

SYSTEMATIC STUDIES IN PLECOPTERA

By
WILLIAM E. RICKER



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IN PLECOPTERA

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WILLIAM E. RICKER

formerly of the

Department of Zoology, Indiana University

INTRODUCTION

AFTER the publication of Hagen's Monograph and Provancher's papers, the study of stoneflies in North America languished until, near the close of the nineteenth century, Nathan Banks began the neuropteroid studies which he has continued down to the present. J. G. Needham at Cornell University interested himself in this and other aquatic orders early in the present century and also interested students in them. The first of these, Lucy Smith, published two papers and then turned to other activities, but Peter W. Claassen undertook the long labours which culminated in the Needham and Claassen Monograph of 1925.

With the publication of this monograph the study of North American stoneflies entered on a new period of activity. Dr. Claassen supplemented the work on the imagoes with a volume on nymphs in 1931. After this, between periods of ill-health, he published some descriptions and worked on a time-consuming and valuable catalog of the stoneflies of the world, which was published in 1940, shortly after his death. Meantime T. H. Frison had published on the fall and winter stoneflies of Illinois in 1929, and after six years followed this with a volume on all the stoneflies of that state. He then issued a series of systematic papers, culminating in a 120-page bulletin in 1942 which completed the description of nymphs and adults of nearly all our Perlidae, and marked substantial progress in Perlodidae and other groups. Shortly afterward illness struck Dr. Frison in his turn, culminating in his untimely death in 1945.

The death of its two foremost students, both in the prime of life, was and remains a serious setback to stonefly study in North America. Mr. Ferris Neave published several papers during the early 1930's, but he has found it impossible to continue his work in the order. Fortunately, however, Dr. John F.

Hanson became interested in Plecoptera and has published a series of descriptions and revisions, beginning in 1938 and continuing down to the present. Another who has been active recently is Mr. Philip Harden, working in Minnesota.

The present writer's published work dates from 1935, but because of other commitments field work has been done only sporadically, and papers have appeared at infrequent intervals. After Dr. Frison's demise, both the superb collection of the Illinois Natural History Survey and Dr. Frison's notes were placed at my disposal by Dr. H. H. Ross, and this has provided at once the materials and the stimulus for another phase of active work. Other museums and many individuals have also very kindly cooperated in lending materials for examination. Among these may be mentioned Dr. J. Becquaert and Mr. Nathan Banks of the Museum of Comparative Zoology, Harvard College; Dr. E. A. Chapin of the United States National Museum; Mr. Noel M. Comeau of the Museum Provincial de Québec; Dr. D. C. Denning of the University of Wyoming; Dr. Henry Dietrich of Cornell University; Dr. P. W. Fattig of Emory University, Atlanta;⁴ Dr. J. F. Hanson of the University of Massachusetts; Dr. T. H. Hubbell of the University of Michigan Museum of Zoology; Dr. F. P. Ide of the University of Toronto; Mr. Stanley J. Jewett, Jr., of the U.S. Fish and Wildlife Service; Dr. G. F. Knowlton of the Utah State Agricultural College; Dr. J. W. Leonard of the Michigan Institute for Fisheries Research; Drs. J. McDunnough, O. Peck, G. Holland, and W. J. Brown of the Division of Entomology, Department of Agriculture, Ottawa; Drs. H. H. Ross, B. D. Burks, M. W. Sanderson, and others of the Illinois Natural History Survey; Dr. D. C. Scott of the University of Georgia; Dr. William Sprules of the Department of Fisheries, Ottawa; Dr. Henry Townes of North Carolina State College; Dr. Neal Weber of Swarthmore College; and others. A number of drawings made by Drs. Carl O. Mohr and K. M. Sommerman of the Illinois Survey have been made available by Dr. Ross. I am also indebted to four overseas students who have assisted by sending specimens and drawings: M. Jacques Aubert of the Museum of Lausanne, Dr. Per Brinck of the University at Lund, Mr. D. E. Kimmins of the British Museum (Natural History), and Mrs. Mitsuko Kohno of Wakamatsu, Japan.

A major part of the results of these recent studies appear in the present volume. The first two sections are an attempt to

bring together our knowledge of two groups which have not recently been treated as a whole: the genus *Nemoura* and the family Perlodidae. Part III contains more scattered contributions to other divisions of the order, including reviews of a few smaller genera or subgenera. The plan followed has been to illustrate new or imperfectly understood species or structures, but to avoid repeating descriptions and figures already in print. Full bibliographic references are given to such descriptions, so that reference to them may be made as expeditiously as possible. However, complete bibliographies have not been given, as they are already conveniently summarized, up to 1939, in Claassen's catalog (1940). The general distribution of each species treated here has been summarized, but detailed locality records have been omitted except in the case of new species. Of course we may expect many of the indicated ranges to be greatly extended by future collecting.

It would be impossible to overemphasize my debt to Dr. Frison and his industrious colleagues, the results of whose collecting activity form the backbone of the Urbana collection and provide the principal basis for the present paper. Part II, treating the Perlodidae, represents a project which Dr. Frison had himself outlined before his death, and he had gone as far as to draw up a key representing his provisional conception of the generic and subgeneric groupings and relationships. If the arrangement here departs considerably from that outline, it is because repeated study of the specimens has brought new characters to attention and gradually crystallized the concept of two large American genera, each with a considerable number of subgenera.

An attempt at a general phylogeny for Plecoptera has been made recently (Ricker, 1950). The present studies suggest one or two modifications of the scheme proposed there. The "main stem" of stonefly evolution from Eustheniidae to the Systellognatha involves a shift of the origin of the supra-anal process from the tip of the 10th tergite to its anterior margin, thus splitting the tergite in half. At the same time a tough envelope or cowl is developed from the sides of the cleft and surrounds the supra-anal process posteriorly. Study of *Peltoperla zipha* shows that it has a well-developed cowl of this sort, but that it has the 10th tergite entire and the supra-anal process developed in the primitive position from its tip. (In other *Peltoperlae* the

cowl is lost and the supra-anal process much reduced.) Thus *zipha* represents an intermediate situation on the phylogenetic tree, in respect to these characters, which was not recognized in my earlier article. The above structure, together with the lateral thoracic gills (sometimes also cervical gills) found in it and other *Peltoperlae*, ally that genus more closely to the main stem of stonefly development, and less closely to the Nemouridae. This is given formal recognition in the revised family tree of figure 1.

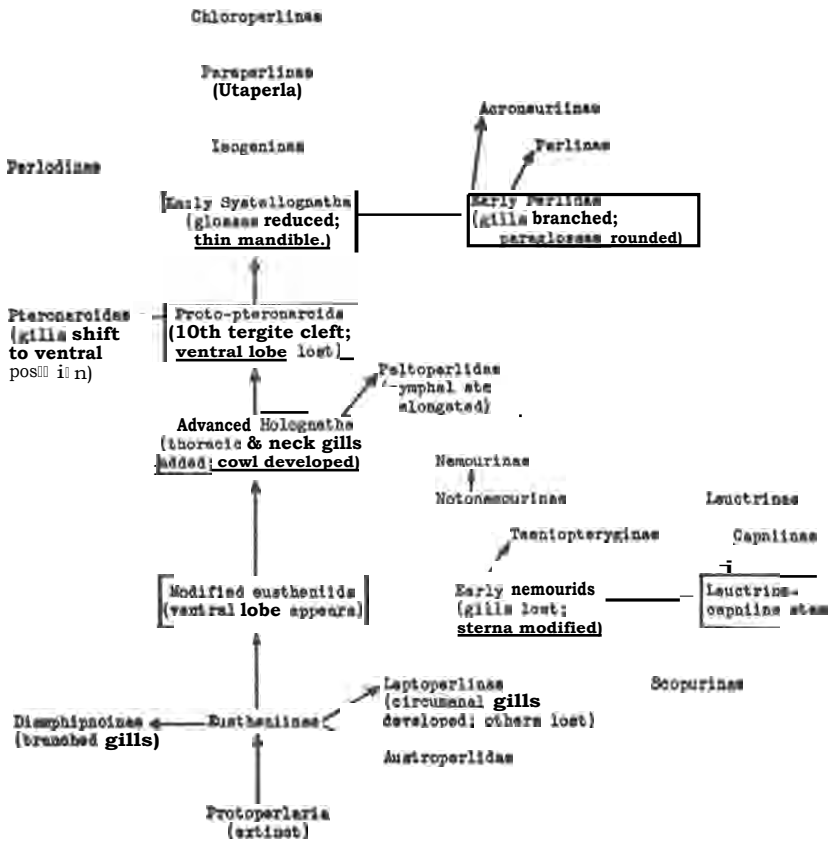


Figure 1. Phylogenetic tree for Plecoptera.

One other transition stage was overlooked in 1950. In developing the Isoperlinae by modification of Isogeninae, attention was called to the intermediate character of *Calliperla*, which

retains a briefly cleft 10th tergite and short membranous supra-anal process. However, in the genus *Isoperla* itself there is a reminder of isogenine ancestry in the species *clio*, where there is a small terminal membranous notch (representing the former complete cleft) and elevated spinulose ridges to either side of it (remains of the "genital hooks").

Finally, the new genus *Utaperla* closes a gap that existed near the crown of the phylogenetic tree. The subfamily *Paraperlinae* has hitherto contained only genera having an elongated head capsule of a type which is quite outside of normal stonefly morphology. Thus in spite of the fact that paraperline genitalia (especially in *Paraperla*) constituted a link between Isogeninae and Chloroperlinae, it was thought necessary to assign that role to an hypothetical ancestral group. *Utaperla*, however, while evidently belonging in *Paraperlinae*, has the head capsule very little elongated and thus practically qualifies itself for the ancestral role. In any event the subfamily *Paraperlinae*, with this broader range of structure, would include that ancestor, and thus one less reconstructed group need be postulated in the family tree.

Collections referred to frequently in the text are abbreviated as follows

CNC: Canadian National Collection, Division of Entomology, Ottawa.

CU: Cornell University, Department of Entomology, Ithaca.

INHS: Collection of the Illinois Natural History Survey, Urbana.

MPQ: Collection of the Quebec Provincial Museum, Quebec City (containing the Provancher collection).

UMMZ: University of Michigan Museum of Zoology, Ann Arbor.

USNM: United States National Museum, Washington.

Holotypes and allotypes of species described in this paper are deposited in the INHS collection, except as otherwise indicated.

PART I. The Genus *Nemoura* in North America

ALTHOUGH *Nemoura* is one of the larger genera of stoneflies in North America, little attempt has yet been made to indicate the relationships which exist among its species. Two keys to the males are in use : that of Needham and Claassen's Monograph (1925), and one by the writer for British Columbia species (1943) ; but neither makes much attempt at a natural arrangement of the species, and neither includes the whole of the species now known. A key to females has never been attempted.

In Europe four well-defined subgenera of *Nemoura* are recognized, which are considered genera by some. Disregarding species not recently recognized, and all of Navás' species, Claasseh (1940) lists 5 species of *Amphinemura*, 7 of *Protonemura*, 2 of *Nemurella*, and about 28 of typical *Nemoura* from Europe west of the steppes ; while 7 species of *Protonemura* and 4 of *Nemoura* s.s. have been described from the Caucasus.

Of these four European subgenera, two are represented in America. Dr. Frison (1935) proposed the use of *Amphinemura* Ris for *N. venosa* Banks, on the basis of its four branched cervical gills. This and other close resemblances, particularly in the subanal lobes, make the use of this name correct for this species and several others. The other European group represented here is *Nemoura* sensu stricto, to which three species can be assigned, one of them being also a European species. The subgenera *Protonemura* and *Nemurella* have no American representatives, however, and the great majority of our species show no close affinity to European forms, or, as far as known, to Asiatic ones either (cf. Wu, 1938).

The types of structure which have been most useful in defining subgenera and species-groups in *Nemoura* are as follows:

- (1) Peculiarities of wing venation.
- (2) Pigmentation of the wings.
- (3) Presence or absence of gills, their position and structure (observable in both adult and nymph).
- (4) Shape and sclerotization of the cerci (useful chiefly in the male).
- (5) Presence or absence of a lobe on the base of the male 9th sternite.

- (6) Form of the male subgenital plate (9th sternite).
- (7) Form of the male subanal lobes.
- (8) Form of the male supra-anal process.
- (9) Form of the male 10th tergite.
- (10) Form of the female 7th and 8th sternites. (Either of these may be enlarged and produced so as to get the name "subgenital plate".)
- (11) Number, size and arrangement of spines and hairs on the nymph.

In describing the morphology of the different groups it is convenient to have in mind a typical or most frequent condition, with which less frequent, "modified" or "aberrant" types may be compared. A list of these is given below, though in some instances it is difficult to decide which of two or more alternatives is really most frequent. Even if a decision on this point could always be reached, a *Nemoura* constructed by adding up all these "typical" structures would not necessarily represent the original *Nemoura* from which others have descended. For example, comparison with other Nemouridae suggests that deeply-divided subanal lobes may be an ancestral character, though in American *Nemoura* today they appear only in *Amphinemura*.

(1) The wings of *Nemoura depressa*, shown by Needham and Claassen (1925, p. 355, Fig. 6) are typical of a majority of American species, though the more posterior branches of A₂ are longer in the larger species, and occasionally one of them will divide. Other variations are the proximad displacement of the slanting costal crossvein in *Paranemoura* (*ibid.*, p. 355, Figure 3), and the fusion of A₁ and A₂ near their tips in *Soyedina* (*ibid.*, p. 295, Fig. 17).

(2) Clear and pigmented wings occur with about equal frequency, but tend to be uniform within a subgenus. When present, pigment is often heavier along the veins; its lengthwise distribution is usually interrupted by transverse clear areas, giving the wing a "banded" appearance.

(3) Absence of gills is more frequent than their presence. When present, gills are cervical in position, except in *Visoka*, where they are labial. The cervical gills number four in all American species, though six are found in the European *Protonemura*; they may be branched or simple.

(4) The membranous type of cercus is typical. Partial or complete **sclerotization** occurs in *Nemoura* s.s., in *Visoka*, and in *Ostrocerca*.

(5) The lobe at the base of the male 9th sternite is found in all subgenera except *Paranemoura* and *Lednia*.

(6) A simple male 9th sternite or subgenital plate is nearly as broad as long, rounded, with a short acute terminal process. The principal variation in shape is elongation and narrowing, found especially in *Ostrocerca* and *Soyedina*.

(7) The simplest type of male subanal lobe is a **rather** small subtriangular plate, such as is found in *Prostoia*. Departures from this form are numerous and very varied.

(8) The male supra-anal process is never "simple" in the sense of resembling that of the **female**. The fully-sclerotized and anteriorly recurved type is quite common, and may well be primitive. Other types are broader, partly membranous, and complex in structure.

(9) The 10th tergite ordinarily has a fairly simple ring dorsally, with a posterior median extension at the tip of which the supra-anal process is borne. In a group of subgenera this posterior extension is depressed ventrally and the process lies in the depression so formed, being tilted forward but not completely recurved. In a few instances there are lateral processes of the tergite.

(10) The simple form of female 7th and 8th sternites would be a uniformly sclerotized ring. Either segment may be elongated and **sclerotized**, with or without a notched tip ; or only certain parts may be sclerotized. When the 7th is much produced, the 8th underneath is usually only very weakly chitinized.

(11) Aside from the gills, the principal peculiarity of nymphal structure noticed to date is the cirlet of long spines present midway along the femora in *Zapada*. The more ordinary condition is for the femoral spines to be irregularly distributed.

(12) In size the range for males is from about 4 to 15 mm. to the tip of the wings, and for females 5 to 17 mm. Some general notions of size will be indicated for each subgenus, according to the following scheme :

| | Males | Females |
|--------|-------|---------|
| Small | 4-7 | 5-8 |
| Medium | 8-11 | 9-12 |
| Large | 12-15 | 13-17 |

KEYS TO SUBGENERA

MALES

- 1 Cerci elongated and heavily sclerotized out to the tip, on at least the outer surface ; the tip sharp, or with 2 or more processes 2
 Cerci membranous or weakly sclerotized (except for a distinct meso-basal process, often *sclerotized*, in some species of *Malenka*); the tip blunt, without spines or processes 4
- 2(1) Supra-anal process simple, slender, subacute ; subanal lobes broad, with a long slender spine mesally ; gills 2, branched, inserted at the sides of the mentum *Visoka* (p. 53)
 Supra-anal process complex, broad ; subanal lobes not as above ; gills absent 3
- 3(2) Cerci only a little elongated, membranous on the inner surface ; abdominal segments all completely *sclerotized* and of approximately equal width *Nemoura* s.s. (p. 35)
 Cerci long and slender, completely sclerotized ; 9th and 10th abdominal segments *sclerotized* and much wider than the weakly-sclerotized remaining segments *Ostrocerca* (p. 38)
- 4(1) No lobe on the 9th sternite 5
 Lobe present at the base of the 9th sternite 6
- 5(4) Terminal slanting costal crossvein between Sc and C; 10th tergite not elevated or armed *Paranemoura* (p. 41)
 Terminal slanting crossvein between R_1 and C; 10th tergite elevated, heavily sclerotized, and armed with short spines *Lednia* (p. 27)
- 6(4) Veins A_1 and A_2 of the forewing united a little before their outer end ; subanal lobes long, upcurved, and flattened in side view *Soyedina* (p. 50)
 Veins A_1 and A_2 separate at the tip ; subanal lobes not as above 7
- 7(6) Gills present, cervical 8
 Gills absent 10

- 8(7) Gills usually unbranched (commonly 5-branched in *cinctipes*, which has wings with contrasting clear and pigmented bands) *Zapada* (p. 54)
 Gills with 6 or more branches ; wings without any clear transverse bands 9
- 9(8) Subanal lobes divided almost to the base into 2 parts, one or both of them spinulose ; cerci without basal processes *Amphinemura* (p. 16)
 Subanal lobes variously modified, never spinulose; cleft, if at all, for less than half their length ; cerci with a membranous or sclerotized process mesally near their base (this appears to be distinct from the cercus in some species—more like a process of the 10th tergite) *Malenka* (p. 29)
- 10(7) Sides of the 10th tergite produced into erect incurved spiny processes ; wings with alternate clear and pigmented bands *Shipsa* (p. 49)
 Sides of the 10th tergite not as above ; wings banded or uniformly colored 11
- 11(10) Supra-anal process slender, completely recurved along the 10th and 9th tergites, sometimes with basal appendages *Prostoia* (p. 47)
 Supra-anal process rather short, thick, complex in structure, only slightly bent forward, never with basal appendages *Podmosta* (p. 42)

FEMALES

- 1 Gills present under the neck or head 2
 Gills absent 5
- 2(1) One branched gill present on each side of the *mentum* ; wings not banded; 7th sternite moderately produced *Visoka* (p. 53)
 Two gills present on each side of the neck, branched or simple; wings usually banded, spotted, or completely infuscated 3
- 3(2) Gills simple filaments (except in *cinctipes*); 7th sternite produced completely over 8, which is very weak *Zapada* (p. 54)

- Gills branched ; 7th sternite moderately or little produced, not covering all of 8; 8th sternite bearing a distinct terminal or subterminal notch 4
- 4(3) Notch of the 8th sternite in a **sclerotized** band set before the hind margin of the segment (except in the eastern *wui*) *Amphinemura* (p. 16)
 Notch of the 8th sternite terminal; western *Malenka* (p. 29)
- 5(1) Veins A₁ and A₂ united near the margin of the wing ; large species, 7th sternite produced over the full length of 8 *Soyedina* (p. 50)
 Veins A₁ and A₂ not united (sometimes united in *obscura*, a small species in which sternite 7 does not cover 8) 6
- 6(5) Wings mostly dark, with a clear or relatively clear band across the middle of the outer field 7
 Wings entirely clear, or with some or all veins margined with brown, or with a marginal or central dark spot at the level of the cord 10
- 7(6) Terminal costal crossvein running between Sc and C, proximad of the cord ; a small eastern species. *Paranemoura* (p. 41)
 Terminal costal crossvein running between R₁ and C, beyond the cord 8
- 8(7) Sternite 7 **sclerotized** and produced over the full length of 8, its hind margin straight to **broadly rounded** *Nemoura* s.s. (p. 35)
 Sternite 7 only slightly or not at all produced over 8; though the narrowly-rounded margin of the subgenital plate of the 8th sternite in *Shipsa* may be mistaken for the 7th sternite 9
- 9(8) **Sternite 8 with a subgenital plate terminating anterior to** the well-developed hind margin, and bearing contrasting dark and light color bands *Shipsa* (p. 49)
 Sternite 8 with a terminal subgenital plate not separated from the hind margin of the sternite, and uniformly colored *Prostoia* (p. 47)

- 10(6) Sternite 8 very weak and **unsclerotized** medially; sternite 7 produced over the full length of 8, and not laterally excavated *Nemoura s.s.* (p. 35)
 Sternite 8 **sclerotized** medially, at least near the posterior margin; sternite 7 only slightly or not at all produced (except in *Ostrocerca prolongata* where it is excavated laterally) 11
- 11(10) Sternite 8 produced and rounded medially, not notched; two squarish patches of sclerotization on the hind margin, separated from the median produced portion (Fig. 15) *Lednia* (p. 27)
 Sternite 8 produced and notched, or not produced; its lateral **sclerotization**, if present, continuous with that of the median area 12
- 12(11) Sternite 8 with a narrow median sclerotized band contrasting sharply with the unsclerotized field at either side *Podmosta* (p. 42)
 Sternite 8 without any median stripe, usually uniformly **sclerotized** *Ostrocerca* (p. 38)

Subgenus **Amphinemura** Ris

1902. *Amphinemura* Ris, Mitt. Schweiz. Ent. Gesell. 10, p. 384. **GENOTYPE:** *Nemoura cinerea* Oliver (Europe).

SIZE: Small to medium.

GILLS: Four cervical gills, branched.

VENATION: **Typical.**

WING COLOR: Evenly and often darkly pigmented, except in *venusta*, which has the middle of the cells clear, giving the wing a spotted appearance.

♂ **9TH STERNITE:** Moderately produced and pointed; basal lobe present.

SUBANAL LOBES: Divided into 2 parts, both of which are slender, and are sometimes recurved forward alongside the supra-anal process; the inner part and usually the outer also bear few to many rather heavy spinules.

CERCI: Unmodified.

SUPRA-ANAL PROCESS: Completely recurved, rather slender, partly **sclerotized.**

TERGITES: Unmodified.

9 STERNITES: 7th usually produced about halfway over the 8th (not produced in *wui*) ; 8th with a median notch, sometimes produced.

DISTRIBUTION: North America generally, except on the plains ; south in the cordillera to Mexico City ; Europe ; China.

This subgenus, in America, consists of *wui* and a group of closely related species which may be called the nigritta-complex. The single western member, *venusta*, is distinguished by spotted wings, but the five eastern species have heretofore been confused under the name *venosa*. The points of difference are most evident in the male subanal lobe. In general, this is divided into a narrow outer and a broader inner sclerotized band, these often fused near the tip, which is usually unsclerotized or only weakly sclerotized. Both divisions or members of the lobe may bear spinules, and their number and distribution, as well as the shape of the lobe itself, are characteristic of each species.

MALES

- | | | |
|------|---|------------------|
| 1 | Outer (upper) division of the supra-anal process long, recurved, spinulose ; inner (lower) division about half as long, unarmed | <i>wui</i> |
| | Outer division of the supra-anal process no longer than the inner, which is spinulose | 2 |
| 2(1) | Western species ; wings pigmented along the veins, with a clear rounded spot in most of the cells, these fairly regularly distributed over the wing surface | <i>venusta</i> |
| | Eastern and northern species ; wings pigmented, often heavily so, but without clear dots | 3 |
| 3(2) | Subanal lobes short, not recurved onto the 10th tergite, the inner members armed with only 4-6 spines | <i>Linda</i> |
| | Subanal lobes long, recurved over at least part of the 10th tergite, the inner members armed with at least 8 spines (except possibly in <i>mockfordi</i>) | 4 |
| 4(3) | Inner member of the subanal lobe produced backward less than the outer member, and not armed except at its apex | <i>mockfordi</i> |
| | Inner member produced backward farther than the outer, and heavily armed near that point on its mesal or dorso-mesal surface | 5 |

- 5(4) Tip of the outer member of the subanal lobes expanded and bearing a group of large spines separately from the inner member (Fig. 2) *varshava*
 Tip of the outer member slender, bound to the inner member, with a few short spines or no spines at all 6
- 6(5) Inner member of the subanal lobe much produced rearward at the bend, where it is thin and compressed; its tip *unsclerotized* and not recurved *delosa*
 Inner member not compressed at the bend ; its tip recurved at least on the inner side *nigritta*

FEMALES (*mockfordi* unknown)

- 1 Western species ; wings spotted as described under 2 above *venusta*
 Eastern and northern species ; wings not spotted 2
- 2(1) Tip of the subgenital plate (8th sternite) not exceeding the level of the sides of the 8th segment 3
 Tip of the subgenital plate considerably *exceeding* the 8th segment *linda*
- 3(2) Border of the subgenital plate with a median notch and a small but definite V- or U-shaped lateral notch on either side (Fig. 5) *delosa*
 Border of the plate *merely* sinuate laterally (Figs. 3, 8), or less often with a broad V-shaped notch 4
- 4(3) Northern and northwestern species, ranging south to Michigan *linda*
 Range elsewhere 5
- 5(4) Range in the Middle West: Indiana, Illinois *varshava*, or rarely *nigritta*
 Range from eastern Ohio to eastern Tennessee, and from Quebec to Florida *nigritta*

Nemoura (Amphinemura) delosa (new species)

1935. *Nemoura venosa* Frison (in part), *Bull. Illinois Nat. Hist. Surv.* 20, p. 349. (Not *venosa* Banks.)
 1942. *Nemoura venosa* Frison, *ibid.* 22, p. 261, fig. 26, ♂ 9.
 1945. *Nemoura venosa* Ricker (in part), *Proc. Indiana Acad. Sci.* 54, p. 226.

MALES: Length of body, 5.5 mm.; to tip of wings, 8 mm. Differs from others of the complex in that the inner member of the subanal lobe, at its most posterior extension, is thin and compressed vertically. The sclerotized part of the outer member is very thin throughout its length, which extends almost to the tip of the inner member and is fused to it; near its tip it may have 1 or 2 spinules, but no expanded patch as in *marshava*. The unsclerotized tip of the inner member is very little elevated, but bears 2 patches of backward-pointing spinules (Fig. 4).

FEMALE: Length of body, 7 mm.; to tips of wings, 9.5 mm. Usually differs from others of the complex in having a straight-walled notch at either side of the subgenital plate (Fig. 5), instead of a straight or merely wavy margin. However, there is considerable variation in some populations, the Elgin Botanical Garden population used by Frison for his 1942 figures being by far the most variable which I have seen. The plate shown in his figure 26 is about "average" for that population, but some specimens would match our figure 5, and some would be indistinguishable from *linda* (Fig. 8). For the species as a whole, our figure 5 is of the most common and "typical" shape.

Holotype ♂ and allotype ♀: McCormick's Creek, McCormick's Creek State Park, Spencer, Indiana, April 28, 1941, W. E. Ricker.
Paratypes as follows:

ARKANSAS

West of Malvern. April 15, 1939, 9, H. H. and J. A. Ross.
Winslow. May 1, 1939, ♂ 9, H. H. and J. A. Ross.
Washington County. May 6, 1939, 4 ♂

GEORGIA

Swamp Creek, 7 mi. S. Dalton. May 25, 1931, ♂ 2 ♀ 9, P. W. Fattig.

ILLINOIS

Hogthief Creek, Elizabethtown. May 11, 1935, 9, C. O. Mohr.
Karber's Ridge. April 23, 1935, ♂, T. H. Frison.
Gibbon's Creek, Herod. May 13, 1937, ♂; May 13, 1939, ♀; May 27, 1942, 4 ♀; May 2, 1946, ♂; May 24, 1946, 2 ♂ 6; Frison, Ross Mohr, and Burks.
Botanical Gardens, Elgin. May 23 and June 6, 1939, many ♂ ♀; September 19, 1939, ♀; June 20, 1946, 11 ♂ 8 ♀; Burks, Riegel, Ross, Sanderson.

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Same locality ♀♀ holotype. April 28, 1941, 18 ♂ 6 ♀; April 25, 1949, 3 ♂ 1 ♀; May 15, 1949, ♂; W. E. Ricker.
 Warm Creek at Springville, NW of Oolitic. April 26, 1946, 7 ♀, Ross, Burks, Scott, Ricker.
 Tributary of Trail Creek, Laporte County. June 25, 1947, ♂, Ed Mockford.

KENTUCKY

Hopkinsville. April 26, 1938, 3 ♂, Ross and Burks.

MICHIGAN

Trout Creek, Cheboygan County. May 29, 1938, many ♂ ♀, F. E. Lyman.
 Betsie River, Benzonia. May 27, 1939, 2 ♂ 3 ♀, Frison and Ross.
 Sanborn Creek, Nirvana. May 28, 1939, 3 ♂ 4 ♀, Frison and Ross.
 Brooks Creek, near Brunswick. May 29, 1939, 2 ♀, Frison and Ross.
 Platte River, Honor. May 27, 1939, 2 ♂, Frison and Ross.
 Rifle River, Omer. May 21, 1936, ♀, Frison and Ross.
 Tributary of Manistee River, Wellston. May 28, 1939, ♀, Frison and Ross.
 Boardman River, Mayfield. May 28, 1939, ♀, Frison and Ross.
 Tributary of Little Pigeon River, Cheboygan County. July 3, 1938, 3 ♂ 11 ♀, J. W. Leonard.
 Pere Marquette River, Lake County. May 17, 1947, ♂, J. W. and F. A. Leonard.
 Kinne Creek, Lake County. May 27, 1937, ♀, J. W. Leonard.
 Small stream just below Wakeley Bridge, Crawford County. May 28, 1948, ♀, J. W. and F. A. Leonard.
 Au Sable River, Crawford County. May 23, 1948, 5 ♀ 5 ♂; June 24, 2 ♀; Rogers and Leonard.
 Hunt Creek, Montmorency County. June 23, 1939, 3 ♀, 1 gynandromorph; June 3, 1940, ♀; June 6, ♂; June 26, ♂ ♀; May 15, 1942, ♂; Leonard, Cooper, and Frank.
 S. Branch Boardman River, Grand Traverse County. June 27, 1947, ♀, J. W. and F. A. Leonard.
 Tributary of Long Lake, Mason County. June 9, 1947, 3 ♀, J. W. and F. A. Leonard.
 Boardman River, Grand Traverse County. June 11, 1947, ♀, J. W. and F. A. Leonard.
 Silver River, Keweenaw County. June 3, 1949, ♂, J. W. and F. A. Leonard.
 Sanborn Creek, T17, 18N, R13W, Sec. 1, 36. May 31, 1947, 3 ♂ 3 ♀; June 1, ♂; June 5, ♂ ♀; J. W. and F. A. Leonard.
 Fontinalis Creek, Rifle River area, Ogemaw County. May 26, 1948, ♀, J. W. and F. A. Leonard.

MISSOURI

Ozark Mountains, Van Buren. June 10, 1930, ♀, E. A. Pence.

OHIO

Clifton. May 30, 1938, 4 ♂ 9 ♀, D. J. and J. N. Knull.
 Delaware County. July 1, 1943, 2 ♂ 1 ♀, J. N. Knull.

OKLAHOMA

Boy Scout Camp, Latimer County. April 25, 1931, 2 ♂, R. D. Bird.
 Page. June 23, 1937, ♂, Standish-Kaiser.

ONTARIO

Costello Lake, Algonquin Park. May 30 to June 29, 1938, many ♂ ♀, F. P. Ide. July 7, 1939, ♂ ♀; June 13-20, 1939, 4 ♂; May 28 to June 19, 1941, 5 ♂ 3 ♀; W. M. Sprules.
 Costello Creek, Algonquin Park. July 1-4, 1938-39, ♂ ♀, F. P. Ide.
 Black Ash Creek, nos. 1 to 4, Collingwood Township. June 6 to August 7, 1948, 6 ♂ 33 ♀, F. P. Ide.
 Bothwell. May 23, 1925, ♂ 5 ♀; June 13, 1925, 2 ♂ 5 ♀; May 29, 1929, 4 ♂ 9 ♀; G. S. Walley.
 Delhi. June 2, 1931, ♂, G. S. Walley.
 Fishers Glen. July 1-2, 1925, 3 ♀; June 12, 1931, ♀; G. S. Walley.
 Mad River, Glen Huron. June 3-5, 1930, ♀ 7 ♀, F. P. Ide.
 Glen Major. August 17, 1928, 1 ♀, 3 nymphs, W. E. Ricker.
 Beaver River, Grey County. June 16, 1930, 2 nymphs, W. E. Ricker.
 Noisy River and small creeks, Horning's Mills. June 5 to July 24, 1928, many ♂ ♀, F. P. Ide and W. E. Ricker.
 Jordan. June 18, 1926, ♂ ♀, G. S. Walley.
 Clear Creek, Miner's Bay. May 26, 1931, ♂ ♀, G. S. Walley.
 Creek on Kimmount Road, Miner's Bay. May 28, 1931, ♂, J. McDunnough.
 Orillia. June 11-14, 1925, 2 ♂ 2 ♀, J. McDunnough and C. H. Curran.
 Island Park, Ottawa. June 9-29, 1931, 2 ♀, L. J. Milne.
 St. Williams. June 4, 1934, ♀, F. P. Ide.
 Mad River, ~~Singhampton~~. June 5 to September 4, 1930-32, many ♂ ♀, F. P. Ide and W. E. Ricker.
 Tillsonburg. June 4, 1923, ♂; June 1, 1937, 2 ♀; G. S. Walley.
 Terra Cotta. May 24 to June 13, 1946, many ♀, F. P. Ide.
 Wilson's Creek, DeGrassi Point, Lake Simcoe. June 22, 1929, ♂ ♀ ♀, E. M. Walker.

QUEBEC

Cascade. June 12, 1923, ♂, C. H. Curran.
 Fairy Lake, Hull. July 3, 1925, ♀; June 1, 1927, 5 ♂ 5 ♀; June 6, 1927, ♂; G. S. Walley and F. P. Ide.
 Hull. June 11, 1924, ♂, C. H. Curran.
 Kazubazua. June 6-10, 1927, 6 ♀, McDunnough, Ide, and Brown.
 Masham Mills. June 29 to July 2, 1935, ♂ 2 ♀, G. E. Bucher.
 Ottawa Golf Club. June 3, 1925, ♂ 2 ♀, J. McDunnough; June 27, 1932, 2 ♀, F. P. Ide.

TENNESSEE

Shelbyville. April 26, 1938, 5 ♂ 2 ♀, Ross and Burks.
 Ozone. June 11, 1935, 2 ♀, H. H. Ross.

***Nemoura (Amphinemura) linda* (new species)**

1125. *Nemoura venosa* Needham and Claassen (in part: Port Arthur record only), Monogr. Plecop., p. 209. (Not Banks 1897.)
1944. *Nemoura venosa* Ricker, Can. Ent. 76, p. 177.

MALE: Length of body, 3.5-4.5 mm.; to tip of wings, 5.5-7.5 mm. Color dark brown. Cervical gills 4, branched. Wings almost clear in young specimens, but quite dusky later.

Ninth sternite with an anterior lobe and posterior projection. Subanal lobes double (Fig. 11), both branches armed with stout recurved spines (usually 2 on the outer branch, 4 or 5 on the inner); these lobes are *not* recurved forward and are not visible, or are barely visible, in dorsal view (Fig. 12). Ninth tergite somewhat elevated rearward, the posterior margin bearing 4 or 5 long and rather stout hairs on either side of the mid-line. Tenth tergite mostly sclerotized, elongate, and slightly concave; the supra-anal process mostly membranous dorsally but **sclerotized** along the sides.

FEMALE: Length of body, 4-7.5 mm.; to tip of wings, 6-10.5 mm. Seventh sternite produced halfway over 8; the 8th rather short, the subgenital plate sclerotized, sinuate (Fig. 8).

Holotype, allotype ♀, 10 ♂ 24 ♀ paratypes: Hunt Creek (section C), Montmorency County, Michigan, August 30 to September 3, 1940, J. W. Leonard. Paratypes from the same locality, September 17, 1940, 6 ♂ 41 ♀, E. Cooper.

Other material:

ALBERTA

Nordegg. Aug. 8, 1921, ♂, J. McDunnough (CNC).

BRITISH COLUMBIA

Alcan Highway at mile 496, Hot Springs, Laird River. July 29, 1949, ♀, E. K. Miller.

MACKENZIE

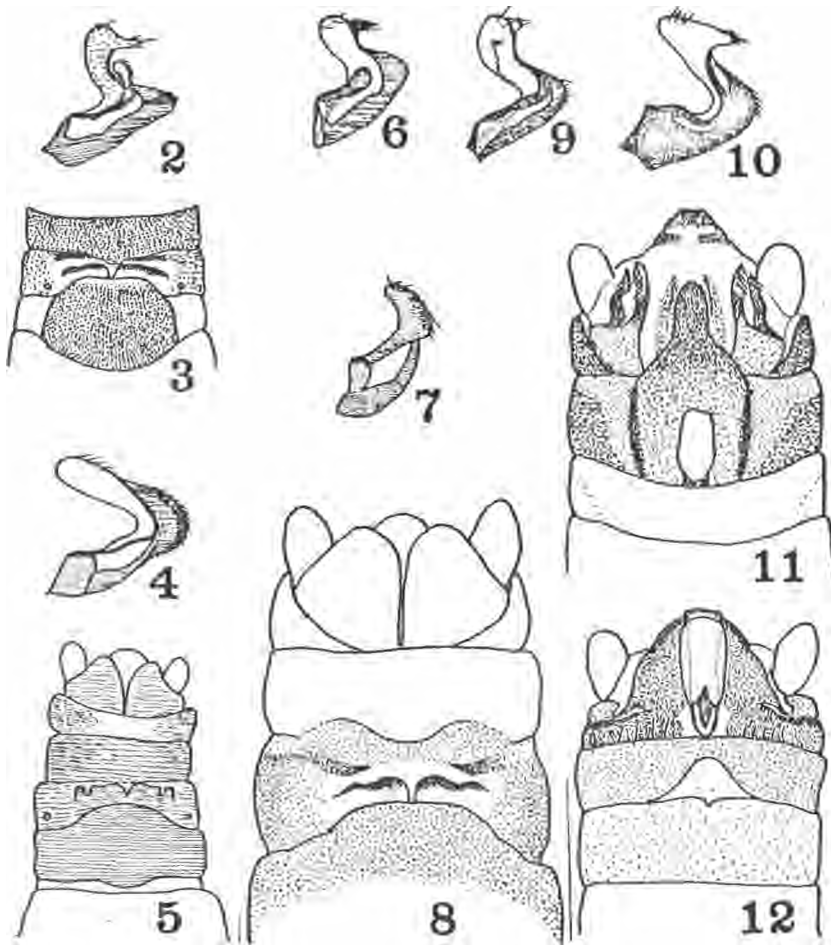
Radium City, Cameron Bay, Great Bear Lake. August 15, 1937, 2 ♂ 3 ♀, T. N. Freeman (CNC).

MANITOBA

Goose Creek, Station 7, Churchill. July 23 to August 7, 1948, 4 ♂ 3 ♀, F. P. Ide (CNC).

Hospital Stream, Station 4, Churchill. August 15, 1948, ♂ ♀, F. P. Ide (CNC).

Water tower, Churchill. August 1, 1948, 2 ♂ 2 ♀, F. P. Ide (CNC).



Nemoura varshava. 2. Subanal lobe of holotype ♂, from the side. 3. Sternites of allotype ♀.

Nemoura delosa. 4. Subanal lobe of holotype ♂. 5. Sternites of allotype ♀.

Nemoura nigritta. 6. Subanal lobe of a ♂ from Cold Brook, New York, 9.

The same, from Little Pigeon River, Gatlinburg, Tennessee. 10. The same, from Clifty Creek, New Columbia, Illinois.

Nemoura mockfordi. 7. Subanal lobe of holotype ♂.

Nemoura linda. 8. Sternites of allotype ♀, 11. Terminal segments of holotype ♂, from below. 12. The same, from above.

MICHIGAN

Merriweather. July 20, 1937, 9, Frison and Ross.

ONTARIO

Port Arthur. September 8, 1889, 9, Hubbard and Schwarz (CU).

QUEBEC

Gracefield, June 26, 1937, 9, O. Peck.

Great Whale River, 1949, 3 9, J. R. Vockeroth (CNC).

The features distinguishing this species from other species of the *nigritta* complex are the short, weakly-armed subanal lobes, which curve to an erect position only, not onto the dorsal surface. The female subgenital plate is most like *varshava*, but the geographic range of *linda* overlaps only with *delosa*, which has U-shaped lateral notches, whereas *linda* is merely *sinuate*. When specimens from Great Bear Lake were reported as *venosa* in 1944, the distinguishing features of the male were pointed out; however, at that time several species were already confused under the name *venosa*, and the arctic specimens added little to the apparent variability of the "species." Northern specimens of *Linda* are considerably smaller than those from Michigan, as reflected in the wide length ranges given in the description above.

Nemoura (*Amphinemura*) *mockfordi* (new species)

MALE: Length of body, 6.5 mm.; to tip of wings, 9 mm. Similar to *nigritta* in color and general appearance, and in the supra-anal process. The subanal lobes differ from *nigritta* and *delosa* in being shorter and in the distribution of spinules and **sclerotization**. The outer member is boot-shaped and fully **sclerotized** (side view) and bears strong spinules on the dorsal surface (Fig. 7). The inner member is sclerotized, does not project backward even as far as the outer, and bears spinules only near the tip where it is fused to the outer member.

Holotype ♂ and paratype ♂: Monteagle, Tennessee, April 26, 1938, H. H. Ross and B. D. Burks.

Nemoura (*Amphinemura*) *nigritta* Provancher

- 1876. *Nemoura nigritta* Provancher, Naturaliste Canadien 8, p. 217. Type locality: vicinity of **Quebec** City.
- 1897. *Nemoura venosa* Banks, Trans. Amer. Ent. Soc. 24, p. 21. New Synonymy.
- 1920. *Nemoura atplata* Banks, Bull. Mus. Comp. Zool. 64, p. 324. New Synonymy.
- 1925. *Nemoura venosa* Needham and Claassen (in part), Monogr. Plecop. p. 209; p. 363, figs. 9-12.

1931. *Nemoura venosa* Claassen, Plecop. Nymphs, p. 95; p. 143, figs. 141-46, nymph.
1935. *Nemoura venom* Frison (in part), Bull. Illinois Nat. Hist. Surv. 20, p. 349.
1947. *Nemoura venosa* Ricker, Trans. Roy. Can. Inst. 26(2), p. 405.

Provancher's description seems sufficiently clear to exclude any species of the region except *venosa*. The wings particularly: "a peine transparents, les nervures marginées de brun-foncé" apply better to *venosa* than to any other eastern species. There are 4 specimens in the Provancher collection labelled *nigritta*, of which a ♂ is here designated lectotype, and a ♀ is of the same species. Another ♂ is *Nemoura vallicularia*, and the fourth specimen was not identified. Later Provancher (Nat. Canadien 10, p. 126, 1878) regarded *nigritta* as a variety of *N. perfecta*; this however, does not prejudice our use of *nigritta* today. A recent examination of the lectotype males of both *venosa* Banks and *stylata* Banks shows that Needham and Claassen's description is accurate and their synonymy of *stylata* correct. The *stylata* ♂, though from Virginia (Glen-carlyn), is like the holotype of *venosa* rather than like specimens from farther south (Tennessee, etc.). The geographic variation of the species is considerable, but material is scarcely adequate for describing subspecies. Southern specimens sometimes have a few spinules on the side of the inner member of the subanal lobe, near the tip of the outer member. In the Middle West the tip of the outer member tends to be more sharply recurved (Fig. 10); specimens from eastern Tennessee show a reduction of the inner terminal spines (Fig. 9).

• DISTRIBUTION: Eastern North America, including southern Quebec (eastern townships to Quebec City), the Maritime Provinces, New England and New York south to Tennessee, Georgia, and Florida; also extreme southern Illinois (New Columbia), Ohio (Athens), and Kentucky (Cumberland Falls). Not yet known from Ontario and Michigan.

Nemoura (*Amphinemura*) *varshava* (new species)

1925. *Nemoura venosa* Needham and Claassen (in part: Lake Forest, Illinois, specimen only), Monogr. Plecop., p. 209. (Not *venosa* Banks.)
1935. *Nemoura venosa* Frison (in part), Bull. Illinois Nat. Hist. Surv. 20, p. 349.
1945. *Nemoura venosa* Ricker (in part), Proc. Indiana Acad. Sci. 54, p. 226.

MALE: Length of body, 5 mm.; to tip of wings, 7.5 mm. Differs from other members of the *nigritta* complex in that the outer member of the subanal lobe terminates in a slightly bulbous retrorsely-spinulose process. This is distinct from the larger tip of the inner member, which is recurved and weakly sclerotized, and bears 2 separate spinulose areas, each with only a few spinules (Fig. 2). The inner member is sharply bent and projects backward considerably at its most posterior elongation; the mesal surface is armed with a band of appressed spinules which show through as a dark band in a lateral view.

FEMALE: Length of body, 7 mm. ; to tip of wings, 10 mm. The subgenital plate (Fig. 3) is often scarcely distinguishable from that of *nigritta*. In some specimens the outer edge (beyond the lateral excavation) bends more to the rear, and in one specimen from the type collection there is a larger rounded notch on each side of the plate.

Holotype ♂, allotype ♀, 14 ♂ 6 ♀ paratypes : Small spring creek 3 mi. E of Warsaw, Indiana, May 20, 1943, W. E. Ricker.

Paratypes as follows :

ILLINOIS

Clay Lick Creek, Carbondale. April 17, 1935, ♂, H. H. Ross.
 Lake Forest. June 28, 1903, ♂, J. G. Needham (CU)
 Fox Ridge State Park. May 13, 1938, ♂, Ross and Burks.
 Watson. April 23, 1932, ♂♂ ♀♀, Ross and Mohr.
 Rudement. April 30, 1942, ♂♀, Mohr and Burks.
 Spring at Herod. May 2, 1946, ♂, Mohr and Burks.
 Fountain Bluff. May 14, 1932, 4 ♂, Frison, Ross and Mohr.
 In marsh at Rock. May 6, 1950, 2 ♀, M. W. Sanderson.
 Camp Packintuck, Ozark. May 5, 1950, ♂, Sanderson and Standard.

INDIANA

Cold stream at Springville, NW of Oolitic. April 26, 1946, ♂, Ricker et al.
 Newby Gulch, Turkey Run State Park. May 11, 1933, ♂♂ ♀♀, Frison and Mohr.
 Creek above University Reservoir, Bloomington. May 13, 1949, ♂ ♀, Ed. Mockford.

KENTUCKY

No locality. ♂ coll. by Walsh, No. 47609 (INHS).

This species and *delosa* are the common representatives of the group in Indiana and Illinois. *N. varshava* is found in cool

spring streams, whereas *delosa* frequents warmer streams, but seems to avoid the largest rivers.

***Nemoura (Amphinemura) venusta* Banks**

1911. *Nemoura venusta* Banks, Trans. Amer. Ent. Soc. 37, p. 337. Type locality: Arizona.
 1925. *Nemoura venusta* Needham and Claassen, Monogr. Plecop., p. 209; p. 363, figs. 5-8.

DISTRIBUTION: Southern Rocky Mountain region of the United States and Mexico ; there are records from Utah, Wyoming, Colorado, New Mexico, and the Federal District of Mexico, not far from the capital city.

***Nemoura (Amphinemura) wui* Claassen**

1923. *Nemoura sinuata* Wu, Bull. Lloyd Libr. 23, p. 47 (footnote).
 1925. *Nemoura sinuata* Needham and Claassen, Monogr. Plecop., p. 208; p. 363, figs. 1-4.
 1931. *Nemoura sinuata* Claassen, Plecop. Nymphs, p. 94; p. 181, fig. 209; p. 32, fig. 226; nymph.
 1930. *Nemoura wui* Claassen, Ann. Ent. Soc. Amer. 29, p. 623. New name.

DISTRIBUTION: Southern Quebec, New Brunswick, Nova Scotia, New England, New York, south in the mountains to Tennessee and northern Georgia.

Subgenus **Lednia (new)**

SUPGENOTYPE and only known species : *Nemoura tumana* new species.

SIZE: Rather small.

GILLS: Absent

VENATION: Typical

WINGCOLOR: Clear.

♂ 9TH STERNITE : Narrowly produced and upturned, rounded at the tip ; basal lobe absent.

SUBANAL LOBES: Reduced to slender scimitar-shaped blades applied to the base of the supra-anal process.

CERCI : Not modified.

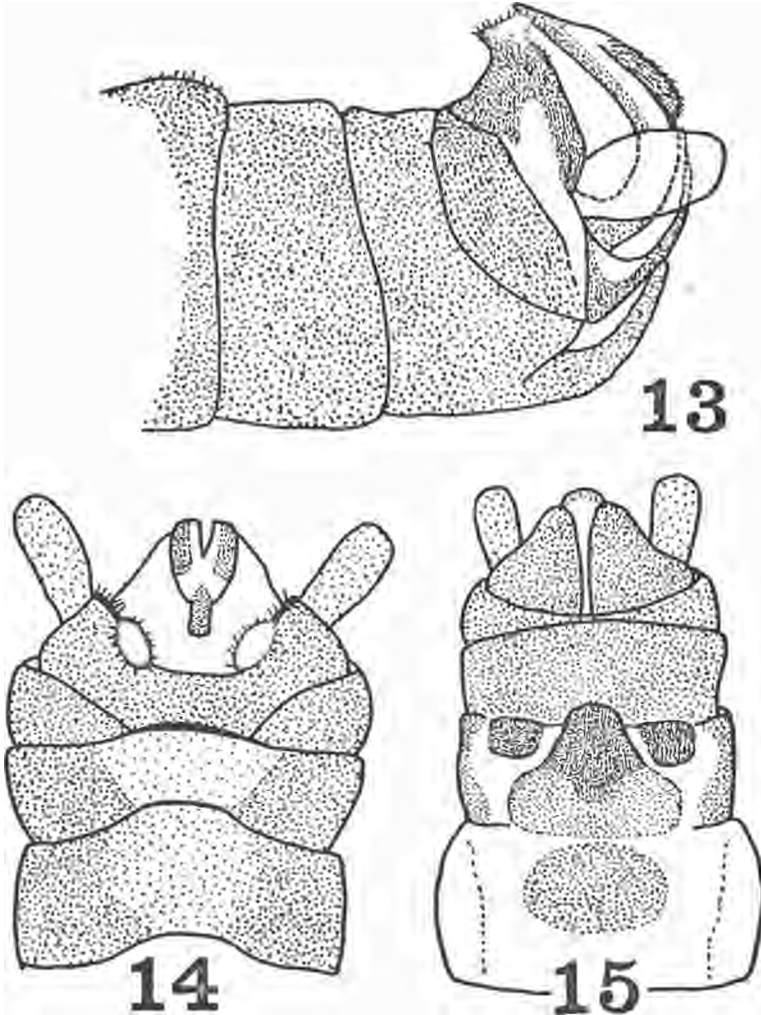
SUPRA-ANAL PROCESS: Rather short, slender, incompletely recurved, fully sclerotized.

♂ TERGITES : 1-3 unsclerotized ; 4-6 sclerotized on the anterior half ; 7 almost completely sclerotized ; 8-9 with the sclerotiza-

tion reduced medially ; 10 unsclerotized anteriorly, and with a spinulose process on either side of the declivitous sclerotized excavated hind portion.

9 STERNITES : 7 with a median sclerotized patch, not produced ;
8 with a central sclerotized region which is narrower behind, and separated from a pair of lateral sclerotized spots.

DISTRIBUTION: Western North America.



Nemoura tumana. 13. Terminal segments of the holotype ♂, from the side.
14. The same, from above. 15. Terminal sternites of allotype 9.

Nemoura (*Lednia*) *tumana* (new species)

MALE: Length of body, 4 mm.; to tip of wings, 7 mm. Color dark brown. Wings without dark markings, except a small spot at the very base. Venation much as in *N. depressa* (Needham and Claassen, 1925, p. 355), but there are only 3 branches of *A*₁ in the hindwing. In one forewing of the holotype there is a crossvein between *R*₁ and *R*₂ near the tip. Gills absent.

Tergites 1-3 and sternites 2-5 only very weakly sclerotized; tergites 8 and 9 with a light area medially. Sternite 9 lacks the usual anterior lobe; its posterior margin is produced and upturned, blunt and finger-like distally. Tergite 10 divided by a suture, the posterior portion elevated with 2 heavily sclerotized spinous knobs (Fig. 13). Cerci not modified. Subanal lobes sclerotized along their ventral and inner margins, scythe-like and acuminate at their tips. Supra-anal process broad at the base, rather slender apically, its posterior margin grooved, with an area of retrorse hairs on either side of the groove (Figs. 13, 14).

FEMALE: Length of body, 5 mm.; to tip of wing, 8 mm. Abdominal segments 1-6 little sclerotized; 7th sternite sclerotized in the posterior median area; 8th sternite sclerotized and produced medially, and with sclerotized areas on either side; 9th segment normally sclerotized above and below (Fig. 15).

Holotype ♂, allotype ♀, and paratype ♀. Small glacial stream, el. 5,500 feet, Many Glaciers, Glacier National Park, Montana, August 24, 1946, W. E. Ricker.

This species is remarkable chiefly for the absence of a ventral lobe on the 9th sternite. The only other North American species with this trait is *N. (Paranemoura) perfecta* Walker, but there seems to be little other resemblance between them.

Subgenus **Malenka** (new)

SUBGENOTYPE: *Nemoura carnuta* Claassen.

SIZE: Small.

- GILLS: Cervical, 4 in number, 4- to 7-branched.

VENATION: Typical.

WING COLOR: Clear.

9TH STERNITE: Pointed; lobe present.

SUBANAL LOBES: Single, elongate, variously divided distally, with one or more notches along the inner edge.

CERCUS: A basal inwardly-directed process is peculiar to this group. In some species it is closely joined to the outer part, and both are only weakly sclerotized; in others the process is strongly sclerotized and the outer part cercus proper is membranous, so that the process looks as though it originated from the 10th tergite directly. Since intermediate conditions exist, it is believed that the process in every case has originated from the cercus.

SUPRA-ANAL PROCESS: Short, subcylindrical, partly membranous, completely recurved.

♂ TERGITES: Normal.

9 STERNITES: 7th slightly produced at the mid-line; 8th not produced, with a narrow median notch.

DISTRIBUTION: Western North America.

MALES

- | | | | |
|---|---|---|------------------|
| 1 | Mesobasal lobe of the cercus | sclerotized and sharply pointed, appearing to be a part of the 10th tergite | 2 |
| | Mesobasal lobe of the cercus | rounded, usually membranous | 3 |
| 2 | 1 | Mesobasal lobe directed straight back; outer part of the subanal lobes narrow, twice constricted | cornuta |
| | Mesobasal lobe directed inward and backward; outer part of the subanal lobes broad, not constricted, but with a notch on the mesal margin | <i>californica</i> | |
| 3 | 1 | Tip of the subanal lobes deeply bilobed | 4 |
| | Tip of the subanal lobes simple, or divided into 2 short prongs | | 5 |
| 4 | 3 | Terminal divisions of the subanal lobes blunt; tip of the 9th sternite truncate or somewhat rounded, not knob-like | <i>bifurcata</i> |
| | Terminal divisions of the subanal lobes slender and acute; tip of the 9th sternite a rounded knob | Una | |
| 5 | 3 | Tip of the subanal lobes slender, acuminate, at least slightly twisted | 6 |
| | Tip of the subanal lobes blunt, truncate, or divergent | | 7 |
| 6 | 5 | Tip of the subanal lobes conspicuously twisted; main lobe of the cercus of normal size, completely membranous, sharply marked off from the basal lobe | <i>flexura</i> |

- Tip of the subanal lobes only slightly twisted ; main lobe of the cercus enlarged and sclerotized, though unpigmented, continuous with the basal lobe on the outside *perplexa*
- 7(5) Mesobasal lobe of the cercus about twice as broad as the cercus proper, and moderately sclerotized *depressa*
 Mesobasal lobe of the cercus no broader than the cercus itself, and unsclerotized 8
- 8(7) Tip of the subanal lobes, seen from behind and to the side, divided into a narrow inner and broader outer member, both acute and divergent *biloba*
- Tip of the subanal lobes with a median posterior carina and short lobes on either side, these sharply angled but not produced *coloradensis*

FEMALES (*tina* unknown)

- 1 Sternite 7 produced and rounded, but lacking a nipple; sternite 8 greatly swollen, considerably produced, and often very irregular in shape at either side of the notch ; the anterior third of the notch bordered by a square patch of heavy sclerotization *cornuta*
 Produced portion of sternite 7 bearing a distinct nipple, whose base is often anterior to the hind margin of the sternite (best seen in side view ; sometimes obscure in *depressa*) ; sternite 8 not as above 2
- 2(1) Median notch not completely bisecting sternite 8 ; *i.e.*, there is a complete, though sometimes narrow, band of weak, normal, or heavy sclerotization anterior to the notch 3
 Median notch completely bisecting sternite 8 5
- 3(2) Notch of the 8th sternite cut about halfway through the sternite, nowhere margined by extra sclerotization 4
 Notch of the 8th sternite cut almost to the anterior margin, near which it is narrowly margined by heavy sclerotization *coloradensis*
- 4(3) Nipple of the 7th tergite low, inconspicuous, often scarcely recognizable; its base confluent with the hind margin of the sternite *depressa*

- Nipple of the 7th tergite erect, easily distinguished in side view at least, its base set somewhat anterior to the hind margin of the sternite *californica*
- 5(2) Sternite 8 swollen on either side of the notch 6
 Sternite 8 not swollen 7
- 6(5) Notch of sternite 8 not margined by heavier sclerotization *bifurcata*
 Notch of sternite 8 margined by extra heavy sclerotization in its anterior third, which is very narrow *biloba*
- 7(5) Notch of the 8th sternite long, equal to at least the full lateral length of the sternite ; its posterior half V-shaped ; its anterior half parallel-sided and margined by a series of irregular transverse lines or grooves *flexura*
 Notch of the 8th sternite short, not as long as the lateral length of the sternite, very narrow at the middle and V-shaped at either end *perplexa*

Nemoura (Malenka) bifurcata Claassen

1923. *Nemoura* bifurcata Claassen, Can. Ent. 55, p. 282. (No locality for the type specimen.)
 1925. *Nemoura* bifurcata Needham and Claassen, Monogr. Plecop., p. 204; p. 359, figs. 18-20, .

FEMALE: Length of body, 6 mm.; to tip of wings, 10 mm. Color dark ; wings smoky, especially along the veins. Sternite 7 somewhat produced rearward, bearing a blunt nipple. Sclerotized covering of sternite 8 completely divided medially by a narrow fissure. Figure 19 is made from a specimen which had been partly dried, one of a series taken by K. M. Fender at Peavine Ridge, McMinnville, Oregon.

DISTRIBUTION: Western Washington and Oregon.

Nemoura (Malenka) biloba Claassen

1923. *Nemoura* biloba Claassen, Can. Ent. 55, p. 282. Type locality: Los Angeles County, California.
 1925. *Nemoura* biloba Needham and Claassen, Monogr. Plecop., p. 205; p. 361, figs. 1-4, ♂ ♀,
 1927. *Nemoura* biloba Seeman, J. Ent. and Zool. 19, p. 54; Plate I, figs. 4-9, wings, nymph.

DISTRIBUTION: Southwestern California.

Nemoura (Malenka) californica Claassen

1923. *Nemoura californica* Claassen, Can. Ent. 55, p. 284. Type locality: California.
1925. *Nemoura californica* Needham and Claassen, Monogr. Plecop., p. 207; p. 361, figs. 16-18, ♂. (Fig. 19, of a 9 subgenital plate, is evidently *N. dimicki*.)
1929. *Nemoura californica* Neave, Contr. Canadian Biol. N.S. 4, p. 162; fig. 8, 9.
1936. *Nemoura lobata* Frison, Ann. Ent. Soc. Amer. 29, p. 260, Plate I, figs. 5-7, ♂.

DISTRIBUTION: The cordillera generally, from New Mexico and California north to southern British Columbia and western Alberta (Jasper).

Nemoura (Malenka) coloradensis Banks

1897. *Nemoura coloradensis* Banks, Trans. Amer. Ent. Soc. 24, p. 21. Type locality: Colorado.
1925. *Nemoura coloradensis* Needham and Claassen, Monogr. Plecop., p. 210; p. 363, figs. 13-16, ♂.
1931. *Nemoura coloradensis* Claassen, Plecop. Nymphs, p. 96, nymph.

DISTRIBUTION: New Mexico, Colorado, Wyoming, and Utah.

Nemoura (Malenka) cornuta Claassen

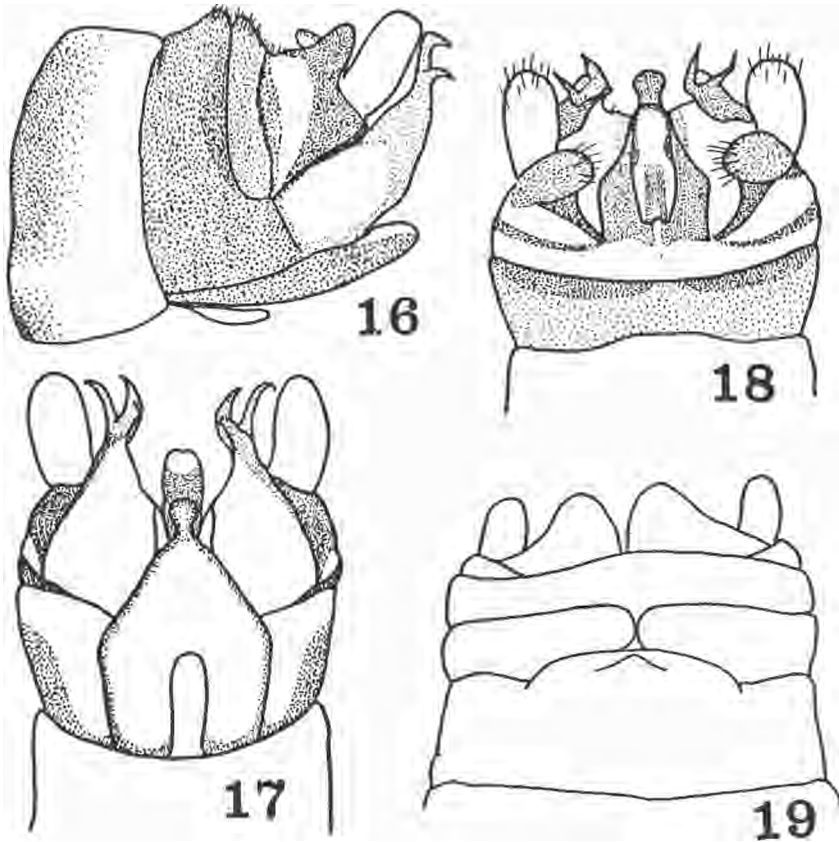
1923. *Nemoura cornuta* Claassen, Can. Ent. 55, p. 285. Type locality: Nanaimo, British Columbia.
1925. *Nemoura cornuta* Needham and Claassen, Monogr. Plecop., p. 207; p. 361, figs. 13-15, .
1943. *Nemoura cornuta* Ricker, Stoneflies SW B.C., p. 62; p. 60, figs. 26-28, 9 and nymph.

DISTRIBUTION: Coast and Cascade Mountains of British Columbia, Washington, and Oregon.

Nemoura (Malenka) depressa Banks

1898. *Nemoura depressa* Banks, Trans. Amer. Ent. Soc. 25, p. 200. Type locality: Cottage Grove, Oregon.
1925. *Nemoura depressa* Needham and Claassen, Monogr. Plecop., p. 206; p. 361, figs. 9-12, ♂.

DISTRIBUTION: West of the Cascade Mountains in southern Oregon and northern California ; New Mexico.



Nemoura tina. 16. Terminal segments of holotype, from the side. 17. The same, from below. 18. The same, from above.
Nemoura bifurcata. 19. Terminal segments of a ♀, somewhat dried. McMinnville, Oregon.

***Nemoura (Malenka) flexura* Claassen**

1923. *Nemoura flexura* Claassen, Can. Ent. 55, p. 284. Type locality: Boulder, Colorado.
 1925. *Nemoura flexura* Needham and Claassen, Monogr. Plecop., p. 205; p. 361, figs. 5-8, ♂ ♀.

DISTRIBUTION: Central Rocky Mountain region: Montana, Utah, Wyoming, and Colorado provide records.

***Nemoura (Malenka) perplexa* Frison**

1936. *Nemoura perplexa* Frison, Ann. Ent. Soc. Amer. 29, p. 259; pp. 264-65, figs. 2-4, 18, ♂ ♀.

DISTRIBUTION: Western Oregon and Washington.

Nemoura (Malenka) tina (new species)

MALE: Length of body, 5 mm. ; to tip of wings, 6.5 mm. Color brown. Two pairs of branched gills on the neck ventrally. Wings without pigmented markings, venation as in *N. foersteri* Ricker (1943, p. 71).

Abdominal segments mostly membranous through the 8th, but dorsally they have more sclerotized anterior margins (except in the mid-line), and there is a pair of sclerotized plates on either side of the median line ventrally. Ninth sternite with an elongate lobe depending from the anterior margin, the posterior margin triangularly produced and with a terminal knob, scarcely upturned. Subanal lobes triangular, sclerotized near the outer margin, terminating in two strong hooks, the under one shorter and stouter than the other (Figs. 16-18). Tenth tergite sclerotized dorsally, with a posterior sclerotized plate bearing the supra-anal process on its tip ; the process erect, bent forward at the tip, mostly sclerotized. Cerci membranous, with rounded sclerotized knobs pointing inward near the base.

Holotype ♂ and paratype ♂ : Iron Creek, Lewis County, Washington, June 15, 1932.

This species has close relatives among others of the subgenus, being best distinguished from them by the subanal lobes. Of these relatives *bifurcata*, which is probably closest, differs in having only one of the prolongations of the subanal lobes hooked, the other being slender and truncated. The knobbed tip of the 9th sternite of *tina* also seems distinctive. The type specimens were recorded by Hoppe (1938) as *N. bifurcata*.

Subgenus **Nemoura** sensu stricto

TYPE: *Nemoura variegata* Oliver (Europe).

SIZE: **Medium.**

GILLS: **Absent.**

VENATION: Typical.

WING COLOR: Various ; sometimes clear, or evenly infuscated, or with darker pigment near the middle of the cord, or even with a series of transverse bands in the apical region.

♂ 9TH STERNITE: Pointed, lobe present.

SUBANAL LOBES: Single, broad.

CERCI: **In** the male, strongly sclerotized on the outer surface, and with terminal spines or ridges.

SUPRA-ANAL PROCESS: Thick, largely membranous, incompletely recurved.

TERGITES: Normal.

♀ 7TH STERNITE: Broadly produced over much of 8, and heavily sclerotized.

♀ 8TH STERNITE: Unmodified or broadly excavated behind, weak.

DISTRIBUTION: Northern and northeastern North America ; Europe.

MALES (normani unknown)

Posterior outer edge of the cercus produced into a slender acute spine, which may be forked once or twice at the tip *trispinosa*

Posterior outer edge of the cercus bordered by a crenulate shelf or ridge *arctica*

FEMALES

1 Length to tips of wings, 10-11 mm.; northwestern Canada and Alaska *normani*

Length to tips of wings, 7-8 mm 2

2(1) Arctic species, known south to Churchill, Manitoba *arctica*

Eastern species, known north to Temiskaming, Quebec *trispinosa*

Nemoura (N.) *arctica* Esben-Petersen

1910. *Nemoura arctica* Esben-Petersen, *Tromsø Mus. Aarshefter* 31/22, p. 85. Type locality: Norway.

1944. *Nemoura trispinosa* Ricker, *Can. Ent.* 76, p. 177; p. 180, figs. 5, 6, 8, and 10. (Not *trispinosa* Claassen 1923.)

1950. *Nemoura trispinosa* Weber, *Trans. Am. Ent. Soc.* 76, p. 175.

In 1944 I identified arctic specimens as *trispinosa*, while figuring their morphological differences from more southern specimens. Additional material has convinced me that northern specimens should be recognized as distinct from *trispinosa*, and Swedish material kindly lent by Dr. Per Brinck shows that our northern species is the same as *arctica* Esben-Petersen of northern Europe.

DISTRIBUTION: At present *arctica* has been taken in America from Alaska to Hudson Bay, south to Churchill, Manitoba.

Nemoura (N.) normani (new species)

1944. *Nemoura* species E, Ricker, Can. Ent. 70, p. 177; p. 180, figs. 2, 3, wing.

1950. *Nemoura* sp. A, Weber, Trans. Ann. Ent. Soc. 76, p. 175.

FEMALE: Length to tip of wings, 12-13 mm. Gills absent. Forewings strongly patterned in the holotype, much less so in the paratype, perhaps because of earlier capture. Anal field of the hindwing with 6 veins, one of them forked, and with 1 or more crossveins. Seventh sternite much produced over 8 and part of 9, the produced portion strongly sclerotized. Eighth sternite short, unsclerotized.

Holotype ♀ : Fort Norman, Mackenzie River, Mackenzie, June 29, 1922, C. H. Crickmay. In the Canadian National Collection. (This is the specimen illustrated in 1944.)

Paratype ♀ : Anaktuvuk Pass, Alaska, 68° 20' NL, 151° 30' WL, July 6, 1949, N. A. Weber. (No. 2398.)

The much larger size and less rounded 7th sternite are the principal features distinguishing this species from *Nemoura arctica*, the only other one of the subgenus whose range overlaps with it. Doubtless the male exhibits more striking peculiarities.

Nemoura (N.) trispinosa Claassen

1923. *Nemoura trispinosa* Claassen, Can. Ent. 55, p. 289. Type locality: Tompkins County, New York.

1925. *Nemoura trispinosa* Needham and Claassen, Monogr. Plecop., p. 213; p. 365, figs. 12-15, 9.

1942. *Nemoura trispinosa* Frison, Bull. Illinois Nat. Hist. Surv. 22, p. 261; fig. 27, ♂ 9.

1942. *Nemoura trispinosa* Harden, Ann. Ent. Soc. Amer. 35, pp. 322-27, figs. 4, 9-12, nymph.

1944. *Nemoura trispinosa* Ricker (in part), Can. Ent. 76, p. 180, fig. 9, ♂ cercus (not figs. 5, 6, 8, and 10, which are *arctica*.)

The name *Nemoura incerta* Provancher is proposed without a description (Nat. Canadien 10, p. 126, 1878), but with *completa* Walker and *albidipennis* Walker listed as varieties. In the list of species in the same journal (10, p. 144, 1878) *completa* Walker, *albidipennis* Walker, and *perfecta* Walker are given as synonyms of *incerta*. This may suggest that Provancher made a revision of the group, in which *incerta* was described; but, if so, it does not seem to have been published. In the Provancher collection there are two specimens labelled *incerta*; one is a

Nemoura trispinosa and the other a ♀ *N. nigritta*. The first of these bears the number and label, and would be a logical lectotype if one becomes necessary. However, unless a description turns up somewhere among Provancher's publications, *incerta* remains a nomen nudum.

DISTRIBUTION: The maritime provinces of Canada, New England, New York, southern Ontario, and Quebec north to Great Whale River and Murray Bay.

Subgenus *Ostrocerca* (new)

SUBGENOTYPE *Nemoura foersteri* Ricker.

SIZE: Small.

GILLS: Absent.

VENATION: Typical.

WING COLOR: Not banded.

♂ 9TH STERNITE: Much produced, usually exceeding the cerci ; rather slender and variously excavated on the sides ; sometimes asymmetrical. Basal lobe present.

SUBANAL LOBES: Elongated and heavily sclerotized.

CERCI: Elongated, curved inward, sharply pointed.

SUPRA-ANAL PROCESS: Pointed backward and upward, sometimes extremely complex in shape.

♂ TERGITES : 9th and 10th are wide and heavily sclerotized, the rest are narrower and weak.

♀ 7TH STERNITE: Produced in one species only.

♀ 8TH STERNITE: Either excavated, or produced and notched.

DISTRIBUTION: Cordilleran and eastern North America.

All the species of this subgenus appear to be rather uncommon, except perhaps the western *dimicki*.

MALES

- 1 Cerci definitely bent, in side view ; lobe of the 9th sternite attached at the front margin of the sternite 2
- Cerci almost straight, in side view; lobe of the 9th sternite attached behind the front margin (almost at the margin in *dimicki*) 3
- 2(1) Cerci with a subterminal notch on the inside *complexa*
- Cerci without any subterminal notch *prolongata*

- 3 1 Subgenital plate produced 9th sternite broadest close to the tip; 10th tergite with a pair of blunt sclerotized "horns" near the mid-line posteriorly *dimicki*
 Subgenital plate no wider near the tip than at a more anterior point, or not as wide; no "horns" on the 10th tergite 4
- 4 3 Tip of the subgenital plate rather broad, with 3 blunt subequal cusps; eastern *truncata*
 Tip of the subgenital plate slender, notched, or tapered 5
- 5 4 Tip of the subgenital plate slender, divided medially by a rather deep notch; eastern *albidipennis*
 Tip of the subgenital plate abruptly narrowed to a slender blunt entire tip, which is bent to the right; western *foersteri*

FEMALES (*truncata* unknown)

- 1 Seventh sternite produced over almost the whole of the 8th *prolongata*
 Seventh sternite little or not at all produced 2
- 2 1 Seventh sternite with a median nipple at its posterior border (Fig. 21 *complexa*
 Hind margin of the 7th sternite smooth 3
- 3 2 Eighth sternite triangularly produced, with a narrow median slit and a median knob just anterior to the slit *dimicki*
 Eighth sternite very little produced, broadly excavated 4
- 4 3 Eastern *albidipennis*
 Western *foersteri*

Nemoura (Ostrocerca) albidipennis Walker

1852. *Nemoura albidipennis* Walker, Cat. Neuropt. Brit. Museum, p. 191, ♀. Type locality: Nova Scotia.
1923. *Nemoura serrata* Claassen, Canad. Entomol. 55: 289. New synonymy.
1925. *Nemoura serrata* Needham and Claassen, Monogr. Plecop., p. 218; p. 369, figs. 4-6, ♀.
1938. *Nemoura albidipennis* Ricker, Trans. Royal Canad. Inst. 22(1):133. New description and figure of terminal sternites of the type.

When I redescribed the female type of *N. albidipennis* in 1938 there was no other described female with which it could be associated. Since then several examples have been found of the association of this kind of female with male *serrata*.

DISTRIBUTION: Southern Quebec, Maine, Nova Scotia, New York.

Nemoura (Ostrocerca) complexa Claassen

1937. *Nemoura complexa* Claassen, J. Kansas Ent. Soc. 10, p. 43, ♂. Type locality: Essex County, New York.

The unknown female of this species may be represented by females from Covey Hill, Quebec, and from Raquette Lake, Adirondack Park, New York. The 8th sternite is briefly but broadly produced and slightly emarginate, while the 7th sternite has a terminal nipple (Fig. 21).

DISTRIBUTION: New York and southern Quebec.

Nemoura (Ostrocerca) dimicki Frison

1936. *Nemoura dimicki* Frison, Ann. Ent. Soc. Amer. 29, p. 256; p. 264, figs. 8-11, ♂; p. 265, fig. 17, ♀.

DISTRIBUTION: Coast and Cascade Mountains, southern British Columbia to Oregon.

Nemoura (Ostrocerca) foersteri Ricker

1943. *Nemoura foersteri* Ricker, Stoneflies SW B.C., p. 70, figs. 38-40, 42, ♂ ♀.

DISTRIBUTION: Coast and Cascade Mountains from southern British Columbia to Oregon.

Nemoura (Ostrocerca) prolongata Claassen

1923. *Nemoura prolongata* Claassen, Can. Ent. 55, p. 289. Type locality: Bretton Woods, New Hampshire.

1925. *Nemoura prolongata* Needham and Claassen, Monogr. Plecop., p. 219; p. 369, figs. 7-10, ♂ ♀.

DISTRIBUTION: New Hampshire, Maine, New Brunswick.

Nemoura (Ostrocerca) truncata Claassen

1923. *Nemoura truncata* Claassen, Can. Ent. 55, p. 290. Type locality: Walden, Massachusetts.

1925. *Nemoura truncata* Needham and Claassen, Monogr. Plecop., p. 218; p. 369, figs. 1-3, ♂.

DISTRIBUTION: Known only from the type specimen and a male from Canaan Township, Athens County, Ohio, April 25, 1941, J. Walker.

Subgenus **Paranemoura** Needham and Claassen

1925. *Paranemoura* Needham and Claassen, *Monogr. Plecop.*, p. 288. **GENOTYPE** and only known species: *Nemoura perfecta* Walker.

SIZE: Rather small.

GILLS: Absent.

VENATION: The terminal **costal** crossvein runs from Sc to C in the region of the cord, instead of in its usual situation from **R to C** well beyond the cord.

WING COLOR: Transversely banded, but the lighter areas are not altogether clear ; costal region dark.

♂ 9TH STERNITE: Narrowly produced, the tip rounded ; basal lobe absent.

SUBANAL LOBES: Small, triangular.

CERCI: Unmodified in shape, but dark in color.

SUPRA-ANAL PROCESS: Short, pointed, recurved forward, heavily sclerotized.

♂ TERGITES: 1-7 are unsclerotized ; 8 and 9 are sclerotized, but the sclerotization is narrow medially ; 10 is **sclerotized** and depressed medially.

9 STERNITES: 7th with a small **rounded sclerotized** projection posteriorly ; 8th with a strongly-sclerotized median stripe, somewhat extended laterally along the hind margin.

DISTRIBUTION: Eastern North America.

Nemoura (Paranemoura) perfecta Walker

1852. *Nemoura perfecta* Walker, *Cat. Neurop. Ins. Br. Mus.*, Pt. I, p. 191. Type locality: Nova Scotia.

1923. *Nemoura punctipennis* Claassen, *Can. Ent.* 55, p. 291.

1925. *Nemoura punctipennis* Needham and Claassen, **Monogr. Plecop.**, p. 221; p. 369, figs. 18-20, ♂ 9.

1938. *Nemoura perfecta* Ricker, *Trans. Royal Can. Inst.* 22(1), p. 133.

DISTRIBUTION: Southern Canada from Ontario to the Maritime provinces ; Maine, New York, North Carolina.

Subgenus *Podmosta* (new)

SUBGENOTYPE: *Nemoura decepta* Frison.

SIZE: Small.

GILLS: Absent.

VENATION: Usually typical but a number of irregularities occur in *obscura*.

WING COLOR: Usually clear, or with the veins margined by brown pigment.

♂ 9TH STERNITE: Little produced, pointed ; basal lobe present.

SUBANAL LOBES: Simple, triangular.

CERCI: Simple.

SUPRA-ANAL PROCESS: Short, thick, mostly membranous, complex in structure, only slightly recurved.

♂ TERGITES : 10th deeply depressed medially.

♀ STERNITES : 7th unmodified ; 8th produced, straight or excavated posteriorly, usually minutely or more obviously notched.

DISTRIBUTION: Cordilleran and eastern North America.

MALES (*rossi* and *weberi* unknown)

- | | | |
|------|--|---------------------|
| 1 | Supra-anal process with sharp curved laterally-directed horns near the tip | <i>decepta</i> |
| | Supra-anal process without such horns | 2 |
| 2(1) | Wings usually (?always) with crossveins in the apical field behind the costal space ; all veins margined with brown | <i>obscura</i> |
| | Wings without crossveins in the apical field except in the costal space ; veins not margined with brown, except along or near the cord | 3 |
| 3(2) | Eastern ; middle members of the supra-anal process sharply bent near the middle (Fig. 25) | <i>macdunnoughi</i> |
| | Western ; the middle members of the supra-anal process lie close to the outer members and are not bent near the middle | <i>delicatula</i> |

FEMALES

- | | | |
|---|---------|---------------------|
| 1 | Eastern | <i>macdunnoughi</i> |
| | Western | 2 |

- 2(1) Wings usually (?always) with crossveins in the apical field behind the costal space ; most veins margined with brown ; 8th sternite a little produced and narrowly notched *obscura*
- Wings without crossveins in the apical field except in the costal space ; veins not margined, except along or near the cord 3
- 3(2) Median sclerotized stripe of the 8th sternite 3 to 4 times as long as its greatest breadth, of nearly uniform width throughout 4
- Median sclerotized stripe of the 8th sternite not more than twice as long as its greatest breadth (the stripe is obscure in *decepta*) 5
- 4(3) Sternite 7 with a small sclerotized area medially next to the hind margin ; hind margin of the 8th sternite produced into two conspicuous lobes beside the median notch *weberi*
- Sternite 7 completely unsclerotized ; margin of the 8th sternite with a tiny median notch but without lobes *delicatula*
- 5(3) Hind margin of the 8th sternite broadly V-shaped and very weak, without any notch in the end of the weakly sclerotized median stripe *decepta*
- Hind margin of the 8th sternite linear, except for a sharp notch in the end of the strongly sclerotized median stripe *rossi* -

Nemoura (Podmosta) decepta Frison

- 1942. *Nemoura decepta* Frison, Pan-Pac. Ent. 18, p. 13, fig. 2a-2d, ♂. Type locality: Estes Park, Colorado.

1943. *Nemoura decepta* Ricker, Stoneflies SW B.C., pp. 69-71, figs. 34-37, ♂, ♀, 9, nymph.

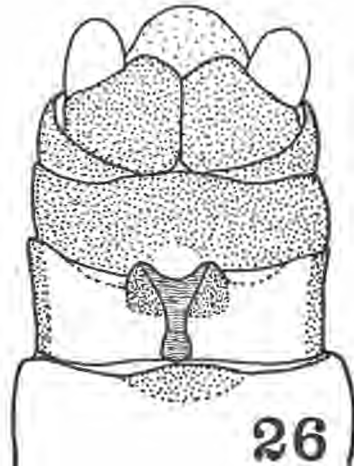
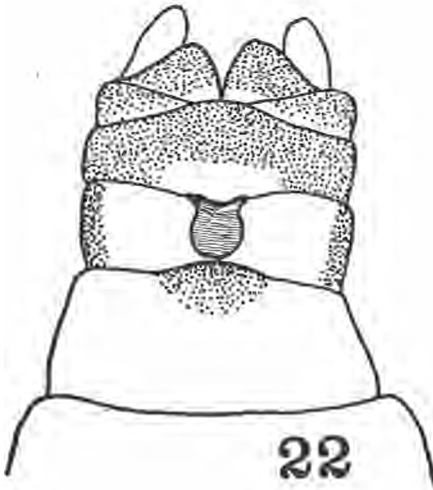
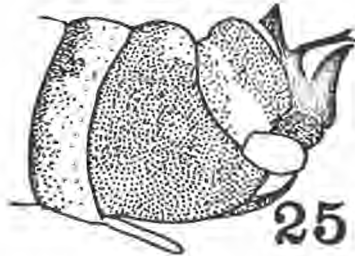
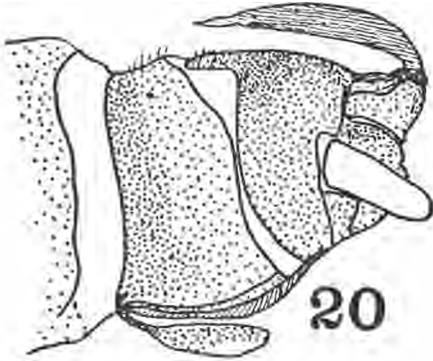
DISTRIBUTION: Colorado, Vancouver Island, and northeastern British Columbia.

Nemoura (Podmosta) delicatula Claassen

1923. *Nemoura delicatula* Claassen, Can. Ent. 55, p. 285. Type locality: Boulder, Colorado.

1925. *Nemoura delicatula* Needham and Claassen, Monogr. Plecop., p. 204; p. 359, figs. 14-17, ♂ ♀.

DISTRIBUTION: Cordillera from California and Colorado north to central British Columbia (Skeena River).



Nemoura (Pod mosta) *macdunnoughi* Ricker

1947. *Nemoura macdunnoughi* Ricker, Trans. Royal Can. Inst. 26(2), p. 403; Plate 10, figs. 1-2, 9, nymphal ♂.

The male genitalia are shown here (Figs. 24, 25), drawn from specimens taken at Temiskaming, Quebec, by Dr. F. P. Ide. The species is closely related to *delicatula*, but the male differs as noted in the key. In the female the sclerotized stripe of the 8th sternite is narrower in *delicatula* and does not broaden at the end as it does in *macdunnoughi*.

DISTRIBUTION: Nova Scotia, Quebec, Newfoundland, Labrador.

Nemoura (Podmosta) *obscura* Frison

1936. *Nemoura obscura* Frison, Ann. Ent. Soc. Amer. 29, p. 258, fig. 1; p. 264, figs. 12-14, ♂; p. 265, figs. 15, 18, ♀.

The venation of this species is aberrant: there are usually 1 to 3 crossveins between R_1 and R_2 beyond the cord, and sometimes 1 or 2 between R_1 and R_2 ; the terminal slanting costal crossveins usually lies between R and C, but sometimes is between Sc and C; occasionally there is fusion of A_1 and A_2 of the forewing near their tips.

DISTRIBUTION: Cascade Mountains of Washington and Oregon.

Nemoura (Podmosta) *rossi* (new species)

FEMALE: Length of body, 4.5 mm.; to tip of wings, 7-8 mm. Color black; wing membrane light brown, heavily pigmented along the cord and adjacent veins. Gills absent. Tergites unsclerotized except the 10th. Sternite 7 slightly produced and sclerotized apically; sternite 8 sclerotized on the sides, and in a central strip which has rounded sides and is broadly notched posteriorly. (As represented in figure 22, this strip is seen

Nemoura besametsa. 20. Terminal segments of the holotype ♂, from the side.

Nemoura complexa(?). 21. Terminal segments of a ♀. Death Creek, Adirondack Park, New York.

Nemoura rossi. 22. Terminal sternites of holotype ♀.

Nemoura completa. 23. Supra-anal process of a ♂, Keewenaw County, Michigan.

Nemoura macdunnoughi. 24. Terminal segments of a ♂, from above. Temiskaming, Quebec. 25. The same, from the side.

Nemoura weberi. 26. Terminal sternites of holotype ♀.

somewhat obliquely and appears relatively broader and with more curved side margins than in a full face view.)

Holotype : Station 11, Nash Creek, Medicine Bow Mountains, Wyoming, August 14-16, 1947, H. H. and J. A. Ross.

Paratypes as follows:

MONTANA

Bear Tooth Creek, Bear Tooth Range, el. ca. 9,500 ft. August 21, 1946, 2 ♀, W. E. Ricker.

WYOMING

Same data as holotype: 9.

Snowy Range Mountain near Brooklyn Lake. July 26, 1947, 9, D. G. Denning.

This species resembles *delicatula*, but differs in having a much broader sclerotized stripe on the 8th sternite, and in having more dark pigment about the cord of the wing.

Nemoura (Podmosta) weberi (new species)

1950. *Nemoura* sp. BB, Weber, Trans. Am. Ent. Soc. 76, p. 175.

FEMALE: Length of body, 5 mm.; to tip of wings, 8.5 mm. Body color dark; wing membrane clear, somewhat darkened along the cord, but this does not spread out along the long veins as in *rossi*. Abdominal tergites unsclerotized, except the 10th. Sternite 7 very slightly produced and sclerotized apically; 8. with a median brown sclerotized stripe, broadened at either end and produced and notched posteriorly. Under the 8th sternite near the tip is a sclerotized (?) plate which is black rather than brown, and shows through the transparent tissue at either side of the median stripe. The dorsal and ventral dark areas combine to form two small flaps on the posterior margin (Fig. 26). Sternite 9 is sclerotized except for a small median anterior spot.

Holotype ♀ and paratype ♀: Anaktuvuk Pass, 68° 20' NL, 151° 30' WL, Alaska, July 5, 1949, N. A. Weber.

Paratypes from the same locality: July 7, 2 ♂; el. 4550 ft., July 22, ♀.

Other paratypes: Watson Lake, Yukon; June 24, 1948, 9, W. R. Mason (CNC)

The median stripe on the 8th sternite associates this species with *Podmosta*, but the produced tips are not found in other species of the subgenus. There are two mature female nymphs taken at Anaktuvuk Pass on July 6, 1949, which may be of this species.

Subgenus **Prostoia** (new)

SUBGENOTYPE: *Nemoura completa* Walker.

SIZE: Small.

GILLS: Absent.

VENATION: Typical.

WING COLOR: Transversely banded.

♂ **9TH STERNITE** Briefly produced and pointed ; basal lobe present.

SUBANAL LOBES: Simple, triangular.

CERCI: Unmodified.

SUPRA-ANAL PROCESS: Long, completely recurved along the 10th and 9th tergites, with a slender process on either side at the base (barely recognizable in *besametsa*).

♂ **TERGITES:** 1-7 little modified ; 8 with extra median sclerotization in *similis* ; 9 deeply excavated behind, and 10 produced to fit into the excavation.

9 STERNITES: 7 swollen and tending to coalesce with 8 along the mid-line ; 8 produced anteriorly ; a little or not at all produced posteriorly, where it is broadly excavated and may have a central notch.

DISTRIBUTION: Cordilleran and eastern North America.

MALES

- 1 Supra-anal process with the basal processes twisted, stiletto-like, divergent, and more than half as long as the process *similis*
Slender processes at the base of the supra-anal process short (less than a sixth as long as the process), appressed and easily overlooked 2
- 2(1) Tip of the supra-anal process with the terminal spine confluent with the ventral margin (fig. 23) ; eastern *completa*
Tip of the supra-anal process marked off by a slight depression both below and above (fig. 20) ; western *besametsa*

FEMALES

- | | |
|---|------------------|
| 1 Sternite 8 distinctly produced laterally ; with a large notch medially (N and C, p. 365, Fig. 16) | <i>similis</i> |
| Sternite 8 little or not at all produced ; median notch small or absent | 2 |
| 2(1) Eastern | <i>completa</i> |
| Western | <i>besametsa</i> |

Nemoura (Prostoia) *besametsa* (new species)

1923. *Nemoura glabra* Claassen (in part: western specimens), Can. Ent. 55, p. 281. (Not the holotype.)
1925. *Nemoura glabra* Needham and Claassen (in part), Monogr. Plecop., p. 202.
1938. *Nemoura glabra* Knowlton and Harmston, Ent. News 49, p. 284.
1938. *Nemoura glabra* Hoppe, Univ. Wash. Publ. Biol. 4 (2), p. 160.
1943. *Nemoura comoleta* Ricker, Stoneflies SW B.C., p. 68, ♂, ♀, nymph. (Not Walker 1852.)
1943. *Nemoura* species A Ricker, *ibid.*, p. 72; p. 71, figs. 41, 43, 9.

MALE: Length of body, 4.5 mm., to tip of wings, 6.5 mm. Color as in the female, as described in 1943. The supra-anal process, in side view, is slightly swollen and marked off from the main part by a slight depression both above and below (Fig. 20).

FEMALE: The 1943 description and figure is of a well-matured specimen. Younger specimens have a darker median sclerotized area near the tip of the 8th sternite. The size of the median notch is variable: sometimes it is scarcely recognizable.

Holotype ♂, allotype ♀, 11 ♂ and 4 ♀ paratypes: Vedder Crossing, British Columbia, April 25, 1937, S. Spencer and W. E. Ricker.

Other paratypes from the type locality : April 26, 1937, 2 ♂ 3 ♀ ; May 9, 1937, 8 ♂ 5 ♀.

The confusion of *besametsa* with the eastern *completa* (*glabra*) has persisted since 1923; however, the males are easily separable (Figs. 20 and 23). My description of a female as "species A" in 1943 resulted from the fact that she was a mature and very strongly-pigmented individual.

DISTRIBUTION: Cordillera generally, from southern British Columbia to California and Colorado. It appears to be rare in western Oregon and extremely abundant in northern Utah.

Nemoura (Prostoia) completa Walker

1852. *Nemoura completa* Walker, Cat. Neurop. Br. Mus. Pt. I, p. 191. Type locality: Nova Scotia.
1923. *Nemoura glabra* Claassen (in part: holotype and allotype), Can. Ent. 55, p. 281.
1925. *Nemoura glabra* Needham and Claassen (in part), Monogr. Plecop., p.202; p. 359, figs. 1-4,
1938. *Nemoura completa* Ricker, Trans. Roy. Canad. Inst. 22(1), p. 133.

DISTRIBUTION: From Nova Scotia through southern Ontario to Michigan and Wisconsin, south in the mountains to Virginia and the Carolinas ; southern Illinois, Mississippi, and Arkansas.

Nemoura (Prostoia) similis Hagen

1861. Taeniopteryx *nimilix* Hagen, Syn. Neurop. N. Amer., p. 34. Type locality: Washington, D. C.
1923. *Nemoura divergens* Claassen, Can. Ent. 55, p. 282. New Synonymy.
1925. *Nemoura similis* Needham and Claassen, Monogr. Plecop., p. 214; p. 365, fig. 16, ♀.
1925. *Nemoura divergens* Needham and Claassen, Monogr. Plecop., p. 203; p. 359, figs. 8-10, ♂.

Hagen's female and Claassen's male can be associated on the basis of a large number of common collections.

DISTRIBUTION: New England south to Virginia and west through Ohio to Indiana and Michigan.

Subgenus *Shipsa* (new)

SUBGENOTYPE and only known species : *Nemoura rotunda* Claassen.

SIZE: Moderate.

GILLS: Absent.

VENATION: Typical.

WING COLOR: Banded.

♂ 9TH STERNITE : Briefly produced ; basal lobe present.

SUBANAL LOBES: Produced, irregular in shape.

CERCI: Unmodified.

SUPRA-ANAL PROCESS: Large, partly membranous, only partly recurved.

♂ TERGITES: 10th tergite, on either side, produced into a pair of stout curved spiny hooks.

9 STERNITES : 7th much produced, excavated laterally ; 8th not produced. (The produced part of 7 is attached to 8 basally, and appears to be part of the latter segment).

DISTRIBUTION: Eastern and northern North America.

Nemoura (Shipsa) rotunda Claassen

1923. *Nemoura rotunda* Claassen, Can. Ent. 55, p. 290. Type locality: Waldeboro, Maine.

1925. *Nemoura rotunda* Needham and Claassen, Monogr. Plecop., p. 219; p. 369, figs. 11-14, ♂ 9.

DISTRIBUTION: Alaska, Mackenzie, Keewatin, and Ungava, south to northern Saskatchewan, Manitoba, Minnesota, Michigan, southern Ontario, and in the east to Maryland.

Subgenus **Soyedina** (new)

SUBGENOTYPE : *Nemoura vallicularia* Wu.

SIZE: Medium.

GILLS: Absent.

VENATION: Distinguished by the union of A_1 and A_2 in the forewing, a short distance proximad of the margin of the wing. Occasional individuals lack this union, but usually only in one wing.

WING COLOR: There is considerable brown pigment, somewhat darker along the anterior veins of the cord, but definite transverse bands are absent.

9TH STERNITE : Much elongated and bent upward above the middle, sometimes very sharply so. Basal lobe present.

SUBANAL LOBES: Much produced, their outer parts tending to be twisted to a position parallel to the long axis of the body, so that their breadth is best observed in side view. They are usually closely applied to the supra-anal process.

CERCI: Unmodified.

SUPRA-ANAL PROCESS: Erect, or even directed somewhat backward ; complex in structure.

♂ TERGITES : In *vallicularia* the 6th to 8th tergites are elevated posteriorly ; *producta* has knobs on the 2d, 3d and 4th tergites.

9 STERNITES : The 7th is much produced and rounded ; the 8th is excavated, not produced.

DISTRIBUTION: Cordilleran and eastern North America.

MALES

- 1 Tergites 2, 3, and 4 with elevated processes ; western
producta
- Tergites 2 to 4 without processes 2
- 2 1 Supra-anal process with numerous tiny spinules along
the outer edges of the *lateral sclerotized* ridge ;
western *nevadensis* 3
- Lateral (posterior) *sclerotized* ridge of the supra-
anal process not spinulose ; eastern 4
- 3 2 Subanal lobes tapering regularly to their broad tips,
no notch to be seen on the mesal surface when the
specimen is viewed either from the side or from
behind, though there is a broad excavation near
the base N and C, p. 367, Fig. 10
nevadensis nevadensis
- Mesal margin of subanal lobes notched ; their tips
rather narrow N and C, p. 367, Fig. 18
nevadensis interrupta
- 4(2) Subanal lobe with its anterior margin straight near
the narrow truncate tip, without any suggestion of
a process N and C, p. 367, Fig. 3 ; tergite 7 ele-
vated posteriorly *vallicularia*
- Subanal lobe with the anterior margin concave near
the tip, often but not always with a distinct antero-
dorsal projection N and C, p. 367, Fig. 14 ; tergite
7 not elevated *washingtoni* 5
- 5 4 Ends of the subanal lobes nearly truncate
washing toni washingtoni
- Subanal lobes rounded at the inner apical corner
was carolinensis

FEMALES

(No adequate key seems possible, but the following may be helpful.)

- 1 Eastern 2
Western 3
- 2(1) Subgenital plate of the 7th sternite narrower *washingtoni*
Subgenital plate broader *vallicularia*

- 3(1) Subgenital plate of the 7th sternite more broadly rounded (Ricker, 1943, p. 67, Fig. 30) *nevadensis*
Subgenital plate less broadly rounded (*ibid.*, Fig. 29) *producta*

***Nemoura (Soyedina) nevadensis* Claassen**

a. Subspecies *nevadensis* sensu stricto

1923. *Nemoura nevadensis* Claassen, Can. Ent. 55, p. 286. Type locality: Reno, Nevada.
1925. *Nemoura nevadensis* Needham and Claassen, Monogr. Plecop., p. 216; p. 367, figs. 8-11, ♂ ♀.

DISTRIBUTION: Northeastern California and western Nevada.

b. Subspecies *interrupta* Claassen

1923. *Nemoura interrupta* Claassen, Can. Ent. 55, p. 288. Type locality: Seattle, Washington.
1925. *Nemoura interrupta* Needham and Claassen, Monogr. Plecop., p. 217; p. 367, figs. 16-18, ♂.
1942. *Nemoura pseudoproducta* Frison, Pan-Pac. Ent. 18, p. 11; p. 12, figs. 1a-1b, ♂.
1943. *Nemoura interrupta* Ricker, Stoneflies SW B.C., p. 66; p. 67, fig. 30, ♀.

DISTRIBUTION: Coast and Cascade Mountains of southern British Columbia, Washington, and Oregon.

Going from north southward, the size of the excavation on the mesal surface of the subanal lobes of *nevadensis* (s.l.) decreases. It is largest in B.C. specimens, somewhat smaller in Oregon, and absent in specimens from California and Nevada.

***Nemoura (Soyedina) producta* Claassen**

1923. *Nemoura producta* Claassen, Can. Ent. 55, p. 286. Type locality unknown.
1925. *Nemoura producta* Needham and Claassen, Monogr. Plecop., p. 211; p. 365, figs. 1-4, ♂.
1937. *Nemoura tuberculata* Frison, Bull. Illinois Nat. Hist. Surv. 21, p. 84, fig. 71, ♂.
1939. *Nemoura producta* Ricker, Proc. Ent. Soc. B.C. 42, p. 22 (*Nemoura tuberculata* is mis-spelled *tuberculifera*).
1943. *Nemoura producta* Ricker, Stoneflies SW B.C., pp. 65-67, figs. 29, 31, ♀, nymph.

DISTRIBUTION: Coast and Cascade Mountains from southern British Columbia to Oregon.

Nemoura (Soyedina) vallicularia Wu

1923. *Nemoura vallicularia* Wu, Bull. Lloyd Libr. 23, pp. 1-81, ♂, ♀, nymph. Type locality: Ithaca, New York.
1925. *Nemoura vallicularia* Needham and Claassen, Monogr. Plecop., p. 216; p. 366, figs. 1-4, ♀.

DISTRIBUTION: Southern Quebec, the Maritime Provinces, New York, Pennsylvania, southern Ontario, Michigan, and Indiana.

Nemoura (Soyedina) washingtoni Claassena. Subspecies **washingtoni** sensu stricto

1923. *Nemoura washingtoni* Claassen, Can. Ent. 60, p. 287. Type locality: Mt. Washington, New Hampshire.
1925. *Nemoura washingtoniana* Needham and Claassen (misspelling), Monogr. Plecop., p. 217; p. 367, figs. 12-15, ♂, ♀.

DISTRIBUTION: New England.

b. Subspecies **carolinensis** Claassen

1923. *Nemoura carolinensis* Claassen, Can. Ent. 60, p. 287 (below *washingtoni*).
1925. *Nemoura carolinensis* Needham and Claassen, Monogr. Plecop., p. 215; p. 367, figs. 5-7, ♂.

DISTRIBUTION: Virginia, North Carolina, and Tennessee. The gap which separates this race from typical *washingtoni* may be filled by later collecting, as the species emerges early in the year and is infrequently captured.

Examination of a number of specimens of *carolinensis* taken from Virginia to Tennessee shows them to be almost indistinguishable from *washingtoni*. There is, however, some tendency for the 'ends' of the subanal lobes to be rounded at the inner 'apical corner, instead of being squarish as in northern specimens. Needham and Claassen's key (p. 199) distinguishes *carolinensis* by the absence of fusion of A_1 and A_2 in the forewing. If this is in fact the situation in the holotype, it represents merely an example of a not-too-common deviation from the typical condition in the subgenus. The spinules on the anterior member of the supra-anal process, figured by Claassen for *carolinensis*, are present also in *washingtoni*, though easily overlooked.

Subgenus Visoka (new)

SUBGENOTYPE and only known species: *Nemoura cat aractae* Neave.

SIZE: **Small.**

GILLS: A branched gill arises from between the labium and maxilla on either side. Cervical gills absent.

VENATION: Normal.

WING COLOR: Veins margined with brown.

♂ **9TH STERNITE:** Moderately produced and upturned; blunt.

SUBANAL LOBES: Broad at the base, triangular, and with a long, slender, acute spine developed from the inner margin.

CERCI: Partly sclerotized, with a major hook and minor cusp at the tip; this character being weakly developed in the female also.

SUPRA-ANAL PROCESS: Slender, fully sclerotized, completely recurved but rather short.

♂ **TERGITES:** 1-7 unsclerotized except for a narrow anterior lateral strip; 8 and 7 sclerotized laterally, but unsclerotized dorsally except along the anterior margin.

♀ **STERNITES:** 7th produced over half of the 8th; underneath it is a strongly-sclerotized truncate patch; 8 narrow, its hind margin moderately sclerotized and broadly excavated.

DISTRIBUTION: Western North America.

Nemoura (*Nemoura*) *Nemoura* Neave

1933. *Nemoura cataractae* Neave, *Can. Entomol.* 65, p. 238; *ibid.*, 236, p. 3-4, ♂.

Nemoura cataractae: L. O'Hara, B.C.

1943. *Nemoura cataractae* Ross, *Southern British Columbia* SW B.C., p. 58; p. 60, p. 20-22, 9, p. 11.

DISTRIBUTION: Southern British Columbia to Oregon and Montana.

Subgenus *Nemoura* (*Nemoura*)

SUBGENOTYPE: *Nemoura haysi* (new).

SIZE: Small to large.

GILLS: 4 cervical gills, unbranched except in *cinctipes* where they are normally 4-5 branched.

VENATION: Typical.

WING COLOR: Either transversely banded or uniformly dark.

♂ **9TH STERNITE:** Somewhat produced and pointed; basal lobe present.

SUBANAL LOBES: Variously modified, typically large and subrectangular; a slender lobe is present on the inner margin (reduced in *frigida*).

CERCI: Unmodified.

SUPRA-ANAL PROCESS: Rather large, mostly unsclerotized, almost completely recurved.

TERGITES: 10th somewhat grooved dorsally.

STERNITES: 7th produced over the 8th, which is unsclerotized.

DISTRIBUTION: North America, chiefly cordilleran.

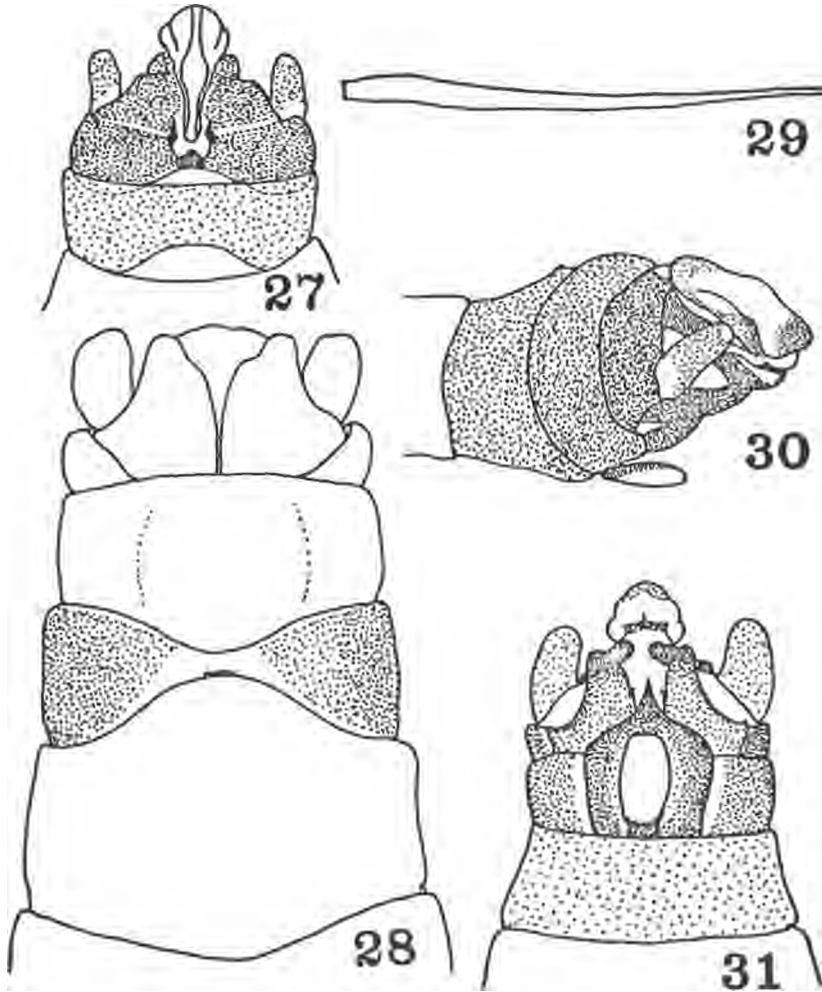
MALES AND FEMALES

- 1** Wings uniformly dark ; gills 12-15 times as long as wide 2
 Wings conspicuously banded or mostly clear; gills
 less than 10 times as long as wide 3
- 2(1)** Gills of uniform thickness almost to the tip ; western
frigida
 Gills gradually tapered to their tips; eastern *chila*
- 3(1)** Gills branched one to several times (very rarely un-
 branched) ; tip of the wing clear *cinctipes*
 Gills simple 4
- 4(3)** Gills constricted at the base, and one or more times
 (usually twice) beyond the base *columbiana*
 Gills constricted at the base only, if at all (a slight
 subterminal constriction occasionally in *haysi*) 5
- 5(4)** Subanal lobes quadrangular, the inner terminal angle
 rather sharp, without any sclerotized knob on the
 inner membrane; produced part of ♀ sternite 7'
 light colored and *narrowly* rounded, almost *semi-*
circular *oregonensis*
 Subanal lobes with the inner terminal angle obtuse
 and rounded, so that the lobe appears almost tri-
 angular (Fig. 33), and bearing a sclerotized knob
 on the distal lateral corner of the inner membrane ;
 produced part of ♀ sternite 7 dark in color, at least
 along the *broadly* rounded or nearly straight hind
 margin (Fig. 35) *haysi*

Nemoura (Zapada) chila (new species)

MALE: Length of body, 5 mm. ; to wing tips, 7.5 mm. Color dark brown, abdomen lighter. Wings rather darkly infuscated, lacking a pattern. The 4 cervical gills slender and gradually tapered, 12-15 times longer than their greatest width. Tenth tergite is slightly excavated on the mid-line, its posterior half

abruptly declivitous. Supra-anal process recurved, tapering to the tip in dorsal view, its surface sculptured, weakly sclerotized (Fig. 27). Subanal lobes not greatly produced, rounded, with a slender mesal process (Fig. 31). Ninth sternite with a large lobe.



Nemoura chila. 27. Terminal segments of holotype ♂, from above. 30. The same, from the side. 31. The same, from below. 28. Terminal sternites of allotype ♀. 29. Gill of ♀.

FEMALE: Length of body, 6 mm. ; to wing tips, 9 mm. The 7th sternite inflated and produced over the 8th ; 8th sternite con-

stricted medially and lacking sclerotization there, except for a dark anterior strip largely covered by the 7th (Fig. 28).

Holotype ♂ : Walker Prong at road bridge, 1 mi. N of Newfound Gap, Smoky Mountains National Park, Tennessee, April 4, 1949, W. E. Ricker.

Allotype ♀ : The same, April 14, 1949, D. C. Scott.

Paratype : Newfound Gap, Smoky Mountains National Park, May 11, 1944, Frison and Ross.

This is the smallest representative of the subgenus. It is closely allied to *frigida*, which differs in details of the shape of the supra-anal process, and in having gills of nearly uniform width throughout their entire length.

Nemour (Zapada) cintipes Banks

1897. *Nemoura cintipes* Banks, Trans. Amer. Ent. Soc. 24, p. 21. Type locality: Olympia, Washington.

1925. *Nemoura cintipes* Needham and Claassen, Monogr. Plecop., p. 212; p. 355, fig. 2, wings; p. 37, figs. 5-8, ♂ 9.

1939. *Nemoura cintipes* Castle, Can. Ent. 71, pp. 208-209, fig. 1, nymph.

DISTRIBUTION: Alaska to California, and Alberta to Colorado and Nevada ; east to Manitoba and South Dakota. An abundant species.

Nemoura (Zapada) columbiana Claassen

1923. *Nemoura columbiana* Claassen, Can. Ent. 55, p. 286. Type locality: Laggan (Lake Louise), Alberta.

1925. *Nemoura columbiana* Needham and Claassen, Monogr. Plecop., p. 203; p. 359, figs. 11-13, ♂.

1933. *Nemoura columbiana* Neave, Can. Ent. 65, p. 238; p. 236, fig. 5, ♀.

1943. *Nemoura columbiana* Ricker, Stoneflies SW B.C., p. 61, fig. 24, nymph.

DISTRIBUTION: Southern Alaska, British Columbia, montane Alberta, Washington, Oregon, Utah.

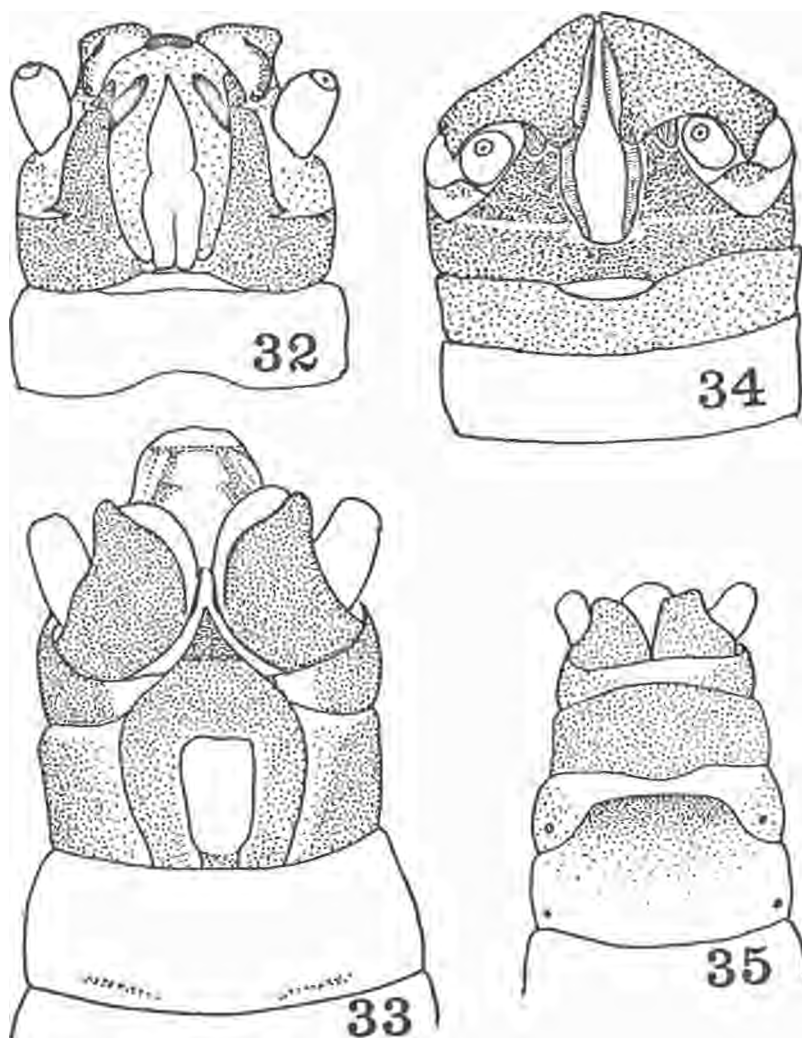
Nemoura (Zapada) frigida Claassen

1923. *Nemoura frigida* Claassen, Can. Ent. 55, p. 285. Type locality: Sitka, Alaska.

1925. *Nemoura frigida* Needham and Claassen, Monogr. Plecop., p. 202; p. 359, figs. 5-7, ♂.

1943. *Nemoura frigida* Ricker, Stoneflies SW B.C., pp. 59-60, figs. 23, 25, ♀, nymph.

DISTRIBUTION: Southern Alaska, British Columbia, Washington, Oregon, Colorado, and Wyoming.



Nemoura haysi. 32. Terminal segments of holotype ♂, from above. 33. The same, from below. 34. Terminal segments of a ♂ from Sonora Pass, California. (The subanal lobes are twisted inward so that the distal margins lie almost parallel to the supra-anal process.) 35. Terminal sternites of allotype 9.

Nemoura (Zapada) haysi (new species)

1943. *Nemoura oregonensis* Ricker (in part), *Stoneflies SW B.C.*, p. 61. (Not *oregonensis* Claassen.)
 1950. *Nemoura oregonensis* Weber, *Trans. Am. Ent. Soc.* 76, p. 175.

MALE: Length of body, 5.5 mm.; to tip of wings, 8 mm. Color black. Wings mostly rather lightly infuscated, with a light transverse band beyond the cord; tip of wing dark. Gills 4, unbranched, cylindrical or slightly swollen in the basal half, 6-9 times as long as broad, usually only slightly constricted at the base, sometimes slightly constricted close to the tip. Supra-anal process fully recurved, mostly *unsclerotized*; with minute teeth on two sclerotized bands ventrally, in some specimens at least. Subanal lobes broadly rounded on the inner margin; on the dorsal (anterior) face lies a loosely-attached membranous fold which bears a small sclerotized knob at the distal lateral corner (Fig. 32). (This contrasts with *oregonensis* in which the membranous fold is more firmly attached and lacks any sclerotization.)

FEMALE: Length of body, 6.5 mm.; to tip of wings, 10.5 mm. Color as in the male. Seventh sternite (Fig. 35) broadly produced over 8, its tip slightly curved, dark in color, or at least with a dark terminal margin. Eighth sternite weak medially, not produced.

Holotype ♂, allotype ♀, 12 ♂ and 12 ♀ paratypes: Upper Gallatin River, 5 mi. E of Highway no. 191, Yellowstone National Park, Wyoming, June 13, 1949, R. A. Hays.

Other material:

ALASKA

Anaktuvuk Pass, 68° 20' N, 151° 30' W. July 6, 1949, 2 ♀, N. A. Weber. (Identified by the writer and recorded as *oregonensis*, Weber 1950.)

ALBERTA

Lake Louise. July 16, 1938, ♂, G. S. Walley (CNC).

BRITISH COLUMBIA

Fraser R. at Agassiz. April 14, 1938, W. E. Ricker. (Recorded as *oregonensis*, 1943.)

CALIFORNIA

Near Sonora Pass, el. 8,500 feet. July 7, 1948, ♂, H. K. Townes.

COLORADO

Cameron Pass, Lake Agnes, el. 11,000 ft. August, 1947, ♀, H. H. Ross. Phantom Valley, Rocky Mountain National Park, el. 9,400 ft. August 10, 1948, ♀, H. K. Townes.

Independence Pass, Station 3, Mt. Boy Park. August 6, 1943, ♀, H. H. and J. A. Ross.

MONTANA

Cascade Creek, 30 miles S of Bozeman. April 24, 1949, ♂, R. Hays.

OREGON

Anne's Spring, Crater Lake National Park. June 28, 1950, ♀, W. E. Ricker.

UTAH

Providence Canyon. May 28, 1939, ♀, G. F. Knowlton and R. E. Nye.

WASHINGTON

N. Branch Nooksack River, el. 2000 ft. May 23, 1937, ♀, W. E. Ricker.
(Recorded as *oregonensis*, 1943.)

WYOMING

Nashes Fork Creek, Centennial. August 17, 1938, ♀, W. P. Hayes.
Centennial. July 2, 1938, ♂ ♀, D. J. and J. N. Knoll.

The separation of *haysi* from *oregonensis* is not always easy. The latter usually has shorter, more tapered gills, with a sharp constriction at their base; the male subanal lobes have a sharper angle mesally; and the female subgenital plate is more narrowly rounded and light in color, without any dark pigment along the terminal margin. However, the gills, especially, can be misleading; Colorado specimens of *oregonensis* approach *haysi* in this respect, and even elsewhere an *oregonensis* specimen which is dried, or has been partly dried before being placed in alcohol, may have the gills folded inward longitudinally, and hence lacking the typical swollen outline. Female specimens of the 2 species do not seem to intergrade in respect to the shape of the subgenital plate.

***Nemoura (Zapada) oregonensis* Claassen**

1923. *Nemoura oregonensis* Claassen, Can. Ent. 55, p. 288. Type locality: Harney County, Oregon.
1925. *Nemoura oregonensis* Needham and Claassen, Monogr. Plecop., p. 213; p. 365, figs. 9-11, ♂.
1937. *Nemoura oregonensis* Frison, Bull. Illinois Nat. Hist. Surv. 21, p. 83-84, fig. 70, ♀.
1943. *Nemoura oregonensis* Ricker (in part), Stoneflies SW B.C., p. 62; p. 67, fig. 31, nymph.

In my 1943 paper the species *haysi* was included with *oregonensis*, though peculiarities of a male specimen of *haysi* were

noted. Of the specimens listed in that paper, only those from the Fraser River and the Nooksack River prove to be *hayasi*; the Mons specimens have not been re-examined. Dr. Frison's 1937 Oregon records are all *oregonensis*. In the southern Rocky Mountain region male specimens of *oregonensis* tend to have the lateral corners of the subanal lobes produced backward.

DISTRIBUTION: Cordilleran region from the Yukon south to Oregon, Utah, Wyoming, and Colorado. There is also a female from Tuckerman's Ravine, Mt. Washington, New Hampshire, June 23, 1941, coll. Frison and Ross, which I cannot distinguish from *oregonensis*; however, the male will be needed to determine this specimen definitely.

PART II. The Family Perlodidae

THE Perlodidae belong to the systellognathous group of stonefly families, these being characterized by their thin jaws, slender maxillary palpi, and by having the glossae of the labium reduced to a rather small knob fused to the side of the paraglossae. They differ from other Systellognatha as follows: from Perlidae, by the absence of *dissected* thoracic gills and by the pointed paraglossa of the nymph ; from Chloroperlidae, by the flatter nymphal body and usually by having the two branches of *A₁* in the forewing leaving the anal cell separately instead of together (however, exceptions occur in both families).

Three structural features of ancient origin, namely gills, the male supra-anal process, and a profusion of crossveins in the apical portion of the wing, have been retained by the more primitive Perlodidae, to be lost in more modern representatives. By these criteria the subfamily Isogeninae is the primitive one, while Perlodinae and Isoperlinae are more specialized. However, there is gradation in these respects within the subfamilies, as well as between them.

It is, unfortunately, impossible to give general characters whereby all females and nymphs can be assigned to subfamily with certainty, though the gills, where they exist, often make this possible.

In the systematic treatment to follow, no attempt is made to treat the exotic species exhaustively, but a list of species currently assigned to each genus or subgenus is included. Where such a species is marked by an asterisk, it indicates that I have had opportunity to examine adult specimens ; two asterisks show that both adults and nymphs have been available. Where direct information is lacking I have followed the most recent synonymy—either Claassen's (1940) catalog or Brinck (1949).

KEY TO SUBFAMILIES

- 1 Male 10th tergite cleft, completely or partially ; supra-anal process well developed; gills frequently present on the submentum, less frequently elsewhere
Isogeninae (p. 63)

- Male 10th tergite not deft, at most with a small membranous notch ; supra-anal process and its associated structures absent (a short *unsclerotized* process occurs in *Calliperla*) ; gills usually absent, but short stubs are found on the submentum of some Perlodinae 2
- 2(1) Male subanal lobes produced inward and upward or backward, meeting each other along their mesal edges, blunt at the tips ; in Asiatic forms the hind margin of the 10th tergite is sometimes much elevated Perlodinae (p. 132)
- Male subanal lobes little modified, or produced upward and sometimes forward as knobs or hooks ; hind margin of the 10th tergite little or not at all elevated Isoperlinae (p. 141)

SUBFAMILY ISOGENINAE

Two great series of species are recognizable in the subfamily Isogeninae, constituting the genera *Arcynopteryx* and *Isogenus*. There seems to be no character which will distinguish all *Isogenus* from all *Arcynopteryx*, yet the two groups both constitute excellent natural assemblages. A list of the distinguishing characters is as follows:

- | <i>Arcynopteryx</i> | <i>Isogenus</i> |
|--|---|
| 1. A network of irregular apical crossveins between R and Rs, sometimes extending back to M or even Cu. | 1. Except for those in the costal space, apical crossveins are usually few; and only in <i>Besdobus</i> are these consistently arranged in a somewhat irregular network between R and Rs. |
| 2. No lobe on the 7th sternite (occasionally a specimen of <i>Megareys</i> gives this appearance). | 2. A well-defined lobe typically present on the 7th sternite (indistinguishable or nearly so in <i>Hydroperla</i> , <i>Besdobus</i> , and <i>Isogenus</i> s.s.). |
| 3. Submental gills always well developed. | 3. Submental gills usually short or absent (well developed in <i>Isogenoides</i> , <i>Hydroperla</i> , and <i>Besdobus</i>). |
| 4. Gills usually present on the thorax (absent in <i>Arcynopteryx</i> s.s., <i>Skwala</i> and <i>Frisonia</i>). | 4. No thoracic gills. |

- | | |
|---|---|
| <p>5. Outer cusp of the nymphal mandible usually with teeth along its ventral margin (these absent in <i>Setivene</i>; nymphs of <i>Sopkalia</i>, <i>Protarcys</i>, and <i>Filchneria</i> are unknown).</p> <p>6. Mesosternum of the imago without a complete transverse ridge joining the anterior corners of the furcal pits.</p> | <p>5. Outer cusp of the nymphal mandible usually not serrate (serrate in <i>Helopicus</i> and some <i>Isogenoides</i>; nymphs of several subgenera are unknown).</p> <p>6. Mesosternum of the imago usually with a complete transverse ridge joining the anterior corners of the furcal pits (incomplete in <i>Dictyogenus</i>; absent in <i>Helopicus</i>, <i>Oribonus</i> and <i>Ostryopsis</i>).</p> |
|---|---|

Each of the six items above can be said to be typical of one genus or the other, but none can be used as a constant character for separating the two. The complex of radial crossveins is the most constant character, but it appears in *Besdolus* and is occasionally suggested in *Dietyogenus*—both European groups. However, since the departures from the norms occur in a sporadic and interlocking manner within each genus there is no substantial basis for further generic comminution. Well marked species-groups exist in both genera, defined by these and other characters, and most of them are sufficiently striking to be treated as subgenera.

The only other isogenine group which appears to have good claim to generic recognition is *Pseudomegarcys* Kohno, from Japan.

KEY TO NORTH AMERICAN GENERA

MALES AND FEMALES

- | | |
|---|-----------------------------|
| Wings with a number of irregular apical crossveins, in the R-Rs position at least; thoracic gills often present | <i>Arcynopteryx</i> (p. 64) |
| Wings with regular apical crossveins, or none; thoracic gills absent | <i>Isogenus</i> (p. 86) |

Genus *Arcynopteryx* Klapálek

1904. *Arcynopteryx* Klapálek, Bull. Int. Česká Akad. Čis. Fr. Jos. 9(2), p. 12. **TYPE:** *Dictyopteryx compacta* McLachlan.

The large genus *Arcynopteryx*, as defined here, is equivalent to the North American *Perlodes* of Needham and Claassen, but

of course does not include the true *Perlodes* Banks of Eurasia. The characters displayed by its various divisions have been used for generic or subgeneric separation in a variety of ways. The distribution of the characters most used in classification is as follows:

VENATION: A network of apical crossveins involving R and Rs is common to all species ; these almost always break up the continuity of the long veins. There are also crossveins connecting the apical portions of the more posterior veins in some of the genera. These are best developed in *Setvena*, where crossveins involving M and even Cu are usually present ; *Oroperla* seems similar but its complete venation has not been worked out. In *Megarcys*, *Sopkalia*, and *Perlinodes* crossveins usually extend no farther back than M, while *Arcynopteryx*, *Skwala*, and *Frisonia* commonly have only the network involving R and Rs.

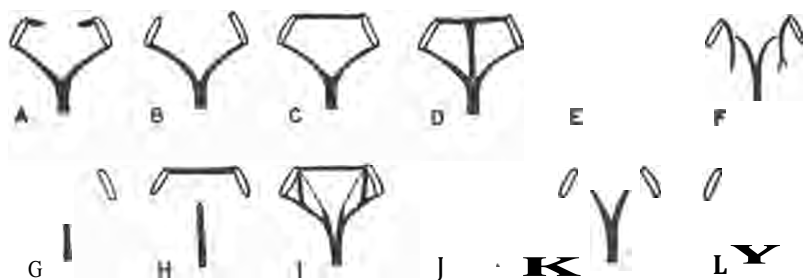


Figure 36. Diagrams of perlodid mesosternal ridge patterns. The oblong lined areas are the furcal pits. **A.** Nymphs and imagos of *Perlinodes* and *Hydroperla*; nymphs of *Oroperla* and *Helopicus*. **B.** Nymphs of several subgenera of *Isogenus*; nymphs and imagos of *Perlodes* and *Dolkrila*. **C.** Imagos of most subgenera in *Isogenus*, and of *Calliperla*; nymphs and imagos of *Diura s.s.*, *Matirekus*, *Besdolus*, and many *Isoperla*. (This is referred to in the text as the *typical* pattern.) **D.** Nymphs and imagos of *Isogenoides*. **E.** Nymphs and imagos of *Skwala*, *Megarcys* and (in part) *Arcynopteryx*; nymphs of *Frisonia*. **F.** Imago of *Sopkalia*. **G.** Nymphs of *Diploperla*. **H.** Imagos of *Diploperla*. **I.** Imago of *Chernokrilus* (drawn from a ♀; the dotted line indicates a weak ridge in a ♂). **J.** Imago of *Osobenus*. **K.** Nymphs and imagos of *Arcynopteryx* (in part). **L.** Nymphs and imagos of *Isoperla* (in part).

GILLS: A pair of submental gills is common to all the subgenera, and these are the only gills in *Arcynopteryx*, *Skwala* and *Frisonia*. There are two pairs of thoracic gills in *Setvena*, three in *Megarcys*, and these plus a pair of cervical gills in *Perlinodes*; in *Sopkalia* the cervical gills are absent but there are 2 pairs on meso- and metathorax, making 5 pairs in all; while *Oroperla* has a pair of cervical gills, 6 pairs of thoracic gills, and 7 pairs of abdominal gills. It is important to notice that gills, when present, are in the same situation in all subgenera, so that, for example, the 2 thoracic gills of *Setvena* appear in exactly the same situation in *Sopkalia*, *Megarcys*, *Perlinodes*, and *Oroperla*.

MESOSTERNUM: The Y-shaped ridge of thickened cuticle terminates at the posterior end of the furcal pits in the subgenera *Oroperla*, *Setvena*, and *Perlinodes*, which is the typical condition found in most other members of the family (Fig. 36). In the subgenera *Megarcys*, *Arcynopteryx*, *Skwala*, and *Frisonia* the principal thickened ridges terminate at the anterior end of the furcal pits, though in some a trace of slightly darker pigmentation remains to mark the other site. *Sopkalia* is somewhat intermediate in that the Y-ridge approaches but does not fuse with a pair of ridges depending from the anterior corners of the furcal pits.

When the arms of the Y are in their primitive position, short inward-projecting stubs are usually developed from near the anterior corners of the furcal pits (*Oroperla*, etc.). There is a complete transverse band in this region in nymphal *Setvena*, but this is much commoner in the genus *Isogenus*. The transverse band of adult *Frisonia* is considerably anterior to the furcal pits.

MALE GENITALIA: The basic isogenine pattern of the supra-anal body is preserved in all *Arcynopteryx*. The lateral stylets are usually well developed, but are absent in *Arcynopteryx* s.s. and in *Filchneria*. Pigmented outlines of lobes on the 7th and 8th sternites are occasionally distinguishable in *Megarcys*, but apparently not elsewhere. In *Perlinodes* the 7th tergite has developed a process.

FEMALE GENITALIA: The subgenital plate is moderately to considerably produced. It is excavated or notched at the tip except in *Setvena* and some *Protarcys*, and in *Frisonia*.

NYMPHAL MOUTHPARTS: In *Oroperla* the outer mandibular teeth have a series of denticles along their edge, the outer row being particularly conspicuous. These become reduced in number and/or size in several other groups, being sometimes difficult to distinguish in *Arcynopteryx* and absent in *Setvena*.

Having regard to the general scheme of phylogenetic development of the perlodids, it is evident that evolution within *Arcynopteryx* has taken the course of a progressive loss of abdominal and thoracic gills, a reduction in number of apical crossveins in the wing, a shift in position of the supporting ridges of the mesosternum, loss of mandibular serration, and loss of lateral stylets. However, there is no one line which includes *all* these modifications.

KEY TO NORTH AMERICAN SUBGENERA

MALES, FEMALES, AND NYMPHS

- 1 Lateral abdominal gills present *Oroperla* (p. 78)
Abdominal gills absent 2
- 2(1) Three pairs of thoracic gills and 1 pair of cervical gills present ; tergite 7 with a bifid process
Perlinodes (p. 79)
Cervical gills absent, ♂ tergite 7 normal 3
- 3(2) Gills present on meso- and metathorax, absent from the prothorax ; the arms of the mesosternal **Y-ridge** meet the posterior corners of the furcal pits ; apical crossveins commonly present from R₁ to Cu₁ or Cu₂ ; lateral stylets absent from the ♂ supra-anal apparatus ; ♀ subgenital plate entire
Setvena (p. 81)
Gills present on all 3 thoracic segments, or entirely absent from the thorax; arms of the mesosternal Y-ridge meet or approach the anterior corners of the furcal pits ; apical crossveins commonly present from R₁ to no farther back than M₁ or M₂; ♀ subgenital plate notched or excavated 4
- 4(3) Gills present on all 3 thoracic segments ; subgenital plate narrowly notched ; apical crossveins commonly present from R₁ to M₁ or M₂ *Megareys* (p. 72)

Thoracic gills absent ; ♀ subgenital plate broadly excavated ; apical crossveins commonly present no farther back than the branches of Rs, or rarely

5

- 5(4) Transverse mesosternal ridge present in the imago; posterior inner corners of the ♂ 10th tergite produced into an erect, slender, acute process ; nymphal lacinia tapered to a short terminal spine, which is equal to one-fourth of the total lacinial length ; nymphal outer mandibular cusps strongly denticulate above and below *Frisonia* (p. 71)

Transverse mesosternal ridge absent ; posterior inner corners of the ♂ 10th tergite blunt, spinulose ; terminal spine of the nymphal lacina equal to one-third or more of the total length ; denticles numerous or almost absent

6

- 6(5) ♂ supra-anal process very long and needle-like; lateral stylets absent ; denticles absent from the cusps of the nymphal mandible, or a few present on the outer left cusp *only*. *Arcynopteryx* s.s. (p. 68)
♂ supra-anal process blunt, not unusually long; lateral stylets present ; denticles numerous along both sides of the outer cusps of both mandibles
Skwala (p. 83)

Subgenus *Arcynopteryx* s.s.

SIZE: Medium.

COLOR: Dark brown.

VENATION: 2-3 apical crossveins in the costal space ; irregular apical crossveins between R and Rs, and sometimes one between Rs and M.

SUBMENTAL GILLS: Slender, of medium length.

OTHER GILLS: None.

MESOSTERNUM OF NYMPH AND IMAGO: The Y-ridge is attached to the anterior corners of the furcal pits (its anterior portions sometimes lacking) ; transverse ridge absent.

♂ 10TH TERGITE: Cleft; lobes thin, flat plates bearing an erect knob.

OTHER TERGITES: 9th notched posteriorly ; 6-9 swollen at the sides.

- SUPRA-ANAL PROCESS: Outer part slender and needle-like, attached to the massive basal part by a reverse loop.
- PARAGENITAL PLATES: Normal.
- LATERAL STYLETTS: Absent; the interior of the cowl has a median and 2 adjacent lateral sclerotized bands, of which the latter might represent the stylets.
- SUBANAL LOBES: Somewhat produced.
- VENTRAL LOBES: Absent.
- SUBGENITAL PLATE: Moderately produced; with a broad shallow notch.
- NYPHAL MAXILLA: Typical; major spine about 0.4 of the length of the lacinia.
- NYPHAL MANDIBLE: Major cusp usually slightly serrate marginally, on at least the left mandible (serration reduced or absent on the right).
- DISTRIBUTION: Holarctic.

Arcynopteryx (A.) *compacta* MacLachlan

1872. *Dictyopteryx compacta* MacLachlan, Ann. Soc. Ent. Beige. 15, p. 53. Type locality: Siberia.
1912. *Arcynopteryx americana* Klapálek, Cat. Coll. Selys. 4(1), p. 21, desc. and fig. of ♂ 9.
1912. *Arcynopteryx minor* Klapálek, *ibid.*, p. 22, desc. of ♂ ♀.
1914. *Perlodes slossonae* Banks, Proc. Philadelphia Acad. Sci. 66, p. 608.
1917. *Arcynopteryx lineata* Smith, Trans. Amer. Ent. Soc. 43, p. 476, desc. and fig. of ♀.
1917. *Arcynopteryx ignota* Smith, *ibid.*, p. 479, desc. and fig. of ♀.
1917. *Arcynopteryx inornata* Smith, *ibid.*, p. 480, desc. and figs. of ♀.
1936. *Perlodes margarita* Alexander, Bull. Brooklyn Ent. Soc. 31, p. 24, desc. of ♂.
1938. *Perlodes minor* Ricker, Trans. Roy. Canad. Inst. 22, p. 144; p. 155, figs. 25-27, ♂ genitalia of holotype and ♀ subgenital plate.
1942. *Arcynopteryx minor* Hanson, Amer. Midland Nat. 28, p. 396, desc. of ♂ ♀; p. 404, fig. 6, head; p. 405, fig. 14, ♀ plate; p. 406, fig. 21, ♂ genitalia.
1942. *Perlodes minor* Frison, Bull. Illinois Nat. Hist. Surv. 22, p. 287, fig. of ♀ plate.
1943. *Arcynopteryx americana* Ricker, Stoneflies SW B.C., p. 114, identification of type ♂.
1944. *Arcynopteryx americana* Ricker, Canad. Ent. 76, p. 183.
1949. *Arcynopteryx compacta* Brinck, Studies Swedish Stoneflies, p. 58.

Additional citations of this species appear in Hanson's 1942 paper and in Brinck's paper.

DISTRIBUTION: Transcontinental in the arctic region, south to Colorado, Lake Superior and New Hampshire; northern and montane Europe; northern Asia.

EXOTIC SPECIES

Arcynopteryx (A.) *dichroa* MacLachlan 1872, Siberia.

**Arcynopteryx* (A.) *jezoënsis* Okamoto 1912, Japan.

Subgenus *Filchneria* Klapálek

1907. *Filchneria* Klapálek, Filchner's Expedition China, Zool.-Biol.

Ergebnisse, p. 67. GENOTYPE: *Dictyopteryx mongolica* Klapálek.

1912. *Filchneria* Klapálek, Cat. Coll. Selys, 4 (1), p. 25.

1947. *Filchneria* Kimmins, Ann. Mag. Nat. Hist. Ser. 11, vol. 13, p. 737.

SIZE: Medium.

COLOR: Dark.

VENATION: 1-3 apical crossveins in the costal space; 1 to several crossveins between R and Rs, usually somewhat irregular; usually 1 or more crossveins posterior to Rs.

SUBMENTAL GILLS: Long.

OTHER GILLS: Absent.

MESOSTERNUM OF IMAGO: Arms of the Y-ridge run to the anterior corners of the furcal pits; in one specimen there is some appearance of a transverse ridge a little anterior to the usual position.

10TH TERGITE: Completely cleft, the lobes rather slender, blunt, incurved.

OTHER TERGITES: An inconspicuous hairy knob on the posterior corners of 8 and 9.

SUPRA-ANAL PROCESS: Rather broad, recurved, concave above, broadened and bifurcate at the tip.

PARAGENITAL PLATES: Apparently normal.

LATERAL STYLETS: None.

SUBANAL LOBES: Not enlarged.

VENTRAL LOBES: Absent.

SUBGENITAL PLATE: Little produced, and with a square or broadly V-shaped notch cut back into it.

NYMPH: Unknown.

DISTRIBUTION: Highlands of central Asia.

This analysis is made primarily from specimens of *Filchneria uncata* Kimmins. The type species *mongolica* is based on a female specimen, and Klapálek's (1912) figure of a male which

he later associated with it fails to show the characteristic supra-anal structures.

SPECIES

Arcynopteryx (Filchneria) clementi Navás 1914, Lake Baikal.

A. (F.) furcifera Navás 1936, Tien Shan, etc., China.

A. (F.) infumata MacLachlan 1869, Mingrelia.

A. (F.) mongolica Klapálek 1903, Mongolia.

**A. (F.) uncata* Kimmins 1946, Ann. Mag. Nat. Hist. Ser. 11 vol. 13, p. 737. Southern Tibet.

Subgenus Frisonia Ricker

1943. *Filchneria* Ricker, *Southern Science Bulletin*, 117. SUBGENOTYPE: *Arcynopteryx furcifera* (= *A. infumata*)

SIZE: Medium to large.

COLOR: Medium brown.

VENATION: Apical costal crossveins 3-5; irregular crossveins between R, the 2 branches of Rs, M₁ and sometimes M₂.

SUBMENTAL GILLS: Moderately long.

OTHER GILLS: Absent.

MESOSTERNUM OF IMAGO: The arms of the Y-ridge run toward the anterior ends of the furcal pits but do not reach them, the forks of the Y being quite short. A transverse ridge is present considerably anterior to the furcal pits.

MESOSTERNUM OF NYMPH: The arms of the Y-ridge do meet the furcal pits, or at any rate appear to, because the region forward of them is rugulose with a transverse wavy pattern, whereas behind them the chitin is smooth. Transverse ridge absent.

♂ 10TH TERGITE: Cleft, the terminal lobes long, slender, subcylindrical, subacute, ascending, curved, meeting in the midline.

OTHER TERGITES: 8 and 9 excavated on the anterior margin; 9 somewhat swollen on the posterior half medially, and spinulose there.

SUPRA-ANAL PROCESS: Subcylindrical, somewhat expanded and blunt at the tip.

PARAGENITAL PLATES: Normal.

LATERAL STYLETS: Large, acute.

SUBANAL LOBES: Little expanded.

VENTRAL LOBES: None.

SUBGENITAL PLATE: Considerably produced, rather irregularly rounded, with a broad central depression.

NYMPHAL MAXILLA: Major spine of lacinia only one-fourth of its total length; mesal edge rather densely margined with hairs.

NYMPHAL MANDIBLE: Major cusp strongly serrate laterally.

DISTRIBUTION: North American cordillera.

Arcynopteryx (*Frisonia*) *picticeps* Hanson

1942. *Arcynopteryx picticeps* Hanson, Am. Midland Nat. 28, p. 397, desc. of ♂; p. 405, figs. 8, 15, head and ♀ plate. Type locality: Mt. Rainier, Washington.

1943. *Arcynopteryx walkeri* Ricker, Stoneflies SW B.C., pp. 118-19, desc. and figs. of head, pronotum, wing, ♂ genitalia, nymphal mouthparts.

DISTRIBUTION: Southern British Columbia to Oregon.

Subgenus *Megarcys* *Klapálek*

1912. *Megarcys Klapálek*, Cat. Coll. Selys 4(1), p. 10. GENOTYPE: *Megarcys ochracea* Klapálek (northern Sakhalin).

1912. *Matsumuria* Okamoto, Trans. Sapporo Nat. Hist. Soc. 4, p. 16.

SIZE: Large.

COLOR: Light brown.

VENATION: 2-3 apical crossveins in the costal space; irregular crossveins present posteriorly to M_1 or occasionally M_2 .

SUBMENTAL GILLS: Long.

OTHER GILLS: 1 pair on each thoracic segment.

MESOSTERNUM OF NYMPH AND IMAGO: The arms of the Y-ridge run forward to the anterior corners of the furcal pits; transverse ridge absent, but the site is sometimes indicated by a slightly darkened band.

♂ 10TH TERGITE: Deeply cleft, the posterior lobes long, flat, up-curved, rounded, or subacute.

SUPRA-ANAL PROCESS: Heavily sclerotized and triangular in cross section in its outer portion; blunt at the tip; with a soft tapering posterior projection.

PARAGENITAL PLATES: Elongate.

LATERAL STYLETS: Rather broad, with a cusp at the tip.

SUBANAL LOBES: Not enlarged.

VENTRAL LOBES: Sometimes rather broadly developed on 7, and

occasionally indicated on 8, but usually impossible to distinguish on either segment.

SUBGENITAL PLATE: Slightly to moderately produced ; with a narrow median notch, often quite deep.

NYMPHAL MAXILLA: With a projection and tuft of slender spines opposite the origin of the 2 larger spines ; mesal sides hairy ; large spine about one-third of lacinial length.

NYMPHAL MANDIBLE: Major cusp weakly serrate along the posterior ventral margin.

DISTRIBUTION: Western North America, and possibly also the Lake Superior region ; Japan, Sakhalin, and Siberia.

In North America at least five taxonomic units can be distinguished in this subgenus, three in the coastal mountains and two in the interior. In our present state of knowledge they could be treated almost equally as species, or as subspecies of Hagen's *signata*; for simplicity I have chosen the former plan. Future work may show that a combination of specific and sub-specific rankings would be preferable, but evidence of intergradation between geographically-separated units is at present lacking. The species which occur in the same general locality live in ecologically different habitats. On the basis of observations at Mt. Rainier, Washington, and near Cultus Lake, British Columbia, their "choice" appears to be as follows:

yosemite: highest reaches of creeks issuing from relatively inactive glaciers (where the silt load is not excessive), flowing through talus almost barren of vegetation. Observed elevations, 6,000-7,000 feet.

irregularis: lower reaches of the same creeks and rivers, from tree line (about 6,000 feet on Mt. Rainier) downstream to sea-level.

subtruncata: small to medium sized creeks from the lowest elevations up to near tree line. (Clear creeks at and above tree line usually contain *A. tibialis*, whose distribution overlaps *subtruncata*).

The occurrence of *watertoni* and *signata* in southern Alberta may parallel that of *subtruncata* and *irregularis*, respectively, near the coast, but observations are scanty as yet.

KEY TO AMERICAN SPECIES

MALES

Genital hooks of 10th tergite expanded neat the tip (in side view), and broadly rounded ; median patch of spinules of the 9th tergite separated from the lateral patches by an area free of spinules (Fig.

38) *irregularis*

- Genital hooks not expanded, their tips pointed (rarely narrowly rounded in *signata*); median patch of spinules on the 9th tergite not separated from the lateral patches by any *completely* spinule-free area (Figs. 37, 42) 2
- 2(1) Lateral stylets bluntly rounded at the tip, with a small backward-pointing subacute process on the posterior corner *sub truncata*
- Lateral stylets narrowed gradually to a terminal acute or subacute spine 3
- 3(2) Anterior-posterior length of the spinule patch of the 9th tergite little greater along the mid-line than on the lateral knobs (Fig. 37) *watertoni*
- Length of the spinule patch at least 1.5 times as great in the median position (Fig. 42) 4
- 4(3) Spinules of the 9th tergite of almost uniform density across the entire area where they occur *yosemite*
- Spinules of the 9th tergite clearly much sparser in the anterior portion of the median patch (Fig. 42) *signata*

FEMALES

- 1 Maximum length of the subgenital plate 0.7 to 1.1 times the length of the 8th segment laterad of the plate; notch of the subgenital plate at least fairly long, and either narrow or broad 2
- Maximum length of the subgenital plate 0.3 to 0.6 of the length of the 8th segment laterad of the plate; notch of the subgenital plate very short, its apex narrowly rounded, and the sides of the slit close together 4
- 2(1) Notch of the subgenital plate narrowly rounded at the apex, its sides closely applied; found above tree line in glacial streams of the Cascade and Sierra Nevada Mountains *yosemite*
- Notch of the subgenital plate broadly rounded at the apex, the sides usually separated by about 0.3 of the length of the notch; found in the forested zones 3

- 3(2) Occurring in the Rocky Mountains and adjacent ranges *signata*
 Occurring in the Coast and Cascade mountains *irregularis*
- 4(1) Occurring in the Coast and Cascade mountains *subtruncata*
 Occurring in the Rocky Mountains region *watertoni*

Arcynopteryx (Megarcys) irregularis Banks

1900. *Dictyopteryx irregularis* Banks, Trans. Amer. Ent. Soc. 26, p. 243, desc. of ♀. Type locality: Mt. Rainier, Washington.
1925. *Perlodes signata* Needham and Claassen, Monogr. Plecop., p. 55, desc. of ♂ 9; p. 309, figs. 3, 7, 8, wings, ♂ and ♀ genitalia; p. 311, figs. 3, 6, ♂ genitalia; p. 299, figs. 6-10, ♂ genitalia.
1943. *Arcynopteryx signata irregularis* Ricker, Stoneflies SW B.C., p. 110.

DISTRIBUTION: Coast and Cascade Mountains of southern British Columbia and Washington. A pair of specimens circumstantially labelled "Macdiarmid, Lake Nipigon, Ont., May 28, 1922" is typical of this species in both sexes, but so remarkable a discontinuity of range probably requires confirmation.

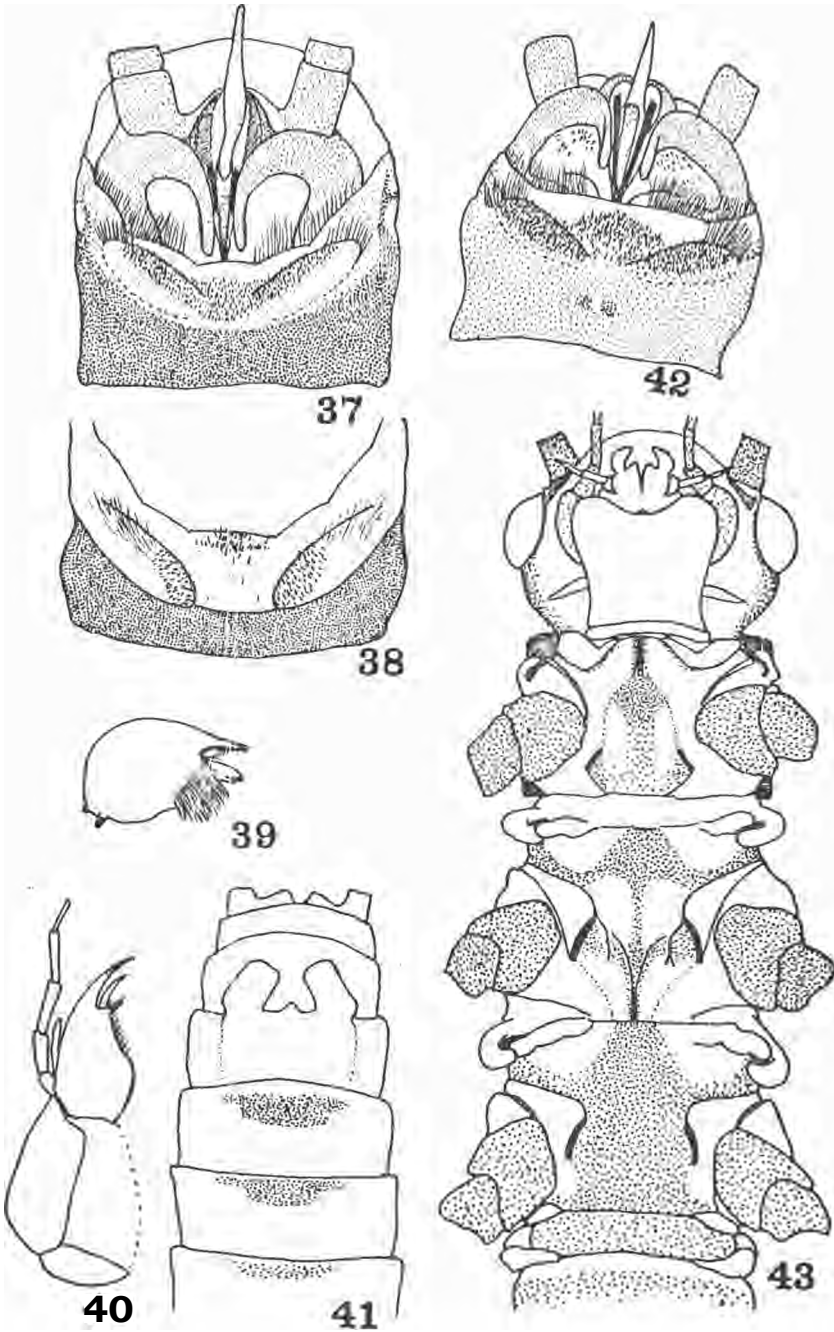
Arcynopteryx (Megarcys) signata Hagen

1874. *Dictyopteryx signata* Hagen, U.S. Geol. Surv. Terr., Rept. for 1873, p. 575. Type locality: Colorado.
1912. *Megarcys signata* Klapálek, Cat. Coll. Selys 4(1), p. 12; desc. and fig. of ♀ plate.
1917. *Megarcys signata* Smith, Trans. Amer. Ent. Soc. 43, p. 472.
1931. *Perlodes signata* Claassen, Plecop. Nymphs, p. 43, desc. of nymph; p. 149, figs. 181, 182, tips of nymphal abdomens.
1942. *Megarcys signata* Hanson (in part), Amer. Midland Nat. 28, p. 398, desc. of ♀; p. 405, figs. 9, 16, head and ♀ plate; p. 405, fig. 23, ♂ genitalia.

DISTRIBUTION: Rocky Mountains and adjacent interior ranges from northern British Columbia south to Utah, Colorado and New Mexico.

Arcynopteryx (Megarcys) subtruncata Hanson

1925. *Perlodes irregularis* Needham and Claassen, Monogr. Plecop., p. 58, desc. of ♂ 9; p. 305, fig. 24, ♀ plate; p. 311, fig. 7, ♂ genital hook. (Not *irregularis* Banks, 1900, Trans. Amer. Ent. Soc. 26, p. 243.)
1942. *Megarcys subtruncata* Hanson, Amer. Midl. Nat. 28, p. 400, desc. of ♂ 9; p. 405, fig. 17, ♀ plate; p. 406, fig. 24, ♂ genitalia. Type locality: Paradise Valley, Mt. Rainier, Washington.



1943. *Arcynopteryx signata subtruncata* Ricker, Stoneflies SW B.C., p. 111, desc. of nymph; p. 115, figs. 91, 92, nymphal pattern, labium, and maxilla (the mesal hairs of the maxilla are omitted).

DISTRIBUTION: Coast and Cascade Mountains from southern British Columbia to Oregon.

Arcynopteryx (*Megarcys*) *watertoni* (new)

MALE: Length of body, 14-18 mm.; to tip of wings, 10-14 mm. Similar in most respects to others of the subgenus. Spinules are present continuously across the rear of the 9th tergite. The genital hooks are pointed. The lateral stylets have a terminal spine.

FEMALE: Length of body, 15-21 mm.; to tip of wings, 16-25 mm. Practically indistinguishable from *subtruncata*, with a short subgenital plate having a very shallow and narrow notch.

NYPH: The nymph seems indistinguishable from *signata* or *subtruncata*.

Holotype ♂ and allotype ♀: Pass Creek, el. 4,800 ft., Waterton Lake National Park, Alberta, July 5, 1937, D. S. Rawson.

Paratypes as follows:

ALBERTA

Shore of Consolation Lake, Banff. August 11, 1936, ♂, D. S. Rawson.

Babel Creek, Banff. August 16, 1938, ♀, D. S. Rawson.

Waterton. July 14, 1923, ♀, E. H. Strickland (CNC).

Lower Pipestone Creek, Banff. July 11, 1938, 22 nymphs, including some showing adult characters, D. S. Rawson.

BRITISH COLUMBIA

Kaslo. June 2-13, ♂ 2 ♀ 9, H. G. Dyar and R. P. Currie (USNM).

Arcynopteryx watertoni. 37. Terminal segments of holotype ♂, from above.

Arcynopteryx signata. 42. Terminal segments of ♂, Chasm Falls, Rocky Mountain National Park, Colorado.

Arcynopteryx irregularis. 38. 9th tergite of ♂, from above and behind. Mt. Rainier, Washington.

Arcynopteryx barbara. 39. Mandible of nymph. 40. Maxilla of nymph (the terminal segment of the palpus is partly missing).

Arcynopteryx yamadae. 41. Terminal sternites of ♀. 43. Ventral view of head and thorax.

MONTANA

Missoula River at Taft. June 2, 1937, 3 ♂, 2 ♀, P. W. Claassen (CU).
 Roe's Creek, Glacier National Park. July 12, 1940, 9, H. H. and J. A. Ross.
 Logan Pass, Glacier National Park. July 12, 1940, 9, H. H. and J. A. Ross.

Arcynopteryx (*Megarcys*) *yosemite* Needham and Claassen

1925. *Perlodes yosemite* Needham and Claassen, Monogr. Plecop., p. 56,
 desc. of ♂ ; p. 305, fig. 20, ♀ plate; p. 311, fig. 8, ♂ genital hook.
 Type locality: Mt. Lyell, California, el. 11,000 feet.

This species was rediscovered on Mt. Rainier in August, 1951, in the severe habitat described earlier. The very high altitude at which the type specimens were taken suggests that it has a similar habitat in the Sierras. Notes on the *yosemite* allotype indicate that Needham and Claassen's figure shows the subgenital plate as somewhat too long, and with the central slit carried somewhat too far forward ; however, the narrowness of the slit is well indicated. The almost triangular outline of each lobe of the plate is characteristic of some specimens, others having them more rounded.

DISTRIBUTION: Cascade and Sierra Nevada Mountains.

EXOTIC SPECIES

Arcynopteryx (*Megarcys*) *bussoni* Navás 1923, Siberia.

A. (*M.*) *lepneva* Šámal 1939, Vestnick Ces. Zool. Spolecnosti, vol. 7-8, p. 420 (*Perlodes*), Altai Mountains.

**A. (*M.*) *ochracea* Klapálek 1912, Sakhalin.

A. (*M.*) *sjöstedti* Navás 1930, Kamchatka.

A. (*M.*) *yarizawana* Uéno, Japan. (*Perlodes yarizawana* Uéno 1931, possibly a synonym of *ochracea*.)

Subgenus *Oroperla* Needham

1933. *Oroperla* Needham, J. Ent. and Zool. 25, p. 17. GENOTYPE: *Oroperla barbara* Needham.

SIZE: Medium.

SUBMENTAL GILLS: Moderately long.

OTHER GILLS: 1 pair cervical gills; 3 double pairs thoracic gills; 7 pairs abdominal gills.

MESOSTERNUM OF NYMPH: Y-ridge complete, terminating at the posterior ends of the furcal pits ; transverse ridge represented by only a short stub on either side.

GENITALIA: Unknown.

NYMPHAL MAXILLA: Typical ; spine a little less than half of the total length ; hairs all along the mesal lacinial surface. Galea undivided.

NYMPHAL MANDIBLES: Dorsal and ventral edges of the anterior pair of teeth serrate ; that is, they are lined with a row of denticles (Fig. 39).

DISTRIBUTION: Western North America.

Arcynopteryx (Oroperla) barbara Needham

1933. *Oroperla barbara* Needham, J. Ent. and Zool. 25, p. 17, desc. and fig. of nymph. Type locality: Rubicon River, near Lake Tahoe, California.

Needham's prediction that the adult of this species would lack wings is not confirmed by later material, which exhibits well-developed wing pads showing considerable of the adult venation. Figures of the nymphal mouthparts are presented here (Figs. 39, 40). Unfortunately the adult remains unknown.

DISTRIBUTION: Sierra Nevada of California.

Subgenus Perlinodes Needham and Claassen

1925. *Perlinodes* Needham and Claassen, Monogr. Plecop., p. 286 (subgenus of *Perlodes*). SURGENOTYPE: *Arcynopteryx vagans* Smith = 4. *aurea* Smith.

1942. *Perlinodes* Hanson, Amer. Midl. Nat. 28, p. 392.

SIZE: Medium to large.

COLOR: Light brown.

VENATION : 2-4 apical costal crossveins; a network of apical crossveins between R₁ and R₂; 0-2 apical crossveins farther back.

SUBMENTAL GILLS: Long and slender, sometimes extending to the outer border of the eye (in the imago).

OTHER GILLS: 1 pair on the neck ventrally and 1 pair on each thoracic segment ; all long and slender.

MESOSTERNUM OF IMAGO AND NYMPH: Y-ridge typical, except for an expansion at the fork of the Y; transverse ridge absent except for inwardly-directed stubs from the anterior corner of the furcal pits.

♂ 10TH TERGITE: Completely cleft, the lobes long, rather slender, extended upward, inward and forward, strongly sclerotized.

- OTHER TERGITES: 9th and 8th excavated behind ; 7th with a raised bifid acute process.
- SUPRA-ANAL PROCESS: Flattened and laterally extended, expanded and notched at the tip, heavily sclerotized.
- PARAGENITAL PLATES: Normal.
- LATERAL STYLETS: There are 2 pairs of sclerotized bands having their origin at the bend of the supra-anal body ; the anterior one is rather long and slender, the posterior one shorter and broader. Both are bound to the inner surface of the cowl, however, rather than having their tips free as is normal for lateral stylets.
- SUBANAL LOBES: Slightly expanded.
- VENTRAL LOBES: Absent.
- SUBGENITAL PLATE: Moderately produced and swollen ; broadly and rather deeply notched.
- NYMPHAL MAXILLA: Major spine about one-third of length of lacinia; inner margin of lacinia with abundant hairs, which are somewhat stouter distally. No knob below the origin of the spines.
- NYMPHAL MANDIBLE: Dorsal and ventral edges of the anterior group of teeth with strong serrations.
- DISTRIBUTION: Western North America.

Arcynopteryx (*Perlinodes*) *aurea* Smith

1917. *Arcynopteryx aurea* Smith, Trans. Amer. Ent. Soc. 43, pp. 477-78, desc. of ♀, figs. of 9 genitalia and wings. Type locality: California.
1917. *Arcynopteryx vagans* Smith, *ibid.* pp. 478-79, desc. of ♂, figs. of ♂ genitalia and wings.
1925. *Perlodes aurea* Needham and Claassen, Monogr. Plecop., p. 62, desc. of ♀, p. 305, fig. 23, 9 genitalia.
1925. *Perlodes* (*Perlinodes*) *vagans* Needham and Claassen, *ibid.*, p. 66, desc. of ♂; p. 309, fig. 2, wings; p. 311, figs. 1, 2, 9, ♂ genitalia.
1942. *Perlodes aurea* Frison, Bull. Illinois Nat. Hist. Surv. 22(2), p. 288, figures of head, pronotum, sterna, and 9 subgenital plate.
1942. *Perlinodes aurea* Hanson, Amer. Midland Nat. 28, p. 401, desc. of ♀; p. 405, fig. 10, head, fig. 18, ♀ genitalia; p. 406, fig. 25, ♂ genitalia.

NYMPH: Our only specimens are quite immature, the largest 13 mm. long. There is little indication of a color pattern. The gills are all long and slender, as in the adult. The lacinia has a major and minor terminal spine, and the entire mesal margin is lined with closely-set long hairs, but there is no distal knob

or dense tuft of hairs. The mandibles bear strong denticles along the margin of the outer cusp.

DISTRIBUTION: Washington to California.

Subgenus *Protarcys* **Klapálek**

1912. *Protarcys* **Klapálek**, Cat. Coll. Selys 4(1), p. 8. GENOTYPE: *Protarcys caudata* **Klapálek** (China).

1938. *Protarcys* Wu, *Plecopt. Sinensis.*, p. 30.

SIZE: Small to moderate.

COLOR: Medium brown.

VENATION: "Crossveins numerous and absent only in the M_1 field" (**Klapálek**).

6 10TH TERGITE: Fully cleft, the lobes raised and flattened fore-and-aft.

SUBGENITAL PLATE: Triangularly produced, half as long as segment 9, subacute or notched.

DISTRIBUTION: China.

No study of specimens of this group appears to have been made since **Klapálek's** original description, as Wu merely copies **Klapálek's** illustrations and translates his text. Smith (1917) introduced the name into American usage, applying it, with reservations, to the 2 species here grouped under *Setvena*; in this she has been followed, with equal reserve, by Hanson (1942) and (as subgenus) by Ricker (1943).

Klapálek's description provides information concerning few of the comparisons we should like to make, in relating this subgenus to others. The venation indicates that it should be retained in the genus *Arcynopteryx s. l.*

SPECIES

Arcynopteryx (Protarcys) caudata **Klapálek** 1912, Moupin, China.

A. (P.) lutescens **Klapálek** 1912, Szechuan, China.

Subgenus *Setvena* (new)

1917. *Protarcys* Smith, Trans. Am. Ent. Soc. 43, p. 469 (not **Klapálek** 1912, Cat. Coll. Selys 4(1), p. 8).

1942. *Protarcys* Hanson, Am. Midland Nat. 28, p. 392.

SIZE: Medium to large.

COLOR: Yellowish brown.

VENATION: 3 or 4 apical crossveins in the costal space; posteriorly a network of apical crossveins involves all the long veins of the wing back to Cu_1 or Cu_2 .

SUBMENTAL GILLS: Rather short; 1.5-2 times as long as broad.

OTHER GILLS: 1 pair each on the meso- and metathorax.

MESOSTERNUM OF IMAGO: Y-ridge normal; transverse ridge absent or at most vaguely suggested.

MESOSTERNUM OF NYMPH: Similar, but the transverse ridge is strongly developed and sinuate.

♂ 10TH TERGITE: Deeply cleft; the lobes short, subconical, pointing inward.

SUPRA-ANAL PROCESS: Rather slender, nearly cylindrical, blunt, sclerotized on the posterior surface.

PARAGENITAL PLATES: Normal.

LATERAL STYLETS: Slender, acute, or spinulose at the tip.

SUBANAL LOBES: Little modified.

VENTRAL LOBES: Absent.

SUBGENITAL PLATE: Much produced, broadly rounded.

NYMPHAL MAXILLA: Normal; major spine about one-third of the length of the lacinia; 2 rather large hairs or tertiary spines occupy a knob below the inferior spine; mesal margin quite hairy.

NYMPHAL MANDIBLES: Without serrations along the edges of the cusps.

DISTRIBUTION: Cordilleran North America.

There has long been considerable doubt concerning the association of our 2 species of this subgenus with Klapálek's name *Protarcys*. Venation alone has been its basis. Since the lobes of the 10th tergite of Klapálek's type species *caudata* are much larger and are flattened transversely, and since the female subgenital plate is of a different type, there is little likelihood of any close relationship.

MALES

Lateral stylets slender, tapering to a single acute point *bradleyi*

Lateral stylets broader, with 3-4 short cusps at the tip *tibialis*

***Arcynopteryx (Setvena) bradleyi* Smith**

1917. *Protarcys bradleyi* Smith, Trans. Amer. Ent. Soc. 43, p. 470, desc. and figs. of ♂ 9. Type locality: Lake Louise, Alberta.

1925. *Perlodes bradleyi* Needham and Claassen, Monogr. Plecop., p. 53, desc. of ♂ 9; p. 309, figs. 4, 5, wings and 9 genitalia; p. 311, fig. 4, ♂ genital hook.
1942. *Perlodes tibialis* Frison, Bull. Illinois Nat. Hist. Surv. 72, p. 289, fig. of 9 genitalia. (Not Banks 1914.)
1942. *Protarcys bradleyi* Hanson, Amer. Midland Nat. 28, p. 402, desc. of ♂ 9; p. 405, fig. 11, head, fig. 19, 9 genitalia; p. 406, fig. 26, ♂ genital hook, supra-anal process, and lateral stylets.

DISTRIBUTION: Rocky Mountains region of Alberta, British Columbia, and Montana.

Arcynopteryx (Setvena) tibialis Banks

1914. *Perlodes tibialis* Banks, Proc. Acad. Nat. Sci. Philadelphia 66, p. 608, desc. and fig. of ♂. Type locality: Olympic Mountains, Washington.
1917. *Protarcys dolobrata* Smith, Trans. Amer. Ent. Soc. 43, p. 469, desc. of ♀, figure of subgenital plate and wings.
1925. *Perlodes tibialis* Needham and Claassen, Monogr. Plecop., p. 54.
1925. *Perlodes dolobrata* Needham and Claassen, Monogr. Plecop., p. 52, desc. of ♂ 9; p. 309, figs. of wings and 9 genitalia.
1931. *Perlodes tibialis* Claassen, Plecop. Nymphs, p. 44, desc. of nymph; p. 131, figs. 44-49, fig. of mouth parts of nymph.
1942. *Perlodes dolobrata* Frison, Bull. Illinois Nat. Hist. Surv. 22, p. 289, fig. of ♂ genitalia.
1942. *Protarcys tibialis* Hanson, Amer. Midland Nat. 28, p. 402, desc. of ♂ 9; p. 405, fig. 12, head, fig. 20, 9 genitalia; p. 406, fig. 27, ♂ genitalia.

DISTRIBUTION: Coast and Cascade Mountains of British Columbia, Washington and Oregon.

Subgenus Skwala Ricker

1943. *Skwala* Ricker, Stoneflies SW B.C., p. 113. SUBGENOTYPE: *Hydropervia parallela* Frison.

SIZE: Medium.

COLOR: Dark brown.

VENATION: 1-2 apical costal crossveins ; a network of irregular crossveins between branches of R, Rs, and usually also M1.

SUBMENTAL GILLS: Moderately long.

OTHER GILLS: Absent.

MESOSTERNUM OF IMAGO AND NYMPH: Arms of the Y-ridge terminate at the anterior corners of the furcal pits ; transverse ridge absent.

- ♂ 10TH TERGITE: Cleft, the lobes rather long, subcylindrical, pointing inward and forward, spinulose.
- OTHER TERGITES: 9 emarginate posteriorly, 6-9 swollen at the sides.
- SUPRA-ANAL PROCESS: Subcylindrical near the tip, with 2 flaps rolled inward at either side.
- PARAGENITAL PLATES: Normal.
- LATERAL STYLETS: Strong, acute.
- SUBANAL LOBES: Only slightly expanded.
- VENTRAL LOBES: Absent.
- SUBGENITAL PLATE: Somewhat produced, truncate, or slightly excavated.
- NYMPHAL MAXILLA: Rather typical, the major spine almost half as long as the whole lacinia ; a tuft of slender spines on a projection opposite the origin of the larger spines ; mesal margin quite hairy.
- NYMPHAL MANDIBLE: Major cusps serrate along the edge.
- DISTRIBUTION: Western North America.

MALES

"Dorsal hook" of the 10th tergite 2-3 times as long as the breadth of its constricted middle portion *parallela*
Dorsal hook 4-5 times as long as its minimum breadth *curvata*

Arcynopteryx (Skwala) curvata Hanson

1942. *Arcynopteryx curvata* Hanson, Amer. Midland Nat. 28, p. 395, desc. of ♂ 9; p. 405, fig. 13, 9 plate; p. 406, fig. 22, ♂ genitalia. Type locality: Wallace, Idaho.
1943. *Arcynopteryx parallela curvata* Ricker, Stoneflies SW B.C., p. 114, desc. of ♂ 9; p. 115, figs. 93-95, 97-98, forewing, 9 plate, ♂ genitalia.

The discovery of *A. curvata* in Oregon by S. G. Jewett, Jr., removes my former reservations concerning this form's claim to full specific status. Neither there nor in British Columbia has it been found to intergrade with *A. parallela*. *A. curvata* is apparently much less common than its near relative. Female *curvata* seems indistinguishable from *parallela*.

DISTRIBUTION: Southern British Columbia to Oregon, Idaho, and Montana.

Arcynopteryx (Skwala) parallela Frison

1925. *Perlodes americana* Needham and Claassen, Monogr. Plecop., p. 61, desc. of ♂ ♀, p. 305, fig. 21, 9 plate; p. 311, fig. 5, genital hook of . (Not Klupálek 1912, Cat. Coll. Selys 4(1), p. 21.)
1931. *Perlodes americana* Claassen, Plecop. Nymphs, p. 44, incomplete desc. of nymph.
1936. *Hydroperla parallela* Frison, Ann. Ent. Soc. Amer. 29, p. 261, desc. of ♂; figs. 19-23, genitalia of ♂. Type locality: Corvallis, Oregon.
1937. *Hydroperla paraVela* Frison, Bull. Illinois Nat. Hist. Surv. 21, p. 90, desc. of ♀, figs. of ♀ plate and head and pronotum.
1942. *Hydroperla parallela* Frison, *ibid.* 22, p. 298, desc. and figs. of nymph. and its mouthparts.
1942. *Arcynopteryx americana* Hanson, Am. Midland Nat. 28, p. 394, desc. of ♂ ♀; p. 104, fig. 7, head.
1943. *Arcynopteryx parallela parallela* Ricker, Stoneflies SW B.C., p. 113.

In the Utah specimens the males are always short-winged, whereas this has not been observed elsewhere.

DISTRIEU : Southern British Columbia to Oregon, Montana, and Utah.

Sopkalia new subgenus

TYPE: *Megarcys yamadae* Okamoto, Ent. Mag. (Japan) 3, p. 79, 1917.

SIZE: Large.

COLOR: Light brown.

VENATION: 2-4 apical crossveins in the costal space, variously branched; irregular crossveins joining the apical portions of R, Rs, M₁, and even M₂. Anterior branch of A₂, in the forewing, forked once or twice beyond the anal cell.

SUBMENTAL GILLS: Moderately long, conical.

OTHER GILLS: One pair on the prothorax; two pairs on the meso- and metathorax, in the same position as in *Oroperla*; the inner one is somewhat shorter than the outer (Fig. 43). The membranous expansions at the outer posterior corner of the first two abdominal sternites are almost large enough to be regarded as gills and are of course in the same position as the abdominal gills of *Oroperla*. (Other subgenera of *Arcynopteryx* have similar but smaller expansions in this region.)

MESOSTERNUM OF IMAGO: Arms of the Y-ridge approach a pair of narrow ridges depending from the anterior corners of the

furcal pits, but these lateral ridges do not terminate at the point the Y-ridge meets them ; transverse ridge absent (Fig. 43).

♂ 10TH TERGITE: Cleft ; the lobes long and tapered, much as in *Megarcys*.

SUBANAL LOBES: Much produced upward to enclose the supra-anal process.

SUBGENITAL PLATE: Produced, notched, and with the notch expanded anteriorly ; sternites 5-7 have the hind part more heavily sclerotized than do the other sternites.

DISTRIBUTION: Japan.

SPECIES

**Arcynopteryx (Sopkalia) yamadae* Okamoto. I have seen a of this species from Kiso-Fukushima, Province of Shinano, Japan ; May 14, 1930, M. Uéno. Okamoto's description and figures unfortunately give no details of the supra-anal apparatus.

Genus *Isogenus* Newman

1833. *Isogenus* Newman, Ent. Mag. 1, p. 415. GENOTYPE: *Isogenus rubicula* Newman.

The genus *Isogenus* in North America has developed a richness and variety of forms which contrasts sharply with its meagre development in Europe and, apparently, in most of Asia. It is not yet possible to make a complete revision of even the described North American species, because in some cases only the females are known, and in many cases nymphs are unknown. Much progress, however, has been made in recent years, notably by Frison (1942) and Hanson (1942, 1943). These studies, together with our recent examination of several poorly-known types, make it possible to present a fairly satisfactory review of the genus.

VENATION: Except in *Besdolus* and some *Dictyogenus*, the apical crossveins are reduced to 0-5 behind the radius and 1-5 in the costal space. In general, the smaller species tend to have fewer crossveins. A character which occurs rarely is the fusion of the two branches A_1 to a point beyond the anal cell in the forewing—much as in the Chloroperlid genus *Alloperla*.
GILLS: The submental gills are fully developed in *Hydroperla*, *Isogenoides*, and *Helopicus*; in other subgenera they are

variously shortened, rudimentary, or indistinguishable. No other gills occur.

MESOSTERNUM: The primitive isogenine pattern of ridges is still present in *Hydroperla* and *Helopicus*, and in adult *Dictyogenus*; that is, there are only two short stubs to represent the transverse band. The condition which may be regarded as typical for imagos of the genus *Isogenus*, and which occurs in the typical subgenus, has a complete transverse band. Nymphs are sometimes similar, but more often lack the transverse band entirely. *Isogenoides* has developed an additional ridge, running medially from the fork of the Y to the transverse ridge. In *Diploperla* the arms of the Y-ridge are absent. In *Kogotus*, *Remenus*, *Podmostus*, and some species of *Gun* = the imago has the typical *Isogenus* form, but the transverse ridge is absent in the nymph. Absence of the transverse ridge in the nymph alone is also characteristic of the Japanese *Ostrovus*, where the arms of the Y-ridge are weak in the nymph and absent in the adult except for short stubs. In some specimens of *Chernokrillus* the arms of the Y-ridge fork, each branch being about half the width of the base of the Y; the more posterior branch runs to meet or almost to meet the posterior corner of the furcal pit, the anterior branch runs in the direction of the anterior corner, but does not reach it. These variants may be intermediate steps toward the condition of *Osobenus* and the Japanese *Stavsolus* in which the arms of the Y-ridge are shifted forward to meet the anterior corners of the furcal pits, and project somewhat beyond the latter (this also occurs in some specimens of *Chernokrillus*). A similar condition was noted in the more specialized subgenera of *Arcynopteryx*, but in *Isogenus* it has evidently been developed independently. The nymphs of *Chernokrillus*, *Osobenus*, and *Stavsolus* are unknown.

MALE GENITALIA: The typical isogenine pattern is followed in most cases, with of course the usual variety in the actual form of the various structures. The posterior lobe on the 7th sternite, which, in general, characterizes this genus, is absent or only faintly indicated in *Besdolus*, *Hydroperla*, *Helopicus*, and *Isogenus* s.s. Similar lobes on the 8th sternite are well developed in *Diploperla* and *Remenus*; elsewhere 8th-sternite lobes are, at most, much weaker than those of the 7th sternite and in a majority of cases are not evident. The most striking

variation of the supra-anal apparatus is the complete absence of lateral stylets in *Helopicus*, *Kogotus*, *Ostrovus*, *Pictetia*, *Remenus*, and *Stavsolus*. In *Kogotus* and *Helopicus* the tips of the paragenital plates are produced and apparently perform the spreading function usually done by the stylets. In *Diploperla* the lateral stylets greatly exceed the supra-anal process, which is very short and weak near the tip, so that it has been overlooked in the past. Tergites anterior to 10 exhibit only minor modifications except in *Ostrovus*, where there is a large process on 8 and sometimes one on 7.

FEMALE GENITALIA: The subgenital plate is always well produced over the 9th sternite, or even the 10th; it is usually broadly rounded but is notched in a few species.

NYMPHAL MAXILLA: The relative size of the spines and hairs of the maxilla is subject to some variation. Most distinctive are *Remenus* and *Kogotus*, which completely lack accessory spines or hairs. Nymphs of other subgenera, in so far as they are known, have a shorter accessory spine inside the main one, and none to many bristles along the mesal margin. The major spine is unusually long in *Diploperla*, about half the length of the lacinia. Opposite or near the origin of the two spines there is in some forms an angle, or sometimes even a knob, bearing a group of short spinules or stout hairs. This is present in *Besdolus*, *Dictyogenus*, one *Helopicus*, *Hydroperla*, most *Isogenoides*, *Iso genus*, *Malirekus*, and *Pictetia*; absent in *Cultus*, *Diploperla*, *Yugus*, one *Helopicus*, and one *Isogenoides*. In *Dictyogenus* the spinules are more or less evenly distributed from the lesser spine to the corner of the angle; this is also true of *Besdolus*, which has the spinules in two parallel rows, diverging from each other and with a blank space between.

NYMPHAL MANDIBLE: Denticles along the outer cusp are present in *Helopicus* and most *Isogenoides*, but are absent from other known nymphs.

Obviously *Isogenus* is a genus of more modern aspect than *Arcynopteryx*. It has gone further in the development of the trends toward loss of gills, loss of apical crossveins, changes in genitalia, and in the development of a greater variety of patterns for the mesosternal ridges and for the nymphal mouth parts. It has for the most part lost the primitive serration of the man-

dibles which appears in *Oroperla* and is retained in most other subgenera of *Arcynopteryx*. To portray an *Isogenus* with the maximum of primitive characters now existing in the genus, it is necessary to assemble an hypothetical or "ancestral" type. Such an ancestral *Isogenus* would have had well-developed submental gills (as in *Hydroperla*, *Isogenoides*, and *Helopicus*); no lobe on the male 7th sternite (as in *Besdolus*, *Hydroperla*, *Helopicus*, and *Isogenus s.s.*); well developed lateral stylets (as in most subgenera); some development of the apical radial cross-vein network (as in *Besdolus* and to a less extent *Dictyogenus*); incomplete development of the transverse ridge of the mesosternum in the imago at least (as in *Dictyogenus*, *Hydroperla*, and *Besdolus*); and serrate nymphal mandibles (as in *Helopicus* and some *Isogenoides*). Such an ancestor, if it existed today, could be classified equally in the genus *Iso genus* or in the genus *Arcynopteryx*. Of the better-known of the existing subgenera of *Arcynopteryx*, *Setvena* comes closest to occupying the role of immediate predecessor of the ancestral *Isogenus*; however, it lacks the lateral stylets, which would scarcely be reacquired later. Among existing *Isogenus*, the subgenera *Besdolus*, *Helopicus*, and *Hydroperla* seem to be about equally endowed with primitive characteristics.

KEYS TO NORTH AMERICAN SUBGENERA

MALES (AND FEMALES)

- 1 Arms of the mesosternal Y-ridge meet the anterior corners of the furcal pits (western species; submental gills short or absent) 2
 - Arms of the mesosternal Y-ridge meet or approach the posterior corners of the furcal pits 3
- 2(1) Wings almost clear; ♂ lateral stylets short, with 2 or 3 terminal spinules *Osobenus* (p. 118)
 - Wings dark brown; lateral stylets long, smoothly rounded *Chernokrilus* (in part) (p. 93)
- 3(1) A median mesosternal ridge present running from the fork of the Y to the transverse ridge; submental gills long *Isogenoides* (p. 105)
 - Median mesosternal ridge absent from the fork of the Y to the transverse ridge 4

| | | |
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| 90 | Indiana University Publications, Science Series | |
| 4 3 | No lobe on the ♂ 7th sternite ; submental gills at least twice as long as wide | <i>Hydroperla</i> p. 104 |
| | A well-defined lobe present on the ♂ 7th sternite ; submental gills mere stubs, or absent | 5 |
| 5 4 | Lateral stylets absent from the ♂ supra-anal apparatus | 6 |
| | Lateral stylets present | 10 |
| 6 5 | Produced tip of the anterior sclerotized band of the supra-anal process normally coiled within the process | <i>Kogotus</i> p. 115 |
| | Tip of the supra-anal process not coiled | 7 |
| 7 6 | The basal support of the supra-anal apparatus situated at the anterior edge of the 10th tergite | <i>Helopicus</i> p. 100 |
| | Basal support of the supra-anal process situated at least halfway back on the 10th segment, much behind the anterior margin ; the tergite before the support quite membranous | 8 |
| 8 7 | Supra-anal process terminating in an eversible lash scarcely surrounded by a cowl posteriorly ; paragenital plates free, flap-like; lobe of the 8th sternite almost as well marked as that of the 7th, though smaller | <i>Remenus</i> p. 122 |
| | Supra-anal process of normal length, and with a complete cowl behind ; paragenital plates normal ; lobe of the 8th sternite much less distinct than that of the 7th, or absent | 9 |
| 9 8 | Short submental gills present ; western | <i>Pictetia</i> p. 120 |
| | Submental gills completely lacking; eastern | <i>Yugus</i> p. 123 |
| 10 5 | Lateral stylets greatly exceeding the tiny tip of the supra-anal process (the latter often difficult to find) | <i>Diploperla</i> p. 99 |
| | Lateral stylets no longer than the well-developed tip of the supra-anal process | 12 |
| 12 10 | Submental gills completely absent ; lateral stylets slender, acute | <i>Cultus</i> p. 95 |
| | Submental gills short but distinct ; lateral stylets not as above | 13 |

- 13 12 Submental gills conical ; lateral stylets hooked at the tip ; eastern Malirekus p. 117
 Submental gills rounded; lateral stylets rounded at the tip; western *Chernokrillus* in part p. 93

NYMPHS (*Chernokrillus* and *Osobenus* unknown)

- 1 Maxilla terminating in a single spine and lacking spinules or hairs on the mesal margin 2
 Maxilla with a shorter spine mesad of the main one, and often with additional spinules or hairs 3
- 2 1 Maxilla broad at the base, abruptly narrowed into a long slender spine; eastern Remenus p. 122
 Maxilla gradually narrowed from the base outward ; western *Kogotus* p. 115
- 3 1 The portion of the submental gill projecting beyond the submentum at least twice as long as its greatest width 4
 Submental gills less than twice as long as their greatest width, usually about as long as wide; or entirely absent 6
- 4 3 Mesosternum with a median ridge joining the fork of the Y to the transverse ridge Isogenoides p. 105
 Median ridge absent anterior to the fork of the Y; transverse ridge absent or very indistinct 5
- 5 4 Sides of the ventral cusps of the mandibles margined by minute denticles ; labrum much produced medially Fig. 55 Helopicus p. 100
 Ventral cusps of the mandibles without denticles, labrum normal similar to Fig. 64 *Hydroperla* p. 104
- 6 3 Submental gills absent, or at least not projecting beyond the borders of the submentum 7
 Submental gills projecting beyond the border of the submentum for a distance about equal to their greatest breadth 8
- 7 6 Mesal margin of the maxilla with many hairs, and with a distinct tufted knob set somewhat proximad of the origin of the spines Yugas p. 123

- Mesal margin of the maxilla with 0-4 hairs, and lacking a tufted knob *Cultus* (p. 95)
- 8(6) Major spine equal to half of the total length of the lacinia ; the basal part of the lacinia rounded mesally, its margin with 3-5 hairs ; median ridge of the mesosternum unforked *Diploperla* (p. 99)
- Major spine equal to no more than a third of the total length of the lacinia ; the basal part with 10 or more hairs on the mesal margin; median mesosternal ridge forked anteriorly 9
- 9(8) Transverse ridge present on the mesosternum ; eastern *Malirekus* (p. 117)
- Transverse ridge absent ; western *Pictetia* (p. 120)

Subgenus *Besdolus* (new)

SUBGENOTYPE and only known species: *Dictyogenus imhoffi* Pictet.

SIZE: Medium.

COLOR: Light brown.

VENATION: 3 or 4 apical crossveins in the costal space, several rather irregular ones between R and Rs, usually 1 beyond.

SUBMENTAL GILLS: Quite short, sometimes barely distinguishable.

MESOSTERNUM OF NYMPH AND IMAGO: Typical. Transverse ridge present ; Y-ridge runs to the posterior corners of the furcal pits.

♂ 10TH TERGITE: Lobes rather large, subtriangular, elevated and then dropped down, hairy but not spinulose.

OTHER TERGITES : 6-8 slightly swollen laterally.

SUPRA-ANAL PROCESS: Subcylindrical, with an anterior band continued over the tip, but not hooked.

PARAGENITAL PLATES: Normal.

LATERAL STYLETS: Large, acute.

SUBANAL LOBES: Considerably expanded.

VENTRAL LOBES: Very faintly marked on 7, absent on 8.

SUBGENITAL PLATE: Moderately produced and rounded ; on 9 there is a small terminal sclerite, free of hairs.

NYMPHAL MAXILLA: Truncate and produced laterally at the origin of the terminal spines, with a series of large spinules set on either margin of the surface so produced ; smaller

spinules or hairs are present along the mesal margin ; the longer terminal spine is slightly more than a third of the entire length of the maxilla.

DISTRIBUTION: Europe.

SPECIES

"Isogenus (Besdolus) imhoffi Pictet 1841, Europe.

Subgenus Chernokrilus (new)

SUBGENOTYPE: *Perla misnoma* Claassen (*P. obscura* Needham and Claassen) .

SIZE: Large.

COLOR: Dark brown, wings heavily infuscated.

VENATION: Usually a few apical crossveins beyond the cord, and 3 or 4 in the costal space.

SUBMENTAL GILLS: Short.

MESOSTERNUM OF IMAGO (*misnomus*): In the ♀ the Y-ridge proceeds to the posterior corners of the furcal pits, but gives off a short anterior stub on either side, and a more lateral branch that reaches the anterior corner of the pits. In the single male specimen the ridges are rather obscure, but the "short stubs" of the ♀ seem traceable to the anterior corners of the pits, while the branch to the posterior corners is poorly developed or absent. There is a transverse ridge in both sexes, but rather indistinct in the ♂ .

SUPRA-ANAL PROCESS: Simple, well-developed.

PARAGENITAL PLATES: Normal.

LATERAL STYLETS: Large, rounded at the tip.

SUBANAL LOBES: Somewhat expanded.

VENTRAL LOBES: Large on 7; smaller but distinct on 8 (at least in *misnomus*).

SUBGENITAL PLATE: Long, rounded.

DISTRIBUTION: Western North America.

The basal anchor of the supra-anal apparatus is unusually large and heavily sclerotized in this group, with two projections to either side, seen in dorsal view.

MALES

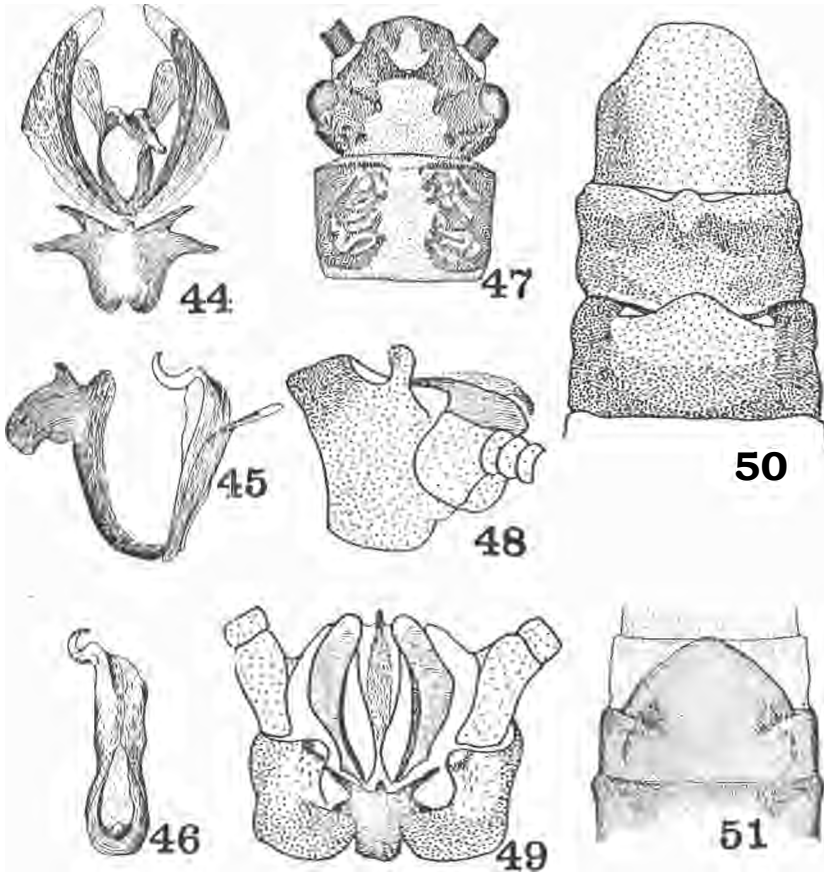
Supra-anal process bluntly hooked at the tip *erratus*
 Supra-anal process straight at the tip *misnom,us*

Isogenus (*Chernokrilus*) *erratus* Claassen

1925. *Perla venosa* Needham and Claassen, Monogr. Plecop., p. 93, desc. of ♀; p. 313, fig. 8, wings; p. 327, figs. 11, 12, ♂ genitalia. Type locality: Fieldbrook, California.

1936. *Perla errata* Claassen, Ann. Ent. Soc. Am. 29:62. New name.

This species is assigned tentatively to *Chernokrilus* chiefly because of the large size of the basal anchor of the supra-anal process. The genitalia of the holotype are illustrated in figures



Isogenus erratus (holotype). 44. Supra-anal apparatus from above. 45. Side view of supra-anal process, basal anchor and lateral stylet. 46. Rear view of supra-anal process.

Isogenus misnomus. 47. Head and pronotum of ♀. 48. Terminal segments of ♂, from the side. 49. The same, from above. 50. The same, from below. 51. Subgenital plate of ♀.

44-46; the asymmetrically twisted end of the process may be the result of drying or injury. The transverse ridge of the mesosternum seems very diffuse, if it is recognizable at all. Only the holotype is known.

Isogenus (Chernokrilus) misnomus Claassen

1925. *Perla obscura* Needham and Claassen, Monogr. Plecop., p. 92, desc. of ♀; p. 341, fig. 15, subgenital plate. Type locality: Oregon Caves, Josephine County, Oregon.

1936. *Perla misnomus* Claassen, Ann. Ent. Soc. Am. 29: 622. New name.

MALE: Length of body, 12 mm. ; to tip of wings, 18 mm. Color dark brown, with a broad yellow pronotal stripe and head markings (Fig. 47). Wings darkly infuscated.

Tenth tergite cleft, with small erect lobes posteriorly. Supranal process with a very strong basal body, black limb, and whitish distal portion covered with retrorsely appressed hairs (Figs. 48, 49). Lateral stylets large, flat, their tips rounded. Sternite 7 with a broad posterior lobe, 8 with a smaller inconspicuous one (Fig. 50).

FEMALE: A new drawing of the subgenital plate is presented (Fig. 51).

Neallotype ♂: Yew Creek, Alsea, Oregon, June 1, 1946, B. R. Smith.

We owe the male of this interesting species to the courtesy of Mr. S. G. Jewett, Jr.

DISTRIBUTION: Western Oregon.

Subgenus Cultus (new)

SUBGENOTYPE: *Diploperla pilata* Frison.

SIZE: Medium to small.

COLOR: Yellowish.

VENATION: 1-4 crossveins in the costal space, usually none beyond.

SUBMENTAL GILLS: None.

MESOSTERNUM OF IMAGO: Almost typical, but the arms of the Y-ridge may become weak or unrecognizable near the furcal pits.

MESOSTERNUM OF NYMPH: Typical in *pilatus*; transverse ridge not evident in *decisus*, *aestivalis*, and *tostonus*.

♂ 10TH TERGITE: Lobes short, rounded, spinulose.

SUPRA-ANAL PROCESS: Slender ; subcylindrical or swollen near the tip ; with anterior and posterior sclerotized bands, either sometimes incomplete.

PARAGENITAL PLATES: Normal.

LATERAL STYLETS : Slender, acute.

SUBANAL LOBES: Little enlarged.

VENTRAL LOBES: Always distinct on 7, absent or present (small) on 8.

SUBGENITAL PLATE: Long, broadly or narrowly rounded.

NYMPHAL MAXILLA: Spine half as long as the whole maxilla ; otherwise of typical form and with the usual 2 teeth, but with only 1 or 2 mesal hairs and no knob near the teeth.

DISTRIBUTION: Cordilleran and eastern North America.

MALES AND FEMALES

- | | | |
|------|---|-------------------|
| 1 | Eastern and northeastern species | <i>decisus</i> |
| | Cordilleran species | 2 |
| 2(1) | Hind head yellow centrally and with yellow lobes extending forward between the ocelli and between eyes and ocelli, 3 in all | <i>pilatus</i> |
| | Head pattern not as above | 3 |
| 3(2) | Head mostly yellow, the only important dark marking being the bands which join the anterior to the lateral ocelli ; median pronotal stripe, at its middle, about one-fifth of the width of the pronotum | <i>tostonus</i> |
| | Head mostly dark, with restricted yellow patches ; median pronotal stripe about one-tenth of the width of the pronotum | <i>aestivalis</i> |

Isogenus (Cultus) aestivalis Needham and Claassen

1925. *Perla aestivalis* Needham and Claassen, Monogr. Plecop., p. 87, desc. of ♂ 9; p. 319, fig. 5, wings; p. 327, figs. 7-10, ♂ 9 genitalia eggs. Type locality: Yellowstone National Park.
1931. *Perla aestivalis* (?) Claassen, Plecop. Nymphs, p. 53, desc. of nymph.
1943. *Diploperla fraseri* Ricker, Stoneflies SW B.C., p. 106, fig. 85, head and pronotum; figs. 83, 86, 87, 90, ♂ genitalia; fig. 84, 9 subgenital plate. New Synonymy.

A study of the two types shows that both are of the kind described as *fraseri* in my 1943 paper. The Needham and Claassen

figure of the subgenital plate shows its sides slanting inward too soon from the base, thus approaching *tostonus*.

DISTRIBUTION: Coastal and interior southern British Columbia, south to Utah, Colorado, and Wyoming.

Isogenus (*Cultus*) *decisus* Walker

1852. *Perla* (*Chloroperla*) *decisa* Walker, Cat. Neurop. Ins. Br. Mus. I, p. 170, desc. of ♂. Type locality: St. Martin's Falls, Albany River, Ontario.
1920. *Perla verticalis* Banks, Bull. Mus. Comp. Zool. 64, p. 318.
1920. *Isoperla isolata* Banks, Bull. Mus. Comp. Zool. 64, p. 322.
1925. *Perla verticalis* Needham and Claassen, Monogr. Plecop., p. 89, desc. of ♂ 9; p. 319, fig. 8, wings; p. 327, figs. 13-15, ♂; 9 genitalia.
1931. *Perla verticalis* (?) Claassen, Plecop. Nymphs, p. 57, desc. of nymph; p. 133, figs. 55-59, mouth parts of nymph; p. 155, fig. 189, nymph.
1938. *Perla decisa* Ricker, Trans. Roy. Canad. Inst. 22, p. 141, desc. of holotype ♂; p. 154, figs. 18, 19, genitalia of holotype.
1944. *Diploperla decisa* Ricker, Can. Ent. 76, p. 179; p. 182, fig. 121, 9 subgenital plate.

North Carolina specimens differ from Michigan or Ontario specimens in having the tip of the supra-anal process more tapered and the lateral arms of the anchor of the supra-anal apparatus somewhat longer and more tapering.

DISTRIBUTION: Northern Ontario and Quebec, south in the mountains to northern Georgia.

Isogenus (*Cultus*) *pilatus* Frison

1942. *Diploperla pilata* Frison, Bull. Illinois Nat. Hist. Surv. 22, pp. 305-7, desc. and figs. of ♂, 9, and nymph. Type locality: Vedder Crossing, British Columbia.

DISTRIBUTION: Coast and Cascade Mountains from northern British Columbia to Oregon.

Isogenus (*Cultus*) *tostonus* new species

1943. *Diploperla aestivalis* Ricker, Stoneflies SW B.C., p. 107, fig. 88, head and pronotum; fig. 89, supra-anal process and lateral stylets. (Not *aestivalis* Needham and Claassen.)

MALE: Length of body, 9.5 mm.; to tip of wings, 11 mm. In size and general structure very similar to *aestivalis* (*fraseri*), though averaging perhaps a little larger. It is distinguished from that species by a generally lighter color, the dark markings

of the head being confined to a diffuse V-mark joining the anterior and lateral ocelli, and sometimes a dusky area behind the eyes. The median pronotal stripe is broader than in *aestivalis* (see Ricker, 1943, fig. 88). The male genitalia differ from *aestivalis* in that the supra-anal process is more slender and blunter, and the lateral stylets more slender and less curved (*ibid.*, Fig. 89).

FEMALE: Length of body, 11 mm.; to tip of wings, 14 mm. The subgenital plate is much produced and rounded, and its sides begin to narrow right from the base (Fig. 52).

Holotype, allotype 2, and 9 ♂, 8 ♀ paratypes: Toston, Montana, June 22, 1940, H. H. and J. A. Ross.

Para types as follows:

BRITISH COLUMBIA

Oliver. June 2, 1924, 2 ♂, P. N. Vroom (CNC).

MONTANA

Yellowstone River at Corwin Bridge, Park County. July 21, 1948, 9, R. Hays.

Madison River, Madison County. June 18, 1938,  9, D. J. Pletsch.

OREGON

5 miles S of Union Creek on Mill Creek. June 24, 1937, ♂ 9, S. J. Jewett, Jr.

WASHINGTON

Yakima. "7.8-35," ♂, E. I. Beamer.
Omak, Okanogon County. May, 1934, 4 ♀.

WYOMING

Tributary of Pine Branch River, Boulder. July 6, 1936, ♂ 9, H. H. Ross.
Green River, N of Pinedale. July 6, 1936, 9, H. H. Ross.

Subgenus *Dictyogenus* **Klapálek**

1904. *Dictyogenus* Klapálek, Ceska Akad. Fr. Jos. I, Trida, 2: 13(17), 8,
SUBGENOTYPE: *Isogenus alpinus* Pictet.

SIZE: Medium.

VENATION: 1 or 2 crossveins in the coastal space ; 2-6 behind it.

SUBMENTAL GILLS: Absent.

MESOSTERNUM OF IMAGO: The Y-ridge runs to the posterior corners of the furcal pits. The transverse ridge joining the

- anterior corners of the furcal pits of the imago may be present or absent, sometimes varying within the species (*alpinus*).
- MESOSTERNUM OF NYMPH: Like the imago, but the transverse band is absent in all specimens of the 2 species examined (*alpinus*, *fontium*). A mature nymph of *fontium* shows the band absent from the nymphal cuticle and present in the imaginal cuticle below.
- ♂ 10TH TERGITE: Lobes rounded, with few long spinules and very long hairs.
- SUPRA-ANAL PROCESS: Slender, somewhat extended laterally near the tip, with anterior and posterior sclerotized bands and a terminal sclerotized hook.
- PARAGENTAL PLATES: Normal.
- LATERAL STYLETS: Large, bluntly rounded.
- SUBANAL LOBES: Considerably expanded.
- VENTRAL LOBES: Well developed on 7, and perhaps suggested on 8.
- SUBGENITAL PLATE: Slightly produced, shallowly notched.
- NYMPHAL MAXILLA: Normal.
- DISTRIBUTION: Europe.

SPECIES

- Isogenus (Dictyogenus) alpinus* Pictet 1841, Switzerland.
- ***Isogenus (Dictyogenus) fontium* Ris 1896, Switzerland.
- Isogenus (Dictyogenus) gaullei* Navás 1925, France.
- Isogenus (Dictyogenus) gelidus* Klapálek 1906, Europe.
- Isogenus (Dictyogenus) ventralis* Pictet 1841, Balkans.

Subgenus **Diploperla** Needham and Claassen

1925. *Diploperla* Needham and Claassen, Monogr. Plecop. p. 286 (for *bib-beta* and *duplicata*).
1941. *Diploperla* Kimmins, Ent. 74; p. 87. Designates *duplicata* as SUBGENOTYPE.

SIZE: Small.

COLOR: Light, wings smoky.

VENATION: 4-7 crossveins in the coastal space, usually none behind it.

SUBMENTAL GILLS: Quite short, but usually projecting beyond the submentum.

MESOSTERNUM OF IMAGO: Arms of the Y-ridge absent, and its median member rather weak ; transverse ridge strong.

MESOSTERNUM OF NYMPH: Similar, but the transverse ridge absent.

10TH TERGITE : Lobes short, blunt, finely spinulose.

SUPRA-ANAL PROCESS: Very slender, weak, light in color, with a small whitish knob at the tip ; much shorter than the lateral stylets and easily overlooked.

PARAGENITAL PLATES: Normal.

LATERAL STYLETS : Stout, dark in color, blunt at the tips.

SUBANAL LOBES: Very little expanded.

VENTRAL LOBES: Narrow, sharply marked off and produced on both segments ; the 8th somewhat smaller than the 7th.

SUBGENITAL PLATE: Long, rounded.

NYMPHAL MAXILLA: Base of the lacinia rounded mesally and with only 1-4 hairs ; the 2 spines unusually long, the large one almost as ~~long~~ as the remainder of the lacinia.

DISTRIBUTION: Eastern North America.

The many structural contrasts between the species *duplicatus* and *bilobatus* make it necessary to reserve the name *Diploperla* for the former species and erect a new subgenus for the latter.

Isogenus (Diploperla) duplicatus Banks

1920. *Pe, la duplicata* Banks, Bull. Mus. Comp. Zool. 64, p. 316. Type locality: Newington, Virginia.

1925. *Perla duplicata* Needham and Claassen, Monogr. Plecop., p. 94, desc. of ♂ ♀ ; p. 327, figs. 5, 6, genitalia of ♂.

1935. *Isoperla duplicata* Frison, Bull. Illinois Nat. Hist. Surv. 20, pp. 449-53, desc. and fig. of nymph; pp. 312-20, mouth parts of nymph; p. 326, fig. 204, genitalia of ♂.

The short, slender tip of the supra-anal process of this species **has been overlooked heretofore.**

DISTRIBUTION: Indiana, Ohio, Kentucky, and Virginia to North Carolina and northern Georgia.

Subgenus **Helopicus** (new)

SUBGENOTYPE : *Hydroperla nalata* Frison.

SIZE: Medium.

COLOR: Medium brown.

VENATION: **1-3** apical crossveins in the coastal space, 0-1 behind

it. In many specimens of *nalata* the 2 branches of \aleph_2 leave the anal cell together.

SUBMENTAL GILLS: Long.

MESOSTERNUM OF IMAGO: Typical.

MESOSTERNUM OF NYMPH: Differs from the imago in that the transverse ridge is absent, except for a short stub on either side.

♂ **10TH TERGITE:** Completely cleft ; lobes bluntly triangular, covered with long hairs but no spinules.

SUPRA-ANAL PROCESS: Slender, cylindrical or flattened, acute, bent backward near the tip.

PARAGENITAL PLATES: Produced near the tip into free subacute lobes.

LATERAL STYLETS: Absent.

SUBANAL LOBES: Much expanded.

VENTRAL LOBES: Broadly marked out by pigment on both 7 and 8, though sometimes not very distinct.

SUBGENITAL PLATE: Moderately produced and rounded (*subvarians*.)

NYMPHAL MAXILLA: Major spine of lacinia a little less than one-third of its total length ; small knob bearing spinules on the mesal edge present or absent

NYMPHAL MANDIBLE: Minute serrations can be observed along the inner edge of the outer cusps.

DISTRIBUTION: Eastern North America.

MALES AND FEMALES

Posterior end of the paragenital plates with a dorsal carina, subacute at the tip ; anal area of hindwing without a dark mark ; known range Michigan and Indiana

nalatus

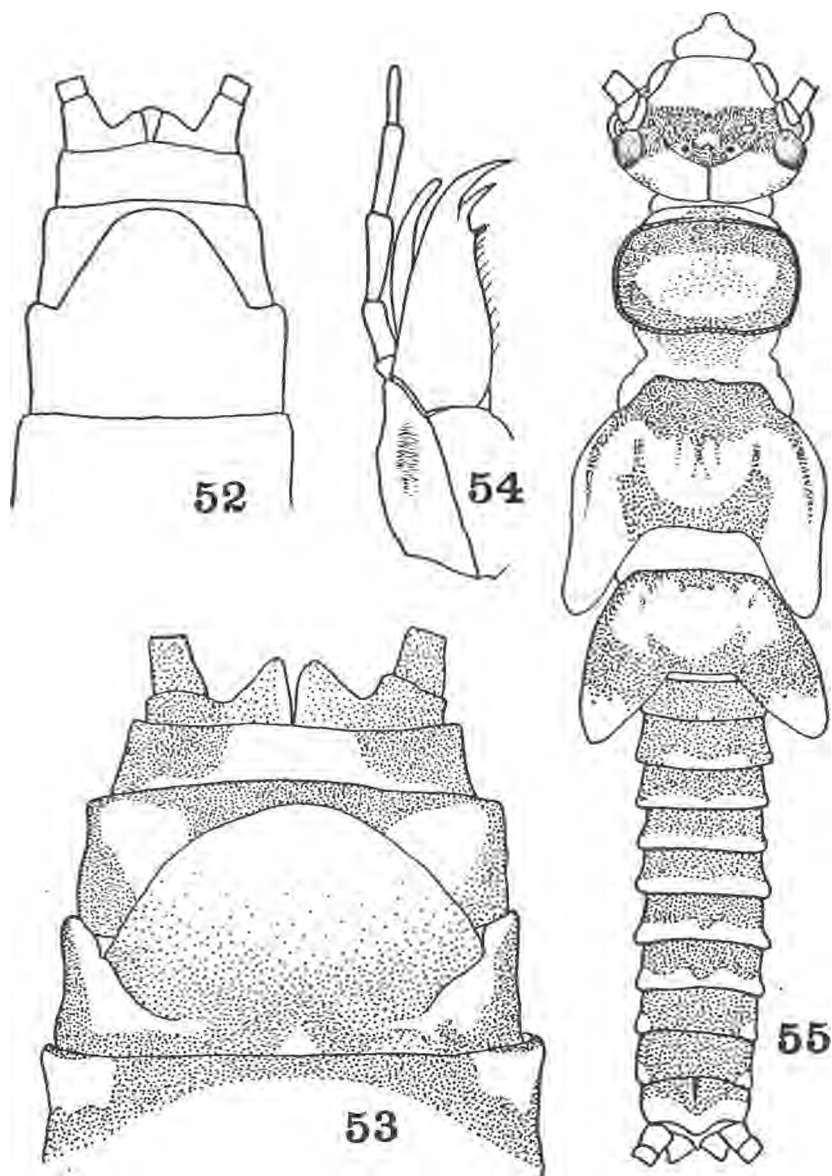
Tip of the paragenital plates without a carina, rounded ; anal area of the hindwing with a large dark spot (except in teneral specimens) ; known range Quebec to Georgia

subvarians

NYMPHS

Transverse black band on the head narrow, not including the ocellar triangle ; lacinia without a knob on the mesal margin ; stipes without a patch of stout hairs

nalatus



Isogenus tostonus. 52. Terminal sternites of allotype 9.

Isogenus subvarians. 53. Terminal sternites of 9; Calais, Maine. 55. Nymph. Roanoke Virginia. 54. The same, maxilla.

Transverse black band broad, including the ocellar triangle except for a small central spot ; lacinia with a small tufted knob on the mesal surface a little proximad of the major spines ; stipes with a brush-like patch of stout hairs ventrally *subvarians*

Isogenus (*Helopicus*) *nalatus* Frison

1942. *Hydroperla nalata* Frison, Bull. Illinois Nat. Hist. Surv. 22, pp. 293-95, desc. and figs. of ♂ and nymph. Type locality: Washtenaw County, Michigan.

DISTRIBUTION: Southern Michigan to southern Indiana.

Isogenus (*Helopicus*) *subvarians* Banks

1920. *Perla subvarians* Banks, Bull. Mus. Comp. Zool. 64, p. 317. Type locality: Great Falls, Virginia.
1925. *Perla postica* Needham and Claassen, Monogr. Plecop., p. 82, desc. of ♂ 9, p. 313, fig. 3, wings. (Not Walker 1852.)
1925. *Perla tinctoria* Needham and Claassen, Monogr. Plecop., p. 89, desc. of ♀ 9 ; p. 319, fig. 3, wings; p. 325, fig. 15, 9 plate. Type locality: North Carolina. New Synonymy.
1936. *Perla tinctoria* Claassen, Ann. Ent. Soc. Amer., 29, p. 622. New name for *tinctoria*. New Synonymy.
1942. *Hydroperla subvarians* Frison, Bull. Illinois Nat. Hist. Surv. 22, p. 292, figs. of ♂ genitalia and color pattern.

The tinting of part of the anal area of the hindwing, shown by Needham and Claassen for *tinctoria*, is present on all but the most teneral specimens of this species. The color in the forewing is much less clear in specimens at hand, but traces of it appear.

MALE: Frison's figures are excellent, although, as he notes, the supra-anal process is somewhat longer than in more southern specimens.

FEMALE: The subgenital plate is shown in figure 53.

NYMPH: The dorsal color pattern of brown or black and yellow is characteristic (Fig. 55), particularly the black band across the head. The labrum has the central flap longer than in most isogenine nymphs, being equal to one-third of the total median length of the labrum, as compared with one-fifth or less in other species. The lacinia of the maxilla has a small knob below the origin of the major spines, and a series of mesal hairs. On the stipes there is a brush-like patch of stout hairs (Fig. 54). The mandibles have minute denticles along the side of the ventral cusp.

DISTRIBUTION: Southern Ontario and Quebec, Maine, New York, Virginia, North Carolina, and northern Georgia.

Subgenus *Hydroperla* Frison

1935. *Hydroperla* Frison, Bull. Illinois Nat. Hist. Surv. 20, p. 417. GENO-TYPE: *Perlodes crosbyi* Needham and Claassen.

SIZE: Medium.

COLOR: Medium brown.

VENATION: 1-3 apical crossveins in the coastal space ; 0-2 behind it.

SUBMENTAL GILLS: Long.

MESOSTERNUM OF NYMPH AND IMAGO: Y-ridge normal; transverse ridge absent except for very short stubs at the corners of the furcal pits. In the adult *crosbyi* there is a short unattached cross ridge present just posterior to the normal position of the (absent) transverse ridge.

♂ 10TH TERGITE: Completely cleft, lobes narrowly rounded (thumb-like in *crosbyi*).

SUPRA-ANAL PROCESS: Hood-like near the tip (concave anteriorly) with blunt or acute forward-pointing processes on the margin.

PARAGENITAL PLATES: Normal or somewhat produced (*fugitans*).

LATERAL STYLETS : Present, rounded, or acute.

SUBANAL LOBES: Much expanded.

VENTRAL LOBES: Unrecognizable.

SUBGENITAL PLATE: Slightly to moderately produced, rounded or bluntly triangular.

NYMPHAL MAXILLA: Terminal spines short, a small knob mesally a little behind the origin of the spines ; mesal hairs moderately numerous.

DISTRIBUTION: Mississippi valley.

MALES AND FEMALES

Supra-anal process terminating in a large hook bent completely ventrad ; subgenital plate produced only one-fourth of the lateral length of its sternite *crosbyi*

Supra-anal process bluntly pointed, not hooked ; subgenital plate produced about half of the lateral length of its sternite *fugitans*

Hydroperla crosbyi
Needham and Claassen
1935

x

NYMPHS

- Anterior half of each tergite dark in color, the remainder
light *crosbyi*
Anterior half of the tergites light in color, except for a row
of 6-8 small dots *fugitans*

Isogenus (Hydroperla) *crosbyi* Needham and Claassen

1925. *Perla crosbyi* Needham and Claassen, Monogr. Plecop., p. 79, desc. of ♂ ♀; p. 313, fig. 4, wings; p. 325, figs. 7, 8, genitalia of ♂. Type locality: Missouri.
1935. *Hydroperla crosbyi* Frison, Bull. Illinois Nat. Hist. Surv. 20, pp. 419-23, desc. and fig. of nymph; pp. 312-23, figs. 43, 73, 103, 133, 168, mouth parts of nymph; p. 324, fig. 183, forewing; p. 418, fig. 328, ♂ genitalia; p. 417, fig. 325, ♀ subgenital plate.

DISTRIBUTION: Indiana and Illinois to Arkansas and Oklahoma.

Isogenus (~~Hydroperla~~) *fugitans* Needham and Claassen

1925. *Perla fugitans* Needham and Claassen, Monogr. Plecop., p. 85, desc. of ♂; p. 315, fig. 7, wings; p. 325, figs. 13, 14, ♂ genitalia. Type locality: Austin, Texas.
1935. *Hydroperla harti* Frison, Bull. Illinois Nat. Hist. Surv. 20, p. 423, desc. of ♂, ♀, and nymph; p. 300, fig. 24, egg; pp. 312-22, figs. 44, 74, 104, 134, 167, mouth parts of nymph; p. 417, fig. 324, ♀ subgenital plate; p. 418, fig. 326, ♂ genitalia; p. 422, fig. 330, nymph. New Synonymy.

DISTRIBUTION: ~~Indiana~~, Illinois, Tennessee, Arkansas, and Texas.

Subgenus *Isogenoides* Klapálek

1912. *Isogenoides kalpálek*, Cat. Coll. Selys 4(1), p. 57. SUBGENOTYPE: *Isogenus frontalis* Newman.

SIZE: Rather large.

COLOR: Dark.

VENATION: 3-5 apical crossveins in costal space; 0-1 behind.

SUBMENTAL GILLS: Long.

MESOSTERNUM OF NYMPH AND IMAGO: With the typical ridges, and in addition a median ridge joining the transverse ridge to the fork of the Y (Fig. 36D).

♂ 10TH TERGITE: Completely cleft, lobes directed medially or anteriorly rather than posteriorly.

SUPRA-ANAL PROCESS: Slender, with a terminal or subterminal backwardly-directed sclerotized or membranous hook or hooks

(long lash in *olivaceus*), and usually an anterior more proximal hook or hooks.

PARAGENITAL PLATES: Normal.

LATERAL STYLETS: Slender, acute, or blunt.

SUBANAL LOBES: Much expanded.

VENTRAL LOBES: Well developed on 7, absent or nearly so from 8; in *doratus* there are also lobes on 6 and in some specimens even on 5.

SUBGENITAL PLATE: Moderately produced, rounded or notched.

NYMPHAL MAXILLA: Rather typical ; the spines of the lacinia short ; a projection usually present on the mesal edge close to the origin of the smaller spine ; mesal hairs numerous.

NYMPHAL MANDIBLES: Ventral cusps almost always serrate marginally, at least on the left mandible, but the denticles are very minute except in *hansonii* and *elongatus*.

DISTRIBUTION: North America, rather generally distributed.

MALES (AND FEMALES)

- | | | |
|------|--|------------------|
| 1 | Supra-anal process ending in a long, slender lash ; female subgenital plate moderately produced, with a shallow broadly V-shaped median notch ; northern | <i>olivaceus</i> |
| | Supra-anal process short, usually hooked ; subgenital plates are varied, but have a deep rounded notch in northern species | 2 |
| 2(1) | Supra-anal process with a pair of short acute lobes posteriorly | 3 |
| | Supra-anal process without lobes posteriorly | 5 |
| 3(2) | Males brachypterous ; subgenital plate little produced, broadly truncate behind, with or without a small median notch ; cordilleran | <i>elongatus</i> |
| | Males long-winged ; subgenital plate produced, rounded, entire; middle-western | 4 |
| 4(3) | Tip of the supra-anal process sclerotized and excavated (saddle-like) | <i>varians</i> |
| | Supra-anal process produced into a slender blunt tip (Fig. 61) (female unknown) | <i>krumholzi</i> |
| 5(2) | Genital hooks (terminal sclerotized corners of the 10th tergite) directed inward and then somewhat | |

- forward; subgenital plate only a little produced,
with a deep U-rounded notch *frontalis* 6
- Genital hooks directed inward and backward; sub-
genital plate considerably produced, lacking a
rounded notch 7
- 6(5) Posterior inner angles of the genital hooks of the
10th tergite sharp, practically a right angle;
western and northern (east to Northwestern Mani-
toba) *frontalis colubrinus*
- Posterior inner angles of the genital hooks broadly
obtuse or rounded ; eastern and northern (west
to Churchill) *frontalis frontalis*
- 7(5) Yellow area of the rear of the head continued forward
into the ocellar triangle; subgenital plate usually
entire ; Appalachian region *hansoni*
- Yellow area of the rear of the head not extending
beyond the occipital suture; subgenital plate usual-
ly with a shallow broadly V-shaped notch ; middle-
western region *doratus*

NYMPHS (*krumholzi* unknown)

- 1 Conspicuous denticles present along the margins of the
ventral cusp of both mandibles 2
- Margin of the ventral cusp of only the left mandible
with minute scarcely-distinguishable denticles; or
denticles entirely absent 4
- 2(1) Cordilleran species; denticles in a double row, the
outer row slender, the inner row coarser *elongatus*
- Mid-western or eastern species ; denticles in a single
row 3
- 3(2) Appalachian species ; denticles large ; body conspicu-
ously patterned (Fig. 64) *hansoni*
- Middle-western species ; denticles small ; an X-shaped
mark on the head but otherwise the body is nearly
uniformly colored *doratus*
- 4(1) Abdomen ringed : the anterior half of each segment
dark, the remainder light ; fore part of head, from
the M-line out, predominantly light in color, and the
part immediately behind the M-line dark *olivaceus*
- Abdomen uniformly colored ; head not as above 5

- 5(4) Light-colored nymphs ; the pronotum with a sub-
marginal dark band which is broad laterally *varians*
Dark-colored nymphs ; the pronotum uniformly
dark *frontalis*

Isogenus (Isogenoides) doratus Frison

1942. *Hydropola dorata* Frison (in part), Bull. Illinois Nat. Hist. Surv. 22(2), pp. 295-96, desc. and figs. of nymph (figs. of ♀ imagos are not the same as the holotype, but are *E. hansonii*). Type locality: Baldwin, Michigan.

Illustrations of the ♂ and ♀ are presented in figures 56-59.

DISTRIBUTION: Southern Michigan, Iowa.

Isogenus (Isogenoides) elongatus Hagen

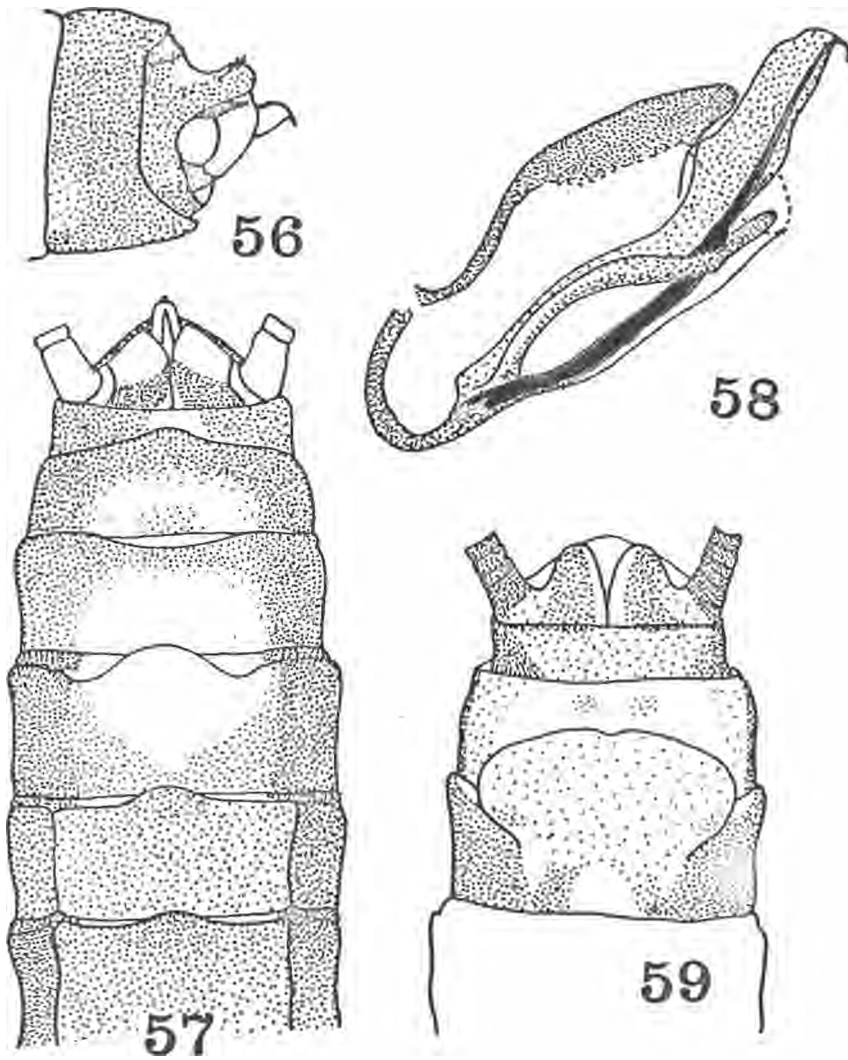
1874. *Isogenus elongatus* Hagen, Bull. Geol. Surv. Tern, p. 576. Type localities: "Foothills of Colorado and Ogden, Utah."
1925. *Isogenus elongatus* Needham and Claassen, Monogr. Plecop., p. 71, desc. of ♂ ; p. 311, fig. 12, ♂ supra-anal process, fig. 17, ♀ subgenital plate.
1943. *Isogenoides elongatus* Hanson, Amer. Midl. Nat. 29, p. 660, desc. of ♂ ♀ ; p. 667, fig. 6, ♂ genitalia; p. 668, figs. 11, 12, ♀ subgenital plate.

NYMPH: Length of mature ♀, 27 mm.; ♂, 22 mm. Very similar to the nymph of *frontalis* in body form, arrangement of spinules, and shape of maxilla. Its body color is brown with very little pattern, even less than in *frontalis*. It is best distinguished from *frontalis* by the double row of denticles lining the basal part of the outer mandibular cusp (Fig. 60). Those of the inner (dorsal) row are rather short, coarse, and black ; those of the outer row are long, slender, and yellow (possibly modified hairs). As in other species, the spinules are best developed on the left mandible. No other species has a double row of this sort. These nymphs were from the upper Yellowstone River near Livingstone, Montana, collected by R. A. Hays.

DISTRIBUTION: Rocky Mountain region and adjacent plains in British Columbia, Alberta, Washington, Montana, Idaho, Utah, and Colorado.

Isogenus (Isogenoides) frontalis Newman

This species can be divided into two fairly-well marked subspecies, as follows:



Isogenus doratus (Des Moines River at Fraser, Iowa). 56. Terminal segments of ♂, from the side. 57. The same, from below. 58. Side view of supra-anal apparatus, except the basal anchor. 59. Terminal sternites of 9.

a. Subspecies *frontalis* s.s.

1838. *Perlida (Isogenus) frontalis* Newman, Ent. Mag. 5, p. 178.

1912. *Isogenus (Isogenoides) frontalis* Klapálek, Cat. Coll. Selys 4(1), p. 57, desc. and figs. of ♂ 9.

1925. *Isogenus frontalis* Needham and Claassen (in part) Monogr., Plecop., p. 69, desc. of ♂ ♀; p. 313, fig. 1, wings; p. 311, figs. 10-16, ♂ ♀ genitalia.
1942. *Isogenus frontalis* Frison (in part), Bull. Illinois Nat. Hist. Surv. 22, pp. 290-92, desc. and figs. of ♂, ♀, and nymph.
1943. *Isogenoides hudsonicus* Hanson, Amer. Midland Nat. 29, p. 662, desc. of ♂ ♀; p. 667, fig. 1, ♂ genitalia; p. 668, figs. 17, 18, ♀ subgenital plate.

DISTRIBUTION: Northeastern United States, Quebec, Labrador and Newfoundland, west to Michigan, Minnesota, and Churchill, Manitoba.

b. Subspecies *colubrinus* Hagen

1874. *Isogenus colubrinus* Hagen, Bull. Geol. Surv. Terr., p. 576. Type locality: Snake River, Idaho.
1918. *Perla titusi* Banks, Bull. Mus. Comp. Zool. 42, p. 6.
1920. *Perla incesta* Banks, *ibid.* 64, p. 318.
1925. *Isogenus colubrinus* Needham and Claassen (in part), Monogr. Plecop., p. 72 (figures are *I. f. frontalis*).
1931. *Isogenus colubrinus* (?) Claassen, Plecop. Nymphs, p. 45, desc. of nymph; p. 131, figs. 39-43, mouth parts of nymph. (These nymphs "without locality label" could equally belong to the typical subspecies.)
1943. *Isogenoides frontalis* Hanson, Amer. Midland Nat. 29, p. 660, desc. of ♂ ♀; p. 667, fig. 3, ♂ genitalia; p. 668, figs. 17, 18, ♀ subgenital plate. (Not Newman.)

A comparison of specimens from say the Fraser River with those from Ungava would suggest that the form *colubrinus* is completely distinctive. The former have the angle of the genital hooks sharp and slightly acute (less than a right angle), whereas in the latter it is blunt and obtuse (about 135°). In the Mackenzie basin the typical hook has an angle slightly greater than 90°; i.e., is closest to *colubrinus*, but specimens occur in which the angle is quite obtuse, often *on one side only*. Similar asymmetrical specimens have turned up within the general range of *frontalis*; specifically, from northern Michigan and from Niagara Falls.

Males of *colubrinus* taken in the Rocky Mountain and Great Basin regions, from southern Utah to southern Alberta, are quite brachypterous; in the Coast and Cascade Mountains and northward their wings are only slightly shorter than those of the females. A similar situation exists in the species *Arcynopteryx parallela*.

DISTRIBUTION: Cordillera from southern Utah, Colorado and Oregon north to Alaska, east in Mackenzie and northern Alberta to the Mackenzie River, Great Slave Lake, and Lake Athabasca, and to the vicinity of The Pas, Manitoba.

Isogenus (Isogenoides) hansonii (new species)

1942. *Hydroperla dorata* Frison (in part), Bull. Illinois Nat. Hist. Surv. 22, pp. 295-96. Figures of the head and pronotum, male and female genitalia are *hansonii*; the nymph figured is *dorata*.
1943. *Isogenoides dorata* Hanson, Am. Midland Nat. 29, p. 665, desc. of ♂ 9; p. 668, fig. 8, head and pronotum; p. 667, fig. 4, ♂ genitalia; p. 668, figs. 14, 15, 9 subgenital plate.

MALE AND FEMALE: A description and figures of the adults of this species are available in Hanson's paper above. The inclusion of two species in Frison's original series of *dorata* is responsible for the confusion which exists in the use of that name. The holotype of *dorata* is a mid-western species, now illustrated on page 100, but Frison's 1942 drawings (except those of the nymph) are of the species here called *hansonii*. Dr. Hanson, relying upon the drawings, was naturally led to call his eastern specimens *dorata*.

The species *hansonii* is distinguished from *dorata* by having the posterior yellow spot on the head extend into the ocellar triangle, and by having the terminal hook of the supra-anal process much heavier and more curved.

NYPH: Length, 14-18 mm. when mature. Strikingly patterned with yellow and brown. Dorsal pattern as in figure 64; ventrally mostly yellow, but the subanal lobes have a broad brown stripe, and part of the sides of sternites 9 and 10 are brown. The mouth parts (Figs. 62, 63) are characterized by well-developed denticles along the edge of the major mandibular cusp.

Holotype ♂ and allotype ♀; Broadhead Creek, Analomink, Pennsylvania, April 23, 1939, Preston Jennings.

The adult specimens to follow are to be considered paratypes:

MARYLAND

Cabin John. April 28, 9, C. H. Curran (CNC).

NEW BRUNSWICK

Fredericton. June 24, 1934, 9, C. E. Atwood.

NEW YORK

Phoenicia. May 5, 1940, 2 ♂, Preston Jennings.
Schoharie. May 5, 1938, 9, Preston Jennings.
Neversink River, Claryville, el. 1,600 ft. June 2, 1940, 9, 1'. J. Jennings.
Esopus. April 27, 1935, 9, P. Jennings.

NORTH CAROLINA

Okonaluftee River, Smoky Mountains National Park, el. 1,500-2,500 ft.
April 21 to June 10, 1949, 4 exuviae, W. E. Ricker.

NOVA SCOTIA

Moose River near Parrishboro. June 20, 1950, exuvia, E. L. Bousfield.

PENNSYLVANIA

Same data as holotype. April 15, 1939, ♀; April 27, 1939, ♂

WEST VIRGINIA

Red Creek, near Dry Run Creek. April 30, 1944, 7 ♀, 3 exuviae, Edson and Ross.

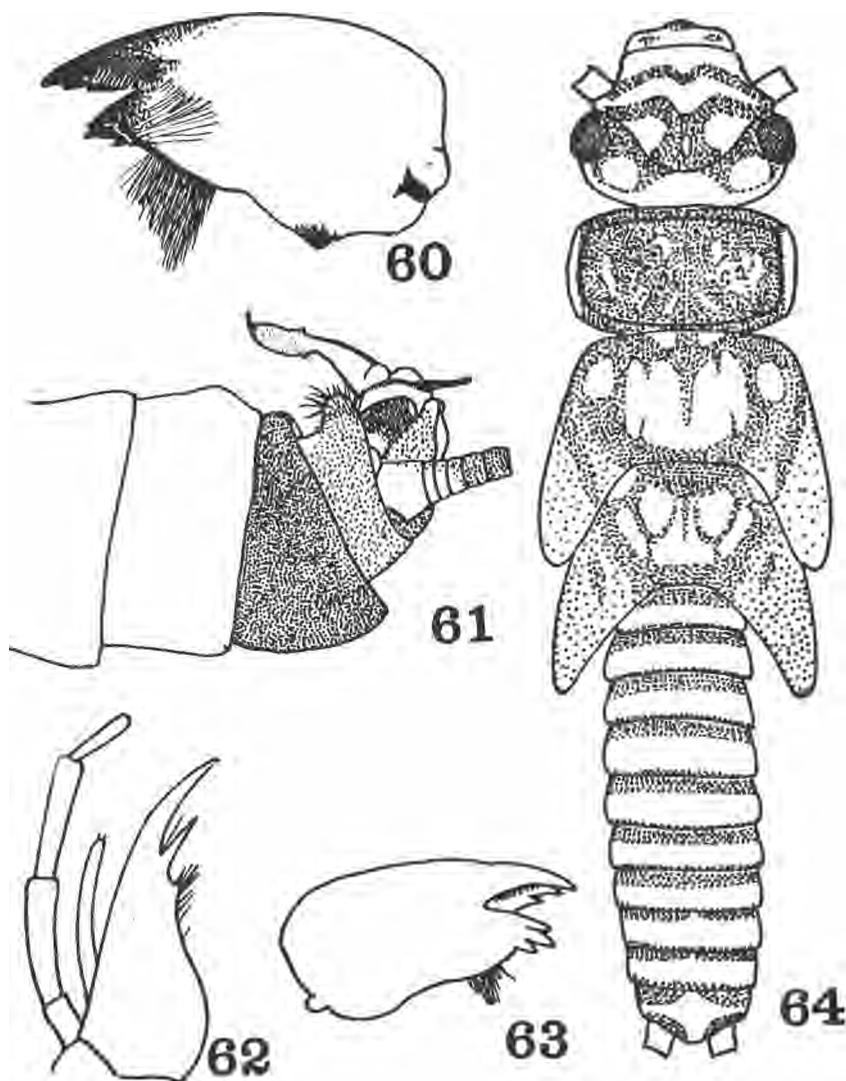
To these records are to be added those cited by Hanson (1943) from Amherst, Massachusetts, and Gatlinburg, Tennessee, under the name *dorata*.

The association of adult and nymphs is made fairly certain by the West Virginia collection.

Isogenus (Isogenoides) krumholzi (new species)

MALE: Length of body, 16 mm.; to tip of wings, 19 mm. Head brown except for a central yellow spot on the hind margin, which reaches forward nearly to the occipital suture. Pronotum a lighter brown than the head, with a broad yellow stripe. Meso- and metathorax mostly brown. Wings clear, except for a dusky spot around R_1 near the end of the Sc; 2-3 crossveins in the costal space, none behind it. Rs 4-branched.

Sternite 7 with a large distinct "nail"; tergite 9 not notched terminally. Tergites 5-8 only slightly swollen laterally. Tergite 8 somewhat elevated and swollen in its posterior half. Tergite 10 cleft, the posterior lobes of the cleft rounded, and bearing very long spinules (Fig. 61). Supra-anal process mostly membranous, with two anterior sclerotized bands curving outward and terminating about two-thirds way along the process. A single posterior sclerotized band runs the full length and ends



Isogenus elongatus. 60. Mandible of nymph; Yellowstone River, Park County, Montana.

Isogenus krumholzi. 61. Terminal segments of holotype ♂.

Isogenus hansonii (Red Creek, West Virginia). 64. Nymph. 62. Labium of nymph. 63. Mandible of nymph.

in a blunt terminal "spine"; and there are two small lateral projections on the posterior surface, about two-thirds way from the base. Lateral stylets slightly curved, blunt.

Holotype ♂: Walker's Bridge, Pine River, Lake County, Michigan, May 31, 1938, J. W. Leonard.

Paratype ♂: Hennepin County, Minnesota, May 11, 1920.

This species somewhat resembles the western *I. elongatus* in the shape of the supra-anal process; however, the long spines of the lobes of the 10th tergite are distinctive. Three nymphs taken September 2, 1949, from Lake Superior at Porcupine Mountain State Park, Michigan, might belong to this species. Their ventral mandibular cusps are coarsely serrate.

Isogenus (Isogenoides) olivaceus Walker

- 1852. *Perla (Isogenus) olivacea* Walker, Cat. Neurop., p. 146. Type locality: St. Martin's Falls, Albany River, Ontario.
- 1876. *Perla sulcata* Provancher, Naturaliste Canadien 8, p. 213. New Synonymy.
- 1938. *Perla olivacea* Ricker, Trans. Roy. Canad. Inst. 22(1), p. 142, desc. of ♂ ♀; pp. 154-55, figs. 20-24, genitalia of ♂, ♀.
- 1942. *Hydroperla olivacea* Frison, Bull. Illinois Nat. Hist. Surv. 22, pp. 296-98, desc. of nymph, figs. of ♀ and nymph.
- 1943. *Isogenoides olivaceus* Hanson, Am. Midland Nat. 29, p. 663, desc. of ♂ ; pp. 667-68, figs. 1, 2, 13, ♂ genitalia; fig. 14, ♀ subgenital plate.

The single specimen, a female, labeled *sulcata* by Provancher in the MPQ, is here designated lectotype.

DISTRIBUTION: Northern Wisconsin and Michigan ; Ontario and Quebec.

Isogenus (Isogenoides) varians Walsh

- 1863. *Perla varians* Walsh, Proc. Acad. Nat. Sci. Philadelphia 13, p. 364. Type locality: Rock Island, Illinois.
- 1925. *Perla varians* Needham and Claassen, Monogr. Plecop., p. 83, desc. of ♂ ♀; p. 17, fig. 3, wings. On page 325, figs. 11 and 12, of the ♂ and ♀ genitalia, are not clearly *varians*, and Frison (1935) notes that more than one species was included under this name by Needham and Claassen.
- 1935. *Hydroperla varians* Frison, Bull. Illinois Nat. Hist. Surv. 20, p. 426; p. 418, fig. 327, ♂ genitalia.
- 1937. *Hydroperla varians* Frison, *ibid.* 21, p. 82, desc. of nymph; figs. of head and pronotum, ♀ subgenital plate, and nymph.
- 1943. *Isogenoides varians* Hanson, Am. Midl. Nat. 29, p. 664, desc. of ♂ ♀; p. 667, fig. 5, ♂ genitalia; p. 668, fig. 19, ♀ subgenital plate.

This is a species of large rivers.

DISTRIBUTION: Southern Michigan, Indiana, and Illinois ; Tennessee and South Carolina.

Subgenus *Isogenus* sensu stricto

1833. *Isogenus* Newman, Ent. Mag. 1, p. 415. TYPE: *Isogenus nubecula* Newman.

1841. *Nephelium* Pictet, Perlides, p. 144 (subgenus).

SIZE: Medium to large.

COLOR: Dark.

VENATION: 4-5 crossveins in the costal space, usually none elsewhere.

SUBMENTAL GILLS: Present, rather short.

MESOSTERNUM OF IMAGO: The Y-shaped ridge runs from the posterior border of the sternum to the posterior end of each furcal pit ; joining the 2 pits anteriorly is a straight transverse ridge.

SUPRA-ANAL PROCESS: Rather slender, bluntly pointed, with a sclerotized band anteriorly and posteriorly, compressed fore-and-aft.

PARAGENITAL PLATES: Broadly rounded, swollen.

LATERAL STYLETS : Long, with expanded rounded tips.

SUBANAL LOBES: Moderately expanded and swollen.

VENTRAL LOBES: Absent from 8, and absent or only very vaguely indicated on 7.

SUBGENITAL PLATE: Much produced, broadly excavated.

NYMPHAL MAXILLA: Major cusp one-third as long as the whole lacinia ; mesal edge having hairs along on its outer half, with a tuft of spinules anteriorly set on an angle opposite the major spines.

SPECIES

**Isogenus nubecula* Newman. Europe.

Subgenus *Kogotus* (new)

SUBGENOTYPE : *Perla nona* Needham and Claassen.

SIZE: Moderate to small.

COLOR: Yellowish to dark brown.

VENATION: Usually no apical crossveins beyond the costa.

SUB MENTAL GILLS: Indistinguishable.

MESOSTERNUM OF IMAGO: Typical.

MESOSTERNUM OF NYMPH: Similar, but with the transverse bar absent.

SUPRA-ANAL PROCESS: Subacute, with the tip of the anterior band coiled inside it.

PARAGENITAL PLATES: Produced and subacute.

LATERAL STYLETS: Absent.

SUBANAL LOBES: Somewhat expanded.

VENTRAL LOBES: Strong on 7th, absent from 8th.

SUBGENITAL PLATE: Long, rounded.

MAXILLA: Unicuspid, lacking hairs and spinules.

DISTRIBUTION: Cordilleran North America.

The most distinctive feature of this group is the supra-anal process, in which the anterior sclerotized band is considerably longer than the rest of the process, but is normally directed down into and is coiled inside the process. Probably it becomes uncoiled and is used as a probe in coitus.

MALES AND FEMALES

Median yellow pronotal stripe sharply marked off from the dark disk ; projecting tip of the paragenital plate slightly longer than the length of the shortest cereal segment *nonus*

Median pronotal stripe diffusely confluent with the darker disk ; projecting tip of the paragenital plate less than half as long as the shortest cereal segment *modestus*

Isogenus (*Kogotus*) *modestus* Banks.

1908. *Perla modesta* Banks, Trans. Amer. Ent. Soc. 34, p. 255. Type locality: Boulder, Colo.
1925. *Perla modesta* Needham and Claassen, Monogr. Plecop., p. 88, desc. of ♂ 9; p. 315, fig. 1, venation; p. 325, figs. 16-19, ♂ and ♀ genitalia.
1931. *Perla expansa* Claassen, Plecop. Nymphs, p. 55. (Not *expansa* Banks.)
1942. *Diploperla modesta* Frison, Bul. Illinois Nat. Hist. Surv. 22, pp. 303-5, desc. of nymph, figures of nymph and mouth parts.

DISTRIBUTION: Interior cordilleran ranges from southern British Columbia to New Mexico.

Isogenus (*Kogotus*) *nonus* Needham and Claassen

1925. *Perla nona* Needham and Claassen, Monogr. Plecop., p. 86, desc. of ♀ 9; p. 325, fig. 21, ♀ subgenital plate. Type locality: Corvallis, Oregon.
1937. *Perla nona* Claassen, J. Kansas Ent. Soc. 10, p. 49, desc. of ♂ p. 51, figs. 5, 14, genitalia of ♂

The two species *modestus* and *nomus* are closely allied and may later be found to intergrade. I cannot certainly distinguish the nymphs, although *nomus* has the pronotum mostly dark with a central light stripe, whereas in *modesta* the disc is flecked with yellow. The genitalia of *nomus* are shown in figures 65-67.

DISTRIBUTION: Coast and Cascade ranges from southern British Columbia to Oregon.

Subgenus Malirekus (new)

SUBGENOTYPE: *Isogenus hastatus* Banks.

SIZE: Medium to large.

COLOR: Brown.

VENATION: 2-4 apical crossveins in the costal space, 0-1 behind it.

SUBMENTAL GILLS: Short, conical.

MESOSTERNUM OF IMAGO AND NYMPH: Typical.

♂ 10TH TERGITE: Cleft completely, lobes subtriangular.

SUPRA-ANAL PROCESS: Flattened, blunt, very hairy.

PARAGENITAL PLATES: Normal.

LATERAL STYLETS: Rather broad, hooked at the tip.

SUBANAL LOBES: Much expanded.

VENTRAL LOBES: Broad and distinct on 7, not evident on 8.

SUBGENITAL PLATE: Much produced, shallowly excavated.

NYMPHAL MAXILLA: Similar to *Isogenoides*; spines of the lacinia rather short, a blunt angular projection opposite the origin of the spines; mesal hairs numerous.

DISTRIBUTION: Eastern North America.

Isogenus (Malirekus) *hastatus* Banks

1920. *Isogenus hastatus* Banks, Bull. Mus. Comp. Zool. 64, p. 314. Type locality: Andrews, North Carolina.

1925. *Perla hastata* Needham and Claassen, Monogr. Plecop., p. 84, desc. of ♂, 9; p. 313, fig. 2, wings; p. 17, figs. 1-3, ♂ and ♀ genitalia.

1931. *Perla hastata* Claassen, Plecop. Nymphs, p. 55, desc. of nymph; p. 131, figs. 33-38, mouth parts of nymph; p. 155, fig. 188, and p. 191, fig. 230, nymph.

This is an abundant species of small Appalachian streams.

DISTRIBUTION: Gaspé region, New York, and New England to South Carolina, Georgia, and eastern Tennessee.

Subgenus *Osobenus* (new)

SUBGENOTYPE and only known species : *Perla yakimae* Hoppe.

SIZE: Small.

COLOR: Yellowish.

VENATION: 2 apical crossveins in costal space, none behind.

SUBMENTAL GILLS: Absent.

MESOSTERNUM OF IMAGO: The arms of the Y-ridge meet the anterior corners of the furcal pits ; transverse ridge present.

A deep groove runs from the posterior end of each furcal pit to the fork of the Y; its base seems somewhat thickened but it lacks extra sclerotization.

♀ 10TH TERGITE: Completely cleft ; lobes erect, subacute.

SUPRA-ANAL PROCESS: Bulky and of complex structure, acutely pointed.

PARAGENITAL PLATES: Normal.

LATERAL STYLETS: Short, broad, and blunt, lying anterior (dorsal) to the process.

SUBANAL LOBES: Present on 7, absent from 8.

VENTRAL LOBES: Little modified.

SUBGENITAL PLATE: Much produced, rounded.

NYMPH: Unknown.

DISTRIBUTION: Central cordillera of North America.

Isogenus (*Osobenus*) *yakimae* Hoppe

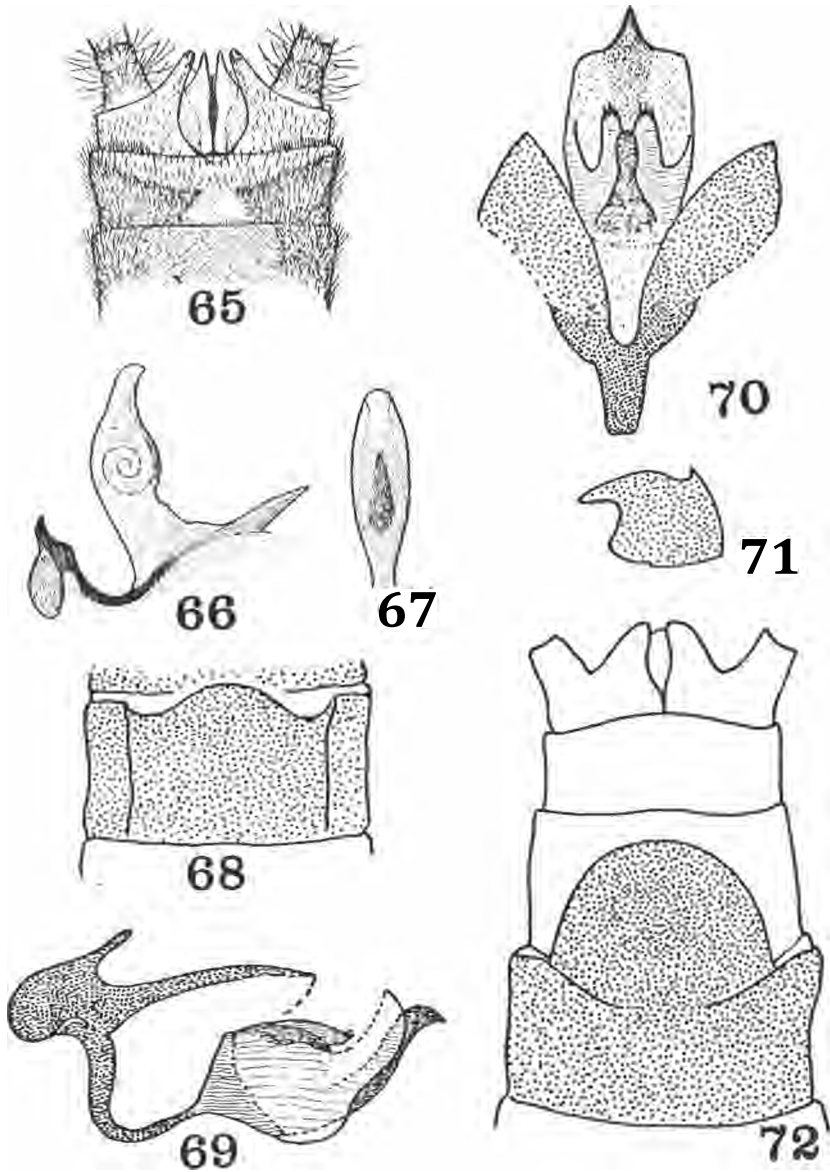
1938. *Perla yakimae* Hoppe, Univ. Washington Publ. Biol. 4, p. 150, desc. of ♀; p. 171, figs. of ♂ genitalia. Type locality: Yakima, Washington.

MALE: Length of body, 11 mm., to tip of wings, 13 mm. New figures of the genitalia are presented (Figs. 68-71). The supra-anal process has a rather complex structure, almost impossible to illustrate satisfactorily. Two cylindrical dorsal lobes, tipped by a few spines, may be homologous with the lateral stylets of other subgenera, though their position is unusual.

FEMALE: Length of body, 12 mm.; to tip of wings, 15 mm. Color yellowish brown with a broad yellow pronotal stripe, as in the male. Subgenital plate rounded, produced over most of the 9th sternite, marked off from the 8th sternite by lateral grooves (Fig. 72).

Neallotype ♀ : Wenatchee River, Cashmere, Washington, July 10, 1936, H. H. Ross. Another ♂ and a ♀ were taken at the same time.

DISTRIBUTION: Central Washington.



Isogenus nonis (Siletz River, Oregon). 65. Terminal tergites of ♂. 66. Supra-anal process, from the left side. 67. The same, from in front. *Isogenus yakimae* (Wenatchee River, Washington). 68. 7th sternite of ♂. 69. Supra-anal apparatus, from the side. 70. The same, from above. 71. Left half of the 10th tergite. 72. Terminal sternites of ♀.

Subgenus *Pictetia* Banks

1947. *Pictetia* Banks, Psyche 54, p. 281. GENOTYPE: *Perla expansa* Banks.

SIZE: Large.

COLOR: Light brown.

VENATION: 2-4 apical crossveins in the costal space, 2-5 behind it.

SUBMENTAL GILLS: Short ; about as long as wide.

MESOSTERNUM OF IMAGO: Typical except that the transverse ridge is interrupted at the middle.

MESOSTERNUM OF NYMPH: Similar, but the transverse ridge is absent.

10TH TERGITE : A broad membranous area anteriorly, the supra-anal apparatus set halfway back on the segment ; lobes rounded, hairy, and spinulose.

SUPRA-ANAL PROCESS: Rather broad and flattened, narrowing to a slender blunt tip ; sclerotized along a single strip behind and along 2 in front.

PARAGENITAL PLATES: Normal.

LATERAL STYLETS : None.

SUBANAL LOBES: Somewhat produced and swollen, covered with fine appressed hairs similar to those on the supra-anal process.

VENTRAL LOBES: No material available.

SUBGENITAL PLATE: Broad, much produced, entire.

NYMPHAL MAXILLA: Rather typical, without an angular projection on the mesal surface near the origin of the lesser spine ; mesal hairs numerous.

DISTRIBUTION: Southern Rocky Mountain region.

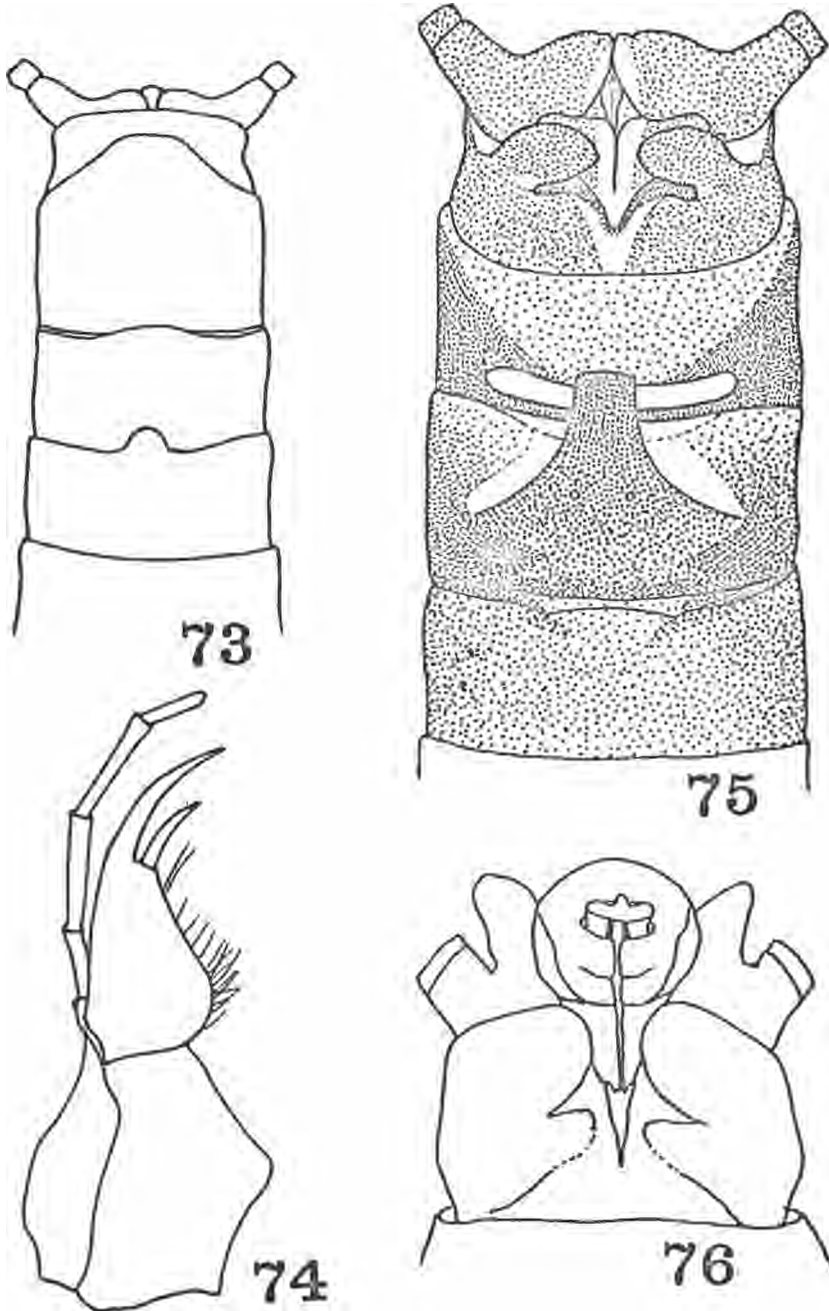
Isogenus (*Pictetia*) *expansus* Banks.

1920. *Perla expansa* Banks, Bull. Mus. Comp. Zool. 64, p. 317, 9. Type locality: Grant, Colorado.

1925. *Perla expansa* Needham and Claassen, Monogr. Plecop., p. 81, desc. of ♂ 9; p. 313, fig. 7, wings; p. 325, figs. 4-6, ♂ ♀ genitalia (♂ possibly incorrectly associated).

1931. *Perla expansa* Claassen, Plecop. Nymphs, p. 55, incorrect nymphal association.

MALE: A nymph collected by Dr. Frison from Coal Creek, Wilson, Wyoming, August 12, 1940, shows much of the adult structure, and in adult color pattern agrees very well with *expansus* females. The supra-anal process is transversely flattened, mostly membranous and covered by fine appressed hairs, sclerotized along two bands anteriorly and one posteriorly. Its



Isogenus nihkoensis (Ogawa, Shinano Province, Japan). 73. Terminal segments of ♂, from below. 75. The same, from above.
Isogenus expansus (Wilson, Wyoming). 74. Maxilla of nymph. 76. Terminal tergites of ♂, dissected from nymphal skin.

tip is slender, blunt, unsclerotized, and apparently points backward. The paragenital plates have a transverse groove anterior to the emergence of the supra-anal process (though this might disappear in a mature imago) and the cowl has appressed hairs near and posterior to the emergence of the supra-anal process. The subanal lobes are similarly covered on their medial surfaces. Figure 76 shows the dorsal aspect, but it should be remembered that the proportions might differ after emergence.

NYMPH: Color brown, not very strikingly patterned. The ocellar triangle, M-line, front of head, and lateral tubercles are light ; there is a reticulate spot near each eye, and the pronotum is reticulately marked. Abdominal segments are spinulose on their posterior half and are marked with darker pigment in a narrow band near the anterior margin, which, however, is interrupted medially. The maxilla (Fig. 74) lacks a knob but its mesal margin is hairy.

DISTRIBUTION: Colorado and Wyoming.

Subgenus *Remenus* (new)

SUBGENOTYPE and only known species : *Perk bilobata* Needham and Claassen.

SIZE: Small.

COLOR: Light.

VENATION: 2 crossveins in costal space, none behind it.

SUBMENTAL GILLS: Absent.

MESOSTERNUM OF IMAGO: Typical.

MESOSTERNUM OF NYMPH: Similar, but with the transverse ridge absent.

♂ **10TH TERGITE:** Cleft for only a third of its length, posteriorly ; lobes very short, rounded, scarcely spinulose.

SUPRA-ANAL PROCESS: Weakly sclerotized, cylindrical near the tip, and terminating in a long thread-like lash.

PARAGENITAL PLATES: Short, flap-like, free from the cowl which encloses the basal part of the supra-anal process.

LATERAL STYLETS: None.

SUBANAL LOBES: Not enlarged.

VENTRAL LOBES: Well developed and produced on both segments, the 8th much smaller than the 7th.

SUBGENITAL PLATE: Moderately produced, rounded.

NYMPHAL MAXILLA: Lacinia unicuspid, the broad basal part very short, mesal hairs absent.

DISTRIBUTION: Appalachian region of North America.

Isogenus (*Remenus*) *bilobatus* Needham and Claassen

1925. *Perla bilobata* Needham and Claassen, Monogr. Plecop., p. 95, desc. of ♂ 9 ; p. 319, fig. 7, wings; p. 327, figs. 1-3, ♂ 9 genitalia. Type locality: Old Forge, New York.
1931. *Perla bilobata* Claassen, Plecop., Nymphs, p. 54, desc. of nymph; p. 133, nymphal mouth parts.
1942. *Diploperla bilobata* Frison, Bull. Illinois Nat. Hist. Surv. 22, p. 302, figs. of nymph and mouth parts.

DISTRIBUTION: New York to the Carolinas and Georgia.

Subgenus *Yugus* (new)

SUBGENOTYPE: *Diploperla bulbosa* Frison.

SIZE: Medium to large.

COLOR: Light or dark brown.

VENATION: 1-3 apical crossveins in the costal space ; 1-3 behind it.

SUBMENTAL GILLS: Absent.

MESOSTERNUM OF IMAGO: Typical.

MESOSTERNUM OF NYMPH: Similar, but the transverse ridge is difficult to recognize except at the sides.

♂ 10TH TERGITE: Only the posterior third is cleft ; the lobes are much produced rearward.

SUPRA-ANAL PROCESS: Well developed, the tip slightly or considerably recurved.

PARAGENITAL PLATES: Normal, sclerotized.

LATERAL STYLETS: Absent.

VENTRAL LOBES: Indistinct or distinct on both the 7th and 8th sternites.

SUBGENITAL PLATE: Much produced, rounded, usually slightly or considerably excavated.

NYMPHAL MAXILLA: Lacinia with 2 teeth, a hairy mesal margin, and a knob bearing a tuft of hairs near the origin of the teeth.

DISTRIBUTION: Southern Appalachian region of North America.

MALES AND FEMALES

Color contrasting brown and yellow, with large lateral yellow spots on the disc of the pronotum ; tip of the supra-anal process slender, acute, transversely flattened ; subgenital plate with only a minute terminal notch *arinus*

Color uniform light brown, almost without pattern ; tip of the supra-anal process rounded, subcylindrical ; subgenital plate usually with a terminal excavation at least as wide as one-sixth of the sternite *bulbosus*

NYMPHS

Knob of the lacinia situated immediately opposite the origin of the spines (teeth) ; dorsal color largely light (Frison, 1942, p. 311) □ □ □ □ □

Knob of the lacinia situated some distance below the origin of the spines ; dorsal color largely streaked (*ibid.* p. 309) *bulbosus*

Isogenus (*Yugus*) *arinus* Frison

1942. *Diploperla arina* Frison, Bull. Illinois Nat. Hist. Surv. 22, pp. 309-11, desc. and figs. of ♂, ♀, and nymph. Type locality: Balsam, North Carolina.

DISTRIBUTION: Mountains of North Carolina, Tennessee, and Georgia.

Isogenus (*Yugus*) *bulbosus* Frison

1942. *Diploperla bulbosa* Frison, Bull. Illinois Nat. Hist. Surv. 22, pp. 307-9, desc. and figs. of ♂, ♀, and nymph. Type locality: Greenbrier Cove, Tennessee.

DISTRIBUTION: Mountains of North Carolina, Tennessee, and Georgia.

Subgenus *Stavsolus* (new)

SUBGENOTYPE: *Isogenus japonicus* Okamoto.

SIZES Medium.

COLOR: Medium brown.

VENATION: 3-4 apical crossveins in the costal space ; usually 1, sometimes 2, beyond.

SUBMENTAL GILLS: Rather short; length about twice their width; tapered, subacute.

OTHER GILLS: Absent.

MESOSTERNUM OF IMAGO: Branches of the Y-ridge meet the sides of a sclerotized patch bordering the furcal pits, and can be traced along its anterior border to the anterior corner of each pit. Transverse ridge fairly well developed, sometimes with 2 small parallel ridges.

MESOSTERNUM OF NYMPH: Like the imago, except that the transverse ridge is absent.

♂ 10TH TERGITE: Cleft, the lobes triangular, blunt, little sclerotized, set off by an unsclerotized area at the base.

OTHER TERGITES: Posterior margin of 9 membranous.

SUPRA-ANAL PROCESS: With an anterior sclerotized band terminating in a strong decurved hook; the basal body large and broadly exposed dorsally.

PARAGENITAL PLATES: Rather large, dark in color and strongly sclerotized; very little covered by the 10th tergite.

LATERAL STYLETS: Large, partly membranous, broadly rounded and sclerotized at the tip.

SUBANAL LOBES: Considerably produced.

VENTRAL LOBES: Well marked on 7, and quite distinct on 8.

SUBGENITAL PLATE: Much produced, rounded.

NYMPHAL MAXILLA: Two-cusped; major cusp one-half of the total lacinial length; mesal margin of the lacinia lacking hairs or spinules, without any knob opposite the origin of the spines.

DISTRIBUTION: Japan.

SPECIES

***Isogenus japonicus* Okamoto 1912, Trans. Sapporo Nat. Hist. Soc. 4, p. 110. The male and nymph of this species were recently described and illustrated by Kohno (Trans. Kansai Ent. Soc. 9 (2) : 12-17, 1941).

Subgenus *Ostrovus* (new)

SUBGENOTYPE: *Isoperla mitsukonis* Okamoto and Kohno.

SIZE: Small.

COLOR: Rather dark brown.

VENATION: 2-4 apical costal crossveins; none behind R_1 .

SUBMENTAL GILLS: Absent.

MESOSTERNUM OF IMAGO: Branches of the Y-ridge short; transverse ridge present.

MESOSTERNUM OF NYMPH: Branches of the Y-ridge weak, but apparently extending to the posterior corners of the furcal pits; transverse ridge absent.

♂ 10TH TERGITE: Shallowly cleft, the lobes distinct, thumb-like, constricted at the base.

OTHER TERGITES: A backwardly-directed truncate process on 8; a process sometimes present on 7 as well.

SUPRA-ANAL PROCESS: With a central sclerotized plate, and a membranous expansion on the outer part.

PARAGENTAL PLATES: Rather short.

LATERAL STYLETS: Absent.

SUBANAL LOBES: Considerably produced.

VENTRAL LOBES: Lobe on 7 rather narrow, sometimes considerably produced over 8; lobe on 8 absent or, at most, slightly suggested.

SUBGENITAL PLATE: Broadly produced and subtruncate.

NYMPHAL MAXILLA: Major spine half as long as the whole lacinia; hairs absent.

DISTRIBUTION: Japan.

SPECIES

***Isogenus (Ostrovus) mitsukonis* Okamoto and Kohno, in Kohno, Mushi 13, 1940 (*Isoperla*), Fukuoka, Japan.

**Isogenus (Ostrovus) nikkoënsis* Okamoto, Trans. Sapporo Nat. Hist. Soc. 4, p. 114.

The male of this species has apparently not been described. A male in the INHS collection from Ogawa, southern part of Shinano Province, Japan, collected by M. Uéno in June, 1930, is identical in color, etc., with two females from Kamikochi, July 16, 1935, collected by Mitsuko Kohno, and determined by her as *nikkoënsis*. The Ogawa specimen is described here as the probable male of *nikkoënsis*:

Length of body, 11 mm.; to tip of wings, 15 mm. Color dark brown varied only by a small yellow spot just outside of each ocellus, and a narrow dark line in the anterior and posterior pronotal grooves. Both wings dark smoky, but with the costal space yellow as far as the cord. Venation similar to *I. mitsukonis*.

Sternites normal to the 7th, which has a median lobe produced over 8 (Fig. 73). The 8th tergite has a very broad termi-

nal lobe, not easily distinguishable. The 9th is long, produced over part of 10, and square-tipped. The 10th is short, and its posterior third is light colored and weakly sclerotized. The tergites (Fig. 75) are normal to the 7th, which has a broad inconspicuous terminal lobe. On the 8th there is a large truncate process which projects over onto 9, very reminiscent of the dorsal process of *Leuctra tenuis*. Tergite 9 has a narrow band of very weak sclerotization near the anterior border. Tergite 10 is cleft, but incompletely so; the sides of the cleft are developed into thumb-like lobes. Paragenital plates are short, not covering the whole of the supra-anal process, which is shielded posteriorly by the expanded subanal lobe. The supra-anal process consists of a deep, sclerotized median support with membranous lateral expansions dorsally. Lateral stylets are absent.

Tadamus (new subgenus)

SUBGENOTYPE: *Isogenus kohnonis* Ricker (= *Hydroperla japonica* Kohno).

SIZE: Medium.

COLOR: Brown with small yellow marks.

VENATION: 1 or 2 crossveins in the costal space; usually none posterior to it.

SUBMENTAL GILLS: Slender, about 3 times as long as broad.

MESOSTERNUM OF IMAGO: Arms of the Y-ridge meet the posterior corners of the furcal pits; transverse ridge region light in color, but without extra sclerotization; an oblong sclerotized area bordering each furcal pit.

MESOSTERNUM OF NYMPH: S₁ □ □ □ □ , but the transverse ridge region is not demark ated.

♂ **10TH TERGITE:** Completely cleft, the lobes rounded and projected somewhat posteriorly.

OTHER TERGITES: Normal.

SUPRA-ANAL PROCESS: □ Outer portion somewhat swollen, and membranous except for an anterior and posterior sclerotized band, the latter of which reaches the tip.

PARAGENITAL PLATES: Rather small, sclerotized near the tip.

LATERAL STYLETS: Slender, sclerotized, subacute.

SUBANAL LOBES: Somewhat swollen.

VENTRAL LOBES: Distinguishable as an area of light pigment at the margins of sternites 6, 7, and 8.

SURGENTAL PLATE: Considerably produced, the margin transverse with broadly-rounded corners.

NYMPHAL MAXILLA: Narrowly tapered, the major spine about a third of the total length ; a small tuft of bristles near the origin of the spines ; mesal margin hairy.

DISTRIBUTION: Japan.

"*Isogenus* (*Tadamus*) *kohnonis* (new name)

1946. *Hydroperla japonica* Kohno, Collecting and Breeding (Japan), vol. 8, no. 2, pp. 30-34 (in Japanese).

This species of Mrs. Kohno's is an *Isogenus* in the broad sense, and hence her name is preoccupied by *Isogenus japonicus* Okamoto 1912. The characterization of the subgenus *Tadamus* applies equally to the species *kohnonis*. *Tadamus* is closest to *Hydroperla* among the American subgenera, but differs in having well-marked lobal areas on ♂ sternites in having the subanal lobes little expanded, a different type of supra-anal process, and a somewhat different mesosternal ridge pattern.

NORTH AMERICAN ISOGENUS SPECIES OF UNCERTAIN
RELATIONSHIP

***Isogenus alameda* Needham and Claassen**

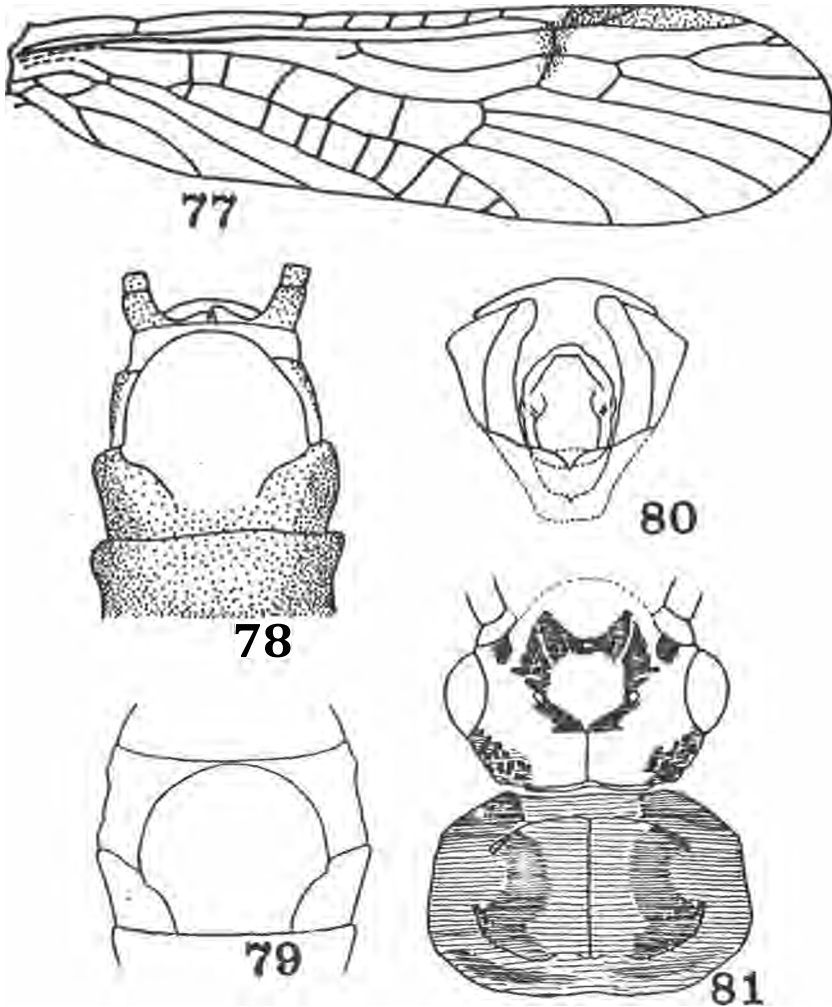
1925. *Perla alameda* Needham and Claassen, Monogr. Plecop., p. 78, desc. of ♂; p. 315, fig. 2, wings; p. 327, fig. 4, ♂ genitalia. Type locality: Alameda County, California.

The exact appearance of this species is obscure because the holotype male is in poor condition. The supra-anal process give some appearance of a coiled tip, which would suggest *Kogotus*, but the paragenital plates are not produced.

***Isogenus innubilis* Needham and Claassen**

1925. *Perla innubila* Needham and Claassen, Monogr. Plecop., p. 77, desc. of ♀; p. 315, fig. 6, wings; p. 325, fig. 20, ♀ subgenital plate. Type locality: North Carolina.

FEMALE: Length of body, 12 mm.; to tip of wings, 17 mm. Color yellowish brown, with the **lateral ocelli joined to the anterior one** by vaguely darker bands, and the ocellar triangle quite light. There is also a suggestion of a light median pronotal



Isogenus innubilis (Gatlinburg, Tennessee). 77. Forewing. 78. Terminal sternites of ♀.

Isogenus alameda. 80. Supra-anal apparatus of holotype ♂.

Isogenus sorptus. 79. Terminal sternites of holotype ♂. 81. Head and pronotum of holotype ♂.

stripe, broadening rearward. The wings are rather clear, but with a dark spot in the costal space and adjacent part of the cord. Vein R_s has 4 or 5 branches in the forewing, and the crossveins in the costal space vary from 2 to 4. In 2 specimens from Tennessee the vein A_2 leaves the anal cell with a common

branch and forks beyond it ; however, this is not true of the holotype. There is a tendency to develop spur veins having free ends: one is present in all the forewings on Rs just posterior to its origin from R. Others occur irregularly, for example from Rs in a more distal position. The subgenital plate (Fig. 78) is long and rounded.

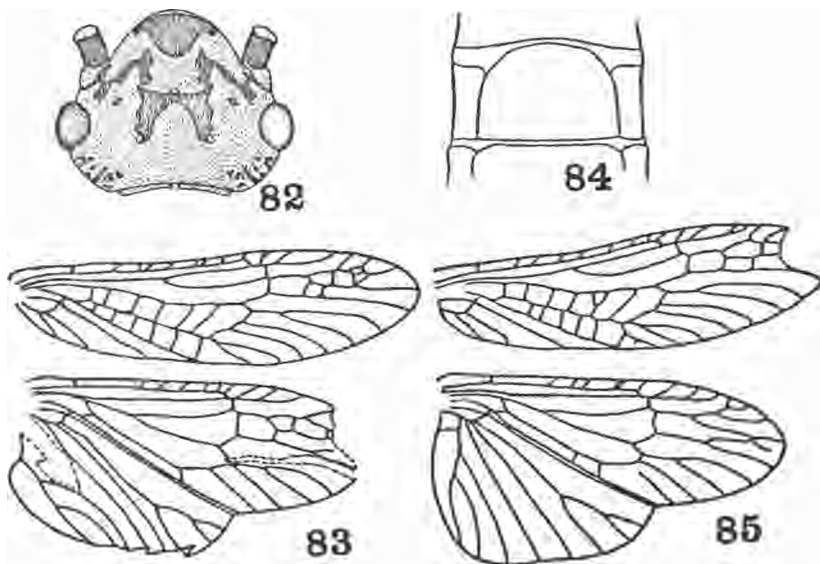
Without a male, the relationships of this species cannot be exactly determined, but its general appearance is very close to *I. (Yugus) bulbosus*. A spur vein below the origin of R_{3+4} is present in occasional specimens of other *Isogenus*, for example *I. decisus*.

DISTRIBUTION: Mountains of North Carolina and Tennessee.

Isogenus nubes Pictet

1841. *Isogenus (Nephelion) nubes* Pictet, Perlides, p. 174. Type locality: America.

This species might be any one of several now known, and as the type has been lost, the name must be considered unrecognizable. Even the generic placement is uncertain.



Isogenus phaleratus (holotype ♀). 82. Head. 84. Subgenital plate. 83, 85, Wings.

Isogenus phaleratus Needham

1917. *Dictyogenus* (?) *phaleratus* Needham, in Smith, Trans. Am. Ent. Soc. 43, p. 485. Type locality: New Mexico.
 1925. *Perla phalerata* Needham and Claassen, Monogr. Plecop., p. 91, desc. of ♀; p. 325, figs. 9-10, 9 subgenital plate and egg.

This species is known only from the type, whose striking head pattern will make it easy to associate it with new material when it becomes available (Fig. 82). The variable venation of the holotype is illustrated in figures 83 and 85. The species may well belong in *Isoperla*.

Isogenus sorptus Needham and Claassen

1925. *Perla sorpta* Needham and Claassen, Monogr. Plecop., p. 90, desc. of ♂; p. 315, fig. 4, wings; p. 341, fig. 10, 9 plate. Type locality: Sequoia National Park, California.

Figures 81 and 79 show the head and subgenital plate of the holotype.

DISTRIBUTION: Oregon and California.

EXOTIC ISOGENUS OF UNCERTAIN RELATIONSHIP

- Isogenus nakaharae* Okamoto 1912, Japan.
Isogenus scriptus Klapálek 1912, Japan.
Isogenus sibiricus Navás 1930, Kamchatka.
Isogenus servillei Pictet 1841, from Egypt, can scarcely belong in *Isogenus* as now understood.

Genus *Pseudomegarcys* Kohno

1946. *Pseudomegarcys* Kohno, Collecting and Breeding (Japan) 8(3), p. 58 (in Japanese). GENOTYPE and only known species: **Pseudomegarcys japonicus* Kohno, *ibid.*, 1946.

SIZE: Body length of ♂, 13 mm.; of ♀, **18 mm.**

COLOR: Dark brown with yellow markings.

HEAD: The head capsule is considerably elongated behind the **eyes.**

VENATION: 2-3 apical crossveins in the costal space, 0-5 posterior to it, back as far as the intercubital position; the proximal M-Cu and intercubital crossveins of the forewing are much reduced in number, sometimes to only one **each**; in the hind-

wing the anal field is broad and extends almost to the tip of the wing.

MESOSTERNUM OF IMAGO: Arms of the Y-ridge meet the anterior corners of the furcal pits. Transverse ridge absent, though there is a faint line of pigment somewhat anterior to the usual position for the ridge.

MESOSTERNUM OF NYMPH: Like the imago ; no trace of a transverse ridge.

GILLS: Entirely absent.

♂ **10TH TERMITE:** Broadly cleft, with a slender erect process from each posteromesal corner.

OTHER TERGITES: The lateral corners of tergites 4-9 are swollen, especially 6 and 7.

SUPRA-ANAL PROCESS: Cylindrical and completely sclerotized near the tip ; more proximally there is a plate-like anterior projection.

PARAGENITAL PLATES: Normal ; the sclerotized strip is narrow and proximally is quite black.

LATERAL STYLETS: Flat, rounded at the tip, and sclerotized.

SUBANAL LOBES: Little enlarged.

VENTRAL LOBES: None.

SUBGENITAL PLATE: Narrowly produced and deeply excavated, so that the produced portion consists merely of 2 slender lobes.

NYMPHAL MAXILLA: Major spine almost half as long as the whole lacinia ; a broad angular shoulder present opposite the origin of the 2 spines ; shoulder and mesal margin densely lined with spinules and hairs.

NYMPHAL MANDIBLE: No serrations present on the cusps.

DISTRIBUTION: Japan.

It should be noted that *Pseudomegarcys* is here ascribed to Kohno, in case this should prove to be its first description in a western language.

Subfamily PERLODINAE

The subfamily Perlodinae has developed from Isogeninae, the principal change being the loss of the supra-anal apparatus. Because a terminal network of crossveins persists in two of the genera, the ancestral form almost certainly was an offshoot of *Arcynopteryx* rather than of *Isogenus*; further, it was from the more primitive type of *Arcynopteryx* in which the shift of the mesosternal Y-ridge had not occurred and in which the trans-

verse ridge had not yet developed. In *Perlodes* the transverse mesosternal ridge is completely absent in nymph and adult; in *Skobeleva* it is absent in the imago at least; in *Diura* it is absent in subgenus *Dalkrila*, but it is well developed in the imago of the typical subgenus and weakly developed in its nymph. Almost all of the gills of the ancestral *Arcynopteryx* have been lost: submental gills are quite distinct, though short, in *Perlodes*, *Skobeleva*, and *Dalkrila*, but are not distinguishable in *Diura* s.s. No information is available concerning gills or mesosternum of *Perlodinella*.)

Perlodes is the most primitive perlodine. From it has developed on the one hand *Dalkrila* and then *Diura* s.s.; another line has produced *Skobeleva* and then *Perlodinella*. The two latter groups might perhaps be better included in a single genus, but their structure is imperfectly known.

Sexual specificity among the Perlodinae is most apparent in the modifications of the subanal lobes, which are produced inward and then backward, meeting along their inner edges. The two posterior male tergites are provided with spinules, and in *Skobeleva* and *Perlodinella* the 10th is much elevated. Female subgenital plates are rather briefly produced, and often notched or excavated.

Further study of Old World Perlodinae might suggest that some of the nominal genera would be better regarded as subgenera.

KEY TO GENERA AND SUBGENERA males

- 1 Hind margin of the 10th tergite much elevated and spinulose along the margin Fig. 88 2
 - Hind margin of the 10th tergite normal, spinules present elsewhere than along the margin 3
- 2(1) Apical network of crossveins present; subanal lobes lacking a posterior subterminal notch
 - genus *Skobeleva* p. 139
 - Apical crossveins absent, except in the costal space; subanal lobes long, erect, with a small posterior subterminal notch genus *Perlodinella* p. 138
- 3(1) Apical network of crossveins present; subanal lobes equal to less than half the median length of the 10th tergite
 - genus *Perlodes* p. 134

- Apical crossveins absent or nearly so; subanal lobes
 about as long as the 10th tergite . genus *Diura* 4
- 4(3) Males brachypterous; transverse mesosternal ridge
 present subgenus *Diura* s.s. (p. 136)
 Males long-winged ; transverse mesosternal ridge
 absent subgenus *Dolkerila* (p. 138)

Genus *Perlodes* Banks

Dictyopteryx Pictet, *Perlides*, p. 149 (in part). GENOTYPE: *Perla microcephala* Pictet (Europe).

Perlodes Banks, *Canad. Ent.* 38, p. 223 (in part); new name.

SIZE: Rather large.

COLOR: Dark.

VENATION: 3-4 apical crossveins in the costal space and 2-4 between C and R_{1+2} , the latter group often slanted and irregular; usually none posterior to R_{1+2} . Males often brachypterous.

SUB MENTAL GILLS: Short.

MESOSTERNUM OF IMAGO: Transverse ridge not developed, though its position is marked by a hairless band across the sternum; Y-ridge joined to the posterior corners of the furcal pits.

MESOSTERNUM OF NYMPH: Similar, the transverse ridge completely unrecognizable.

♂ **10TH TERGITE:** Little produced posteriorly, entire, bearing a central patch of spinules.

SUPRA-ANAL APPARATUS: Absent.

SUBANAL LOBES: Produced mesally and then backward, meeting along their mesal surfaces ; the produced length about equal to the length of the 2 proximal tarsal segments.

VENTRAL LOBES: Absent.

SUBGENITAL PLATE: Moderately produced, rounded or excavated.

NYMPHAL MAXILLA: Rather narrow, major spine somewhat less than one-third of the total lacinial length, minor spine well developed, other spines or hairs usually absent. (Küthreiber, 1934, shows a few close to the minor spine in *P. intricata*).

NYMPHAL MANDIBLES: Major cusp not serrate.

DISTRIBUTION: Europe and northern Asia, to Japan.

The above description is based on specimens of *Perlodes mor-toni*, *P. jurassica*, *P. microcephala*, and *P. frisonana*.

SPECIES

The following list of described species is largely from Claassen (1940). Doubtless it includes many synonyms, and generic placement may not always be correct.

- Perlodes anisoptera* Navás 1923, Siberia.
Perlodes arnauzi Navás 1914, Spain.
Perlodes bicolor Navás 1909, Madrid, Spain.
Perlodes brevipennis Navás 1936, Szechuan, China.
Perlodes cadevallii Navás 1922, Catalufia, Spain.
Perlodes debilior Navás 1936, Kansu, China.
Perlodes dispar Rambur 1842. Europe.
Perlodes festoi Navás 1932, Padola.
Perlodes fonti Navás 1917, Catalufia, Spain.
 ***Perlodes frisonana* Kohno 1943, Mushi (Japan) 15, p. 48, Fukushima, Japan.
Perlodes intricata Pictet 1841, Europe.
 ***Perlodes jurassica* Aubert 1946, Plecop. Suisse Rom., p. 13, Switzerland.
Perlodes lobata Wu and Claassen 1934, Szechuan, China.
Perlodes macrura Klapálek 1906, Alps.
 ***Perlodes microcephala* Pictet 1833, France.
 **Perlodes mortoni* Klapálek 1906, Scotland.
Perlodes principissa Navás 1917, Catalufia, Spain.
Perlodes rectangula Pictet 1841, Turin, Italy.
 • *Perlodes simplicior* Navás 1936, Szechuan, China.
Perlodes sinensis Navás 1933, Minchow, China.
Perlodes transversa Klapálek 1912, Coll. Zool. Selys Longchamps 4(1), p. 40. Rheinwald. (The figure accompanying this description says "North America," and that is the locality quoted in Claassen's Catalog. However, the European locality is mentioned quite definitely in Klapálek's text.)
Perlodes truncata Wu and Claassen 1934, China-Tibet border.

Genus *Diura* Billberg

1820. *Diura* Billberg, Enumeratio Insectorum in Museo Billberg, p. 96.

GENOTYPE: *Phryganea bicaudata* Linné.

1904. *Diet yopterygella* Klapálek, Rozpr. Ces. Akad. 13, p. 5.

SIZE: Medium to small.

COLOR: Light to dark brown.

VENATION: 2-4 apical crossveins in the costal space, usually none beyond it; a terminal network is occasionally weakly suggested in *D. recta*.

SUBMENTAL GILLS: Short or absent.

MESOSTERNUM OF IMAGO: Transverse ridge present or absent ; the Y-ridge meeting the posterior corners of the furcal pits.

MESOSTERNUM OF NYMPH: Like the imago, but the transverse ridge always weak or absent.

♂ 10TH TERGITE : Produced posteriorly, spinulose, sometimes with a central membranous area at the hind margin.

OTHER TERGITES : 9th and sometimes the 8th shortened and spinulose.

SUPRA-ANAL PROCESS: Absent.

SUBANAL LOBES: Produced inward and backward to meet along their mesal surfaces; the produced length equal to about twice the length of the 2 proximal tarsal segments.

VENTRAL LOBES: Absent.

SUBGENITAL PLATE: Slightly or moderately produced ; rounded, truncate, or excavated.

NYMPHAL MAXILLA: Major cusp equal to one-third to one-half the total length of the lacinia ; subspinular process present or absent; mesal hairs fairly numerous.

NYMPHAL MANDIBLES: Cusps rather short, not serrate.

DISTRIBUTION: Holarctic : northern Europe, Siberia, Japan, and northern North America. In the mountains it is recorded south to New Hampshire, Utah and Vancouver Island.

The synonymy of *Dictyopterygella* with *Diura* is after Brinck (1949), as is the association of 2 of our American species with European ones.

Subgenus *Diura* s.s.

SIZE: Rather small.

COLOR: Dark.

VENATION: 2-4 apical crossveins in the costal space, usually none beyond. Males are quite brachypterous.

SUBMENTAL GILLS: Absent.

MESOSTERNUM OF IMAGO: Of the typical or *Isopterus* type.

MESOSTERNUM OF NYMPH: Transverse ridge very weakly developed.

♂ 10TH TERGITE : Produced posteriorly, entire or with a membranous area medially with a central patch of spinules.

OTHER TERGITES: 9th somewhat shortened, sometimes shallowly notched behind, with spinules.

SUPRA-ANAL APPARATUS: Absent.

SUBANAL LOBES: Produced inward and then backward, to meet along their mesal surfaces; the produced length equal to about twice the length of the 2 proximal tarsal segments.

VENTRAL LOBES: Absent.

SUBGENITAL PLATE: Slightly to moderately produced, rounded, truncate or excavated behind, sometimes excavated at the sides.

NYMPHAL MAXILLA: Major cusp equal to nearly half of the length of the lacinia; a small tufted knob present mesally opposite the origin of the two spines.

NYMPHAL MANDIBLES: Cusp rather short, not serrate.

DISTRIBUTION: Northern holarctic region.

Diura bicaudata Tänné

1758. *Phryganea bicaudata* Linn, Sys. Nat. Ed. X, p. 908. Type locality: Lapland.

1852. *Perla* (Isogenus) *postica* Walker, Cat. Neur. Br. Mus., p. 144. New Synonymy.

1940. *Dictyopterygella hudsonica* Hanson, Proc. Ent. Soc. Wash. 42, p. 148, desc. of ♂; p. 149, figs. 4-6, ♂ wings and genitalia. New Synonymy.

1944. *Dictyopterygella postica* Ricker, Can. Ent. 76, p. 178, desc. of ♀; p. 182, figs. 14, 15, forewing and subgenital plate of ♀.

1949. *Diura bicaudata* Brinck, Studies Swedish stoneflies, p. 61.

DISTRIBUTION: Alaska, Yukon, Mackenzie, Keewatin; far northern Europe and Asia.

Diura nanseni Kempny

1900. Isogenus *nanseni* Kempny, Vehr. K.-K. Zool.-Bot. Gesell. Wien 50, p. 90. Type locality: northern Europe.

1940. *Dictyopterygella washingtoniana* Hanson, Proc. Ent. Soc. Wash. 47, p. 147, desc. of ♂, p. 149, figs. 1, 2, 3, and 7, wings and genitalia. (New Hampshire.)

1949. *Diura nanseni* Brinck, Studies Swedish stoneflies, p. 65.

DISTRIBUTION: White Mountains, New Hampshire (Hanson); far northern Europe and Asia.

EXOTIC SPECIES

Diura frequens Matsumura 1931, Japan.

Diura gracilis Klapálek 1912 Siberia.

Subgenus **Dolkrila** (new)

SUBGENOTYPE: *Dictyopterygella knowltoni* Frison.

SIZE: Medium.

COLOR: Light brown.

VENATION: 3-4 apical crossveins in the costal space ; usually none behind it. Males are not brachypterous.

SUBMENTAL GILLS: Short, conical.

MESOSTERNUM OF NYMPH AND IMAGO: Y-ridge attached to the posterior corners of the furcal pits ; transverse ridge absent.

♂ 10TH TERGITE: With a membranous median triangle at the rear edge, and a few spinules on the surface.

OTHER TERGITES: 8th and 9th somewhat shortened and spinulose.

SUPRA-ANAL APPARATUS: Absent.

SUBANAL LOBES: As in *Diura s.s.*, but with a raised bare knob on the dorsolateral surface of the produced portion.

VENTRAL LOBES: Absent.

SUBGENITAL PLATE: Briefly produced, slightly excavated.

NYMPHAL MAXILLA: Major spine equal to one-third of the length of the lacinia ; no knob present near the origin of the two spines, but a group of spinules is present.

NYMPHAL MANDIBLE: Cusps rather short, not serrate.

DISTRIBUTION: Western North America.

Diura (Dolkrila) knowltoni Frison

1937. *Dictyopterygella knowltoni* Frison, Bull. Illinois Nat. Hist. Surv. 21, p. 89, desc. of figs. of color pattern, forewing, ♂ genitalia. Type locality: Logan, Utah.

1942. *Dictyopterygella knowltoni* Frison, *ibid.* 22, p. 299, desc. of 9 and nymph; figs. of 9 subgenital plate, nymphal pattern, and mouth parts.

DISTRIBUTION: Cordillera from Vancouver Island to Alberta, and from the Yukon south to Utah.

Genus **Perlodinella** Klapálek

1912. *Perlodinella* Klapálek, Cat. Coll. Selys 4(1), p. 28. **GENOTYPE:** *Perlodinella koziovi* Klapálek.

1936. *Perlodinella* Wu, Bull. Peking Nat. Hist. Soc. 11, p. 76.

1946. *Perlodinella* Kimmins, Annals Mag. Nat. Hist., ser. 11, vol. 13, p. 739.

SIZE: Medium.

COLOR: Dark.

VENATION: No apical crossvein network.

♂ 10TH TERGITE: Not cleft ; posterior margin spinulose and strongly produced dorsally, forming a hood which contains the enlarged subanal lobes.

OTHER TERGITES : 6-8 swollen laterally ; 8 with a median swelling.

SUBANAL LOBES: Much enlarged and produced dorsally, with a small hook on the upper apical angle.

VENTRAL LOBES: Apparently lacking.

SUBGENITAL PLATE: Somewhat produced, rounded or excavated.

DISTRIBUTION: Central Asia.

SPECIES

Perlodinella apicalis Kimmins 1946, Ann. Mag. Nat. Hist. ser. 11, vol. 13, p. 739. Yatung, Tibet.

P. heteroptera Wu 1938, Liao-ming, China.

P. kozlovi Klapálek 1912, Tibet.

P. microlobata Wu 1938, Kansu, China.

P. unimacula Klapálek 1912, Tibet.

Genus Skobeleva Klapálek

1912. *Skobeleva* Klapálek, Zool. Coll. Selys-Longchamps 4(1), p. 23.

GENOTYPE: *Dietropteryx olgae* MacLachlan.

SIZE: Medium.

COLOR: Dark.

VENATION: With a small terminal network of crossveins extending from R_1 to R_2 , and several normal crossveins back to Cu_1 or Cu_2 . Known males are brachypterous.

SUBMENTAL GILLS: Short, conical.

MESOSTERNUM OF IMAGO: Y-ridge joined to the posterior corners of the furcal pits ; transverse ridge absent.

SUPRA-ANAL APPARATUS: Absent (see also under *S. olgae*, below).

VENTRAL LOBES: Absent. The 9th sternite is rounded and slightly produced posteriorly (Fig. 89).

♂ 10TH TERGITE: Hind margin elevated and spinulose (Fig. 88).

OTHER TERGITES: 8th densely covered with spinules on its anterior half (Fig. 86).

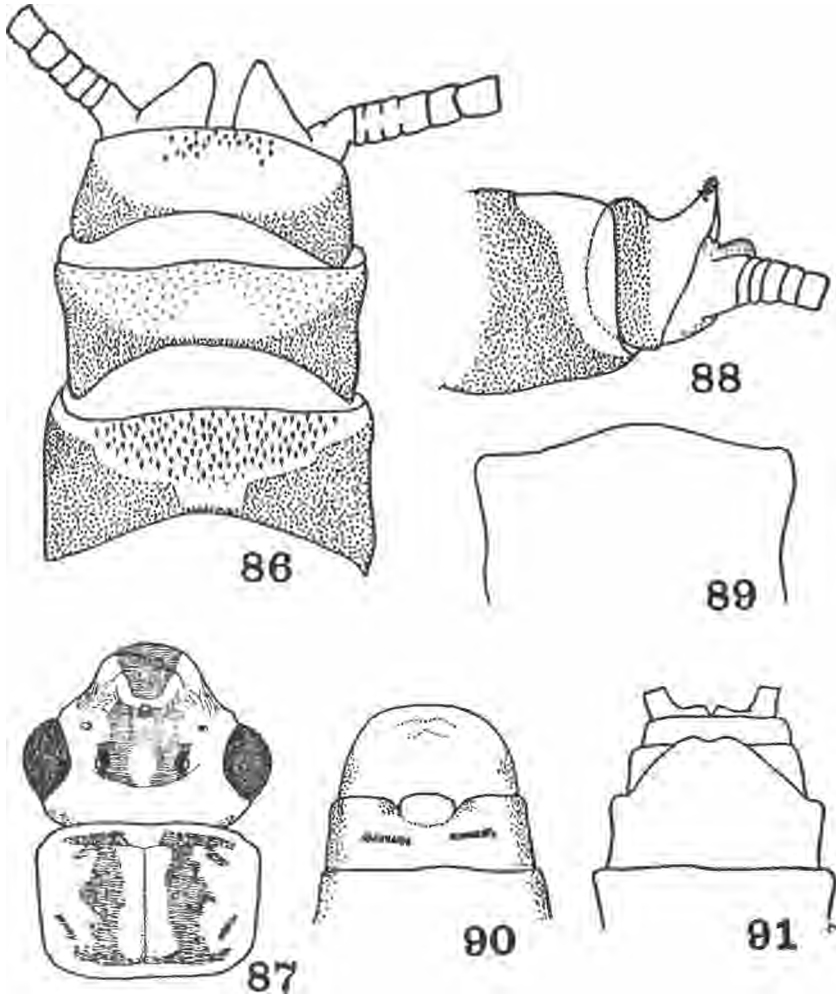
SUBANAL LOBES: Considerably enlarged ; normally sheltered under the raised 10th tergite.

DISTRIBUTION: Central Asia.

SPECIES

Skobeleva kuen-luensis Šámal 1935, Karakorum Mountains, Asia.
(*Perlodes* (*Megarcys*) *kuen-luensis*.)

S. nuristica Brinck, Afghanistan. (*Perlodes* (*Perlodinella*) *nuristica* Brinck, Vidensk. Meddel. Dansk Naturhistorisk Forening 112, p. 133, 1950.)



Skobeleva olgae (cotype; from pencil drawings by D. E. Kimmins). 86. Terminal abdominal segments, from above. 88. The same, from the side. 89. 9th sternite.

Isoperla cotta. 87. Head and pronotum. 90. Terminal sternites of allotype *S.* 91. Terminal sternites of holotype 9.

Skobeleva olgae MacLachlan, Turkestan. Figures 86, 88 and 89 are from sketches of a relaxed cotype of this species very kindly made by Mr. D. E. Kimmins. Klapálek's illustration (1912, Fig. 19A, p. 23) shows a slender terminal process which may be an artifact, or else his specimen is not of this genus.

S. tau Klapálek 1907, western China.

SUBFAMILY ISOPERLINAE

The Isoperlinae represent another development from Isogeniinae. They apparently developed from some *Iso* genus by way of reduction and eventual loss of the supra-anal apparatus, loss of the ventral lobe from the 7th sternite and its retention on the 8th, and by modification of the subanal lobes, typically into hooks. Only two genera are recognized: *Isoperla* is holarctic in distribution and rich in species, especially in North America; *Calliperla* is known from a single cordilleran species, and apparently represents an evolutionary stage in the transition from *Isoperla* to *Calliperla*. Gills are completely lacking among isoperlines, and the mesosternum is usually (?always) of the typical sort with a transverse ridge, and with the Y-ridges in the posterior position.

Genus *Calliperla* Banks

1948. *Calliperla* Banks, Psyche 54:279. GENOTYPE: *Peda luctuosa* Banks.

SIZE: Moderate.

COLOR: Medium brown.

VENATION: 1-3 apical crossveins in the costal space, 0-2 farther back.

SUBMENTAL GILLS: Absent.

MESOSTERNUM OF IMAGO: Typical.

10TH TERGITE: Short, only weakly sclerotized along the mid-line posteriorly, where it is slightly indented. On either side of the mid-line is a strongly sclerotized recurved process.

SUPRA-ANAL PROCESS: Small and not sclerotized; lacking any basal support, enveloping cowl, paragenital plates, or lateral stylets.

SUBANAL LOBES: Not modified.

VENTRAL LOBES: Absent from 7; well developed on 8.

SUBGENITAL PLATE: Somewhat produced, broadly and deeply notched.

NYMPH: Unknown.

DISTRIBUTION: Western North America.

This interesting genus has some characters of the Isogeninae, but is best assigned to Isoperlinae. The development of a nail on the 8th rather than the 7th sternite immediately suggests *Isoperla*. While a definite supra-anal process is present, it is small and unsclerotized, and it lacks any trace of basal support, enveloping cowl or lateral stylets. The 10th tergite is short and is only weakly sclerotized along the mid-line posteriorly, but it is no longer cleft and the supra-anal process therefore is developed terminally. The lobes of the 10th tergite may, however, represent the produced inner corners of the cleft tergite of isogenine ancestors. The 9th tergite is spinulose in its posterior half, and is somewhat produced.

Calliperla luctuosa (Banks)

1906. *Perla luctuosa* Banks, Can. Ent. 38, p. 336, desc. of ♀. Type locality: San Francisco, California.

1925. *Perla luctuosa* Needham and Claassen, Monogr. Plecop., p. 97, desc. of ♂, ♀, 9; p. 315, fig. 8, venation; p. 327, figs. 16-19, ♂, ♀, 9 genitalia.

DISTRIBUTION: Western California and Oregon.

Isoperla Banks

1906. *Isoperla* Banks, Ent. News 17, p. 175. GENOTYPE: Stalls *bilineata* Say.

1841. *Chloroperla* Pictet, *Perlides*, p. 276, and many later authors (not Newman 1836, Ent. Mag. 3, p. 500).

1912. *Suzukia* Okamoto, Trans. Sapporo Nat. Hist. Soc. 4, p. 109. New Synonymy.

1925. *Calliperla* Needham and Claassen, Monogr. Plecop., p. 137.

SIZE: Small to medium.

COLOR: Yellow or brown, rarely black; usually with a light or dark pattern.

VENATION: 1-2 apical crossveins in the costal space, 0-3 farther back.

SUBMENTAL GILLS: Absent.

MESOSTERNUM OF NYMPH AND IMAGO: Of the typical kind, but often the arms of the Y are weakly developed or scarcely distinguishable.

♂ 10TH TERGITE: Not cleft, though in *trictum* there are small terminal horns, and *clio* has the mid-line depressed and little sclerotized near the tip.

SUPRA-ANAL PROCESS: Absent.

SUBANAL LOBES: Either little modified and resembling those of the female, or variously enlarged, bulbous, or hooked; often recurved forward.

VENTRAL LOBES: Absent from 7, usually well developed on 8, but absent in *trictura* and almost so in *ebria*.

9 SUBGENITAL PLATE: Somewhat produced, but usually much less so than in *Isogenus*,

NYMPHAL MAXILLA: Variously modified, but often much as in a typical *Isogenus*.

NYMPHAL MANDIBLE: Cusps not serrate; occasionally the teeth are arranged into 2 widely-separated groups. Peculiarities of the mandibles and maxillae mark off several series of species.

DISTRIBUTION: North America generally, south to Texas and Lower California; Europe; Japan and northern China.

The large and difficult genus *Isoperla* is currently being revised by a colleague, so no attempt will be made to deal with it exhaustively. While the recognition of a number of subgenera within *Isoperla* will be useful, we follow Frison (1935) in rejecting *Clisoperla* as a valid genus. Here one point of American synonymy will be mentioned and a species described which has been some time waiting.

The Japanese species *motonis* Okamoto, type of *Suzukia*, is apparently known only from the female. It is currently assigned to *Isogenus* (Claassen, 1940). A specimen of *motonis* sent by Mrs. Kohno shows that: it is colored with the pronotal stripes and a kind of head pattern common in *Isoperla*, while the subgenital plate is not produced as much as would be usual in *Isogenus*; hence the synonymy above.

Isoperla clio Newman

1833. *Isogenus clio* Newman, Mag. Nat. Hist. 3, p. 86. Type locality: Georgia.

1912. *Isogenus* (? *Isogenoides*) *clio* Klapálek, Cat. Coll. Selys 4(1), p. 60.

1925. *Chippelya elio* Needham and Claassen (in part), Monogr. Plecop., p. 139; p. 315, fig. 3, wing, p. 25, figs. 4-6, ♂ 9.
 1935. *Isoperla confusa* Frison, Bull. Illinois Nat. Hist. Surv. 20, pp. 441-44, ♂, 9, nymph. New Synonymy.
 1938. *Isoperla elio* Ricker, Trans. Roy. Can. Inst. 22, p. 146.

The possible identify of *confusa* with *elio* has been recognized from the time of *confusa*'s description. One stumbling block has been my unfortunate error of 1938 in stating that the *elio* types were from Canada, instead of Georgia. With that cleared away, and the confusion with *marlynia* nymphs having been removed (Frison, 1942, p. 330), the synonymy above became obvious. Large size and the terminal ridges of the 10th tergite distinguish *dio* and *confusa* equally, and are not found in other eastern *Isoperlae*.

DISTRIBUTION: Illinois, Indiana, southern Michigan, Ohio, the Virginias and Maryland, south to Florida in the east and to Arkansas in the Midwest.

Isoperla cotta (new species)

MALE: Length of body, 7.5 mm.; to tip of wings, 11.5 mm. Color yellow and brown. Head dark in front of the M-line and in a broad dark band behind the M-line and connecting to the posterior ocelli. The sides and back of the head are light, as is, often but not always, the central and hind portion of the ocellar triangle. Pronotum mostly dark, but with a light side and posterior margins, and a broad median stripe interrupted along the transverse grooves.

'Nail of the 8th sternite broad and distinct (Fig. 90) ; subanal lobes recurved, blunt.

FEMALE: Length of body, 8.5 mm.; to tip of wings, 13 mm. Subgenital plate produced and bent downward, its sides convergent, its tip usually but not always excavated (Fig. 91).

NYPH: Structurally almost identical with *orata* or *burksi*, particularly in respect to the maxilla. In color it rather closely resembles *orata* (Frison, 1942, p. 325) except for the head, which is more like *burksi* (*ibid.*, p. 334) but is dark on the sides before the M-line.

Holotype ♂ and allotype ♀ : Creidt River at Terra Cotta, Ontario, May 26 to June 2, 1946, F. P. Ide.

Paratypes:

MICHIGAN

- N. Branch Otter River, Houghton County. June 30, 1949, ♂ 4 ♀; July 23, ; July 16-27, 2♂ 1 ♀; J. W. and F. A. Leonard.
- S. Branch Boardman River, Grand Traverse County. June 27, 1947, ♂, J. W. and F. A. Leonard.
- Mud Creek, Marquette County. July 8, 1949, 1♂, J. W. and F. A. Leonard.
- Boardman River, Grand Traverse County. June 11, 1947, 2♂, J. W. Leonard.
- S. Branch Au Sable River, Crawford County. May 30, 1948, ♂, C. L. Hess.
- Sanborn Creek, Lake County. May 18, 1947, ♂, J. W. and F. A. Leonard.
- T 17 N, R 13 W, Sec. 16. June 23, 1947, ♂, J. W. and F. A. Leonard.
- Middle Branch Pere Marquette Railroad, Lake County. May 18, 1947, 3 nymphs; June 5, 3 mature nymphs showing adult color; June 24, ♀; J. W. Leonard.
- Montreal River, Keweenaw County. June 4, 1949, ♂, J. W. and F. A. Leonard.

ONTARIO

- Same data as holotype, ♂ 9.
- Costello Lake, Algonquin Park, Stations No. 3, 3a, and 6. June 2, 1938, 3 ♀; June 4-18, 1939, 7 ♂ 20 ♀; May 28, 1941, ♂ 9; also exuviae. W. M. Sprules and F. P. Ide.

QUEBEC

- Great Whale River. July 12-15, 1949, 2♂ 1 ♀, J. R. Vockeroth (in the CNC).

The Costello Lake specimens are generally darker in color, both in the adult and nymphal form, than those from southern Ontario or from Michigan. The three species *burksi*, *cotta*, and *orata* are a closely-related group, and may not always be separable, particularly as nymphs. *Orata* overlaps the range of *cotta* in Quebec, Ontario, and Michigan; it is distinguished by a lighter head, particularly in front of the M-line, a narrower lobe on the ♂ 8th sternite, and a somewhat more sharply tapered ♀ subgenital plate.

Part III. Miscellaneous Descriptions and Revisions

Family Pteronarcidae

Genus Pteronarcys Newman

Subgenus Allonarcys Needham and Claassen

1925. *Allonarcys* Needham and Claassen, Monogr. Plecop., p. 286.

1941. *Allonarcys* Kimmins, Ent. 74, p. 87. Designates *Pteronarcys proteus* Newman ♂ as GENOTYPE.

Allonarcys includes the species of *Pteronarcys* whose nymphs have paired lateral projections on the abdomen. The males are distinguished by a slender, erect supra-anal process, in contrast to the massive decurved process of other *Pteronarcys*. We appear to have four species, all from eastern North America, including one new one.

MALES (*comstocki* unknown)

- 1 9th tergite with a prominent shelf-like dorsal process, crenulate on the anterior margin, which projects over the front half of the segment *proteus*
- 9th tergite without any dorsal process 2
- 2(1) Supra-anal process, seen in side view, with an anterior projection near the tip which bears a minute ventral spine (Fig. 95) *biloba*
- Supra-anal process, in side view, very slightly or not at all projected forward near the tip, and lacking any spine (Fig. 93) *scotti*

FEMALES

- 1 Tip of the subgenital plate minutely notched, the bottom of the notch much posterior to the sides of the 8th tergite *comstocki*
- Tip of the subgenital plate more deeply notched, the bottom of the notch anterior to the sides of the 8th tergite 2
- 2(1) Lobes of the subgenital plate slender throughout their entire length, arising close together at the base and curving outward, then inward, so that they are usually approximated again at the tips *proteus*

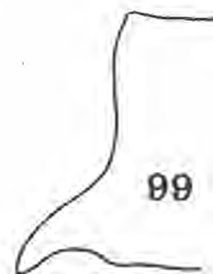
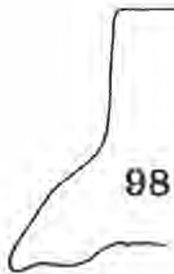
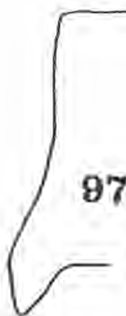
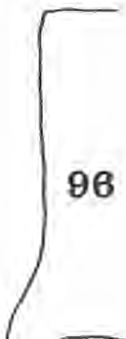
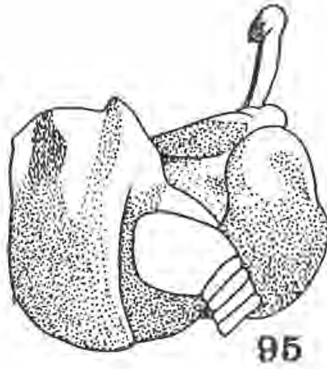
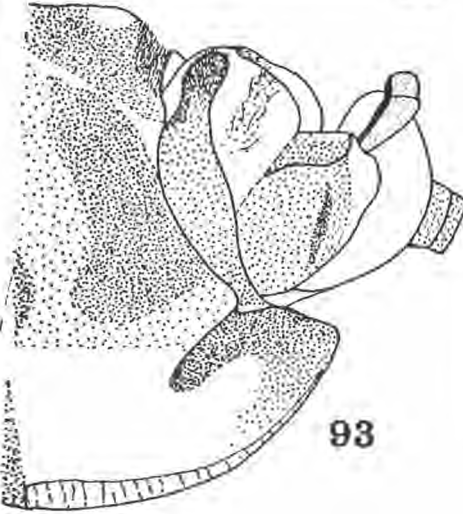
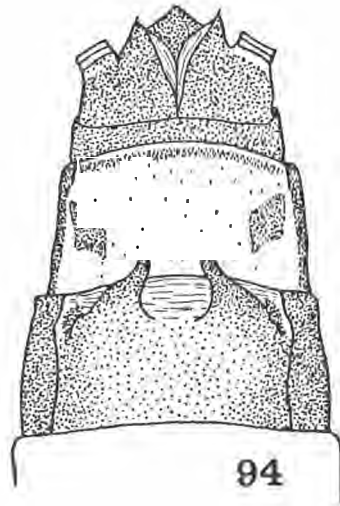
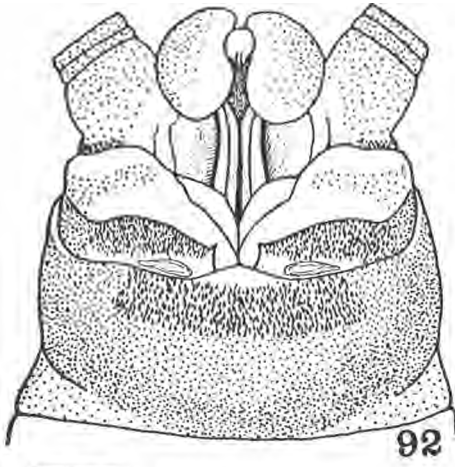
- Lobes of the plate very broad toward the base, not closely approximated either at the base or near the tips 3
- 3(2) Lobes of the subgenital plate strongly concave on the outer margin, and with the median notch somewhat expanded anteriorly *scotti*
- Lobes much stouter, convex or straight or slightly concave on the outer margin, the median notch not expanded anteriorly *biloba*

MATURE NYMPHS

- 1 Mesonotum with a prominent notch laterally New Brunswick nymph of Frison, 1942, p. 245 (*?-comstocki*)
- Mesonotum* without a lateral notch 2
- 2(1) Abdominal spines divergent, almost always with a low knob on the posterior margin of one or more of the pairs (Fig. 98; the affected pair or pairs varies in position, however) ; spine of the 7th segment long, three-fourths to two-thirds as long as that of the 6th *biloba*
- Spines more appressed, rarely with a knob posteriorly (Figs. 96, 97) ; spines 7-8 (*proteus*) or 6-8 (*scotti*) much reduced in size by comparison with more anterior spines 3
- 3(2) Longest abdominal spines, measured along their posterior margin, equal to one-third to one-fourth of the length of their segment ; spines of the 7th segment more nearly like those of the 6th than like those of the 8th *proteus*
- Posterior margin of the longest abdominal spines equal to one-fifth or one-sixth of the length of their segment ; spines of the 7th segment more nearly like the 8th than the 6th *scotti*

Pteronarcys (*Allonarcys*) *scotti* (new species)

MALE: Length of body, 33 mm.; to tip of wings, 40 mm. General color dark brown above, yellowish below. Head with obscure dark markings, and large light yellow scars.



Abdominal segments unmodified through 8. The 9th sternite is somewhat produced and bears a long, light-colored, reticulately-lined percussion surface, bordered by broad whitish areas. The 9th tergite is declivitous posteriorly and bears on that surface numerous spinules (Fig. 93). The 10th tergite consists of two sclerotized spinulose ridges anteriorly, and, near the extreme anterior edge, a pair of rather small transversely-elongate membranous mounds (Fig. 92); posteriorly the segment is membranous or very weakly sclerotized, and much excavated medially. The supra-anal process is blunt, sclerotized anteriorly, lying within the mostly sclerotized cowl. Its tip normally projects only slightly beyond the greatly expanded subanal lobes.

FEMALE: Length of body, 37 mm.; to tip of wings, 46 mm. Subgenital plate produced into slender, subacute horns, lying above the membranous posterior border of the segment (Fig. 94).

NYMPH: Length of body up to 45 mm. in last-instar females; males somewhat smaller. Color brown, with 4 yellow spots at the anterior margins of the abdominal tergites (these often obscure). In general form it mostly closely resembles *P. proteus* (Claassen, 1931, p. 30), but differs in having shorter lateral hooks on the abdomen. On the 3d to 5th segments, where they are longest, the length of the hooks, measured along the posterior surface, is one-fifth to one-sixth of the width of the tergite (Fig. 96). In *proteus* the same length is one-fourth to one-third of the tergite (Fig. 97). The spine of the 7th sternite of *scotti* is much reduced, not much larger than that of 8.

In the course of a Georgia collecting trip with Dr. and Mrs. D. C. Scott early in April, 1949, I was much surprised to find nymphs of a new species of *Pteronarcys* in a number of streams, and finally obtained two adults at Soque Creek. Further collecting showed it to be abundant also in many streams of the mountains of North Carolina and Tennessee. On checking the

Pteronarcys scotti. 92. Terminal segments of ♂ from above; Elkmont, Tennessee. 93. The same, from the side (left cercus and subanal lobe removed). 94. Terminal sternites of ♀. Smokemount, North Carolina.

Pteronarcys biloba. 95. Terminal segments of ♂, from the side. Shenandoah National Park, Virginia.

Allonarcys: Lateral margin of the 5th abdominal segment of mature nymphs, from above. 96. *scotti* (Tennessee) 97. *proteus* (New York). 98. *biloba* (Virginia). 99. *comstocki* (?) (New York).

collection of the Illinois Natural History Survey, I found many additional specimens, taken throughout the southern Appalachian region by Dr. T. H. Frison and his colleagues, by Dr. P. W. Fattig of Emory University, and by Dr. Thelma Howell. However, they had been confused with two other species of the same subgenus: the adults had been identified as *P. biloba*, and the nymphs as *proteus*. This reflects a rather close resemblance to these species in the respective stages mentioned, but in spite of these similarities it is possible to separate the three species at all stages, as shown in the key given earlier.

Holotype ♂ and allotype ♀: Little River, Elkmont, Tennessee, May 14, 1939, T. H. Frison and H. H. Ross. Reared from nymphs.

In the distribution list to follow, the adult specimens are designated as paratypes:

GEORGIA

Bear Foot Creek, 9 mi. E of Hiwassee. Ex, 1931, P. W. Fattig.
 Chestatee River, 11 mi. N of Cleveland. N, 1931, P. W. Fattig.
 Coosa Creek, 3 mi. W of Blairsville. N, 1931, P. W. Fattig.
 Creek just W of Cleveland. N, 1949, Scott and Ricker.
 Hightower Creek, 8 mi E of Hiwassee. Ex, 1931, P. W. Fattig.
 Hiwassee River, Jct. Roads 75 and 180, Towns County. N, 1949, Scott and Ricker.
 Notala River, 7 mi. S of Blairsville. N, 1931, P. W. Fattig.
 Rock Creek, 7 mi. S of Blue Ridge. N, 1931, P. W. Fattig.
 Soque Creek, Habersham County. April 3, 1949, 2 ♀, Scott and Ricker.
 Soque River, N of Clarksville. N, 1949, Scott and Ricker.
 Turnip Town Creek, 4 mi. N of Ellijay. N, 1931, P. W. Fattig.
 Wolf Creek, 3 mi. N of Neel Gap. May 30, 1945, 9, P. W. Fattig.
 Young Harris. N, 1938, Ross and Burks.

NORTH CAROLINA

Balsam. April 24, 1938, ♂, Ross and Burks.
 Soco River, 1 mi. E of Cherokee. April 21, 1949, ♂ 9, W. E. Ricker.
 Shenandoah National Park. April 23, 1940, ♂ reared; May 4, ♀ reared; Frison, Mohr, and Hawkins.
 Okonaluftee River at Smokemont. May 11, 1944, ♂ reared, ♀, Frison and Ross.
 Willetts. April 28, 1940, ♂ reared; May 20, ♀ reared; May 23, ♀ reared; Frison, Mohr, and Hawkins.
 Chattooga River, Norton Mill Creek, Edwards Creek, Big Creek, and Wayah Creek, in Jackson and Macon counties. N, 1938, Thelma Howell.
 Pigeon River, Woodrow. N, 1939, Frison and Burks.
 Shooting Creek. N, 1939, Frison and Burks.

Junction of Ball and Shope Creeks, Big Creek above Lake Randall, Otter Creek, Buckeye Branch of Tessentee Creek, Beaseley Creek, Burning Town Creek, Buck Creek—all in Macon County. N, 1939, Thelma Howell.
 Cullowhee Creek, Fowler's Creek, East Fork Tuckasegee River at Wolf Mt. Club ~~House~~, Slicker Creek, Tuckasegee River below Pine Creek bridge, Tennessee Creek, High Hampton Lake (tributary), Knob Creek, West Fork Tuckasegee River—all in Jackson County. N, 1938-39, Thelma Howell.
 Swain. N, 1944, Frison and Ross.
 Okonaluftee River at and near Cherokee. N, 1949, W. E. Ricker.
 Soco River on Road 19, N of Cherokee. N, 1949, W. E. Ricker.
 Mingus Creek, Couches Creek, and Collins Creek, Smoky Mountain National Park. N, 1949, W. E. Ricker.

SOUTH CAROLINA

CCC Camp F2, Oconee County. May 20, 1937, ♀.

TENNESSEE

Little River, Elkmont. May 14, 1940, 2 ♂ 1 ♀ reared (in addition to ~~holotype~~ type and allotype); May 11, 1944, ♂ ♀ reared. Frison and Ross.
 West Prong of Little Pigeon River near Gatlinburg. June 14, 1940, Z ♀; May 11, 1944, 2 ♂, ♂ reared, ♀ reared. Frison and Ross; 1949, N, W. E. Ricker.
 Fighting Creek, Smoky Mountain National Park. 1934, 1949, N, T. H. Frison, W. E. Ricker.
 Lynncamp Prong of Little River at Townsend. N, 1939, Frison and Ross.
 LeConte Creek near Gatlinburg. N, 1940, Frison et al.
 Cades Cove, Smoky Mountain National Park. Ex. 1940, Frison et al.
 Maryville. N, 1923.
 Little River, Smoky Mountain National Park. N, 1949, W. E. Ricker.

VIRGINIA

Remington. May 13, 1940, 2 ♂ reared. Frison et al.

Pteronarcys (Allonarcys) biloba Newman

1938. *Pteronarcys biloba* Newman, Ent. Mag. 5, p. 176.
 1925. *Pteronarcys biloba* Needham and Claassen, Monogr., Plecop., p. 40; p. 305, figs. 9, 10, ♂ ♀.
 1931. *Pteronarcys biloba* Claassen, Plecop. Nymphs. p. 30; p. 129, figs. 17-21; p. 147, figs. 171, 172; p. 193, fig. 232; p. 195, fig. 235; nymph.

A male is shown in figure 95.

DISTRIBUTION: Southern Quebec and the Maritime provinces of Canada, New England, New York, and in the mountains to northern Georgia; rare southward.

***Pteronarcys* (*Allonarcys*) *comstocki* Smith**

1917. *Pteronarcys comstocki* Smith, Trans. Amer. Ent. Soc. 43, p. 454. Type locality: near Ithaca, New York.
1925. *Pteronarcys comstocki* Needham and Claassen, Monogr. Plecop., p. 41; p. 305, fig. 13, ♀.
1942. *Pteronarcys* species, Frison, Bull. Illinois Nat. Hist. Surv. 22, p. 245, nymph. Probably = *comstocki*.

In the INHS there are two exuviae from a tributary of the Sable River, Keene, New York, June 20, 1941, Frison and Ross. These differ from the New Brunswick specimens of Frison (1942) only in having relatively somewhat shorter abdominal spines (Fig. 99) and a shallower lateral notch on the mesonotum—both of which differences may be related to the fact that Frison's nymphs were younger. Discovery of this nymph in New York increases the already strong probability that it is *P. comstocki* Smith, a species known only from the adult female.

DISTRIBUTION: New York, New Brunswick.

***Pteronarcys* (*Allonarcys*) *proteus* Newman**

1838. *Pteronarcys proteus* Newman, Ent. Mag. 5, p. 177.
1925. *Pteronarcys proteus* Needham and Claassen, Monogr. Plecop., p. 39; p. 15, fig. 2, wings; p. 305, figs. 11-12, ♂ 9.
1931. *Pteronarcys proteus* Claassen, Plecop. Nymphs, p. 30; p. 1, figs. 11-16; p. 147, figs. 169-70; p. 193, fig. 234; p. 195, fig. 237; nymph.

DISTRIBUTION: New Hampshire, southern Quebec, and New York south to Virginia.

Family Peltoperlidae

Genus *Peltoperla* Needham

1905. *Peltoperla* Needham, Proc. Biol. Soc. Wash. 18, p. 107. GENOTYPE: *Peltoperla arcuata* Needham.

Subgenus *Peltoperla* s.s.

GILLS: Two pairs on the side of the mesothorax and metathorax, set just above the coxae ; one pair near the posterior edge of the metasternum, projecting from under the produced sternal plate ; one pair projecting from under the subanal lobes.

♂ 9TH STERNITE: There is a large lobe attached at the anterior border.

♂ SUPRA-ANAL PROCESS: Usually rounded and largely membranous, though in *arcuata* there is also a central sclerotized rod.

STERNITES: 8th sternite little or much produced, notched or entire.

The known species of this subgenus are all from eastern North America. A study of the types at Cornell shows that four species are to be recognized, plus a new one described below. Except for *arcuata*, the males are difficult to distinguish; the subanal lobes and contour of the metasternum offer some characters, but they can scarcely be used in a key. The nymphs also are all much of a pattern: those of *arcuata*, *maria* and *laurie* are known to the writer, and they offer little to distinguish them, though again differences appear to exist in the shape of the hind margin of the metasternum. A key for the females, however, seems quite practical:

FEMALES

- | | | |
|------|--|----------------|
| 1 | Hind margin of metasternum scarcely produced at the sides (Fig. 101); subgenital plate roundly produced with a shallow narrow notch (Fig. 102) | <i>ada</i> |
| | Hind margin of the metasternum considerably produced at the sides (Fig. 103); subgenital plate not as above | 2 |
| 2(1) | Subgenital plate produced and broadly or narrowly notched | 3 |
| | Subgenital plate without any terminal notch, though the central area is thin and its margin straight in <i>arcuata</i> | 4 |
| 3(2) | Notch of the subgenital plate V-shaped, usually broadly so | <i>maria</i> |
| | Notch of the subgenital plate narrow and U-shaped (Fig. 107) | <i>laurie</i> |
| 4(2) | Subgenital plate scarcely produced (Fig. 104) | <i>anna</i> |
| | Subgenital plate produced over much of the 9th sternite | <i>arcuata</i> |

Peltoperla (P.) *ada* Needham and Smith

1916. *Peltoperla ada* Needham and Smith, Can. Ent. 48, p. 86, desc. and fig. of 9. Type locality: Black Rock Mountain, Georgia.

This species was synonymized under *cornelia* by Needham and Claassen, but must be recognized as distinct. The posterior border of the metasternum is little produced laterally, and the subgenital plate is considerably produced and shallowly notched (Fig. 102). Only the female type specimen is known.

Peltoperla (P.) anna Needham and Smith

1916. *Peltoperla anna* Needham and Smith, Can. Ent. 48, p. 83. Desc. and fig. of ♂ 9. Type locality: Burton, Georgia.
1935. *Peltoperla anna* Needham and Claassen, Monogr., Plecop., p. 168; p. 321, fig. 5, wings; p. 353, fig. 8, 9.

This species seems distinct by reason of its unproduced, un-notched subgenital plate. Only the types are known.

Peltoperla (P.) arcuata Needham

1905. *Peltoperla arcuata* Needham, Proc. Biol. Soc. Wash. 18, p. 108. Type locality: Ithaca, New York.
1925. *Peltoperla arcuata* Needham and Claassen, Monogr. Plecop., p. 170; p. 353, figs. 1-3.
1931. *Peltoperla arcuata* Claassen, Plecop. Nymphs, p. 39; p. 153, figs. 186-87.
1935. *Peltoperla arcuata* Frison, Bull. Illinois Nat. Hist. Surv. 20, p. 332, fig. 262, sterna and gills.
1942. *Peltoperla arcuata* Frison, Bull. Illinois Nat. Hist. Surv. 22, p. 246, fig. 5, ♂ abdomen.


Frison's paper illustrates the curved cerci which distinguish the male of this species.

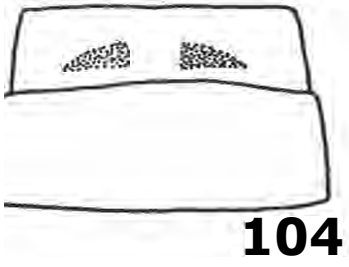
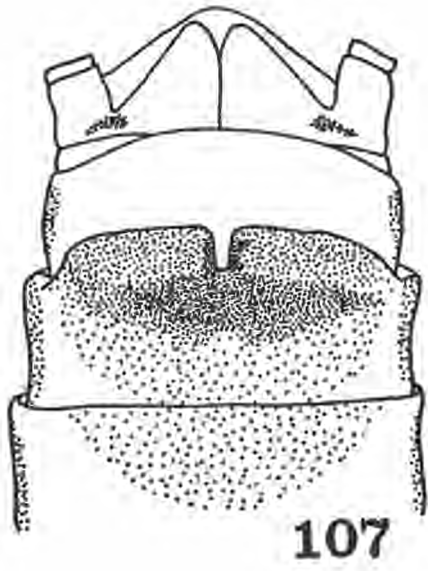
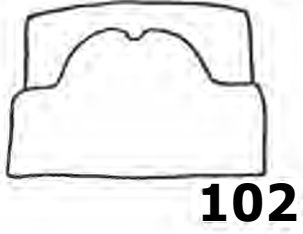
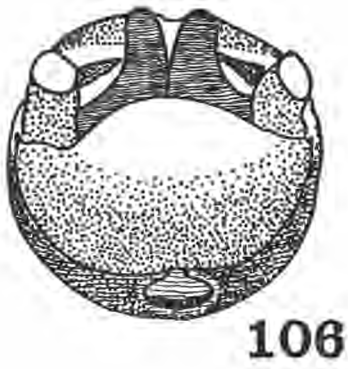
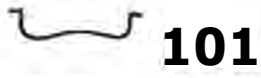
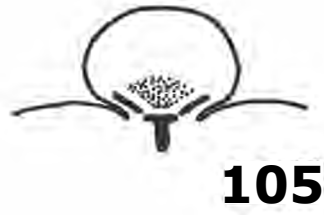
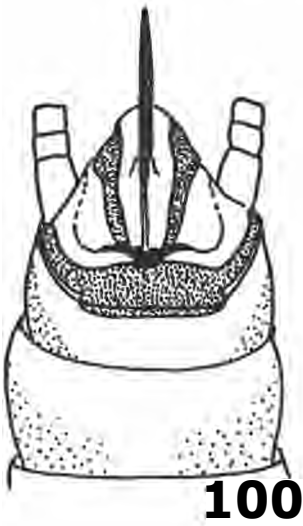
DISTRIBUTION: Southern Quebec, New York, Pennsylvania, Virginia, and Tennessee. Not very common southward.

Peltoperla (P.) laurie (new species)

MALE: Length of body, 9 mm. ; to tip of wings, 14 mm. Color light yellowish brown, somewhat darker in the ocellar triangle. Pronotum coarsely rugose. Gills 2 pairs on the sides of the meso- and metathorax ; 1 pair on the metasternum at the sides; 1 pair on the subanal lobes.

Supra-anal process mostly membranous, coin-shaped, with a pair of divergent sclerotized bands on the upper surface at the base (Fig. 105). Subanal lobes sclerotized behind, blunt at the tips (Fig. 106).

-
- Peltoperla zipha*. 100. Terminal segments of holotype ♂, from above.
Peltoperla ada (holotype ♀). 101. Outline of hind margin of metasternum.
102. Subgenital plate.
Peltoperla anna (holotype ♀). 103. Outline of hind margin of metasternum.
104. Subgenital plate.
Peltoperla laurie. 105. Supra-anal process of allotype  106. End of body of ♂, from behind. 107. Terminal sternites of holotype ♀.



FEMALE: Length of body, 12 mm.; to tip of wings, 18 mm. Subgenital plate produced about one-third of the length of sides of the sternite, and with a rather deep narrow notch Fig. 107 . 9th sternite somewhat produced and broadly rounded.

NYMPH: Closely resembles the known nymphs of other members of the subgenus, *Peltoperla* maria and *P. arcuata*. The latter has been described and illustrated by Claassen 1931, pp. 39, 153 .

Holotype ♀ and allotype ♂ : Small creek on University Farm, 3 mi. S of Athens, Georgia, May 7, 1949, D. C. Scott.

Paratypes taken at the same time: 21 ♂ and 1 ♀. Three exuviae were also taken, and on April 4, 1949, a considerable number of nymphs were taken from the same stream.

The narrow notch of the 9 subgenital plate distinguishes this species from all others.

Peltoperla *P. maria* Needham and Smith

1916. *Peltoperla* maria Needham and Smith, Can. Ent. 48, p. 82. Desc. and fig. of ♀. Type locality: Pelham, Massachusetts.
1916. *Peltoperla* dorothea Needham and Smith, Can. Ent. 48, p. 84. Desc. and figs. of ♂ ♀ New York, North Carolina . New synonymy.
1916. *Peltoperla cornelia* Needham and Smith, Can. Ent. 48, p. 84. Desc. and fig of ♀ Georgia . New synonymy.
1925. *Peltoperla* maria Needham and Claassen, Monogr. Plecop., p. 119; fig. 7, p. 353.
1925. *Peltoperla* cornelia Needham and Claassen, Monogr. Plecop., p. 167; figs. 4-6, p. 353.

The above synonymy is suggested by a study of the types at Cornell University ; dorothea was previously considered a synonym of cornelia.

DISTRIBUTION: Maryland to northern Georgia, rarely north to New England. This species is extremely abundant in the southern Appalachian Mountains.

Subgenus *Yoraperla* new

GILLS: There are 1 pair of cervical gills, and 2 pairs on the side of all three thoracic segments. Subanal gills and ventral thoracic gills are absent.

♂ 9TH STERNITE: The lobe is much broader than long, and is set about one-third way behind the front margin of the sternite.

♂ SUPRA-ANAL PROCESS: Small, lenticular ; weakly sclerotized laterally near the base, and membranous centrally.

♀ 8TH STERNITE: Much produced ; usually either notched or shallowly excavated.

SUBGENOTYPE: *Peltoperla mariana* Ricker.

OTHER SPECIES: *brevis* Banks, *cora* Needham and Smith.

Subgenus Viehoperla (new)

GILLS: One pair each on the meso- and metathorax are all that can be distinguished. However, the nymph is unknown, and on the adult some gills might possibly be overlooked.

♂ 9TH STERNITE: The ventral lobe is marked off only by a fold or groove in the integument ; the slightly raised mound anterior to this groove is centered about one-third way behind the front margin of the sternite.

♂ SUPRA-ANAL APPARATUS: The 10th tergite is elevated, and somewhat produced and rounded, bearing at its tip a long supra-anal process bent in a loop first downward and then up into a slender tip. There is a cowl completely surrounding the process at the sides and posteriorly, its dorsal surface sclerotized in rather narrow strips (paragenital plates), its mesal margin bearing 2 small unsclerotized thumb-like projections (Fig. 100).

♀: Unknown.

SUBGENOTYPE and only known species: *Peltoperla zipha* Frison.

Although it apparently has a reduced gill complement, this subgenus is the most primitive one in respect to its supra-anal apparatus.

Subgenus Soliperla (new)

GILLS: Only 2 pairs, 1 laterally on the meso- and metathorax. Cervical, prothoracic, ventral thoracic, and subanal gills absent.

♂ 9TH STERNITE: The lobe is broad and is set posterior to the anterior border ; much as in *Yoraperla*.

♂ SUPRA-ANAL PROCESS: Strongly sclerotized and often complex in shape.

♀ 8TH STERNITE: Little produced, broadly excavated.

SUBGENOTYPE: *Peltoperla thyra* Needham and Smith.

There is a species closely related to *thyra* in Oregon.

Family Nemouridae

Subfamily Taeniopteryginae

Genus *Brachyptera* Newport

Subgenus *Oemopteryx* *Albarda*

Brachyptera (*Oemopteryx*) *glacialis* (Newport)

1848. *Nemoura* (*Brachyptera*) *glacialis* Newport, Proc. Linn. Soc. 1, p. 389.
1878. *Perla chicoutimiensis* Provancher, Petite Faune Canada, *Névr.*, p. 75.
New Synonymy.
1938. *Taeniopteryx glacialis* Ricker, Trans. Royal Canadian Inst. 22(1),
p. 131.
1938. *Taeniopteryx* (*Oemopteryx*) *alex* Hanson, Bull. Brooklyn Ent. Soc.
33(2), p. 79.
1942. *Brachyptera glacialis* Frison, Bull. Illinois Nat. Hist. Surv. 22, p.
251. (Erroneously ascribed to Newman.)

Two female specimens of *chicoutimiensis* are in the Provancher collection; both are *glacialis*; one is here designated lectotype of *chicoutimiensis*.

The writer's 1938 figure of the type male is misleading in respect to the inward-pointing process developed below the cerci. This process is shown as having a posteriorly-directed projection. Actually this seems to represent only the corner of the basal plate to which the process is attached, viewed at an oblique angle. Mr. D. E. Kimmins of the British Museum has compared Connecticut specimens with the type, and finds them identical in this respect.

DISTRIBUTION: *B. glacialis* has not often been collected, but has a wide distribution: Connecticut, New York, northern Ontario, Minnesota, Saskatchewan, and Utah. Going westward, the terminal breadth of the two anterior members of the supra-anal process become narrower, those from Utah being only half as wide as in eastern specimens.

Subgenus *Taenionema* Banks

Brachyptera (*Taenionema*) *pallida* Banks

1902. *Nemoura pallida* Banks, Can. Ent. 34, p. 125, desc. of ♀. Type locality: Colorado.
1918. *Taeniopteryx pallida* Banks, Bull. Mus. Comp. Zool. 62(1), p. 9. (Described as a new species.)
1925. *Taeniopteryx banksii* Needham and Claassen, Monogr. Plecop., p. 249. (New name for *T. pallida* Banks 1918.)

1925. *Taeniopteryx pallida* Needham and Claassen, Monogr. Plecop., p. 250.
1936. *Nemoura pallidura* Claassen, Am. Ent. Soc. Amer. 29, p. 623. (New name for *N. pallida* Banks 1902.)
1938. *Taeniopteryx kincaidi* Hoppe, Univ. Wash. Publ. Zool. 4, p. 164, desc. and fig. of ♂ 9. New Synonymy.
1942. *Brachyptera pacifica* Frison (in part), Bull. Illinois Nat. Hist. Surv. 22, p. 251. (Not *pacifica* Banks.)
1943. *Taeniopteryx kincaidi* Ricker, Indiana Univ. Publ., Sci. Ser. 12, p. 51, desc. of nymph; p. 54, figs. 15, 16, ♂ and nymph.

Most of the above synonymy has been given or suggested in Dr. Frison's papers ; however, since he also synonymized this species with *pacifica* Banks, a restatement is desirable. The writer's reasons for separating the two species have already been given (1943, p. 51).

DISTRIBUTION: British Columbia to Oregon, Utah, and Colorado.

Brachyptera (*Taenionema*) *raynoria* Claassen

1937. *Taeniopteryx raynoria* Claassen, J. Kansas Ent. Soc. 10, p. 46, desc. and fig. of ♂. Type locality: California.
1942. *Brachyptera pacifica* Frison (in part), Bull. Illinois Nat. Hist. Surv., p. 251. (Not *pacifica* Banks.) Fig. 12, genitalia of ♂, ♀, of *raynoria*.

While recognizing the close relationship of *raynoria* to *pacifica*, *raynoria* is distinguishable by the large laterally-excavated lobes of the ♂ 10th tergite and by the laterally-notched 9th sternite of the ♀.

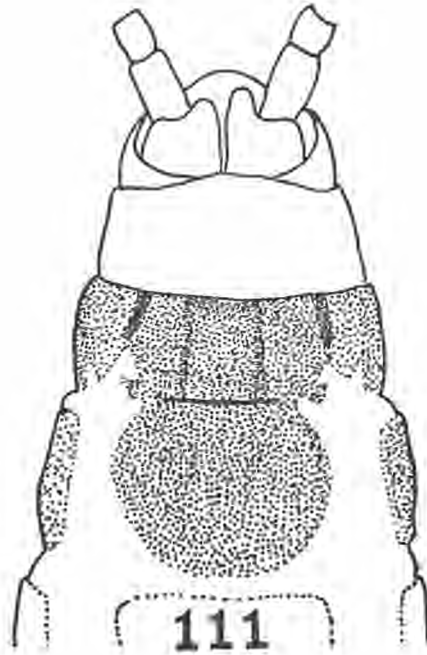
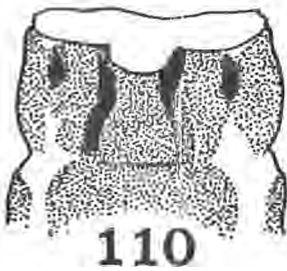
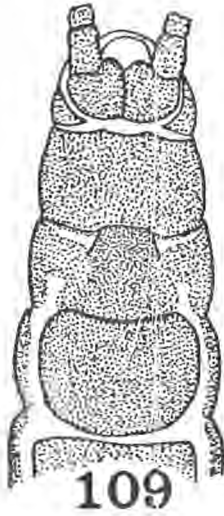
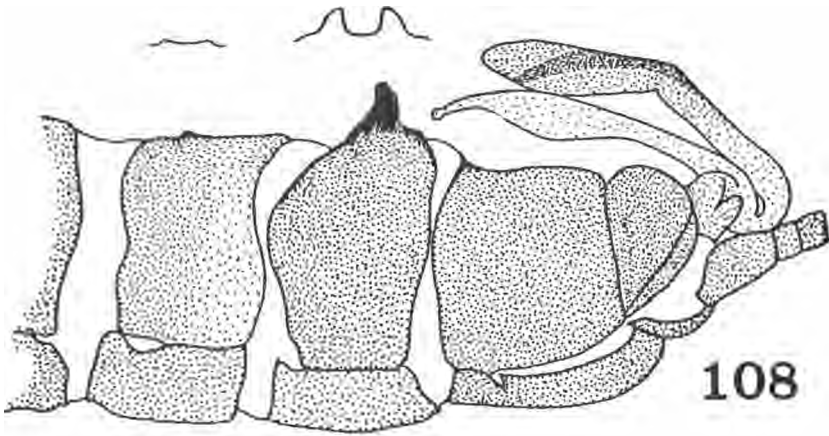
DISTRIBUTION: Sierra Nevada of California.

Subfamily Capniinae

Genus *Allocapnia* Claassen

Allocapnia aurora (new species)

MALE: Length of body, 4.5 mm.; to tip of wings, 4 mm. Tergites 1-4 with an **unsclerotized** median stripe, which is less distinguishable on 5 and 6 also. Tergite 7 usually with a small transverse ridge near its anterior margin ; this varies in development from complete absence to something quite distinct and shallowly **bilobed**. Tergite 8 with a centrally-located eminence bearing 2 erect knobs (Fig. 108), separated by a trough which is 1.5 to 2.0 times the width of a knob, hence wider than in pyg-



Allocapnia aurora (Woodrow, North Carolina). 108. Terminal segments of , from the side. 109. Terminal sternites of 9.
Allocapnia indianae (Medora, Indiana). 110. 7th and 8th sternites of a 9. III. Terminal sternites of a 9.

maea. Supra-anal process very similar to other species of the *pygmaea* group.

FEMALE: Length of body, 5.5 mm.; to tip of wings, 7 mm. Tergites 9 and 10 fully sclerotized, 1-8 with a membranous median stripe. Sternite 7 strongly sclerotized and separated from 8 by a curved groove having extra sclerotization. Sternite 8 divided into an anterior, slightly swollen, portion and a posterior declivitous portion (Fig. 109). The latter, when extended, occupies about a third of the length of the sternite.

Holotype male and allotype ♀: Pigeon River, Woodrow, North Carolina, January 3, 1939, Frison and Burks.

Paratypes as follows:

GEORGIA

Blairsville. January 4, 1939, many ♂, ♀, Frison and Burks.

Young Harris. January 4, 1939, 7 ♂, 3 ♀, Frison and Burks.

NORTH CAROLINA

Balsam. January 3, 1939, many ♂, ♀, Frison and Burks.

Cane River, Sioux. January 2, 1939, 5 ♂, 4 ♀, Frison and Burks.

Cruso. January 3, 1939, many ♂, ♀, Frison and Burks.

Pigeon River, Woodrow. January 3, 1939, many ♂, ♀, Frison and Burks.

Rainbow Springs. January 3, 1939, 6 ♂, 1 ♀, Frison and Burks.

Shooting Creek. January 3, 1939, 6 ♂, 1 ♀, Frison and Burks.

TENNESSEE

Branch of the Ocoee River, Parksville. January 4, 1939, many ♂, ♀, Frison and Burks.

8 mi. W. of Ducktown. January 4, 1939, many ♂, ♀, Frison and Burks.

VIRGINIA

Afton. March 22, 1940, 1 ♂, 2 ♀; Frison, Mohr, and Hawkins.

Crooked Run Creek, Madison. January 1, 1939, 1 ♂, Frison and Burks.

Erwin. January 2, 1939, 8 ♂, 1 ♀, Frison and Burks.

Midmount. January 1, 1939, 1 ♂, Frison and Burks.

Sperryville. March 17, 1940, many ♂, ♀, Frison et al.

This species has been confused with *pygmaea* and *nivicola*, to both of which it is closely related. The male can be distinguished from *pygmaea* by the latter's somewhat more posterior position for the knobs of the 8th tergite, and their closer approximation: they are distant from each other by only about their own width. The small ridge of the 7th tergite, which is

usually found in *aurora*, is absent from *pygmaea*. Specimens of *aurora* having this ridge well developed might be confused with *nivicola*, except that there seems never to be a third knob, however small, between the 2 principal 8th tergite knobs of *aurora* (a small third knob is present in *nivicola* and occasionally occurs in *pygmaea*). In addition, the 7th tergite ridge of *aurora* tends to be bilobed, whereas in *nivicola* it has either 3 lobes or a single central hump. The females are less easy to separate. The shape of the posterior declivitous portion of the subgenital plate seems to be the only criterion: in *pygmaea* this is about twice as wide as long, and rounded at the ends ; in *aurora* it is about 1.5 times as wide as long at its front margin, and tapers rearward ; in *nivicola* it is about as long as wide, and also tapers, but not so much. However, these typical conditions vary considerably, and occasional females occur which could scarcely be placed with certainty.

As compared with its two close relatives, *aurora* is a southern species. Its range overlaps that of *nivicola* in northern Virginia, and *pygmaea* has been taken in the same collection as *aurora* at Madison, Virginia, and apparently also at Sioux, North Carolina, the latter determination depending, however, on a single *pygmaea*-like female.

Allocapnia indianae (new species)

MALE: Apparently indistinguishable from *nivicola*, Fitch. The same variation in form of the tergites occurs as described under that name.

FEMALE: Two types of female occur, often mixed in the same population. Either type differs from *nivicola*, but one seems indistinguishable from *aurora*. In that type the posterior portion of the subgenital plate is evenly sclerotized, marked off at the sides by a membranous notch, and often declivitous. It differs from *nivicola* in having the posterior sclerotized portion broader and the membranous notches narrower (compare Hanson, 1942, Fig. 4, with our Fig. 109). In the second type of female the posterior portion of the plate is less declivitous or not at all so, and the lateral membranous notches are scarcely evident ; the central portion may be completely sclerotized (Fig. 111) but more frequently it loses sclerotization to a greater or less degree:

extreme cases exhibit a deep central excavation (Fig. 110), sometimes with a median lobe of sclerotization at its base.

Holotype ♀ and allotype ♂: Creek northwest of Medora, Indiana, February 14, 1938, Frison and Mohr.

Paratypes :

INDIANA

Same data as holotype, 44 ♂ 8 ♀.

Fourteen-dead Creek, 4 mi. N. of Bloomington on old Road 37. January 25, 1950, ♂ 9, W. E. Ricker.

Gullis Creek, 1 mi. N. of Oolitic. January 25, 1950, ♀, W. E. Ricker.

Bean Blossom Creek, 4 mi. N. of Bloomington on new Road 37. January 25, 1950, 2 ♂, W. E. Ricker.

Center Creek, 2 mi. S of Brooklyn. February 9, 1950, 13 ♂ 2 ♀ March 23, 1950, 3 ♂ 2 ♀, W. E. Ricker.

Junction State Roads 67 and 39, 5 mi. N of Martinsville. February 9, 1950, 9 ♂ 2 ♀, Krumholz and Ricker.

Bryant Creek, 6 mi. S of Martinsville. March 23-25, 1950, 3 ♂ 3 ♀, W. E. Ricker.

ILLINOIS

Dry Run Creek, Fox Ridge State Park. February 14-25, 1938, 3 ♂, Frison and Mohr.

OHIO

Ash Cave. March 6, 1938, 23 ♂ 4 ♀, T. H. Frison.

Tributary of Hocking River, Coolville. March 16, 1940, 15 ♂ 4 ♀, Frison et al.

Margaret Creek, Athens. March 6, 1938, ♂, T. H. Frison.

Mt. Pleasant. March 6, 1938, ♀, T. H. Frison.

Small streams 5-9 miles E of Blue Creek, on Road 125. March 19, 1950, 7 ♂ 6 ♀, W. E. Ricker.

• Turkey Creek', W of Portsmouth. March 19, 1950, 12 ♂ 6 ♀, W. E. Ricker.

• Odle Creek, W of Portsmouth. March 19, 1950, 3 ♂ 2 ♀, W. E. Ricker.

The intra-population variation of the female of this species is no less remarkable than the apparent identity of the male with *nivicola*. If intergradation is later demonstrated between *nivicola* and *indianae* females, the latter name may be reduced to varietal status. However, at the moment there is no sign of this, and differences of similar magnitude and consistency in males would automatically be given specific recognition.

Allocapnia loshada (new species)

MALE: Length of body, 4.5 mm., to tip of wings, 4 mm. Color black. Wings moderately brachypterous. Tergites normal

through the 8th ; 9th bowed in front, behind produced backward and upward over part of the 10th, bearing at the tip a pair of closely-approximated shiny knobs (Fig. 115). Upper lobe of the supra-anal process bent near the base, upturned at the tip.

FEMALE: Length of body, 5.5 mm.; to tip of wings, 6 mm. Tergites 9 and 10 completely sclerotized ; 1-8 with a median membranous stripe. Sternites normal through the 7th, which is separated from the 8th by a complete groove. Eighth shiny, heavily sclerotized, produced into an obtuse-angled plate, usually with a central posteriorly-expanded darker area (Fig. 113).

Holotype male and allotype female: Horse Creek, Jaeger, West Virginia, January 1, 1936, John Addair.

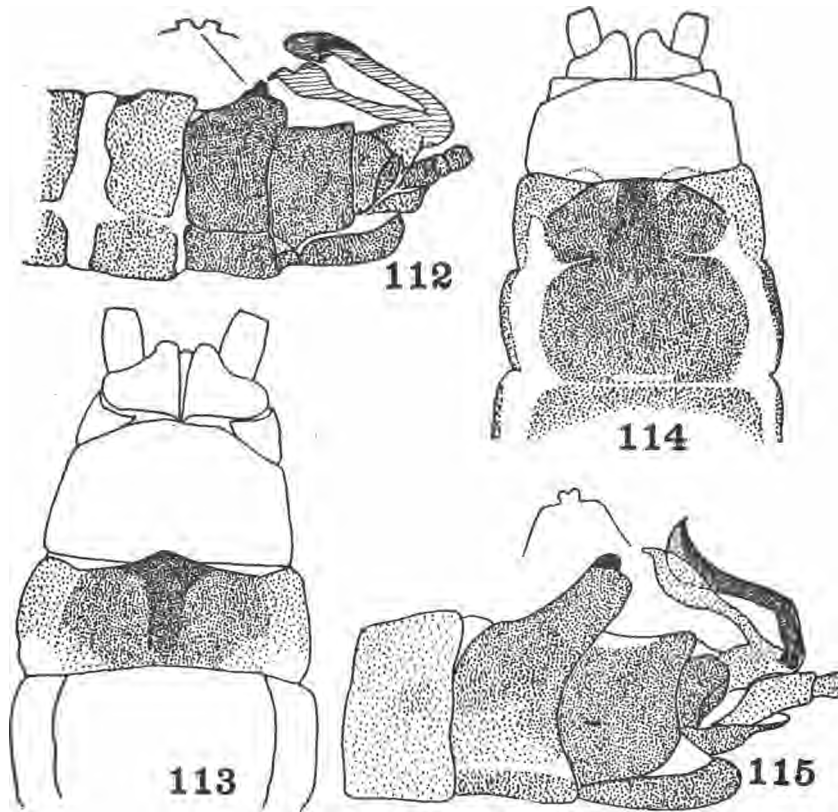
Paratypes : same locality as holotypes, 17 ♂ 20 ♀ on January 1; 7 ♂ 12 ♀ on February 2, 1936, John Addair.

A. loshada is allied to *A. granulata* but differs (1) in having a sharply upturned tip of the supra-anal process ; and (2) in the tip of the process of the 8th tergite, which, seen from behind, in *loshada* has a small erect double tubercle on a flat shelf, whereas *granulata* has 4 tubercles, all pointing more or less rearward, the median pair being separated by a deep notch. In the female the posterior part of the median dark area of the subgenital plate is usually free from the sides of the plate in *granulata*, whereas it is only exceptionally so in *loshada*, and then only to a slight extent. Female *loshada* resembles *recta* a good deal, and may not always be separable from it ; in *recta*, however, the posterior margin of the plate is usually less produced than in *loshada*.

***Allocapnia nivicola* Fitch**

1847. *Perla nivicola* Fitch, Amer. Jour. Agr. and Sci. 5, p. 278. Type locality: New York.
1942. *Allocapnia nivicola* Hanson, Bull. Brooklyn Ent. Soc. 37, p. 83; Plate II, figs. 2, 4,
1942. *Allocapnia pygmaea* Frison (in part), Bull. Illinois Nat. Hist. Surv. 22, p. 266, fig. 33 (male only). (Not *pygmaea* Burmeister, 1839.)

The species *nivicola* is distinguished by a greater variability than most members of the genus. In the male the principal range of variability has been illustrated in the papers cited above: Hanson shows a specimen with the transverse process of the 7th tergite trilobed, and the middle lobe of the process of the 8th tergite almost as high as the lateral lobes ; Frison shows a



Allocapnia sandersoni. 112. Terminal segments of holotype , from the side. 114. Terminal sternites of allotype 9.
Allocapnia loshada. 113. Terminal sternites of allotype 9. 115. Terminal segments of holotype ♂, from the side.

smooth 7th-tergite process and an 8th process with the median lobe quite weak. Both these illustrations are from eastern specimens (Dr. Frison's from Flintstone, Maryland).

DISTRIBUTION: Massachusetts and New York to Virginia.

Allocapnia sandersoni (new species)

MALE: Length of body, 6.5 mm., to tip of wings, 4 mm. Color black. Tergites 1-7 only weakly sclerotized along the midline, the 7th sometimes with a patch of dark sclerotization anteriorly. Eighth tergite with a raised bifid process, the 2 knobs

of the process rather close together and elongate in shape (dorsal view). Supra-anal process as in figure 112.

FEMALE: Length of body, 7 mm.; to tip of wings, 7 mm. Tergites 9 and 10 completely sclerotized; 1 through 8 are unsclerotized medially. Seventh and 8th sternites joined by continuous sclerotization medially, but with narrow unsclerotized notches at the side (Fig. 114). Central margin of the 8th sternite produced antero-laterally as a fold back onto the sternite, forming a curved arc. The 8th sternite is often most heavily sclerotized medially, and there is a small unsclerotized patch on either side at the posterior margin.

Holotype ♂ and allotype ♀: Clear Creek, 2.5 miles N of Fayetteville, Washington County, Arkansas, March 21, 1939, M. W. Sanderson.

Paratypes: Same data as holotype: 8 ♂ ♀, Clear Creek in Fayetteville, Arkansas. March 6, 1938, 4 ♀, M. W. Sanderson.

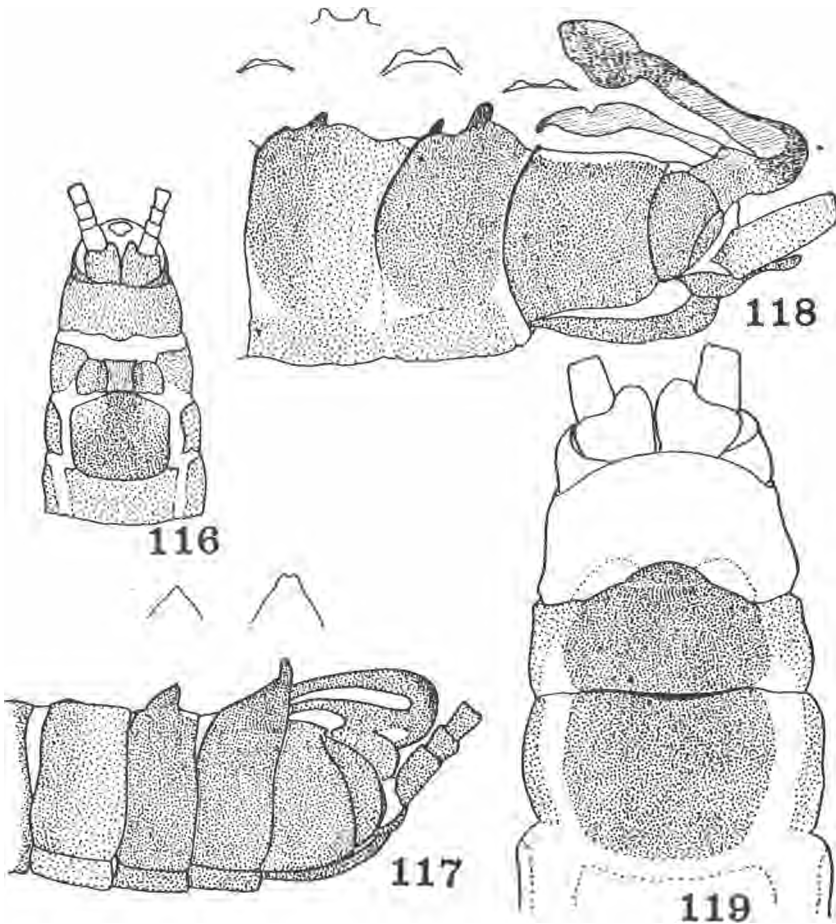
Great House Springs on Clear Creek, Washington County, Arkansas. January 10, 1948, ♂, L. Warren.

This species is perhaps closest to *Allocapnia rickeri*. It differs in having the knobs of the ♂ 8th tergite set much closer together, and in the folds swept back from the subgenital plate of the female. The male *sandersoni* could be confused with *A. pygmaea*, but differs in having the processes of the 8th tergite elongated instead of round, giving a characteristic appearance when viewed from above or from behind. The female *pygmaea* has a sclerotized fold dividing the 7th and 8th sternites.

***Allocapnia zola* (new species)**

MALE: Length of body, 4 mm.; to tip of wings, 3.5 mm. Color black. Wings moderately brachypterous. Tergites normal through the 6th. Seventh tergite with a low scarcely-perceptible anterior ridge, sometimes excavated along the top; a pair of conspicuous knobs set anterior to the middle of the segment. The 8th tergite is modified similarly to the 7th, but both the anterior ridge and the knobs are much larger, and the knobs usually have a low mound between them. The 9th tergite has its median surface unsclerotized, and a pair of small knobs at the anterior margin. Supra-anal process with a bulbous tip (Fig. 118).

FEMALE: Length of body, 7 mm.; to tip of wings, 7 mm. Abdominal tergites 1 through 8 unsclerotized centrally, 9 and 10 completely sclerotized. Both the 7th and 8th sternites expanded and well sclerotized, separated by a groove which is dark and more heavily sclerotized. Tip of the subgenital plate typically produced and rounded (Fig. 119), with a subterminal transverse groove. However, there is considerable variation: in some



Allocapnia maria. 116. Terminal sternites of ♀. 117. Terminal segments of ♀ from the side.
Allocapnia zola. 118. Terminal segments of holotype ♀, from the side. 119. Terminal sternites of ♀

specimens the tip is much less rounded, and may be set off from the side margin by a short straight section ; also, very often there are 2 dark lines running the length of the 8th **sternite**, much as in one form of *A. indianae* (Fig. 111).

Holotype ♂ and allotype : Ash Cave, Ohio, March 6, 1938, T. H. Frison.

Paratypes as follows:

NEW YORK

North Collins. April 13, 1937, 2 ♂ 1 ♀, H. H. Ross.

OHIO

Same data as holotype: 23 ♂ 17 ♀.

Hocking County. March 22, 1938, 1 ♂ 9 ♀, D. J. and J. N. Knull.

Harper's Run, Logan. March 5, 1938 ♀, T. H. Frison.

Clear Creek, Rockridge. March 5, 1938, ♂ ♀, T. H. Frison.

PEN N SYLVANIA

East Sandy Creek, Van. February 18, 1938, 10 ♂ 1 ♀, R. E. Yeatter.

Kratzer Run, Grampian. February 18, 1938, ♂, R. E. Yeatter.

1½ miles E of Emereckville. February 18, 1938, 9 ♂ 2 ♀, R. E. Yeatter.

VIRGINIA

Gore. March 17, 1940, ♂, Frison et al.

WEST VIRGIN IA

Little Cacapon River, Augusta. March 17, 1940, ♂, Frison et al.

Kanetown. March 16, 1940, 7 ♂ 5 ♀, Frison et al.

Fellowship. March 16, 1940, ♀, T. H. Frison.

This species belongs in the *pygmaea* group, and has carried the development of the tergal processes to the most extreme condition yet known. *A. nivicola* is closest, but it lacks processes on the 7th tergite.

Subfamily **Leuctrinae**

Genus **Leuctra** Stephens

Subgenus *Leuctra* s.s.

Leuctra (**L.**) **biloba** Claassen

1923. *Leuctra biloba* Claassen, Can. Ent. 55, p. 258. Type locality: Georgia.

1925. *Leuctra biloba* Needham and Claassen, Monogr. Plecop., p. 225; p. 370, figs. 9, 10.

The specimen used for the illustrations of male genitalia in the above publications was a paratype which differs from the holotype and most of the rest of the type series in having the 2 lobes of the pigmented process of the 8th tergite subtruncate, though scarcely as sharply so as the figures show it. The normal termination of each of these lobes, which the holotype excellently illustrates, is in a point not unlike those of *Leuctra grandis*, but usually somewhat blunter (Fig. 120). There is much variation in the exact configuration of these processes, and I believe there is no question that the paratype above is true *biloba*. The separation of the species from *grandis* may occasionally be difficult, although size will usually suffice. The 8th-tergite process in *grandis* has a V-shaped notch centrally, whereas in *biloba* it is usually (not always) trough-shaped as in figure 120.

DISTRIBUTION: Mountains of Georgia, North Carolina, and Tennessee.

Leuctra (L.) *maria* Hanson

1941. *Leuctra maria* Hanson, Amer. Midland Nat. 26, p. 174.

This distinctive species has been reported only from the type locality. In the INHS there is a series of specimens from Algonquin Park, reared from nymphs by W. M. Sprules, in which male and female are well associated. The female proves to be rather distinctive, and quite different from the female described by Hanson.

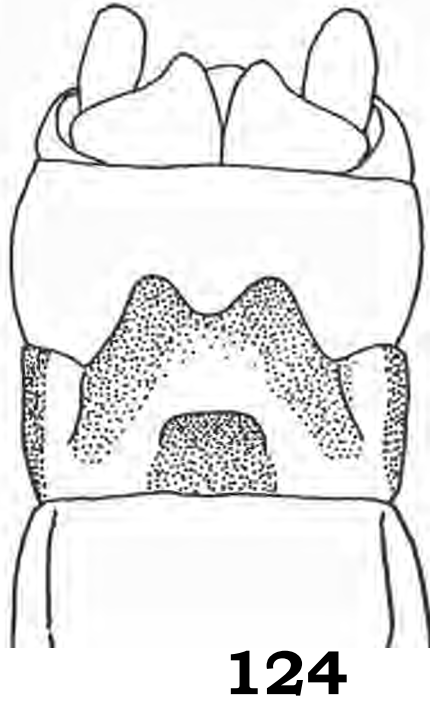
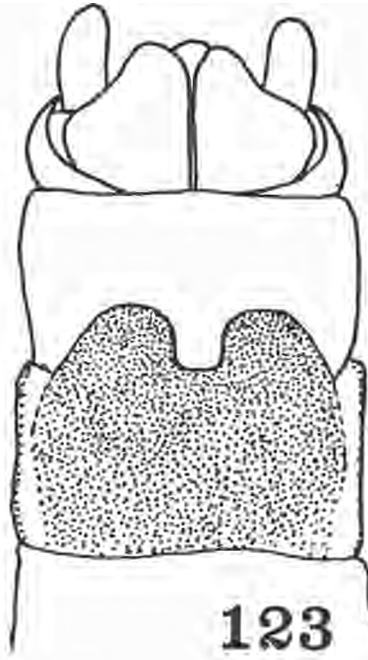
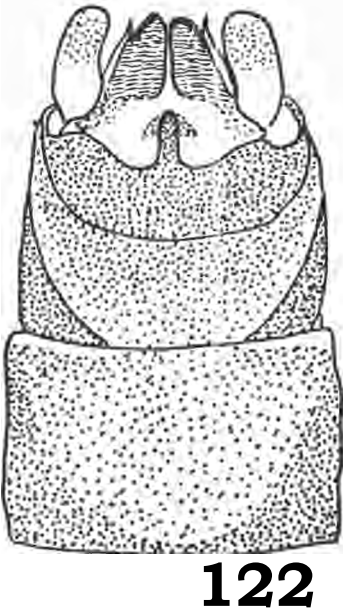
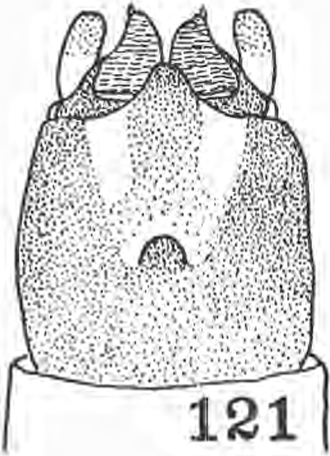
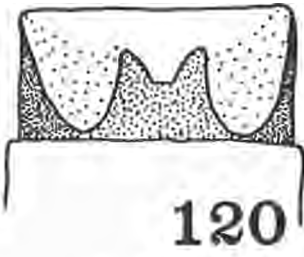
FEMALE: Length of body, 6.5 mm.; to tip of wings, 9 mm. Color dark brown. Eighth sternite with a distinct median hump, much as in *L. duplicata* but more anterior in position. The subgenital plate has a broadly-excavated median notch (Figure 124) unlike the usual narrow notch of typical *Leuctra*.

ONTARIO

Costello Lake, Algonquin Park, Sta. No. 1. May 28, 1939, 5 ; May 30, 2 ♂ 10 ♀; June 1, 3 ♂ 6 ♀; W. M. Sprules.

Leuctra (L.) *moha* (new species)

MALE: Length of body, 4.5 mm.; to tip of wings, 7 mm. Color dark brown. Ninth sternite somewhat produced and rounded ; a short ventral lobe present near the middle of the sternite (Fig.



121). Subanal lobes in two parts. The inner member is broad and concave behind (our figures do not do justice to their full breadth, because they are seen obliquely). The slender outer members of the subanal lobes are pressed to the lateral edge of the inner member. Dorsally the 8th and 9th tergites have a rather faint pattern (Fig. 122). The 10th tergite bears a small supra-anal body.

Holotype ♂: Mossy Creek, 4.6 miles N of Perry, Georgia, October 12, 1945, P. W. Fattig.

This species is distinct from all other *Leuctrae* by reason of the broad inner member of the subanal lobes. Unfortunately, no definite association of male and female can be made. Two types of female were taken along with the holotype; because of its more accordant size, one of these, represented by 2 specimens, is probably *moha*, and a description follows:

FEMALE: Length of body, 6 mm.; to tip of wings, 8.5 mm. Subgenital plate with a broad straight-walled notch, the lobes on either side rounded and swollen (Fig. 123).

Two similar females were taken by Dr. Fattig in Beaver Creek, 5 mi. SE of Roberta, Georgia, October 20, 1944. Both Roberta and Perry are in west-central Georgia.

Leuctra (L.) tenella Provancher

1876. *Leuctra tenuis* Provancher, Naturaliste Canadien 8, p. 218. (Not *tenuis* Pictet.)
 1878. *Leuctra tenella* Provancher, Naturaliste Canadien 10, p. 126. Type locality: vicinity of Quebec City.
 1923. *Leuctra hamula* Claassen, Can. Ent. 55, p. 261, New synonymy.
 1925. *Leuctra hamula* Needham and Claassen, Monogr. Plecop., p. 229; p. 370, figs. 1-2.

The ♂ specimen of *tenella* in the Provancher collection (MPQ) is here designated **lectotype; it is** the only specimen so labeled in the "first collection." It is in excellent condition and is readily identified with *hamula*. The southern species *L. carolinensis* Claassen (Can. Ent. 55, p. 258) is very close to *tenella*, but has

-
- Leuctra biloba* (Trout Branch, Smoky Mountain National Park). 120. 8th tergite of .
Leuctra moha. 121. Terminal segments of holotype ♂, from below. 122. The same, from above. 123. Terminal sternites of a ♀, probably *moha*.
Leuctra maria (Costello Lake, Algonquin Park, Ontario). 124. Terminal sternites of ♀.

a somewhat longer and more acute process on the ♂ 7th tergite, on the average.

DISTRIBUTION of *tenella*: Minnesota through Ontario, Quebec, New York, New England, and the Maritime provinces.

DISTRIBUTION of *carolinensis*: Mountains of North Carolina and Tennessee.

Subgenus **Paraleuctra** Hanson

Leuctra (Paraleuctra) augusta Banks

1907. *Leuctra augustus* Banks, Can. Ent. 39, p. 330. Type locality: Port Renfrew, Vancouver Island, British Columbia.
1923. *Leuctra bradleyi* Claassen, Can. Ent. 55, p. 257. (Emerald Lake, British Columbia.) New Synonymy.
1925. *Leuctra augusta* Needham and Claassen, Monogr. Plecop., p. 224; Plate 42, fig. 1.
1925. *Leuctra bradleyi* Needham and Claassen, Monogr. Plecop., p. 225; p. 373, figs. 12-15.

The type series of *augusta* now consists of a single specimen lacking its abdomen. However, Needham and Claassen's figure, which was drawn from one of the two cotypes, is enough to show its identity with female *bradleyi*, and its dissimilarity to other western *Leuctrae*.

DISTRIBUTION: Cordillera from southern British Columbia to Oregon and Utah.

Leuctra (Paraleuctra) occidentalis Banks

1907. *Leuctra occidentalis* Banks, Can. Ent. 39, p. 329.
1925. *Leuctra occidentalis* Needham and Claassen, Monogr. Plecop., p. 231.

A study of the type material of Bank's *occidentalis* reveals that it consists of three separate species. To conserve current usage I designate as lectotype the complete ♀ specimen associated with no. 11370 in the Museum of Comparative Zoology at Cambridge. The other two species represented in Bank's series are *forcipata* and *purcellana*, both being at the USNM.

DISTRIBUTION: Southern British Columbia to Colorado and northern California.

Leuctra (Paraleuctra) purcellana Neave

1934. *Leuctra purcellana* Neave, Can. Ent. 66, p. 2, desc. of ♂.
1937. *Leuctra bilobata* Claassen, J. Kansas Ent. Soc. 10(2), p. 45, desc. of ♀. New Synonymy.

The above association h; based on 3 females and 4 males taken together at London Hill Mine, Bear Lake, British Columbia, and which are a part of the type series of *L. occidentalis* Banks in the USNM. This species is the most distinctive *Paraleuctra*, the wings being brown rather than black.

DISTRIBUTION: Southeastern British Columbia.

Subgenus **Zealeuctra** (new)

In my paper of 1943 the subgenera of *Leuctra* occurring in western North America were described. The eastern species mostly fall into *Leuctra s.s.* Exceptions are *L. sara* Claassen and an undescribed species which belong in *Paraleuctra*; also *L. claasseni* Frison for which a subgeneric name is now proposed.

The new subgenus is perhaps closest to *Paraleuctra* Hanson, with which it agrees in venation and, to a large extent, in the form of the prosternal sclerites (see Hanson, 1941, Figs. 2, 5). It differs, however, in that the presternum is completely rather than partially separated from the basisternum. The genitalia have been illustrated by Frison (1942, p. 257). The male has a lobe at the back of the 9th sternite. The 9th tergite is cleft and elevated at the sides, low and membranous in the middle; the 10th tergite has a deep median depression in which the stout sclerotized supra-anal process lies. The cerci are somewhat enlarged and moderately sclerotized. The subanal lobes consist of only one member on each side; they run forward and upward, as in the subgenera *Despaxia* or *Moselia*, and lack the initial anterior loop of *Paraleuctra*; they are rather thick near the tips and are fused posteriorly. On the female abdomen there is no median dorsal sclerotized stripe (as found in *Paraleuctra* and *Moselia*), and the 8th sternite is unsclerotized centrally except near the anterior margin. The nymph is distinguished by several delicate stalked and tufted anal gills, which have not been described for other subgenera but might easily be overlooked.

SUBGENOTYPE and only known species: *Leuctra claasseni* Frison, 1929.

Leuctra (Zealeuctra) claasseni Frison

1929. *Leuctra claasseni* Frison, Bull. Illinois Nat. Hist. Surv. 18, p. 404, ♂, ♀, 9, nymph.
 1935. *Leuctra claasseni* Frison, *ibid.* 20, p. 354, ♂, ♀, 9, nymph.

This is a common species in the hillier sections of the Middle West. In southern Indiana it lives in many "dry runs"—streams which may lack water for weeks or months at a time in summer.

DISTRIBUTION: Western West Virginia ; southern Ohio, Indiana, and Illinois ; Missouri and Oklahoma.

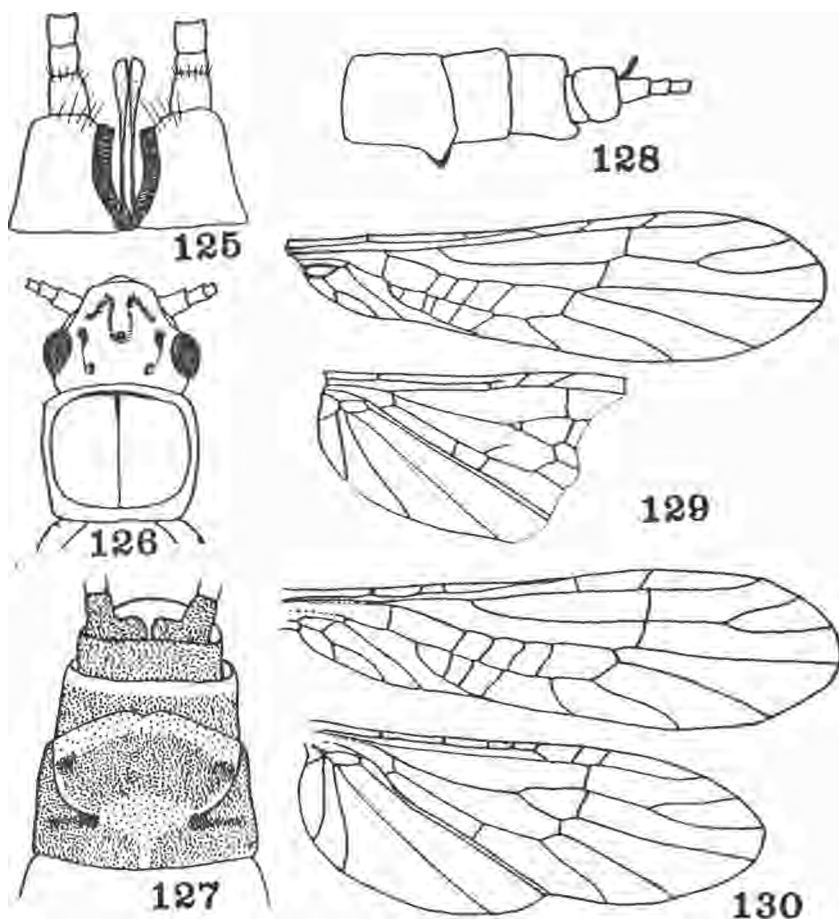
Family **Chloroperlidae**
Subfamily **Paraperlinae**
Genus **Utaperla (new)**

This genus is to be placed in the subfamily Paraperlinae as defined by Ricker (1943). The head capsule is slightly elongated, but much less so than in *Paraperla*, and there is no straight-sided section behind the eyes. The general aspect, in fact, is that of an *Alloperla* of the subgenus *Sweltsa*. However, the basal body of the male supra-anal process is suspended at the anterior edge of the 10th tergite and lies free in the deep median cleft, instead of being attached to the sides of the cleft as in *Alloperla*. On the 7th sternite there is a raised knob, thickly covered by spines. The venation also is much like *Paraperla*, though with fewer crossveins. (Fig. 130).

GENOTYPE: *Utaperla sopladora* (new).

Utaperla sopladora (new species)

MALE: Length of body, 8 mm.; to tip of wings, 9 mm. General color dark brown with lighter and darker markings. Head with a well-defined M-mark and lateral *tubercles* (Fig. 126) ; antennal segments 2-6 yellow, others brown. Pronotum almost as long as wide, brown with narrow yellowish lateral and posterior margins (outside the groove), and with a narrow black mid-line, marginal groove, and reticulations. Meso- and metanota brown with black U-marks, and some other sutures lined with black. Mesoternum with a heavily-pigmented median line from the hind margin to nearly the level of the anterior corners of the furcal pits, but not reaching the rather vague dark band which joins those corners. The wings (Fig. 129) are notable for their rather small size and the shortness of the subcosta. Cu_1 of the forewing is somewhat reduced—about halfway between *Paraperla* and *Alloperla* in that respect. The hindwing has three fairly long branches of A_2 , and one short branch. Abdomen with a broad rather diffuse median stripe dorsally, extending back



Utaperla sopladora. 125. 10th tergite of holotype ♂. 126. Head and pronotum of allotype ♀. 127. Terminal sternites of allotype. 128. Terminal segments of ♂, from the side. 129. Wings of holotype. 130. Wings of allotype.

over the 7th tergite. Ventrally on sternites 2-6 there is a central dot and a pair of dark patches at the front margin ; one or two lateral elongate dark markings appear on sternites 2-7.

The 7th sternite is excavated and raised posteriorly, and bears numerous long hairs and stout spines (Fig. 128) ; 9th sternite slightly produced behind ; 10th sternite membranous near the middle. The 10th tergite completely cleft dorsally, the sides of the cleft very strongly sclerotized (Fig. 125). The supra-anal

body is suspended from the anterior end of the cleft and lies freely in it. It is bow-shaped in side view, its tip is ascending but not recurved, and is somewhat expanded and notched as seen from in front. Cerci incomplete in this specimen, the longer with 6 segments.

FEMALE: Length of body, 9 mm.; to tip of wings, **10** mm. Color and markings as in the ♂. Wings ~~much as~~ in the ♂, but Sc of the hindwing is longer, and there are only **3** intercubital crossveins in the forewing (Fig. 130). Sternite 8 moderately produced and broadly rounded (Fig. 127).

Holotype ♂ = Puffer's Lake, Utah, June 11, 1943, Knowlton and Telford (in the INIIS ; body in alcohol, wings on a slide).

Allotype ♀ : Yukon River, Dawson, Yukon, June 23, 1949, W. W. Judd (in the CNC ; in alcohol).

The male of this interesting species was set aside by Dr. Frison in 1943 as "n. gen. n. sp.". Although it is not in good condition, there is such close agreement in color and structure with the Yukon ♀ that I have little hesitation in describing the latter under the same name. The phylogenetic relationship of *Utaperla* was discussed earlier. It serves as a reminder that our stonefly fauna is not so well known that important new ranges of structure may not still be discovered. It is gratifying, too, that the first specimen should have been taken by Dr. G. F. Knowlton of Logan, Utah, who has for many years been an indefatigable collector of aquatic and other insects of Utah and adjoining states.

The 3 described paraperline stoneflies are all from western North America. However, in 1950 I obtained 3 immature nymphs from the Little Pigeon River, Smoky Mountains National Park, Tennessee, which appear to belong to the subfamily, and it is interesting to speculate whether' they represent still another monotypic genus.

Subfamily **Chloroperlinae**

Genus **Alloperla** Banks

Subgenus **Alloperla** s.s.

Alloperla (A.) leonarda (new species)

MALE: Length of body, 7mm.; to tip of wings, 9 mm. Color pale green, except the black ocellar rings. Supra-anal process

mounted on a fleshy lobe ; slender, nearly straight-sided, its tip nearly truncate, with acute lateral projections (Fig. 132).

FEMALE: Length of body, 7.5 mm. ; to tip of wings, 10 mm. Eighth sternite produced into a brief, narrow subgenital plate (Fig. 135).

Holotype ♂ and allotype ♀: North Branch of Otter River, Houghton County, Michigan, June 18-22, 1949, J. W. and F. A. Leonard.

• Paratypes : same data as holotype, ♂ 4 ♀ ; June 2, 1949, 1 ; June 28—July 27, 1949, 50 ♀ ; Big Sand Creek, Pine County, Minnesota, May 27, 1949, ♂ , P. H. Harden.

The short narrow subgenital plate of the ♂ distinguishes this species from all others of the subgenus. The ♂ supra-anal process is similar to that of *medveda*, but is somewhat more slender and lacks any trace of a terminal point.

Alloperla (A.) *medveda* (new species)

MALE: Length of body 6 mm. ; to tip of wings, 9 mm. Color in life green, in alcohol yellow ; without dark markings.

Supra-anal apparatus consisting of a long inferior sclerotized rod running backward from the anterior edge of the 10th tergite to terminate in a sclerotized basal support, surmounted by and posteriorly continuous with a halberd-shaped supra-anal process (Fig. 137). The 3 points of this process vary somewhat in length and acuteness, being longer and more slender in the holotype series than in the Waterton or Yellowstone specimens.

FEMALE: Many females in this subgenus are distinguishable with difficulty, if at all. Two females taken with a male *medveda* at Waterton on July 23, 1946, are likely to be of this species but they are at present undistinguishable from females of, for example, *A. serrata*, which occurs in the same region. The triangularly produced subgenital plate of these specimens is like Frison's figure of *A. neglecta* (1942, p. 345).

Holotype ♂: Bear Tooth Creek, el. 9,500 ft., Bear Tooth Mountains, southern Montana. August 21, 1946, W. E. Ricker.

Paratypes: same data as holotype 2 ; Waterton National Park, Alberta, July 24, 1946, ♂ , G. F. Knowlton (2 ♀ taken with this specimen) ; Lost Creek, Yellowstone National Park, Wyoming, July 20, 1921, ♂ (Cornell University Collection) ; Watson

Lake, Yukon Territory, June 24, 1948, ♂, W. R. Mason (Canadian National Collection).

As a near relative of this species we may cite *Alloperla elevata* Frison, which has the supra-anal process rounded anteriorly.

A. medveda has already been figured by Needham and Claassen (1925, p. 331, Fig. 10), who showed the Cornell paratype above under the name *A. lineosa* Banks. This specimen was taken with a female *lineosa*, and Needham and Claassen accordingly described it as the male of that species. In this they had the excuse that some preservative had greatly darkened both specimens, making it difficult to separate them on the basis of the presence of the dorsal abdominal line in *lineosa* and its absence in *medveda*. Needham and Claassen's figure is a good representation of *medveda* except that the lateral points of the supra-anal process were overlooked—another omission for which the dark color of the specimen can be blamed.

Alloperla* (A.) *thalia (new species)

MALE: Length of body, 7 mm. ; to tip of wings, 9.5 mm. Color pale in alcohol, presumably green in life, without dark markings except around the ocelli. The tip of the supra-anal apparatus (Fig. 131) is rather slender, straight-sided, rounded distally.

FEMALE: Length of body, 8 mm. ; to tip of wings, 10.5 mm. Subgenital plate produced and rounded (Fig. 134).

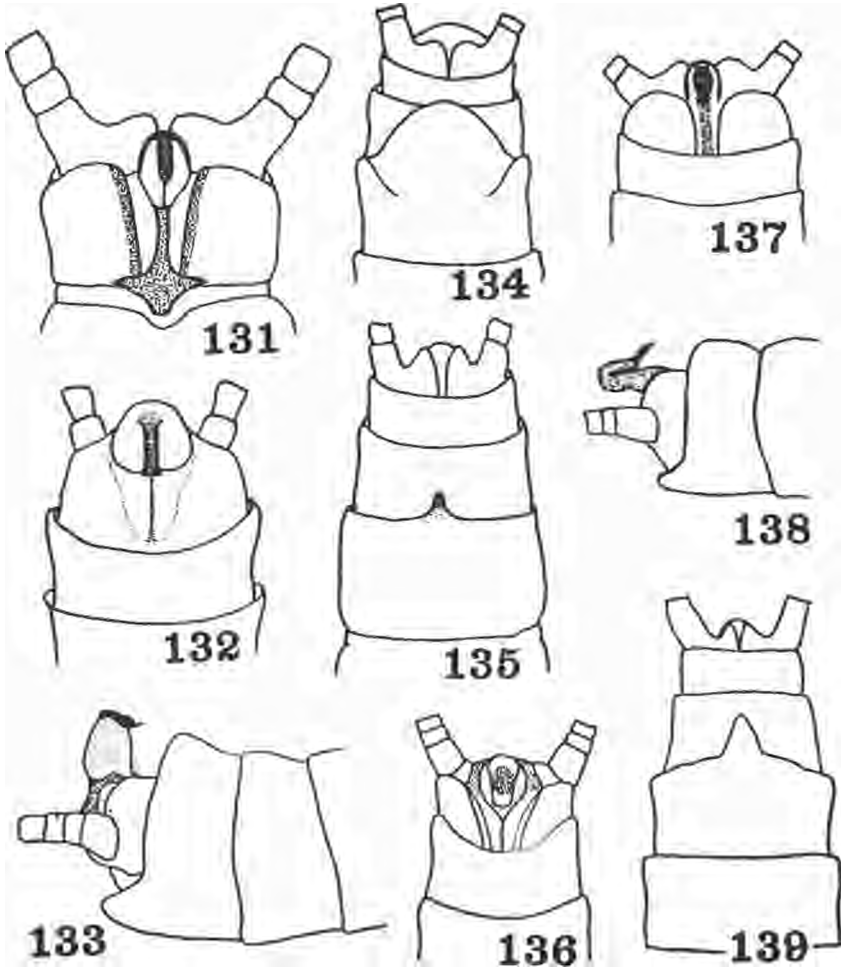
Holotype ♂, allotype ♀, and paratype ♂: Central Park Bridge to Cameron Bridge, Gallatin County, Montana, June 17-18, 1949, R. Herswell.

The male of this species is almost indistinguishable from the eastern species *neglecta* Frison. However, the supra-anal process of *neglecta* is slightly swollen near the tip, in dorsal view, and is somewhat thicker in side view. The female *neglecta* has the subgenital plate triangular, straight-sided and its tip rather narrowly rounded (Frison, 1942, Fig. 124).

Alloperla* (A.) *usa (new species)

MALE: Length of body, 8.5 mm. ; to tip of wings, 10 mm. Color in alcohol pale yellow, in life presumably brilliant green, without dark markings anywhere. In this and in its general

structure it conforms to the typical subgenus of *Alloperla* (type species *imbecilla* Say). The distinctive features of the supra-anal



Alloperla thalia. 131. Terminal tergites of holotype ♂. 134. Terminal sternites of allotype ♀.

Alloperla medveda. 137. Terminal tergites of holotype ♂.

Alloperla leonarda. 132. Terminal tergites of holotype ♂. 135. Terminal sternites of allotype ♀.

Alloperla banksi. 138. Terminal abdominal segments of ♂, from the side. Credit River at Terra Cotta, Ontario.

Alloperla usa. 133. Terminal segments of ♂, from the side, with supra-anal process erected. Leconte Creek, Gatlinburg, Tennessee. 136. Terminal tergites of holotype ♂. 139. Terminal sternites of ♀.

apparatus are shown in figures 133 and 136. The process itself is sclerotized, upturned near the tip (side view) and with a dense patch of yellowish hairs covering its middle half (Fig. 136). It is supported on a structure of satiny finish, capable of considerable vertical extension (Fig. 133), which in turn is surrounded by a sclerotized basal support.

FEMALE: Length of body, 8.5-9.5 mm. ; to tip of wings, 12-13.5 mm. Subgenital plate narrowly produced (Fig. 139).

Holotype ♂ : Little Pigeon River near Alum Cave Creek, Smoky Mountain National Park, Tennessee, June 10, 1949. W. E. Ricker.

Allotype ♀ : Little Pigeon River near Park Headquarters, Smoky Mountain National Park, Tennessee, May 26, 1949. W. E. Ricker.

Paratypes as follows:

GEORGIA

Cornelia. May 10, 1944, 2 ♂, T. H. Frison and H. H. Ross.

TENNESSEE

Same data as holotype, 1 ♂ ; the same, May 26, 1949, 1 ♀.

Same data as allotype, 2 ♀.

Leconte Creek, Gatlinburg. May 14, 1939, ♂ ; June 14, 1940, 2 ; Frison and Ross.

Little Pigeon River at 4,400 ft. el. Smoky Mountains National Park. June 10, 1949, ♂, W. E. Ricker.

Little Pigeon River near Cole Branch, Smoky Mountains National Park. July 10, 1949, ♀, W. E. Ricker.

Cole Branch, Smoky Mountains National Park. May 26, 1949, ♂, W. E. Ricker

Walker Prong, Smoky Mountains National Park. June 10, 1949, ♂, W. E. Ricker

Creek N of Cheoah Dam, Smoky Mountains National Park. May 14, 1948, ; June 9, 1949, ♂, W. E. Ricker.

The closest relatives of this species are among those which have the supra-anal process proper surrounded by a soft body with glistening "satin" surface (this lustre being apparently caused by very minute appressed white hairs), said body being capable of inflation which raises it and the process considerably upward (Fig. 133). The species *A. voinae* Ricker has such a body, but is distinguished by having the supra-anal process elongated transversely. In *Alloperla banksi* Frison the supra-

anal process itself has considerable resemblance to *usa*, but a basal body of the above type is absent. Further the process in *banksi* is, in lateral view, somewhat more gradually bent upward; in dorsal view it is widest near the tip, and it has white hairs, very difficult to distinguish, on the outer third only of the process dorsally, and, more conspicuously, in a terminal tuft. By contrast, the process of *usa* is bent up only near the tip, it is widest near the base, it lacks any terminal tuft of hairs, and has a large area of dense easily-distinguished hairs dorsally near the middle (not near the tip). From these criteria it is obvious that it is *usa* which was illustrated under the name *banksi* by Frison (1942, p. 344, Fig. 123, lower right drawing only). The other, dorsal, views of the process in this same figure are, however, true *banksi*, agreeing with the holotype, and all of the paratypic specimens listed in the same paper have been checked and are *banksi*. It is, nevertheless, unquestionable that the lateral view is *usa* and in all likelihood the same specimen as used for figure 133 of this paper, since there was no other specimen with erected supra-anal process in the INHS collection. It appears that at one time Dr. Frison had not yet distinguished the two species, and used this specimen for an illustration because of the erect, clearly distinguishable process. When later he correctly separated them, the source of the above drawing was overlooked and it was inadvertently included in the description of *banksi*. A lateral view of the process of *banksi* is presented in figure 138.

Subgenus *Sweltsa* Ricker

Alloperla (*Sweltsa*) *naica* Provancher

1876. *Perla naica* Provancher, Naturaliste Canadien 8, p. 214. Type locality: vicinity of Quebec city.
1925. *Alloperla novascotiana* Needham and Claassen, Monogr. Plecop., p. 113, p. 335, fig. 1; description of ♂. New synonymy.
1942. *Alloperla novascotiana* Frison, Bull. Illinois Nat. Hist. Surv. 22, pp. 345-6; desc. and fig. of ♀.

As lectotype of *naica* is designated a male specimen in the Provancher collection, it being the only specimen labelled as *naica*.

The species *naica* is allied to the western species *albertensis*, *coloradensis*, *townesi*, etc., rather than to any eastern species.

DISTRIBUTION: Quebec, Nova Scotia, New York, northern Pennsylvania.

***Alloperla (Sweltsa) onkos* Ricker**

1935. *Alloperla onkos* Ricker, Can. Ent. 67, p. 256. Type locality: Horning's Mills, Ontario. (The female subgenital plate illustrated in figure 13 is not very typical; usually it is smoothly rounded posteriorly.)
1925. *Alloperla mediana* Needham and Claassen (in part), Monogr. Plecop., p. 122. (*Not* Banks, Trans. Amer. Ent. Soc. 37, p. 336.) The male illustration (p. 333, Fig. 4) appears to be *onkos*.

The two species *onkos* and *mediana* are closely related, but are separable structurally and, apparently, geographically. The supra-anal process of *onkos* is deeper, its terminal hook is slightly broader and rounded or bluntly pointed at the tip, and the 9th tergite has a strong median process (Figs. 10 and 11 of Ricker, 1935). The species *mediana* has the basal body of the supra-anal process not so deep, its tip is more slender and is sharply pointed (Fig. 141), while the process of the 9th tergite is at most very weak, and often indistinguishable. In the female the subgenital plate of *mediana* is narrower and more nearly truncate at the tip.

DISTRIBUTION: So far no intergradation between the two species has appeared: *mediana* is known from the mountains of Virginia, North Carolina, and Tennessee, and there is one record for southeastern Ohio; *onkos* is known from Ontario, New York, New England, and Nova Scotia.

***Alloperla (Sweltsa) pacifica* Banks.**

1895. *Chloroperla pacifica* Banks, Trans. Amer. Ent. Soc. 22, p. 313. (Washington State.)
1925. *Alloperla spatulata* Needham and Claassen, Monogr. Plecop., p. 120. (California.) New Synonymy.

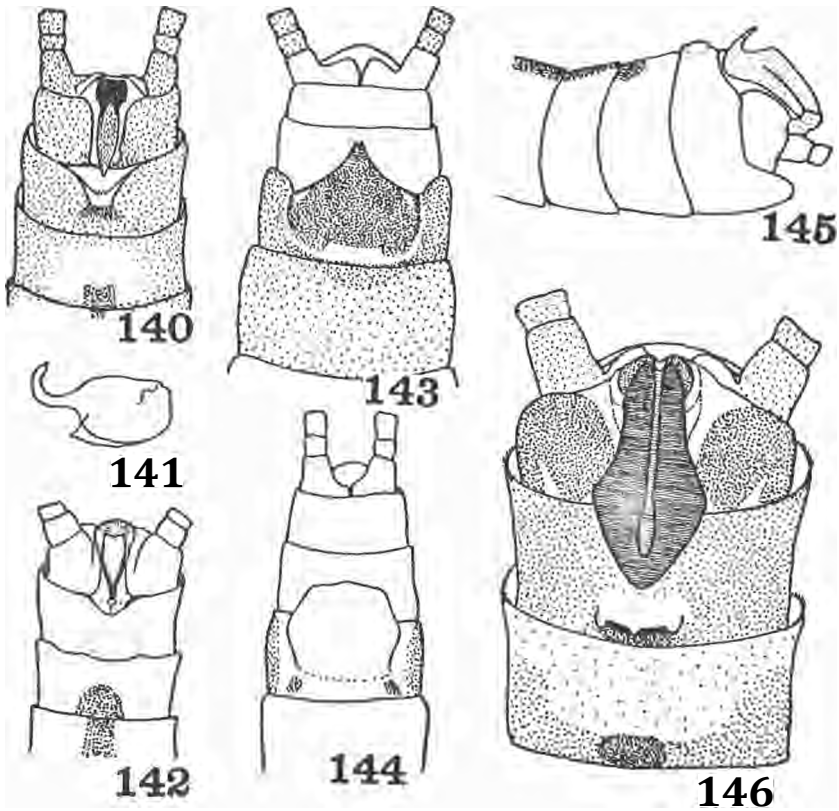
A study of the types of *spatulata* at Cornell shows that Needham and Claassen (1925, p. 106) were mistaken in keying out *spatulata* at couplet 3. The holotype male has a notched tubercle on the 8th tergite, and as it agrees in all other respects, the species becomes a synonym of *pacifica*. In the description of *spatulata* (p. 120) a line of text appears to be misplaced at the point where such a structure would probably have been mentioned.

***Alloperla (Sweltsa) tamalpa* (new species)**

MALE: Length of body, 7 mm.; to tip of wings, 8.5 mm. General color brownish yellow on wings and body. Head yellow, with a dark medial section extending back to the hind ocelli. Pronotum

light brown with darker margin and rugosities, and a very narrow yellow median stripe. Meso- and metanota mostly brown, with dark U-marks. Abdomen with a dark median stripe on segments 1-7 and the front part of 8; lateral stripes on segments 1 and 2.

Tergite 9 with a sclerotized elevated transverse ridge, centrally placed ; sclerotization weak behind it. Tergite 10 depressed medially, the supra-anal process rather short, bluntly pointed (Fig. 140).



- Alloperla mediana.** 141. Supra-anal process, from the side. Little Pigeon River, Tennessee.
- Alloperla tamalpa.** 140. Terminal tergites of holotype ♂. 143. Terminal sternites of allotype ♀.
- Alloperla townesi.** 146. Terminal tergites of holotype ♀. 144. Terminal sternites of allotype ♀.
- Alloperla urticae.** 142. Terminal segments of holotype ♀, from above. 145. The same, from the side, the supra-anal process elevated.

FEMALE: Length of body, 8.5 mm.; to tip of wings, 10.5 mm. Color much as in the male; the median abdominal stripe scarcely extends onto tergite 8. Subgenital plate of the 8th sternite heavily sclerotized, convex ventrally, tapered to a narrow minutely-notched tip; anterior to the plate the segment is membranous, and in front of that again sclerotized (the latter region mostly covered in figure 143).

Holotype ♂, allotype ♀ and 2 ♀ paratypes; Bootjack Camp, Mt. Tamalpais State Park, California, June 25, 1950, W. E. Ricker.

The bronze color of this species contrasts with the lemon yellow of *A. fraterna*, which was taken with it along a tiny creek overlooking the Golden Gate. The subgenital plate of female *tamalpa* is very distinctive; males are structurally somewhat similar to *borealis* or *exquisita*, but the supra-anal process is shorter.

Alloperla (Sweltsa) *townesi* (new species)

MALE: Length of body, 7 mm.; to tip of wings, 9.5 mm. General color yellow. Dark marks are present before the anterior ocellus and behind the compound eyes. The pronotum is completely ringed with black, except at the mid-line, and has the rugosities brownish. Meso- and metanota yellow and brown, with the usual black U-marks. Abdomen brownish yellow; there is a dark dorsal stripe, which is present on segments 1 through the anterior portion of 8; on either side of it, on segment 1, is a white spot.

Ninth sternite produced and truncate. Eighth tergite with the anterior black spot slightly raised and grooved. Ninth tergite with a raised bifid process anteriorly. Supra-anal process large, spatulate, dark chocolate brown, with a median groove extending almost to the tip (Fig. 146); in side view it is club shaped, being produced ventrally on its outer half.

FEMALE: Length of body, 8 mm.; to tip of wings, 10-11 mm. Color as in the male. Subgenital plate moderately produced and nearly straight (Fig. 144), swollen, with long hairs on the posterior third.

Holotype ♂, allotype ♀ and paratype ♀: Dardanelle, California, July 4, 1948, Henry K. Townes. Paratype ♂: Smoky Jack Camp, Yosemite National Park, California, June 22, 1950, W. E. Ricker.

This species is perhaps closest to *coloradensis*, from which male *townesi* differs in lacking a hook at the end of the supra-anal process, and both sexes in having fewer black spots on the head.

Alloperla (*Sweltsa*) *urticae* (new species)

MALE: Length of body, 7.5 mm.; to tip of wings, 10 mm. Color yellow, except for the black rings circling the ocelli, an almost complete black ring circling the pronotum (broken behind), U-marks on mesa- and metanotum, a black spot at the front of the metanotum, and a median black abdominal line terminating on the front half of the 8th tergite.

Supra-anal process deep, flanged for two-thirds of its length posteriorly (Fig. 142), ending with a notch and hook upward (Fig. 145); the tip of the hook with a small transverse expansion. Ninth tergite excavated posteriorly; with a shiny hairless mound on its anterior half, this not excavated along the mid line.

Holotype ♂: Wild Cherry Branch, Smoky Mountain National Park, North Carolina, May 26, 1949, W. E. Ricker.

Paratype ♂: the same, June 8, 1949.

Subgenus *Triznaka* (new)

It is desirable to separate from the subgenus *Sweltsa* of Ricker, 1943, several species which are closer to the subgenera *Suwallia* and *Neaviperla* than to *Sweltsa* or *Alloperla s.s.* The principle feature in which they differ from *Sweltsa* is the supra-anal apparatus. In typical *Sweltsa* or *Alloperla* this consists of a basal body lying in a deep groove of the 10th tergite and attached to its sides, and bearing at its posterior end a terminal portion which is well marked off from the rest of the apparatus, and can be erected by distension of the membranous folds at its base. This condition is not far removed from that of the perlodid ancestors of *Ch2oroperlidae* (Ricker, 1950), except that in them the basal part of the apparatus is attached only at its anterior end and to the distensible membranes. In *Triznaka* the body of the supra-anal apparatus, if it should be recognized at all, is rather short and lies along the surface of and fused to the 10th tergite, usually in a slight depression but never in a deep groove. The tip of the apparatus is directed upward or curved forward, but it has no apparatus of erection. Another

feature in which *Triznaka* resembles *Neaviperla* and some *Suwallia* is the presence of a median dark line inside the U-mark of meso- and metathorax (this is often obscure or absent in *Suwallia*).

SUBGENOTYPE: *Alloperla pintada* new species.

Other species to be included : *A. diversa* Frison, *A. signata* Banks.

The three subgenera *Triznaka*, *Suwallia*, and *Neaviperla* have a supra-anal apparatus of the type found in *Chloroperla* Newman, and most of them agree with that genus also in usually having a median black line inside the U-mark. They differ from *Chloroperla* and resemble *Alloperla* s.s. in having A2 of the forewing forked. It is perhaps open to question whether the difference in venation should carry more weight than the above characters in governing the generic placement of these three subgenera, but on the whole the present arrangement seems best. In any event *Triznaka* makes an excellent ancestral type for *Chloroperla*.

MALES AND FEMALES

- | | | |
|------|---|----------------|
| 1 | Head and pronotum with conspicuous median markings of black on yellow ; a small posterior median lobe on the ♂ 7th sternite | 2 |
| | Head unmarked except for the ocellai rings ; pronotum with dusky lateral margins, otherwise yellow ; no lobe on the 7th sternite | <i>diversa</i> |
| 2(1) | Anterior mark of the head as long as broad, often produced in the mid-line back to the median ocellus ; median pronotal mark broadly T-shaped, little produced laterally rearward ; pronotal rugosities not pigmented or very lightly so | <i>signata</i> |
| | Anterior mark of the head about twice as wide as long, not reaching to the median ocellus ; median pronotal mark narrow, I-shaped, much produced laterally both at the front and the rear (figure 148) ; pronotal rugosities rather heavily pigmented, at least near the mid-line | <i>pintada</i> |

***Alloperla (Triznaka) pintada* (new species)**

MALE: Length of body, 8-9 mm.; to tip of wings, 9.5-10.5 mm. Color yellow with black markings. Head with a black mark some-

what exceeding the ocellar triangle, and a black frontal spot. Pronotum with a dark I-shaped mark, and rugosities brownish to a varying degree (Fig. 148). Mesonotum yellow in front, brown behind, with a dark central line inside the U-mark. Metanotum completely brown dorsally, U-mark similar to the above. Abdominal tergites dark brown with a black central stripe; sides lighter. Pleurites and sternites yellow to brown, patterned more or less distinctly. Ninth tergite elevated and slightly excavated behind. Tenth tergite with a median **sclerotized** strip produced into the erect, forwardly-curved supra-anal process (Fig. 150). Seventh sternite with a small posterior median lobe (Fig. 149).

FEMALE: Length of body, 9-10 mm.; to tip of wings, 10-11 mm. Color similar to the male. Eighth sternite produced as in figure 147.

Holotype male and allotype female: Edloe, Colorado, el. 10,000 ft., July 20, 1938, H. H. and J. A. Ross.

Paratypes: same data as holotype, many ♂ and ♀.

Other material:

COLORADO

Green Mt. Falls. June 14 to July 17, 1938, 12 □ 10 ♀, J. A. Ross.

Grand Lake. July 24, 1938, 1 ♀, H. H. Ross.

Crystola Creek, Crystola. June 27 to July 16, 1938, 9 ♂ many ♀, J. A. Ross.

La Vete Pass. July 21, 1938, ♂, D. J. and J. N. Knull.

Midland, Station 2. August 8, 1943, H. H. and J. A. Ross.

NEW MEXICO

Rito de los Frijoles, Bandelier National Monument. June 12, 1950, 4 ♂ 7 ♀, W. E. Ricker.

Santa Fe. July 11, 2 ♀, D. J. and J. N. Knull.

OREGON

Oak Creek, Corvallis. March 31, 1934, ♂, E. E. Ball.

SOUTH DAKOTA

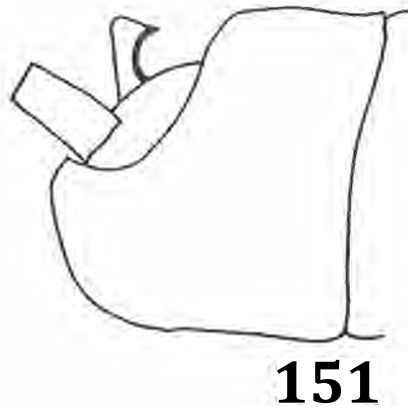
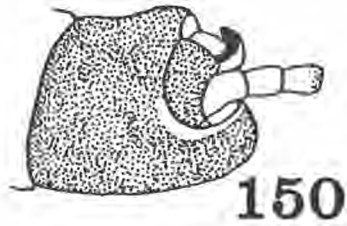
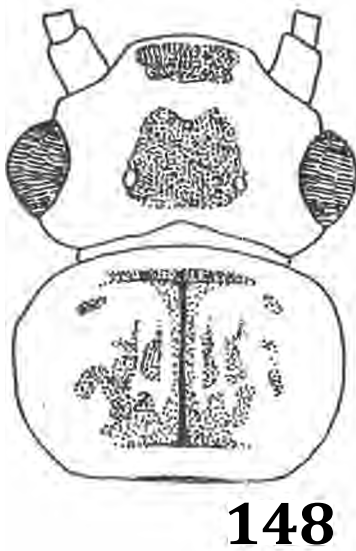
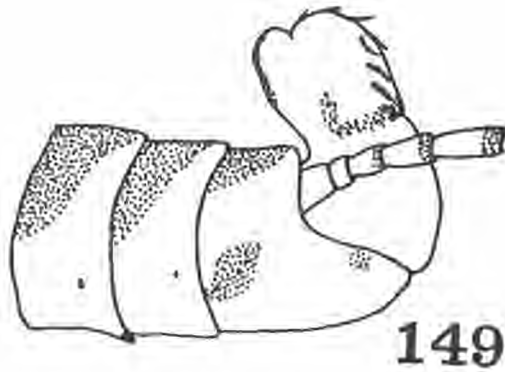
Englewood. June 18, 1925, 2 ♂, H. C. Severin.

Sylvan Lake, Black Hills. June 20, 1940, 2 ♂ 1 ♀, H. H. and J. A. Ross.

WYOMING

Guernsey, N. Platte River. June 20, 1947, 4 ♂ 1 ♀, D. G. Denning.

Pole Mt. near Laramie. June 29, 1947, 3 ♀, D. G. Denning.



A. lopperla pintada. 117. Terminal sternites of allotype 9. 148. Head and pronotum of allotype 9. 150. Terminal segments of holotype, from the side. 149. The same, from a specimen with aedeagus everted. Guernsey, Wyoming.

Hasta perla chilnualna. 151. Terminal segments of holotype, from the side.

The Oregon specimen above has a slightly longer supra-anal process than the Rocky Mountain material, but is not likely to be specifically distinct.

A. pintada is closely allied to *A. signata* Banks, with which it has been confused in the past. Color seems to be the only certain way to distinguish the three species of *Triznaka*, as indicated in the key above. In addition there are average size differences, the order of increasing size being *diversa-signata-pintada*. The collections made to date suggest that *pintada* is a species of smaller or cooler streams, often at high elevations, while *signata* frequents larger and/or warmer rivers.

Genus *Chloroperla* Newman

Subgenus *Rasvena* (new)

It was with considerable surprise that Dr. Frison, several years ago, discovered and described a species of *Chloroperla* in America, *C. terna* (Frison 1942). Associated with European *Chloroperla* on the basis of an unbranched **A2** of the forewing, this species differs from European types in having the anal venation of the hindwing more reduced: there is only one anal vein, it about half as long as the fold of the wing (Frison, p. 338, Fig. 116), whereas *Chloroperla tripunctata* of Europe has three distinct veins, one of them almost as long as the fold. In checking some specimens of *C. terna* recently I discovered in some forewings a small but distinct proximal branch of **A2**; the majority however, seemed to lack it. This might suggest, though it would scarcely prove, that *terna* is more closely allied to our *Alloperlae* of the subgenus *Triznaka* than to any European species of *Chloroperla*. Whether or not this is so, the reduced anal field of the hindwing of *terna* marks it off from close association with any known species of either continent, and this is best recognized by an individual subgeneric designation.

SUBGENOTYPE and only known species: *Chloroperla terna* Frison 1942.

It is appropriate here to point out two apparent errors in Frison's (1942, p. 339) figures. In figure 116, of *Chloroperla terna*, the vein Cu_2 of the forewing is shown as having an origin with A_1 , whereas in the type and all other specimens examined by me Cu_2 curves out from Cu_1 , considerably distad of this point. In figure 115, of *Hastaperla brevis*, an extra vein appears in the

forewing lying distad of the one marked "2A" and proximal of the short curved Cu_1 ; hence it was presumably considered to be A_1 . Actually no vein exists in that position, though the folding of the wing along that line might easily give such an impression to the artist. Thus the vein marked "2A" is really 1A or A_1 , and the one marked "3A" is really A_2 .

Genus *Hastaperla* Ricker
Hastaperla chilnualna (new species)

MALE: Length of body, 5 mm. ; to tip of wings, 6.5 mm. Color yellow, without dark markings. Very similar to the widespread *Hastaperla brevis*, but the anal venation of the hindwing is not quite so reduced: vein A_1 usually terminates slightly distad of the position of the proximal intercubital crossvein, instead of proximal as in *brevis*. However, the anal area apparently does not fold, and A_1 is much shorter than in *Rasviena* or (still more) *Chloroperla* sensu stricto. Vein A_2 of the hindwing present but short. Vein A_2 of the forewing undivided.

The supra-anal process is erect and has a short hook directed forward (Fig. 151).

Holotype ♂ and two ♂ paratypes: Chilnualna River Camp, el. 4,000 feet, Yosemite National Park, California, June 22, 1950, W. E. Ricker.

The hooked supra-anal process best distinguishes this species from *brevis*.

Family Perlidae
Subfamily Perlinae
Genus *Claassenia* Wu
Claassenia sabulosa Banks

1900. *Perla sabulosa* Banks, Trans. Amer. Ent. Soc. 26, p. 242, 9. Type locality: Yakima, Washington.
1916. *Adelungia arctica* Klapálek, Casopis Ceske Spolec. Ent. 13, p. 59, 78. New Synonymy.
1925. *Perla sabulosa* Needham and Claassen, Monogr. Plecop., p. 101; p. 317, fig. 4, wing.
1925. *Perla languida* Needham and Claassen, Monogr. Plecop., p. 100; p. 317, figs. 5, 7, wings; p. 329, figs. 18-20, ♂. New Synonymy.
1931. *Acroneuria depressa* (?) Claassen, Plecop. Nymphs, p. 86; p. 179, fig. 207, nymph. (Not *depressa* Needham and Claassen 1925.)

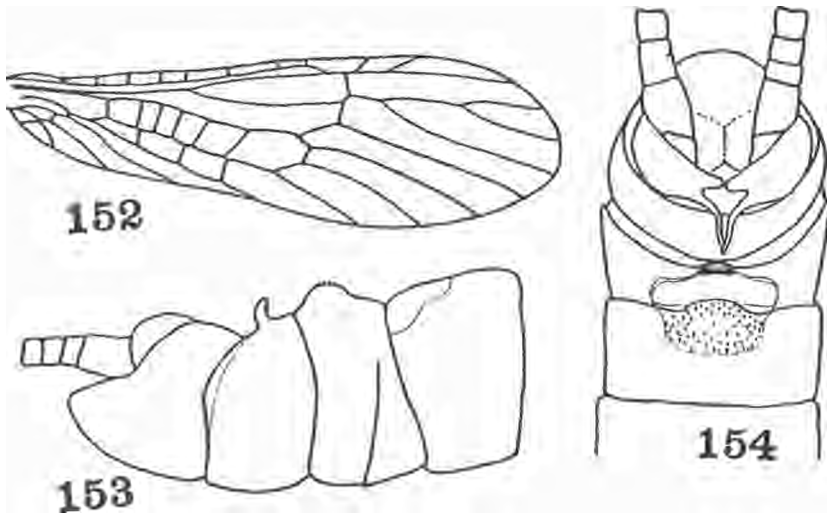
1938. *Claassenia arctica* Ricker, Trans. Roy. Canadian Inst. 22, p. 140; p. 154, figs. 10, 17, ♂ 9.
 1942. *Claassenia arctica* Frison, Bull. Illinois Nat. Hist. Surv. 22, p. 286, figs. 53, 54, nymph.

To the above may be added the fact that a ♀ paratype of *Acroneuria depressa* Needham and Claassen is *sabulosa* Banks. However, the holotype and allotype of *depressa* are a distinct species, not to be included in the synonymy of *sabulosa*, as was done by Frison (1942, p. 285).

DISTRIBUTION: Interior cordilleran region from New Mexico to central British Columbia; northern Manitoba.

Genus **Neoperla** Needham
Neoperla hubbsi (new species)

MALE: Length of body, 8 mm.; to tip of wings, 13 mm. General color yellowish. Medial portion of head brown, except the M-line and an anterior marginal yellow band. Pronotum marked with brown in a broad median band, and also in a narrow marginal ring. Eyes large; posterior ocelli large, close together; anterior ocellus absent. Wings light brown, veins darker, but C, Sc, and the associated crossveins and membrane are yellow. Two crossveins in the costal space, none posterior to it distad of the cord. (Fig. 152).



Neoperla hubbsi. 152. Right forewing. 153. Terminal segments of holotype ♂, from the side. 154. The same, from above.

Abdominal tergites normal through the 6th (Fig. 154). Tergite 7 has a raised spinulose posterior mound, slightly excavated along the mid-line. Tergite 8 is strongly concave posteriorly, and at the mid-line bears a thin erect process (Fig. 153), spinulose on its anterior face, in life apparently applied to the mound on 7. Tergite 9 lacks processes, but is deeply concave behind. Tergite 10 is completely split, the genital hooks developed on the sides of the cleft consisting of a swollen basal body, a short posterior limb and a long slender anterior limb which runs forward to the process of tergite 8.

Holotype ♂ : Kinsley, Kansas, September 23, 1926, no. 869, C. L. Hubbs and L. P. Schultz. In the University of Michigan Museum of Zoology.

The genus *Neoperla* is abundant in the Old World tropics, but we have long been accustomed to recognizing only a single American species, the widely distributed and variable *N. clymene*, which is known from Wisconsin, Ontario, and Nova Scotia south to the states bordering the Gulf of Mexico, and west to Texas, Arkansas, Oklahoma, Kansas, and Iowa. The second American species of the genus, *hubbsi*, is now being described more than a century after *clymene*, and twenty-five years after it was collected by two well-known ichthyologists in the course of a fish-seining expedition on the plains. The new species is not at all closely allied to *clymene*; the latter differs in having a narrow, erect process on the 7th tergite, only a low swelling along the mid-line of the 8th, and the 9th spinulose and produced backward along the mid-line. In fact, both American species have much closer relatives in distant parts of the earth : the African *N. leroiana* seems not greatly unlike *hubbsi*, whereas a species such as *N. formosana* from Formosa has much in common with *clymene*.

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