

**Contributions to the Biology and Taxonomy of
the *Paraleptophlebia* of Oregon¹**
(Ephemeroptera : Leptophlebiidae)

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This paper reports on the biology and taxonomy of western Oregon mayflies. The data are based primarily on monthly collections from Oak Creek, Benton County, in the foothills of the Coast Range, and bimonthly collections from the Metolius River, Jefferson County, on the east side of the Cascade Range. Details of the sampling areas and methods are given in Lehmkuhl and Anderson (1970).

Allen and Edmunds (1956) reported 10 species of *Paraleptophlebia* from Oregon. Three of these, *P. falcula* Traver (type locality, Corvallis, Oregon), *P. rufivenosa* (Eaton) and *P. vaciva* (Eaton) (type locality of both, Mt. Hood, Oregon) are apparently quite rare as Allen and Edmunds (op. cit.) did not see Oregon specimens. Males of 5 species were identified from the study area by using Traver's (1935) key—*P. bicornuta* (McDunnough), *P. debilis* (Walker), *P. gregalis* (Eaton), *P. sculleni* Traver, and *P. temporalis* (McDunnough). However, Day (1954) suggested that *P. sculleni* may be a synonym of *P. gregalis* and we have been unable to distinguish the nymphs or females of these species (see below). The other species recorded from Oregon by Allen and Edmunds were *P. heteronea* (McDunnough) and *P. memorialis* (Eaton) (as *P. pallipes* Hagen). The latter occurs in Idaho and California (Day, 1956) but we did not collect it during the present study. *P. heteronea* was one of the common mayflies in Berry Creek, Benton County, in Kraft's (1963) study. Female specimens labelled *P. heteronea* collected by Kraft from Berry Creek were examined by one of us (DML) and were found to be indistinguishable from female *P. temporalis* of the present study.

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Most *Paraleptophlebia* species are univoltine and pass the winter in the egg stage; the habitat of nymphs ranges from moderately swift riffles to muddy substrates covered with leaf drift (Gordon, 1933). The biology of *P. debilis* in a northern stream is discussed by Clifford (1969). Koss (1968) investigated the fine structure of the eggs of several *Paraleptophlebia* species, including *P. debilis*. Chapman and Demory (1963) found that the nymphs of *Paraleptophlebia* fed mainly on detritus. The nymphs came to the top of stones at night and the proportion of algae in their diet increased at night. Gut contents also reflected changes in food availability at different seasons.

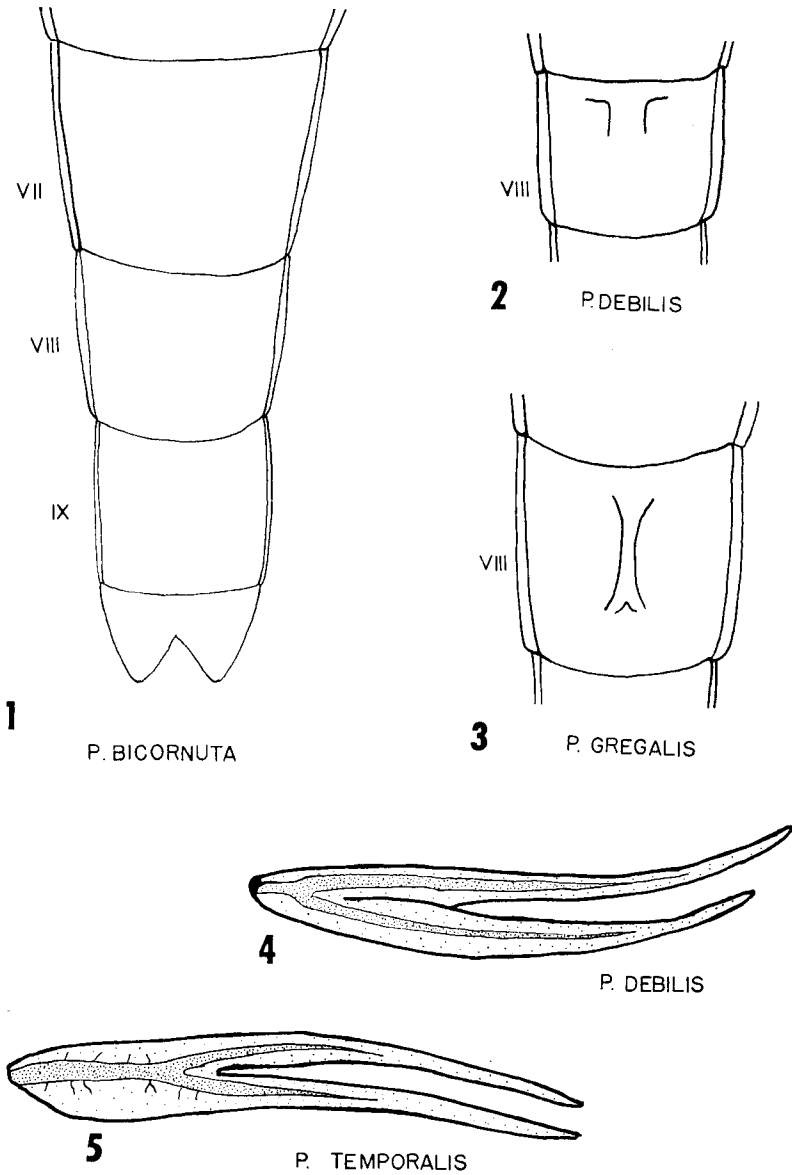
Keys to the western species of *Paraleptophlebia* males are given by Day (1956) for California, and Jensen (1966) for Idaho. Jensen provided a key to the mature nymphs, and Day tabulated potential taxonomic characters for the California nymphs. In the present paper we provide keys to the adult females and mature nymphs of *P. gregalis*, *P. temporalis*, *P. debilis*, and *P. bicornuta*.

KEY TO FEMALES OF PARALEPTOPHLEBIA LESTAGE OF OREGON

1. Notch in terminal abdominal sternite wide at opening, depth of notch about equal to width of opening (Fig. 1); with or without conspicuous sclerotized markings on sternite VIII (Fig. 2 & 3) 2
 - Notch in terminal abdominal sternite a narrow V-shaped, depth of notch $1\frac{1}{2}$ to 2 times the width of the opening; no conspicuous sclerotized markings on sternite VIII; sternite VII produced posteriorly to cover part of segment VIII so that in ventral view segment VII about twice as long as VIII; body usually rusty red and wings slightly tinged with yellow *temporalis* (McDunnough)
2. Markings on sternite VIII indistinct or absent; fork of Rs in hind wing bisected by a well developed 3rd vein, fork encloses 2 or 3 pairs of crossveins *bicornuta* (McDunnough)
 - Markings on sternite VIII as in Fig. 2 or 3; fork of Rs in hind wing either lacking or, if present, with usually none and never more than one pair of crossveins 3
3. Sclerotized markings on segment VIII a narrow dark ridge continuing at least $\frac{1}{2}$ the length of the segment and diverging at both ends (Fig. 3); fork of Rs usually present *gregalis* (Eaton)
 - Sclerotized markings on segment VIII widely divergent at the anterior end and forming a ridge less than $\frac{1}{2}$ the length of the segment (Fig. 2); fork of Rs represented only by detached arms, base of fork indistinct *debilis* (Walker)

KEY TO NYMPHS OF PARALEPTOPHLEBIA LESTAGE OF OREGON

1. Mandibles with large tusks projecting forward and visible from above *bicornuta* (McDunnough)
 - Mandibles without large tusks 2



FIGS. 1-3. Abdominal sterna of *Paraleptophlebia* females: FIG. 1) *P. bicornuta*; FIG. 2) *P. debilis*; FIG. 3) *P. gregalis*. FIGS. 4-5. Gills of *Paraleptophlebia* nymphs: FIG. 4) *P. debilis*; FIG. 5) *P. temporalis*.

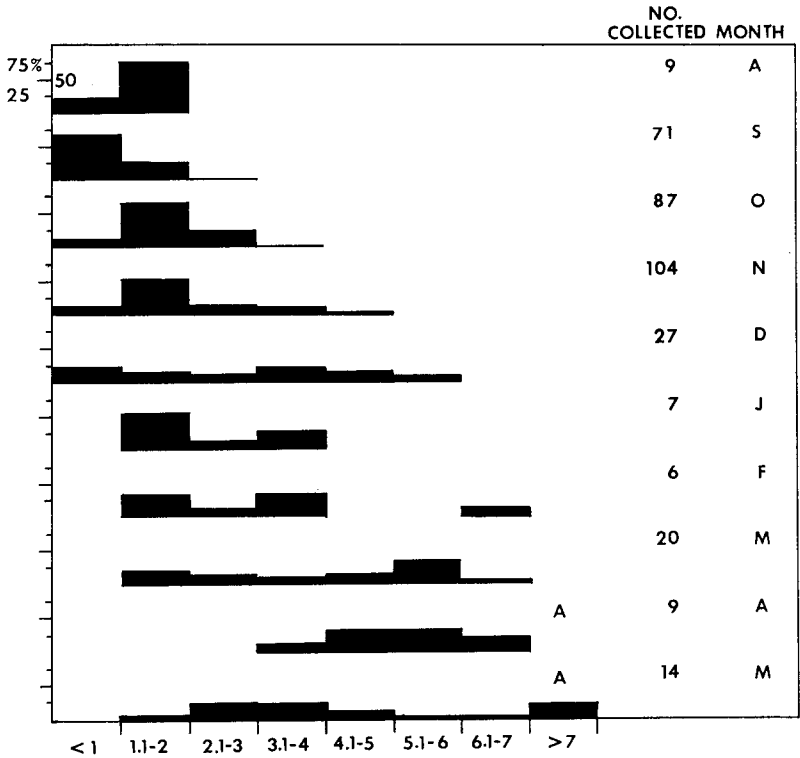


FIG. 6. Size class distribution of *Paraleptophlebia temporalis* nymphs in monthly benthos samples, Oak Creek, Benton Co., Oregon. A = adults collected. Nymphs absent in June and July.

2. Tracheae of gills forked in middle (Fig. 5), dark markings or bands lacking on legs *temporalis* (McDunnough)
- Tracheae of gills forked at base (Fig. 4) 3
3. Denticles of tarsal claws minute, scarcely if at all visible at 60 × magnification; femur, tibia and tarsus without definite dark bands *gregalis* (Eaton)
- Denticles of tarsal claws larger, usually visible at 30 ×; femur, tibia and tarsus each with a dark band *debilis* (Walker)

PARALEPTOPHLEBIA GREGALIS (Eaton)

Leptophlebia gregalis Eaton, 1884. Trans. Linnean Soc. London, Sec. Ser.-Zool., 2: 98.

Paraleptophlebia sculleni Traver, 1934. J. Elisha Mitchell Sci. Soc., 50: 189. NEW SYNONYMY.

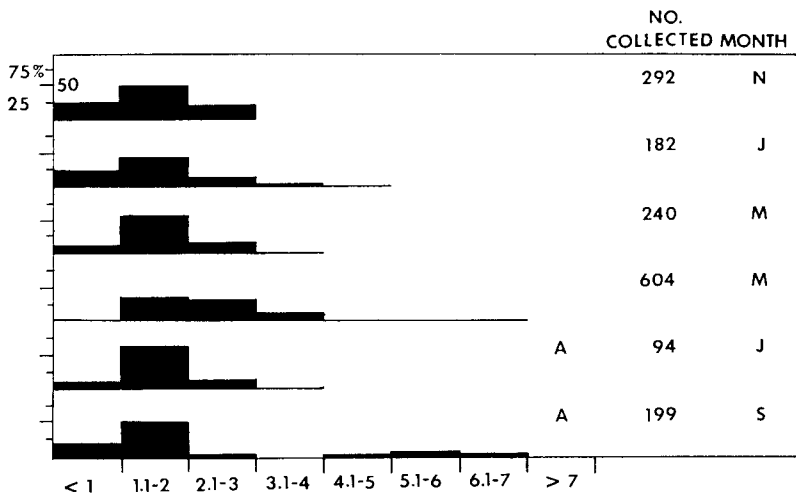


FIG. 7. Size class distribution of *Paraleptophlebia temporalis* nymphs in benthos samples, Metolius River, Jefferson Co., Oregon. A = adults collected.

The type locality of *P. gregalis* is Mt. Hood, Oregon; subsequently Traver described *P. sculleni* from a single male collected at Corvallis, Oregon. On the basis of her 1935 key and verification table, it is distinguishable from *P. gregalis* on color (middle abdominal segments predominantly white in *sculleni*, and brown in *gregalis*) and *sculleni* is slightly smaller. Day (1954) suggested, because of marked similarity of the genitalia, that "*P. sculleni* may . . . prove to be a synonym of *P. gregalis*."

One of us (DML) has collected extensively from the type locality of *P. sculleni*. Both color variants of males were obtained but no difference could be found in genitalic structures. In addition, deliberate searches were made and rearings carried out but distinguishable females or nymphs were not found. Thus we believe that only one polymorphic species is involved and the name *P. gregalis* has priority for the species.

The life cycle of *P. gregalis* is similar to that of *P. temporalis*.

PARALEPTOPHLEBIA TEMPORALIS (McDunnough)

P. temporalis had a univoltine cycle in Oak Creek (Fig. 6). Nymphs were absent in June and July, but the new generation had reached 2 mm in length by August. There was a large increase in the population during September and October, and more than 70% of the annual total nymphs were collected between September and November. Nymphs increased

TABLE 1. Distribution of age classes of *Paraleptophlebia temporalis* in Oak Creek.

Age Class*	Total for year	% per biotope		
		Still Backwater	Glide	Riffle
I	81	5	10	85
II	198	15	8	77
III	42	57	31	12
IV	32	67	28	5
V	5	40	60	0

* I—newly hatched, gills thread-like; II—gills more developed, wing buds absent; III—wing buds evident; IV—mesothoracic wing pads completely cover metathoracic wing pads; V—wing pads black.

gradually in size during the winter, and adults emerged from April to June.

The life cycle is not as clear in the Metolius River (Fig. 7) which is spring fed and has a fairly constant temperature all year. Nymphs of the smallest size class occurred in all collections, so apparently the eggs hatched throughout the year. Adults emerged from June to September, which was somewhat later than at Oak Creek.

In Oak Creek, *P. temporalis* occurred as small nymphs in the riffle areas from August to November. From November to March it was absent from areas of rapid current and was most abundant in slow waters. There was an apparent shift in biotope preference, with eggs hatching in the riffle but the nymphs moving to slower waters as they matured. There is a negative correlation between size and preferred current velocity (Table 1). The species occurred in both gravel areas and plant beds in the Metolius River but was most abundant in the

TABLE 2. Distribution of age classes of *Paraleptophlebia temporalis* in the Metolius River.

Age Class*	Total for year	% per biotope		
		Mid- <i>Ranunculus</i>	Edge- <i>Ranunculus</i>	Gravel
I	37	11	51	38
II	674	27	45	28
III	227	64	27	9
IV	175	88	11	1
V	20	90	10	0

* See Table 1.

TABLE 3. Distribution of age classes of *Paraleptophlebia debilis* in Oak Creek.

Age Class*	Total for year	% per biotope			
		Still Backwater	Glide	Edge- Riffle	Mid- Riffle
I	84	13	20	64	3
II	424	35	28	36	1
III	293	30	26	43	1
IV	297	11	29	60	0
V	22	27	32	41	0

* See Table 1.

plant beds. As is apparent in Table 2, the small nymphs were common on gravel substrates where the current was fast, but a lack of large individuals in the gravel suggests a movement to the plant beds prior to emergence.

PARALEPTOPHLEBIA DEBILIS (Walker)

This species occurred in both Oak Creek and the Metolius River, but in the latter it inhabited only muddy side pools and was not taken in the routine benthos samples. In Oak Creek, the nymphs were scarce or absent in winter, and young nymphs were first collected in the March samples (Fig. 8). In comparison with *P. temporalis*, this is a later emerging species. Adults, or nymphs with dark wing pads, were taken from June to November. The life cycle is univoltine with long periods of hatching and emergence and with most adults occurring in the autumn. The eggs apparently have a resting period of several months during the winter.

Jensen (1966) reported that prior to emergence nymphs often migrate into the still water of marginal pools. This is a similar observation to that noted for *P. temporalis* above. As indicated in Table 3, except for a high proportion of small nymphs in the edge of riffle biotope, *P. debilis* nymphs in Oak Creek were spread through the biotopes sampled, but within these biotopes the nymphs were always in the areas of slowest current velocity.

MATING AND OVIPOSITION.—The following observations were made at Helmick State Park, Luckiamute River, Polk Co., Oregon, on 24–27 July 1966. Mating swarms appeared suddenly as the sun dropped behind the trees in the late afternoon. Only individual males or small groups of males were seen while the sun still shone on the water.

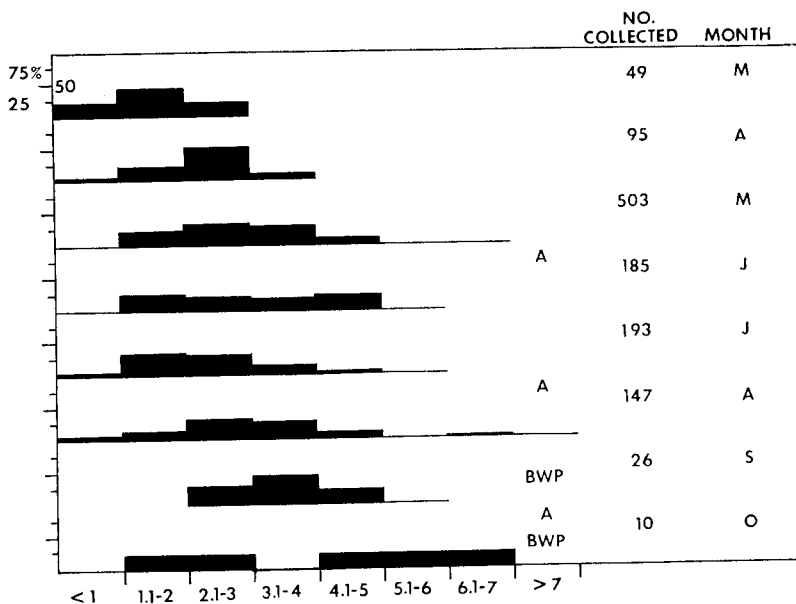


FIG. 8. Size class distribution of *Paraleptophlebia debilis* nymphs in monthly benthos samples, Oak Creek, Benton Co., Oregon. A = adults collected. BWP = mature nymphs with black wing pads. Nymphs absent November–February.

Within 3–4 minutes after the sun ceased shining on the surface, groups of 30–40 males appeared and swarmed 2–4 feet above the water, about 2–10 feet from shore. The dance was performed by the male repeatedly fluttering rapidly upward 4–5 feet above the water, then the wings and cerci were spread, the forelegs were stretched far forward, and they floated down until they were about 2 feet above the surface. Occasionally they fell into the water and usually could not free themselves.

Females appeared about 30 minutes after the males began to swarm. When a female entered a swarm she was immediately grasped by a male. The pair lost altitude and copulation was completed in the time it took them to fall 3 feet. The pair then separated and the female immediately began skipping across the surface of the water depositing eggs. She dropped to the surface of the water, dipped the tip of her abdomen, flew about 2 feet into the air, and dropped again. Three dips were enough to deposit all eggs. The time from the first contact between male and female until the last of the eggs were laid was only

a few seconds. After oviposition the females flew to the bushes along the edge of the stream.

Twenty-two males were captured from a mating swarm and kept in a net to determine the length of adult life. These were captured at about 8 p.m. and by 9 p.m. the next day all but one were dead. Thus it appears that males do not live to swarm more than one day.

PARALEPTOPHLEBIA BICORNUTA (McDunnough)

Although nymphs of several species of *Paraleptophlebia* have large tusks on the mandibles, *P. bicornuta* is the only species with tusks in western Oregon. Nymphs were often collected with *P. debilis* under silty stones in slow moving streams and rivers, and were occasionally collected in Oak Creek. The life cycle of *P. bicornuta* is similar to that of *P. debilis*, with adults emerging in summer and fall.

LITERATURE CITED

- ALLEN, R. K. AND C. F. EDMUNDS, JR. 1956. A list of the mayflies of Oregon. Proc. Utah Acad. Sci., Arts, Lett., 33: 85-87.
- CHAPMAN, D. W. AND R. DEMORY. 1963. Seasonal changes in the food ingested by aquatic insect larvae and nymphs in two Oregon streams. Ecology, 44: 140-146.
- CLIFFORD, H. F. 1969. Limnological features of a northern brown-water stream, with special reference to the life histories of the aquatic insects. Amer. Midland Natur., 82: 578-597.
- DAY, W. C. 1954. New species and notes on California mayflies. II (Ephemeroptera). Pan-Pac. Entomol., 30: 15-29.
1956. Ephemeroptera. In: Aquatic insects of California, ed. by R. L. Usinger. Berkeley, Univ. Calif., p. 79-105.
- GORDON, E. L. 1933. Notes on the ephemerid genus *Leptophlebia*. Bull. Brooklyn Entomol. Soc., 28: 116-134.
- JENSEN, S. L. 1966. The mayflies of Idaho (Ephemeroptera). Unpubl. M.S. Thesis. Univ. Utah, 367 pp.
- KOSS, R. W. 1968. Morphology and taxonomy of Ephemeroptera eggs. Ann. Entomol. Soc. Amer., 61: 696-721.
- KRAFT, G. F. 1963. Seasonal occurrence and distribution of insects in Berry Creek. Unpubl. Ph.D. thesis. Oregon State Univ., 122 pp.
- LEHMKUHL, D. M. AND N. H. ANDERSON. 1970. Observations on the biology of *Cinygmula reticulata* McDunnough in Oregon (Ephemeroptera: Heptageniidae). Pan-Pac. Entomol., 46: 268-274.
- TRAYER, J. R. 1935. Systematics. Part II. In: The biology of mayflies, by J. G. Needham, J. R. Traver, and Yin-Chi Hsu. Ithaca, Comstock, p. 239-751.