

An annotated key to the adult males of the northwestern Nearctic species of *Paraleptophlebia* Lestage (Ephemeroptera: Leptophlebiidae) with the description of a new species

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An illustrated key to the males of the northwestern Nearctic species of *Paraleptophlebia* Lestage is presented together with a short account of the taxonomy and the ecology of the species. *Paraleptophlebia aquilina* n.sp. is described and illustrated. *Paraleptophlebia sculleni* Traver is reinstated as a valid species and how it differs from *P. gregalis* (Eaton), with which it had been synonymized, is described. The status of *P. memorialis* (Eaton) and that of *P. temporalis* (McDunnough) are redefined.

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On trouvera ici une clé illustrée d'identification des mâles des espèces de *Paraleptophlebia* du nord-ouest de l'Amérique du Nord ainsi qu'un bref aperçu du statut taxonomique de chaque espèce et des données écologiques qui la concernent. Une nouvelle espèce, *Paraleptophlebia aquilina*, est décrite et illustrée. *Paraleptophlebia sculleni* Traver redevient une espèce valide et les différences entre cette espèce et *P. gregalis* (Eaton), avec laquelle elle avait été synonymisée, font l'objet d'une discussion. Le statut de *P. memorialis* (Eaton) et celui de *P. temporalis* (McDunnough) sont redéfinis.

The genus *Paraleptophlebia* Lestage is represented in North America by approximately 35 species and the adults of most species can be identified fairly readily with existing keys (Traver 1935; Burks 1953; Day 1956). However, the examination of material from the northwestern United States, mainly from Oregon, has disclosed problems in need of clarification. This, plus the discovery of a new taxon, prompted the

elaboration of this key to the adults of *Paraleptophlebia* species in northwestern North America (areas defined as western Canada and northwestern United States in Edmunds *et al.* 1976). New drawings of the genitalia were made for most species, except in two instances where no material was available.

Key to adult males of northwestern Nearctic species of *Paraleptophlebia*

The nomenclature used in this key is that suggested by Traver (1935). The external genitalia of *Paraleptophlebia* (Figs. 1 to 15) comprise two penis lobes which are more or less fused. In some species, the lobes bear two pairs of lateral appendages, the more distal being called the lateral apical processes; the lower pair, the reflexed spurs. Some species possess only one of these sets, others have no lateral appendages at all. All figures are drawn to the same scale except Figs. 5 and 6, which are taken from Edmunds *et al.* (1976) and Traver (1935), respectively, and for which the scales are unknown. Figures 1, 1a, 2a, 4, 7, 8a to 8d, 9a, 9b, 9d to 9g, and 10a are drawn from slides prepared by the late Dr. J. McDunnough and Fig. 11 is drawn from a slide prepared by Dr. G. F. Edmunds. All others are based on the examination of fresh specimens.

1. Basal segment of forceps with a dorsal rounded enlargement at base (Figs. 1a, 2a, 3a) 2
 Basal segment of forceps straight throughout its length, without basal lobe 4
2. Penis lobes separated by a wide crescent-shaped excavation, each lobe bearing a large flaplike process projecting medially so that excavation is almost closed. Middle abdominal segments predominantly brown *P. bicornuta* (Figs. 1, 1a)
 Penis lobes separated by rounded excavation deeper than wide (Figs. 2, 3). Middle abdominal segments predominantly white 3
3. Lateral apical processes of penis lobes very long, reaching beyond midlength of reflexed spurs as seen in side view; spurs slender, sinuate distally *P. moerens* (Figs. 2, 2a)
 Lateral apical processes of penis lobes short, divided at tip by rounded notch; reflexed spurs fairly wide and strongly outcurved from midlength to tip *P. debilis* (Figs. 3, 3a)
4. Penis lobes without lateral appendages (Figs. 4–9) 5
 Penis lobes with one or two pairs of lateral appendages (Figs. 10–15) 10
5. Penis lobes consisting of two long, slender tubelike structures united at base only, pointed and outcurved at tip; wings deep amber *P. brunneipennis* (Fig. 4)
 Penis lobes not tubelike, stalkier (Figs. 5–9) 6
6. Penis lobes simple, entire (Figs. 5–6) 7
 Each penis lobe divided by a deep notch (Figs. 7–9) 8

7. Wings hyaline with apical portion smoky brown; veins light brown *Paraleptophlebia* sp. (Idaho) (Fig. 5)
Wings hyaline on their entire surface; veins reddish *P. rufivenosa* (Fig. 6)
8. Outer division of each penis lobe shorter than inner division *P. heteronea* (Fig. 7)
Outer division of penis lobe a long twisted spine; inner division tubular and shorter than out (Figs. 8 and 9) 9
9. Tubular portion of penis lobe short, its length on outer side equal to or shorter than its width at base of notch
..... *P. memorialis* (Fig. 8)
Tubular portion of penis lobe longer than wide *P. temporalis* (Fig. 9)
10. Penis lobes without reflexed spurs but with strong aquiline lateral apical processes directed outwards *P. aquilina* (Fig. 10)
Penis lobes with reflexed spurs, with or without lateral apical processes (Figs. 11–15) 11
11. Sternite 9 produced into two fingerlike lateral processes reaching 2/3 length of penis lobes; reflexed spurs sickle-shaped, strongly bent outwards *P. falcata* (Fig. 11)
Sternite 9 more evenly produced without such processes, reflexed spurs not so bent (Figs. 12–15) 12
12. Penis lobes very narrow; lateral apical processes absent; reflexed spurs originating midlength of lobes, slender, tapering to apex and directed outwards and backwards in same plane as lobes; excavation between lobes very narrow *P. vaciva* (Fig. 12)
Penis lobes wider; reflexed spurs not particularly slender and not in same plane as lobes; excavation between lobes wide (Figs. 13–15) 13
13. Lateral apical processes present and fairly long, hooklike and pointing downwards *P. guttata* (Fig. 13)
Lateral apical processes absent (Figs. 14–15) 14
14. Middle abdominal segments predominantly white, wings hyaline with colourless veins; anterior wings about 5.5 mm; penis slender, constricted near midlength, reflexed spurs slender *P. sculleni* (Fig. 14)
Middle abdominal segments predominantly brown; wings hyaline; veins light to dark amber; anterior wings about 7.5 mm; penis stalky with margins usually convex, reflexed spurs wide *P. gregalis* (Fig. 15)

Taxonomic notes

Paraleptophlebia aquilina n. sp.

This new taxon was discovered during the course of a study on the emergence of mayflies in three different third-order streams of the Cascade Range in Central Oregon, Mack Creek (elevation 800 m), Grasshopper Creek (880 m), and Quartz Creek (490 m), which are part of the McKenzie River system draining the western slope of the Cascade Range (44° N, 122° W). Details of these study sites can be found in Anderson *et al.* (1984).

MALE IMAGO (in alcohol): Length of body and of fore wing 5–6 mm. Head and thorax dark reddish brown with darker markings on thoracic pleural folds. All legs yellowish white, hyaline white in some specimens. Wings hyaline, with faint brown tinge at base of fore wing, all veins and crossveins colourless; milky cloud in stigmatic area of some specimens; crossveins in stigmatic area slightly slanted. First abdominal segment dark tan to brown with darker lateral triangular patches on tergum. Terga 2–7 white with blackish brown patches in posterolateral angles, these patches more or less triangular in segments 2 and 3 and never extending upwards to form a continuous line on posterior margin of tergum. Terga 8 and 9 entirely suffused with blackish brown. Tergum 10 yellowish brown, no suffusion. Pleural folds narrowly margined with dark brown in all segments. Sterna 2–7 hyaline white with a blackish brown dot in posterolateral angles, these dots somewhat reaching beyond pleural folds to blend with posterolateral patches of terga. Sterna 8 and 9 yellowish brown with an oblong dark brown blotch medially. Midventral ganglionic marks bright orange on all sternites in some specimens, obsolete in others. Genital forceps white; each penis lobe bearing a beaklike lateral apical process, but no reflexed spur (Fig. 10). Caudal filaments white.

FEMALE IMAGO (in alcohol): Length of body 5–6 mm, of fore wing 5.5–6.5 mm. Head and thorax dark tan. Legs yellowish

white. Wings hyaline, longitudinal veins light tan, crossveins colourless. Abdominal segments entirely suffused with dark purplish brown, more so along pleural folds and somewhat less ventrally. Sterna 8 and 9 with darker oblong blotches medially. Terminal abdominal sternum (9) with a relatively deep broadly rounded excavation on posterior margin; posterolateral angles of sternite rounded.

NYMPH: Unknown.

HOLOTYPE: ♂, Quartz Creek, Cascade Range, Oregon, altitude 490 m. July 16, 1982, G. W. Courtney.

ALLOTYPE: ♀, same data.

PARATYPES: 8♂, 2♀, same locality and collector, July 9 – August 4, 1982. 5♂, 3♀, Mack Creek, Cascade Range, Oregon, altitude, 800 m. July 28, 1982, G. W. Courtney. 2♂, 9♀, Grasshopper Creek, Cascade Range, Oregon, altitude, 880 m. July 28, 1982, G. W. Courtney.

The holotype and allotype and some paratypes have been deposited in the Collection entomologique Ouellet-Robert of the Université de Montréal, Québec; other paratypes have been sent to the Canadian National Collection of Insects (Ottawa) and the Smithsonian Institution (USNM, Washington) collections. The other specimens from the emergence traps, which yielded 447♂ and 667♀, both imagines and subimagines, were used for biomass estimations at Oregon State University and are no longer available.

Taxonomy

Paraleptophlebia aquilina is very similar to the eastern *P. assimilis* Banks (see Traver 1935): the penes of both species are devoid of reflexed spurs and bear aquiline lateral apical processes, hence the name of the new species. The examination of a paratype of *P. assimilis* (Fig. 10a) shows that the only difference in the genital structures of the two species is that the lower margin of the beaklike process is evenly rounded in *P. aquilina* and sinuate in *P. assimilis*. However, additional

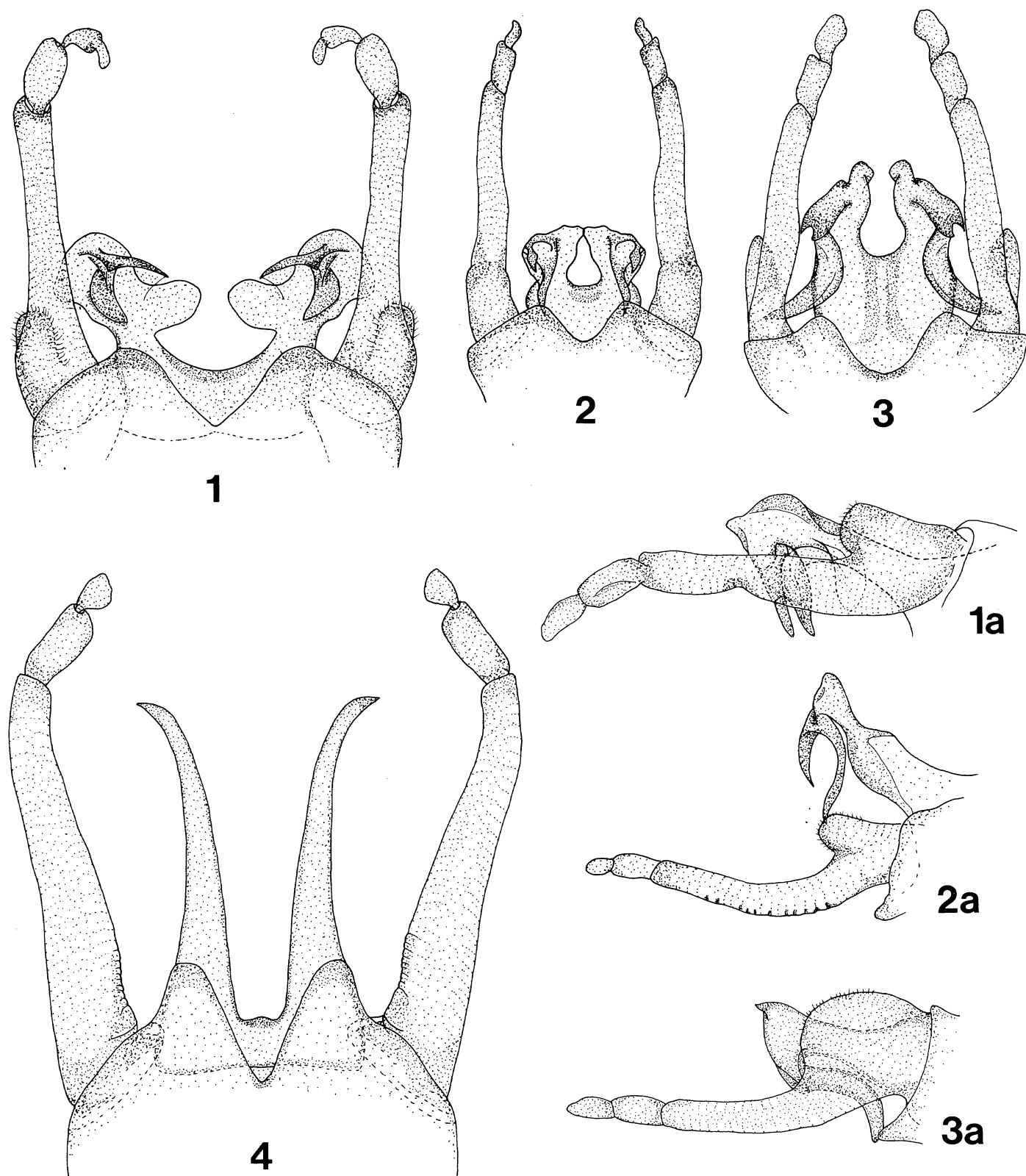


FIG. 1. *Paraleptophlebia bicornuta* (McDunnough), male genitalia, ventral view. FIG. 1a. *P. bicornuta*, male genitalia, lateral view, from paratype. FIG. 2. *P. moerens* (McDunnough), male genitalia, ventral view. FIG. 2a. *P. moerens*, male genitalia, lateral view, from paratype. FIG. 3. *P. debilis* (Walker), male genitalia, ventral view. FIG. 3a. *P. debilis*, male genitalia, lateral view. FIG. 4. *P. brunneipennis* (McDunnough), male genitalia, ventral view, from paratype.

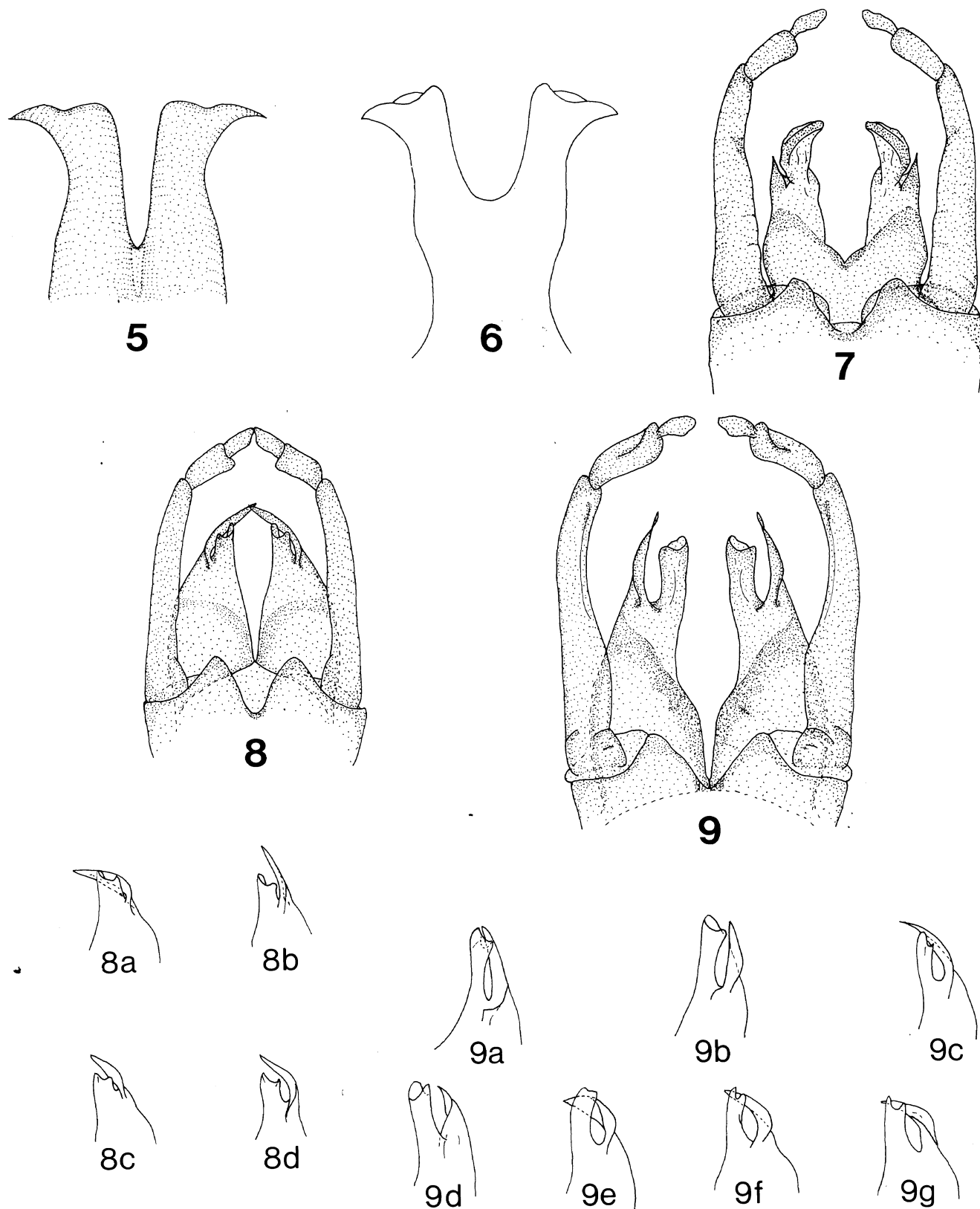


FIG. 5. *Paraleptophlebia* sp. (Idaho), penis lobes, ventral view. FIG. 6. *P. rufivenosa* (Eaton), penis lobes, ventral view. FIG. 7. *P. heteronea* (McDunnough), male genitalia, ventral view, from paratype. FIG. 8. *P. memorialis* (Eaton), male genitalia, ventral view. FIGS. 8a-8d. Variants of the extremity of a penis lobe in *P. memorialis*. FIG. 9. *P. temporalis* (McDunnough), male genitalia, ventral view. FIGS. 9a-9g. Variants of the extremity of a penis lobe in *P. temporalis*. Fig. 9a from paratype.

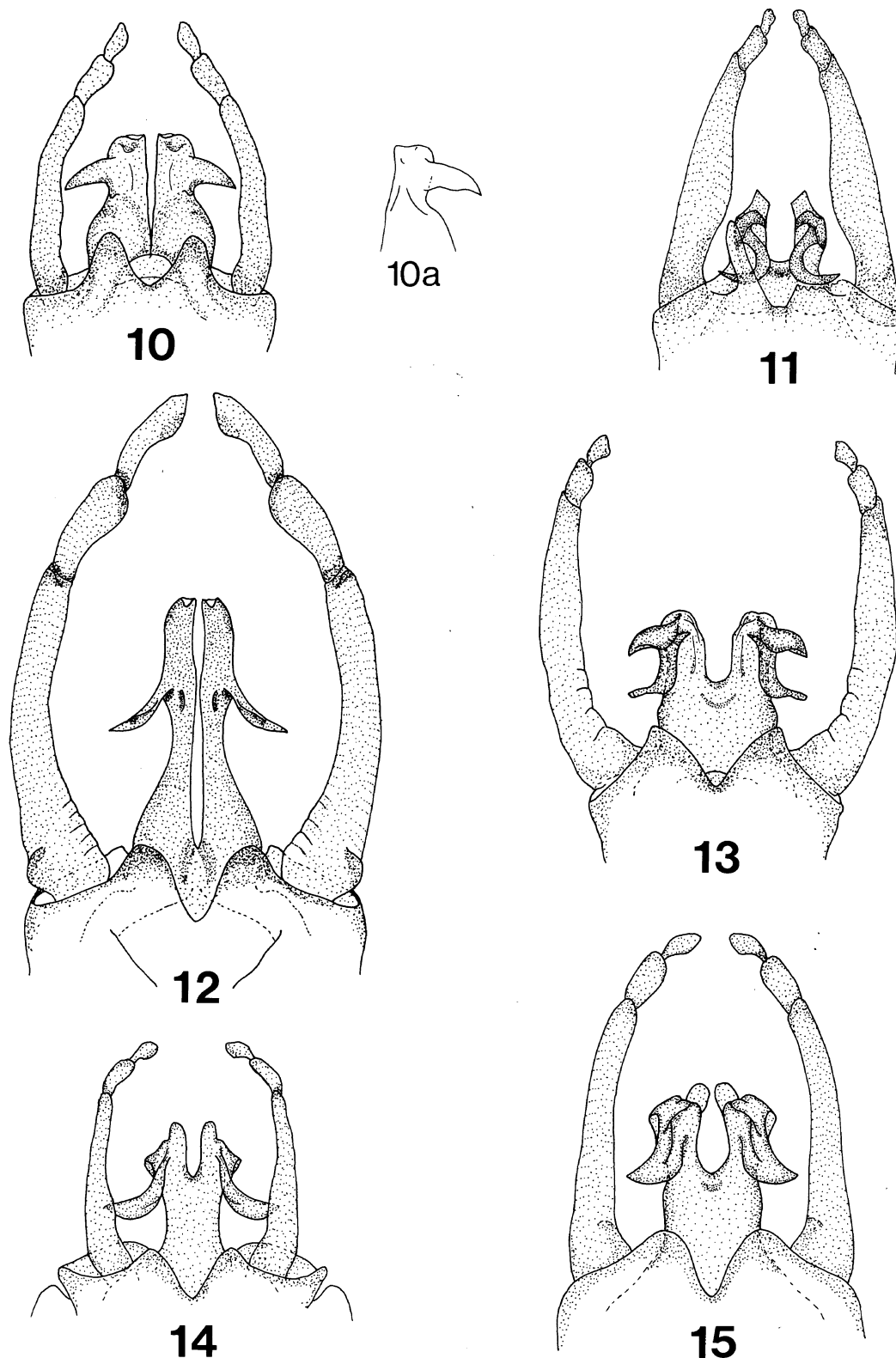


FIG. 10. *Paraleptophlebia aquilina* n. sp., male genitalia, ventral view. FIG. 10a. *P. assimilis* (Banks), extremity of a penis lobe. FIG. 11. *P. falcata* Traver, male genitalia, ventral view, with one process of sternite 9 cut out. FIG. 12. *P. vaciva* (Eaton), male genitalia, ventral view. FIG. 13. *P. guttata* (McDunnough), male genitalia, ventral view, from paratype. FIG. 14. *P. sculleni* (Traver), male genitalia, ventral view. FIG. 15. *P. gregalis* (Eaton), male genitalia, ventral view.

characters will help to separate the two species, notably the coloration of the second and seventh abdominal segments (white in *P. aquilina*, dark in *P. assimilis*), the smaller size of *P. aquilina*, its entirely whitish legs (the first pair of legs is brownish in *P. assimilis*), and the less extensive markings on its abdominal segments.

There is no doubt that *P. aquilina* and *P. assimilis* are sibling species. However, their minor morphological differences, plus the wide geographical gap between their respective ranges, force us to consider them as having evolved separately. *Paraleptophlebia assimilis* was first described from a large warm river (North Fork of the Swannanoah River, North Carolina (Banks 1914)) and has since been found in southeastern Pennsylvania (in White Clay Creek, temperatures reaching 18°C (Sweeny and Vannote 1982), and in a small mountain stream at an elevation of about 400 m (Markarian 1980)). The emergence of *P. assimilis* in the latter stream is reported as extended. So far, *P. aquilina* has appeared only in cold water mountain streams of Oregon (temperature range about 1 to 12°C), at altitudes varying from 480 to 800 m, and its emergence period there is short.

More extensive collecting in the geographical gap separating the two species may eventually uncover the existence of intermediate populations and reduce the status of the two species to geographical variants, but until then, we choose to consider them as distinct species.

Paraleptophlebia bicornuta (McDunnough, 1926)

The nymphs are described by Allen (1955); they also appear in Jensen's (1966) and Lehmkuhl and Anderson's (1971) keys. Moreover, Lehmkuhl and Anderson (1971) key the adult females.

KNOWN RANGE: Alberta, British Columbia, Montana, Idaho, Washington, Oregon.

ECOLOGICAL NOTES: The species seems to prefer warm, slow moving, silted rivers and streams at lower elevations (Kraft 1964; Jensen 1966; Gilpin and Brusven 1970; Lehmkuhl and Anderson 1971). It is a late emerger (August to October; Kraft 1964; Jensen 1966; Lehmkuhl and Anderson 1971), and its cycle is classified as a univoltine summer cycle (Clifford 1982). The nymphs are detritivores (Kraft 1964; Gilpin and Brusven 1970). The adults swarm in late afternoon and early evening in Oregon and Washington (Edmunds *et al.* 1976).

Paraleptophlebia brunneipennis (McDunnough, 1924)

KNOWN RANGE: Washington.

The nymph seems to be unknown. The species is apparently quite rare and is known only from its type locality. Nothing is known of its biology.

Paraleptophlebia debilis (Walker, 1853)

Nymphs are described in Ide (1930), Edmunds (1952), and Leonard and Leonard (1962). The adult females are keyed in Lehmkuhl and Anderson (1971) and the nymphs in Gordon's (1933), Traver's (1935), and Burks' (1953) keys to eastern species and in Edmunds' (1952), Allen's (1955), and Jensen's (1966) keys to western species. The species also appears in a comparative table of known nymphs of California species (Day 1956).

KNOWN RANGE: Widespread across the United States and Canada, south to California on the west coast and south to South Carolina on the east coast.

ECOLOGICAL NOTES: The species prefers slow-moving waters and seems to move to pools prior to emergence. Details on

habitat preferences may be found in a number of works (Ide 1930; Sprules 1947; Leonard and Leonard 1962; Kraft 1964; Jensen 1966; Patrick *et al.* 1967; Gilpin and Brusven 1970; Lehmkuhl and Anderson 1971, 1972). The time of emergence varies depending on the location; the species is commonly known as a late summer emerger in Quebec and Ontario (Sprules 1947; Harper and Harper 1982, 1984; Williams 1982), Michigan (Leonard and Leonard 1962), Alberta (Boerger and Clifford 1975; Clifford 1978), the Rocky Mountains (Edmunds *et al.* 1976), and Idaho (Jensen 1966) but seems to be able to emerge throughout the spring and summer in lowland streams of Oregon (Kraft 1964; Lehmkuhl and Anderson 1971, 1972). The mating flight of the species occurs at sunset in Oregon and earlier and earlier in the day as days become colder in September in Utah (Lehmkuhl and Anderson 1971; Edmunds *et al.* 1976). The nymphs are mostly detritivores and are classified as collectors and gatherers (Hamilton and Clifford 1983). The life cycle is flexible and is discussed at length in Clifford (1982). The eggs are described and illustrated by Koss (1968) and the drifting habits of the species are discussed by Lehmkuhl and Anderson (1972).

Paraleptophlebia falcata Traver, 1934

The nymph has never been described and the biology of the species is still unknown.

KNOWN RANGE: Idaho and Oregon.

Paraleptophlebia gregalis (Eaton, 1884)

The nymphs appear in keys (Allen 1955; Jensen 1966) and in a table (Day 1956). Females and nymphs are keyed along with other Oregon species but are not separated from those of *P. sculleni* (Lehmkuhl and Anderson 1971).

KNOWN RANGE: British Columbia, Oregon, California.

ECOLOGICAL NOTES: The species is said to live in faster waters than *P. debilis*; its emergence in Oregon lasts from March to November (Kraft 1964).

Paraleptophlebia gregalis and *Paraleptophlebia sculleni* Traver 1934 were synonymized by Lehmkuhl and Anderson (1971) but are hereby reinstated to their original status; Lehmkuhl and Anderson recognized two forms of males but were unable to differentiate females or nymphs of the two forms. *Paraleptophlebia sculleni* and *P. gregalis* are most certainly sibling species, but the examination of large series of emerging adults from Mack Creek and Quartz Creek (both species) and from Grasshopper Creek (*P. sculleni* only) in the Cascade Mountains of Oregon has shown sufficient differences (coloration, size, details of the male genitalia, ecology) to warrant the recognition of separate taxa.

In male *P. gregalis*, the anterior wing is about 7.5 mm (7–9 mm); all legs are yellowish; the ground colour of the abdomen is entirely amber brown with an overlaying diffuse grayish suffusion; the wings are hyaline with pale to dark amber venation. The anterior wings of the female are about 7.5 mm in length (7–10 mm); the coloration of the female abdomen is also dark amber brown with grayish diffuse suffusion; the wings of all examined females have a decidedly amber tinge and the veins are dark amber.

In contrast, the male of *P. sculleni* is predominantly hyaline white; all legs are whitish; abdominal segments 2–7 are hyaline white with darker markings, i.e., triangular stigmatic marks, narrowly black posterior margins dorsally; segments 1 and 8–10 are dark brown; the ganglionic marks are sometimes entirely

obsolete, sometimes pale brown, or sometimes visible only on segment 7; the anterior wing of the male is 5.5 mm (5–6 mm), hyaline with colourless veins. In the female, the ground colour of the abdomen is a pale grayish yellow and the abdominal markings are fairly definite, like those of the male, but segments 1 to 4 are sometimes darker than the others. The anterior wing of the female is 6 mm in length (5.5–7 mm); it is hyaline with all veins or only the costal veins a very pale amber.

It is probably through these characters of colour and size, which can be seen even in the subimago, that the species can best be separated. More significantly, however, there are also differences in the male genitalia (Figs. 14 and 15). Both species have large recurved reflexed spurs with widely rounded lower margins, but the spurs are more slender in *P. sculleni*; moreover, the penis lobes are stalkier in *P. gregalis* and their outer margin usually becomes convex about midlength, while those of *P. sculleni* are constricted. Also, the subapical "shoulders" of the penis lobes are more rounded in *P. gregalis*. Females of both species bear the same characteristic sclerotized markings on sternite 8 (Lehmkuhl and Anderson 1971, Fig. 3) but differ by the colour of their wings and abdomens as described above. In a recent study of the emergence of Oregon mayflies in the Cascade Range (in preparation), the two species were also found to exhibit different emergence patterns even where they cohabit: *Paraleptophlebia gregalis* has an extended pattern of emergence (June–October), while that of *P. sculleni* is more synchronized (July–August), which further corroborates their separate identities.

Paraleptophlebia guttata (McDunnough, 1924)

Paraleptophlebia guttata is an eastern species, but Moore (1977) identified nymphs of *P. guttata* in Yellowknife River and Baker Creek, Northwest Territories, so the species has been included in the key. However, we consider these locality records to be questionable since no adults seem to have been available to corroborate the identifications and the nymphs of many species are still undescribed.

The nymphs are described in Ide (1930) and Moore (1977) and are keyed in Ide (1930), Gordon (1933), and Burks (1953) along with other eastern species.

KNOWN RANGE: Ontario, Quebec, New Brunswick, Nova Scotia, New Hampshire, New York, Pennsylvania, West Virginia, Virginia, North Carolina, South Carolina, Tennessee, Georgia, Arkansas, South Carolina, Northwest Territories.

ECOLOGICAL NOTES: Ide (1930) found nymphs in shallow water along the edges of streams, Sprules (1947) found them only in rubble and in very small numbers, and Berner (1975) describes the species as inhabiting mountain streams in North Carolina, Tennessee, and Georgia. Emergence takes place from mid-June to the end of July in New York (Gordon 1933) and from the end of April to the end of June in Arkansas (Peters and Warren 1966), but the species is described as late seasonal in South Carolina (Carlson 1973). The mating flight takes place in bright sunlight, in midsummer (Berner 1975).

Paraleptophlebia heteronea (McDunnough, 1924)

The nymphs are described and keyed in Edmunds (1952) and also keyed in Allen (1955) and Jensen (1966) who cautions that the nymphs of *P. debilis*, *P. heteronea*, and *P. memorialis* are very similar.

KNOWN RANGE: Alberta, British Columbia, Colorado, Montana, Wyoming, Utah, Idaho.

ECOLOGICAL NOTES: The species inhabits small to medium-sized streams and rivers in moderately flowing current; details on its habitat can be found in a number of studies (Kraft 1964; Jensen 1966; Gilpin and Brusven 1970; Minshall and Minshall 1977; Rabeni and Minshall 1977). Emergence takes place from January to November in Oregon (Kraft 1964), and from early June to early August in Idaho (Jensen 1966). Mating flights occur from midday to early afternoon in Utah (Edmunds *et al.* 1976). The species feeds mainly on detritus (Gilpin and Brusven 1970).

Paraleptophlebia memorialis (Eaton, 1884)

Paraleptophlebia memorialis was first described by Hagen (1874) under the name *Leptophlebia pallipes*; the species was then renamed *L. memorialis* by Eaton (1884) who declared *L. pallipes* a secondary homonym.

The nymphs are described by Edmunds (1952) and by Kilgore and Allen (1972) and they are keyed in Allen (1955) and in Jensen (1966).

KNOWN RANGE: Alberta, British Columbia, Colorado, Utah, New Mexico, Arizona, Idaho, Oregon, California.

ECOLOGICAL NOTES: *Paraleptophlebia memorialis* was found in Idaho mountain streams on lightly silted cobbles, in slow to moderate riffles (Jensen 1966; Gilpin and Brusven 1970). It emerges in July in Idaho (Jensen 1966) and its mating flight occurs during midday in Utah (Edmunds *et al.* 1976). It is detritivorous (Gilpin and Brusven 1970). The eggs are described by Koss (1968).

The status of both *P. memorialis* and *P. temporalis* (McDunnough 1926) will be discussed here since the attribution of specimens to either species is very difficult with the existing literature, some specimens possessing the genitalia of one form and the coloration of the other and vice versa. Both have bilobed penis lobes (Figs. 8 and 9), with a tubular inner part and a long sharp spine on the outer side. McDunnough (1926) defined the species *P. memorialis* (under the name of *L. pallipes*) by associating a series of males with the type specimen, a female. In the same paper, he named a new species, *Leptophlebia temporalis*, which he recognized as being very similar to *P. pallipes* but in which "the penes are more widely separated apically and the lateral stimuli do not curve upwards but lie in the same plane and parallel to the penes; at their base is a distinct small ventral tooth which is lacking in *pallipes*." Traver (1935) considered the same characters as distinctive. Examination of a large number of specimens from our own collections in Oregon and from material given to us by Dr. G. F. Edmunds, Jr. (California, Oregon, and Idaho) as well as a reexamination of all specimens of both species in the Canadian National Collection of Insects, determined by McDunnough (Alberta, British Columbia, Wyoming, Colorado, and Oregon), have revealed that there indeed appear to be two species but their definition cannot be based on the characters stated above. Figures 8 and 9 illustrate the genitalia of both species as we recognize them: in *P. memorialis*, the tubular portion of the penis lobe is fairly short, so that the notch between this inner part and the outer spine is very shallow; the length of the spine and its degree of twisting may vary (Figs. 8a–8d); on the other hand, in *P. temporalis*, the tubular part is much longer so that the spine is separated from it by a much deeper excavation. In the material we examined, specimens with genitalia of the *P. memorialis* type are associated with the coloration described by

McDunnough for *P. pallipes* and there seems to be little variation: abdominal tergites 3–6 and the anterior portion of 7 are hyaline whitish with a short black transverse dash in the extreme lateral corner posteriorly, just above the spiracular line; one dot (rarely two) is usually present on the spiracular line; brown ganglionic marks are present ventrally; the thorax and abdominal segments 1 and 8–10 are dark brown and the second abdominal segment is hyaline or paler brown. We have seen two specimens with no markings on the abdominal segments.

In contrast, *P. temporalis* is much more variable in colour and size (wing size ranges from 6 to 9 mm). McDunnough's description of the coloration of *P. temporalis* fits the majority of the specimens. The markings on the abdominal segments are much more extensive than in *P. memorialis*: the transverse dashes on the posterior margin of the abdominal tergites may extend forward into triangles and extend upwards along the entire posterior margin of the segments and there may also be some grayish suffusion covering a large part of each segment. However, some specimens are very pale and may resemble *P. memorialis* in all features except the shape of the genitalia. These variations do not seem to follow any particular geographical gradient as far as could be ascertained from the material at hand. As to the genitalia, they are also very variable (Figs. 9, 9a–9g); the tubular part may be more or less long but never squat as in *P. memorialis*. The length of the spine and the degree of its twisting vary among the specimens and the spine, when long enough, usually lies behind the tubular part, but this is not always the case. In his description of *P. temporalis*, McDunnough mentions the presence of a small ventral tooth at the base of each penis lobe; this tooth is very well defined in some specimens (Fig. 9a), very reduced in others (Fig. 9b), and entirely absent from others.

We believe that the drawings labeled *Paraleptophlebia pallipes* and *Paraleptophlebia temporalis* by McDunnough (1926) and by Traver (1935) all represent the genitalia of *Paraleptophlebia temporalis*. Our Figs. 8 and 9 illustrate the differences between the two species. Notwithstanding these clarifications, some specimens may still prove difficult to identify (e.g., Fig. 8d) because the size of the tubular portion of the penis lobes used to separate the two species does not constitute an absolute character.

Paraleptophlebia moerens (McDunnough, 1924)

This is an eastern species, but adults were found in Reindeer Depot, Northwest Territories (Harper and Harper 1981) and it is therefore included here.

Descriptions and keys of the nymphs can be found in Gordon (1933), Traver (1935), and Burks (1953).

KNOWN RANGE: Ontario, Quebec, Nova Scotia, New York, Illinois, North Carolina, Kentucky, Tennessee, Georgia, Northwest Territories.

ECOLOGICAL NOTES: The species inhabits riffles and pools and is herbivorous (Minshall 1968). It is known to emerge from the end of June through July in New York (Gordon 1933), from May to August in Kentucky (Minshall 1968), and from the end of April to mid-June in Ontario (Coleman and Hynes 1970). Swarming flights have been observed in early afternoon (Ide 1930). The cycle is classified as a univoltine winter cycle (Clifford 1982); Coleman and Hynes (1970) discuss the cycle in relation to temperature. The eggs are described and illustrated by Smith (1935).

Paraleptophlebia rufivenosa (Eaton, 1884) and *Paraleptophlebia* sp. (Idaho)

KNOWN RANGE of *P. rufivenosa*: British Columbia, Idaho, Oregon, California.

Jensen (1966) described a new species (called *Paraleptophlebia* sp. (Idaho) in Edmunds *et al.* 1976). Unfortunately, his description has never been formally published. It seems that the male of this species is very similar to the male of *P. rufivenosa* as described by Traver (1935), but can be distinguished from it by the more pronounced apical projections of its penes and by the smoky apical portion of its fore wings. We have seen no specimens of either species and the characters used in the key are drawn from Jensen's and Traver's descriptions. Jensen (1966) also points out that Traver (1935) described the male of *P. rufivenosa*, known hitherto from females only, without explaining how she associated the male with the previously described females, so the status of the species still appears somewhat uncertain. The biology of both these species is unknown.

Paraleptophlebia sculleni Traver, 1934

KNOWN RANGE: Oregon.

The biology of the species is still unknown; its taxonomic status is discussed under *Paraleptophlebia gregalis* above.

Paraleptophlebia temporalis (McDunnough, 1926)

The taxonomic status of the species is discussed above under *Paraleptophlebia memorialis*. The nymphs have never been formally described, but they appear in a key along with other Oregon species (Lehmkuhl and Anderson 1971).

KNOWN RANGE: Alberta, British Columbia, Wyoming, Idaho, Oregon, California.

ECOLOGICAL NOTES: Small nymphs are present in riffle areas but seem to move to slower waters as they grow; they are passive drifters. Emergence was observed from April to June in a lowland Oregon stream and from June to September in a river with a more constant temperature (Lehmkuhl and Anderson 1971, 1972). The species has a univoltine winter cycle (Clifford 1982).

Paraleptophlebia vaciva (Eaton, 1884)

The nymphs are described and keyed in Jensen (1966).

KNOWN RANGE: British Columbia, Idaho, Washington, Oregon.

ECOLOGICAL NOTES: The species inhabits high mountain streams and rivers. It emerges in mid-July in Idaho (Jensen 1966). The mating flight was observed in sunlight at 1000 and in mid-afternoon in Washington (Edmunds *et al.* 1976) and in mid-afternoon on Mount Hood, Oregon, at the edge of a thicket, a few metres from the stream (personal observations).

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