest point 0.7–0.9 mm. Basolateral angles nearly forming right angles, lateral margin often slightly sinuate near base. Disc shiny, with small, widely spaced punctures accompanied by fine setae; narrow, often indistinct median longitudinal carina extending from near apical margin to near base where it becomes faint or absent. Sublateral carinae usually narrow but not sharply carinate; each bordered medially by a shallow, broad basal and an indistinct apical fossa. Elytron: Convex; shiny with short, sparse setae, medium brown to black. Length 1.3–1.6 mm, width 0.44–0.56 mm. Disk lateral to suture usually slightly depressed at 1/3 of distance from the elytral apex; a slightly shorter carina present at interval 8; both carinae often indistinct. Shallow longitudinal sulcus with deeper fovea containing enlarged punctures adjacent to metasternum. Nine striae with shallow to moderately deep punctures separated by 1X their diameters. Leg: Shiny red-brown, except for distal 1/4–1/3 of femur which is dark brown or entirely dark brown; distinct apical fossa. Femur with closely spaced, minute punctures and sparse setae. Venter: Shiny red-brown to dark brown medially, prostrum darkest; dense silver to golden plastron present laterally. Apex of prostrum narrowly to broadly rounded. Mesosternal disc shallowly concave between mesocoxae. Metasternal disc slightly convex. Male genitalia: In dorsal view (Fig. 6), parameres with outer margins constricted medially, tips narrowly rounded. Penis slightly longer than parameres, slender, and nearly parallel-sided in basal two-thirds, then gradually narrowed to a tip which is not as wide as that of a paramere.

Variation. In B. siskiyou, the development of the longitudinal median pronotal carina and the sublateral elytral carinae varies from fairly visible to low and indistinct. An elytral depression at the basal 1/3, normally present in Bryelmis, may not be evident in some individuals. Metathoracic wings may be present or absent. Females (n = 3) were slightly longer than males (n = 3) in a comparison of the length measurements of the longest and shortest specimens, with the longest specimen a female and the shortest a male.

Comparative and Diagnostic Comments. Externally, B. siskiyou (Fig. 9) most closely resembles B. rivularis, but differs in that the median pronotal carina is reduced, the sublateral elytral carinae are usually not as prominent, and the elytra are not deeply striate and punctate, giving the body a smooth appearance. Conversely, in B. rivularis (Fig. 8) the median pronotal carina is distinct, the sublateral elytral carinae are prominent, and the elytra are deeply striate with large punctures. In addition, the male genitalia of B. siskiyou (Fig. 6) have parameres which are straight at the tips, whereas B. rivularis (Fig. 7) has the paramere tips angled outward. Bryelmis idahoensis (Figs. 3, 4) is more rugose and sculptured with prominent carinae, sulci, striae, and punctures; unlike B. siskiyou and B. rivularis, the median pronotal carina is produced and ridge-like, the pronotal disc is smooth with few punctures and setae, and the lateral elytral sulcus is deep and trench-like.

Material Examined. 59 specimens. HOLOTYPE ♂ in EMEC, labeled: “CA: Shasta Co., Shasta NF, trib. Castle Cr., spring run at FS Rd. 25 5.4 rd. mi. W jct. I-5, 17-IX-1994, C. B. Barr // HOLOTYPE Bryelmis siskiyou” [red label]. Forty-two paratypes (P) [yellow labels] and 16 non-paratypes (NP) were examined from the following localities: Same data as holotype (2 P, BNHM; 1 P, CASC; 7 P, 1 NP, EMEC; 1 P, OSAC; 2 P, USNM); CALIFORNIA: Del Norte Co.: Six Rivers NF, trib. N. Fk. Smith R. at Cooper Flat, Hwy.199 4 mi, W Gasquet, 10-VI-2008, coll. C. B. Barr (2 P, EMEC), Humboldt Co.: Six Rivers Natl. Forest, Dragsaw Spring at FS Rd. 13N01, VII-29-2007, coll. J. J. Lee (2 NP, JJLC); Six Rivers Natl. Forest, Dragsaw Spring at F.S. Rd. 13N01, 14-VI-2008, C. B. Barr // 41.24789° N, 123.69340° W, elevation 784m (7 P, EMEC); data same, except W. D. Shepard (1 NP, WDSC); Six Rivers Natl. Forest, Red Mountain Creek at FS Rd. 10N12, V-30-02, coll. J. J. Lee (1 NP, JJLC); data same, except VIII-27-06 (1 NP, JJLC); data same, except VI-6-03 (2 NP, JJLC); data same, except VIII-27-06 (1 NP, JJLC); data same, except 23-VIII-2007 (1 NP, JJLC); Six Rivers Natl. Forest, Red Mountain Creek at F.S. Rd. 10N12, 14-VI-2008, C. B. Barr // 41.24697° N, 123.68943° W, elevation 722m (2 P, EMEC); data same, except W. D. Shepard (2 NP, WDSC); Redwood Creek trib. 10.6 km E Maple Creek, 7-VIII-2001 // 40°45′17″N, 123°44′23″W, elev. ~1050 m // California Dept. of Fish & Game,
of the collecting localities: *Anpunixis dispar* (Fall), *A. wawona*, *C. addenda*, *H. koebeli*, *L. avara*, *N. concolor*, *O. quadrimaculatus*, *Onobrevia nubifera* (Fall), *Rhzelmis nigra* Chandler, and *Z. parvula*.

**Etymology.** The specific epithet, *siskiyou*, refers to the mountain range, national forest, and county of the same name, all within the geographic range of the species. The origin of the word is unknown, but has been speculated to have been derived in the mid-1800s from Chinook or French names.

**KEY TO THE SPECIES OF BRYELMIS**

1. Pronotal median longitudinal carina prominent; pronotal sublateral carinae explanate and ridge-like, bordered by deep antero-medial depressions; pronotum distinctly wider than long (Figs. 3, 4). Idaho (Fig. 10) .......................... **B. idahoensis**

2. Male genitalia with tips of parameres flared to produce an obtuse angle (Fig. 7); pronotal median longitudinal carina distinct to base; elytra moderately to deeply striate with large punctures, sublateral carinae prominent (Fig. 8). Washington to Oregon (Fig. 10) .......................... **B. rivularis**

2′. Male genitalia with tips of parameres narrowly rounded, not obtusely angled (Fig. 6); pronotal median longitudinal carina low, often indistinct, more visible anteriorly; elytra lightly to moderately striate and punctate, sublateral carinae not prominent (Fig. 9). Oregon to northern California (Fig. 10) .......................... **B. siskiyou**

**DISCUSSION**

**Geographic Distribution.** The genus *Bryelmis* exhibits an interesting pattern of geographic distribution consisting of a coastal Pacific Northwest element, comprising two species, and a disjunct northern Rocky Mountain element in central Idaho. Collection records indicate that *B. siskiyou* and *B. rivularis* occur in the Coast Ranges, the former ranging from northern California to southern Oregon and the latter from northern Oregon to the Olympic Mountains of Washington, and that *B. idahoensis* occurs in northern and central Idaho primarily in the Clearwater River drainage (Fig. 10). Distribution records imply that the geographic ranges of the three species are allopatric, and while this is probably true of *B. idahoensis*, it would not be surprising if the ranges of *B. rivularis* and...
B. siskiyou are found to overlap in the Coast Ranges of west-central Oregon.

Early in the study I collected throughout Washington and Oregon specifically in search of additional records and failed to find Bryelmis in the dry Columbia Basin/Plateau region which occupies the eastern part of the states. Likewise, despite much sampling by me and others in streams of the Sierra Nevada Mountains of California, no specimens have been found there. The most eastern record of the coastal species B. rivularis is from the western Cascade Mountains near Salem, OR. Bryelmis siskiyou, also coastal, has been found as far east as the western Cascades near Medford, OR, and in the Trinity Mountains which are located in the eastern Coast Ranges of northern California. Additional collecting in the Cascades will possibly reveal further eastern occurrences of these species. The northern range of B. rivularis may extend into British Columbia, although examination of museum specimens from the area yielded no members of the species. I did not collect north of the Olympic Mountains of Washington.

Although two records of B. idahoensis are from very close to the Montana state line, the species has not been found in Montana and may not occur there. The border in that area is a barrier formed by the crest of the Bitterroot Range and the Continental Divide, with the terrain on the western side much lower and wetter than that of the east, which is in a rain shadow. As a result, many organisms are restricted to one side of the mountains or the other (M. A. Ivie, in litt.).

This peculiar disjunct distribution exhibited by many plant and animal taxa, and its origins, has been the subject of numerous research publications. The Clearwater River drainage in Idaho, containing the southernmost extension of the mesic coniferous forest in the northern Rocky Mountains, is an area that has long been hypothesized to be a glacial refugium due to the presence of species with coastal forest affinities (Daubenmire 1975). Subsequent studies involving plant distributions (Brunsfeld et al. 2001, 2007; Brunsfeld and Sullivan 2005; Carstens et al. 2005; Gavin 2009) have formally proposed and tested this hypothesis. McCune (1984) used the term “maritime extension” to refer to this area while discussing lichens with oceanic affinities, and it was called the Columbia Plateau Maritime Faunal Incursion Zone by Kavanaugh (1988) in a paper on the patterns, affinities, and origins of the Pacific Northwest insect fauna. Most recently, Björk (2010) discussed similarities between what he termed the Interior Wetbelt and the similar climate of the Northwest Pacific coast, and noted the greatest concentrations of disjunct coastal taxa occur in the Clearwater region.

Although B. idahoensis occurs in a hypothesized glacial refugium, I found that not to be the case for B. rivularis, the northernmost species. Comparison of records of continental and alpine glaciation with the known geographic distribution of the species revealed that the most northern locality from Clallam County, WA was covered by the continental ice sheet at its maximum (Thackray 2001).

Habitat and Microhabitat. The following habitat observations and summarizations are based on personal field notes and collections. Bryelmis idahoensis (13 observations) was found only in low-order, likely spring-fed, clear, cool to cold streams (Fig. 11), whereas the two coastal species also occur in larger streams. Bryelmis siskiyou (11 observations) inhabits clear, cold waters ranging from tiny spring runs to small streams (Fig. 12), while B. rivularis (5 observations) occurs in small to large (>7.5 m wide) streams which ranged from clear to tannin-stained (Fig. 13). One common feature of all of the sites was the presence of coniferous forest canopy cover and apparent high water quality.

The most striking similarity among collection localities was the presence of aquatic bryophytes. Qualitative collecting of microhabitats in streams where Bryelmis is present revealed that the adults almost exclusively occurred in conjunction with aquatic bryophytes, particularly liverworts, rather than other substrates; an exception was the additional utilization of waterlogged wood by B. idahoensis. The larvae of at least two of the three species are sometimes found in root masses as well as bryophytes. Quantitative sampling of B. rivularis from Hell Roaring Creek, WA yielded 53 adults and 17 larvae from bryophytes, 2 adults and 1 larva from substrate kick samples, and 2 adults and 16 larvae from roots. Another collector captured adult beetles in a pitfall trap set in a moist forest within several meters of a stream. Adult beetles in the subfamily Elminae are not known to leave the water, so it is likely that these individuals had recently emerged from pupation, which occurs terrestrially.

Samples of bryophytes associated with all three species of Bryelmis were collected for identification by specialists. Several samples taken from two Washington localities (Donkey and Hell Roaring Creeks), some of which had yielded B. rivularis and some not, indicated that the preferred bryophytes were the aquatic liverworts C. polyanthos rivularis and S. undulata, whereas the non-preferred bryophytes were aquatic mosses, Fontinalis neomexicana Sull. and Lesq. (Fontinalaceae) and P. riparioides. Subsequent to this revelation, I targeted aquatic liverworts while searching for Bryelmis and discovered a second species, B. siskiyou, associated with C. polyanthos rivularis in northern California. Of eight bryophyte samples collected in Idaho in association with the third species, B. idahoensis, six contained C. polyanthos rivularis; at two sites the species was associated...
with aquatic mosses. Other bryophytes present in the samples included the mosses *Brachythecium asperrimum* (C. Müller Hal.) Sullivant and *Kindbergia praelonga* (Hedwig) Ochyra (both Brachytheciaceae), *P. riparioides*, and *Plagiomnium rostratum* (Schrader) T. Koponen (Mniaceae).

The liverwort *Chiloscyphus polyanthos* (L.) Corda, with two subspecies, is widely distributed in western and northeastern North America and western Europe (Global Biological Information Facility data.gbif.org/species/13725423). In a study of the distribution and habitat demands of riparian bryophytes in the western Cascades of Oregon, Jonsson (1996) found *C. polyanthos* to be commonly and abundantly submerged on rocks and boulders in streams, and considered the species characteristic of medium-sized, low-elevation streams at 420–1,250 m. Sites at which I collected both

Figs. 11–13. 11) Fern Creek, Clearwater Co., ID, type locality of *Bryelmis idahoensis*; 12) Dragsaw Spring, Humboldt Co., CA, habitat of *Bryelmis siskiyou*; 13) Hell Roaring Creek, Jefferson Co., WA, type locality of *Bryelmis rivularis*. 
**Chiloscyphus** and **Bryelmis** ranged from 722–1,072 m in elevation.

**Phylogeny and Relationships.** A phylogeny of the Elmidae has yet to be proposed, although research is currently underway using molecular and morphological tools. On the basis of adult and larval morphology, **Bryelmis** appears to be most closely related to the genera **Ampumixis** and **Cleptelmis**, sharing common features with each, although this supposition warrants further examination. Adults of **Bryelmis** and **Cleptelmis** have indistinctly or distinctly forked sublateral carinae on the pronotum, whereas **Bryelmis** and **Ampumixis** both have a median carina on the pronotum. The larva of **Bryelmis** most closely resembles that of **Ampumixis**, both having similar sclerite characters.

**Larvae.** Although it may be possible to find morphological characters to separate the larvae of the three species, I have not attempted to do so. Larvae may be tentatively assigned to species based on association with adults and/or the collection locality.

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